
National Health
and Nutrition
Examination Survey

MUSCLE
STRENGTH
PROCEDURES
MANUAL



(Revised January 2001)

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OVERVIEW OF MUSCLE STRENGTH COMPONENT

1.1 Muscle Strength/Physical Function

The loss of muscle mass, muscular strength, and power with age has important health and functional consequences. These changes predispose elderly people to falls and functional limitations. Numerous studies suggest that functional limitations are causally linked to disability. In NHANES, an observed timed 20-foot walk will assess functional limitations. Measuring the isokinetic strength of the knee extensors (quadriceps) and flexors (hamstrings) will assess lower body strength. The measured walk and isokinetic strength testing will be completed on Study Participants (SPs) aged 50 and older. A Kin Com MP dynamometer will be used to evaluate the strength of the knee extensors and flexors. We will test the strength of the thigh muscles by measuring peak torque of the quadriceps and hamstrings at one speed (60 degrees/second). The Kin Com dynamometer is capable of testing various speeds in major muscle groups, but 60 degrees per second was chosen for this examination because it is clinically relevant and it is reported in the literature as the optimum speed for measuring muscle strength.

2. EQUIPMENT/SUPPLIES/MATERIALS

2.1 Description of Equipment

2.1.1 Kin Com MP Dynamometer

The dynamometer used in this survey is the Kin Com MP dynamometer manufactured by Chattanooga Group, Inc. in Chattanooga, Tennessee.

2.1.2 Goniometer

A goniometer (instrument used to measure joint angles) will be used to measure the angle of the knee joint when the SP is positioned in the dynamometer chair.

2.1.3 Level

A level will be used to check the vertical and horizontal position of the lever arm during the isokinetic test.

2.1.4 Standard Weights

Four 10-pound weights will be used for the load cell calibration procedure.

2.1.5 Walking Test Track

A measured Walking Test Track had been defined along the corridor of the MEC for the Measured Walk. The track is 20 feet long with a line at 8 feet. Strips on the floor indicate the start, stop, and the 8-foot line for the measured walk.

2.1.6 Stopwatch

A hand held stopwatch will be used for the Measured Walk.

2.1.7 Alignment Rod

A stick will be used to align the SP's knee with the rotational axis of the lever arm.

2.2 Quality Control

2.2.1 Diagnostics (Start of Stand and Daily)

The Diagnostics calibration procedures are completed at the beginning of each stand and prior to the AM session daily. The following procedures will be followed:

1. At the Kin Com Main Menu, select **U for UTILITIES**.
2. Type **Test**.
3. Type **Yes**.
4. Remove the load call and shin pad from the lever arm.
5. Position mechanical stop (C) at 2.
6. Position mechanical stop (D) at 34.
7. Move the level arm to the horizontal position. It should be positioned at the mid-range of motion.
8. Set the dynamometer tilt (A) to 90.
9. Get the Patient Abort Switch from the dynamometer unit stand. You will be prompted to press the Patient Abort switch later in the diagnostic calibration procedure. If you wait to get the Patient Abort switch until later, you will need to reach under the lever arm while it is moving.
10. Stand clear of the lever arm during the entire Diagnostics Program.
11. Press **1** for Diagnostic Check.
12. Press **1** for Velocity/Range of Motion.

Initial Status is Highlighted

- Confirm that the mechanical stops are positioned for the maximum Range of Motion (ROM). C should be at **2** and D should be at **34**.
- Confirm the lever arm is positioned at the mid-range of motion.
- Press **Enter** to begin the diagnostic check.

NOTE: You can press Esc to abort this program at any time.

- Follow the instructions on the Kin Com screen.
- As the diagnostics program proceeds, you will see the following messages on the screen indicating what is being tested:
 - Please wait
 - Test 1
 - Checking velocity for up to 4 seconds
 - Waiting 4 seconds
 - Checking velocity for up to 4 seconds
 - Please press **patient abort switch**
 - Checking velocity for up to 4 seconds
 - Testing for proper arm movement
 - Checking ROM: Please Wait
- The machine will perform a soft start to determine the set range of motion before doing the ROM test. The lever arm will move back and forth through the range of motion several times at slow and fast speeds. Stand clear of the lever arm during the Diagnostic calibration check.

- When the Diagnostics Program is complete you will see the following message:

Diagnostic Program Complete

- Press **Esc** twice to return to the Main Menu for the Kin Com Service Program.
- Press **2** for Calibration on the Kin Com Service Program Main Menu to do the Load Cell calibration.

If there is a problem with diagnostics, contact the MEC manager. The MEC manager will need to contact Kin Com for technical help with this type of problem.

If not proceeding with the Load Cell calibration, press **Esc** after the Kin Com Service Program. This will return you to the Kin Com Main Menu.

2.2.2 Load Cell

The Load Cell calibration is done at the beginning of every stand and at the start of the AM session every day. The Load Cell calibration should be completed after the Diagnostics Program using the following procedures.

- Set the dynamometer tilt (A) to **0**.
- Remove the shin pad from the load cell, and then attach the load cell to the lever arm.
- Move the load cell down so the bottom of the load cell is flush with the end of the lever arm.
- Move the load cell to a vertical position. Check the position with the level.
- Select **3** for Load Cell at the next Service Program menu.
- The Load Cell calibration screen will appear. A green box in the center of the screen will display the force.
- The force should read zero (± 0).
- If the force reading is not zero (± 0), adjust Pot 8 (blue marker) on the back of the computer until the force reads zero (± 0). Turn the screw clockwise to decrease the force, counterclockwise to increase the force.

If the force reading is greater than + 2 or less than -2, you must indicate the original value and the corrected value in the Comment area of the ISIS Quality Control screen. For

example, in Figure 2-1, the comment '-15 to 0 LC' means the initial load cell (LC) force reading was -15 and it was adjusted to 0.

- Bring the lever arm to a horizontal position. Use the level to make sure it is horizontal.
- Brace the lever arm with the wooden support bar.
- Put the calibration weight holder in the attachment hole at the end of the lever arm.

Exhibit 2-1. Daily QC

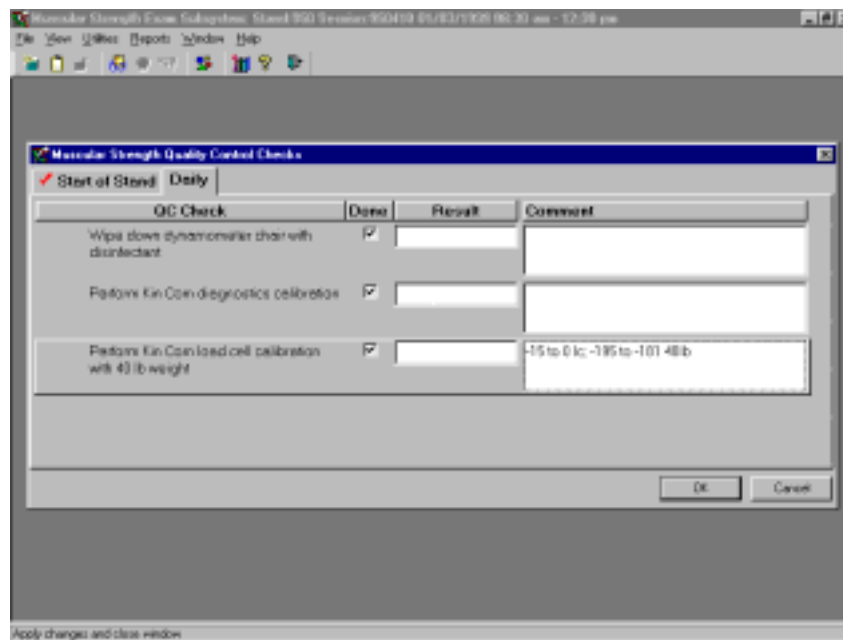
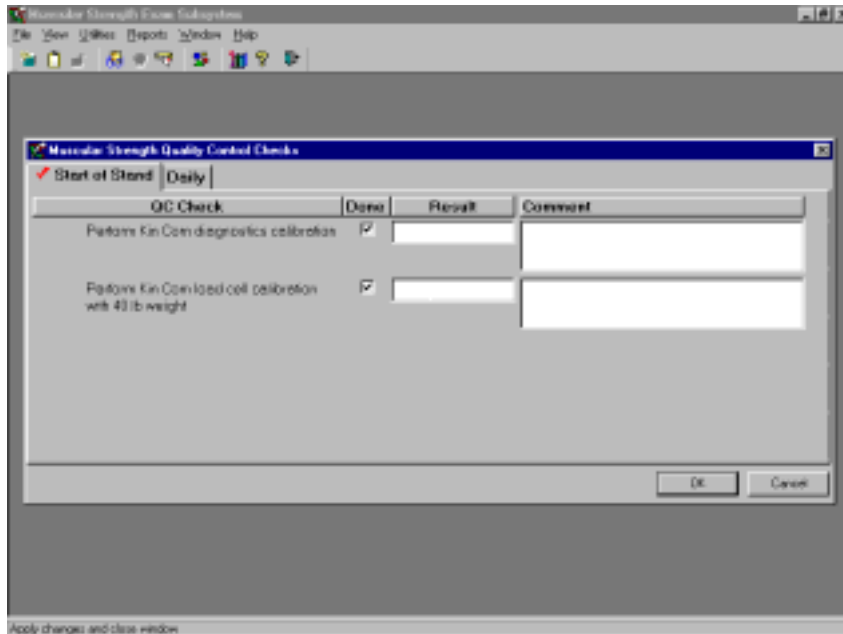


Exhibit 2-2. Start of stand QC



- Four 10-pound weights will be used for the load cell calibration. The weights will be referred to as 10-pound weights, although the actual weight varies slightly. Each of the weights will have the precise weight (in Kg) noted on the plate. The acceptable range to use for the load call calibration is listed on Table 2-1. Please note that the acceptable weight range is in Newtons and is different for each MEC.

Table 2-1. Weight range to use for load cell calibration by MEC

MEC 1	MEC 2	MEC 3
±179-181 Newton	±177-179 Newton	±177-179 Newton

- Place the weights on the bar.
 1. Use all four 10-pound weights for the Load Cell calibration.
 2. If the force is not within the appropriate range for the MEC you are on from Table 2-1, then adjust Pot 7 (red marker) to a force that is within the range.

NOTE: If the force reading is greater than +4 Newtons or less than –4 Newtons out of the appropriate range for the MEC, indicate the value in the Comment area of the ISIS quality control screen and record the value that it was corrected to. For example, in Exhibit 2-1, the comment '-195 to –181 40 lb.' means the initial 40 lb. force reading was –195 and it was adjusted to –181.

- Remove the weights, the bar, and the wooden brace bar.
- Attach the shin pad to the end of the lever arm.
- Move the dynamometer to the initial settings for right side testing.
- Press **Esc** three times to return to the Kin Com Main Menu.

2.2.3 Clean Dynamometer Chair

The dynamometer chair is to be wiped with disinfectant at the start of the AM session every day. This is to be documented in the ISIS QC screen with a check. If there is a problem, it is to be documented in the Comment field. The chair should also be wiped with disinfectant as needed during a session.

2.3 Documentation of Quality Control

Quality control is documented in the ISIS system. After completing the quality control procedures, complete the following steps:

- Go to **UTILITIES** on the ISIS screen.
- Click on **Quality Control**.
- Check either **Start of Stand** or **Daily**.
- Check the boxes for each item listed. If there is a problem or something to be noted, add it to the Comment field.

- The Comment field is to be used when the force is greater than ± 2 out of range for the load cell or ± 4 for the 40 lb. weight.
- When the documentation is complete, press **OK** to exit.

The quality control information entered on the MEC then becomes available for review by Westat and NCHS staff with access to ISIS Quality Control.

2.4 Maintenance and Equipment Repair

Problems with the Load Cell calibration can be corrected by adjusting Pot 7 and Pot 8 as directed above. If problems occur during the Diagnostics calibration, or if other problems occur with the functioning of the dynamometer, the MEC manager is to be notified. The MEC manager may then call the Technical Support Group for the Kin Com at Chattanooga Group, Inc. (800-592-7329 or 800-494-3398).

Problems with the ISIS system or transfer of data to ISIS should be reported to the Data Manager immediately.

2.5 Dynamometer Set-up

The dynamometer will be set up for right sided testing only. The following procedures document how to set up the dynamometer:

- Go to the Kin Com **Main Menu**.
- Press **P** for Patient Position on the **Main Menu**.
- Press **A** for Patient Position on **Patient Positioning** screen.
- Use the up/down arrows to select **NHANES MUSCLE STRENGTH**.
- Press **Enter**.
- The screen will specify right knee EXT/FLEX.
- Press **ENTER**.
- Follow the on-screen directions to position the unit in the standard preset position for knee extension.

The preset positions for the right side are as follows:

- Manually move the dynamometer to **78 CM**.
- Move the dynamometer height to **11 cm**.
- Set the dynamometer tilt (A) to **0 degrees (move up and over)**.
- Set the dynamometer rotation (B) to **30 degrees**.
- Set mechanical stop (C) to **8**.
- Move the lever arm counterclockwise.
- Set mechanical stop (D) to **21**.
- Manually move the seat to **48 cm**.
- Set the seat rotation (E) to **30 degrees**.
- Set the seat back angle (F) to **78 degrees**.
- Set seat bottom depth (G) to **18 cm**.
- Set the seat bottom angle (H) to **15 degrees**.
- Manually move the dynamometer to **69 cm**.
- Press any key to continue.
- Press **Esc** three times.

NOTE: If you press F10 to accept be sure you do not overwrite settings.

3. PROTOCOL

The Muscle Strength component consists of two physical function evaluations, a timed Measured Walk and Isokinetic Testing. This chapter will review the procedures for completing both of these sections. This component is to be completed by all SPs age 50 and older.

3.1 Pre-examination Procedures

1. Introduce yourself to the SP.
2. Give a brief introduction to the component.

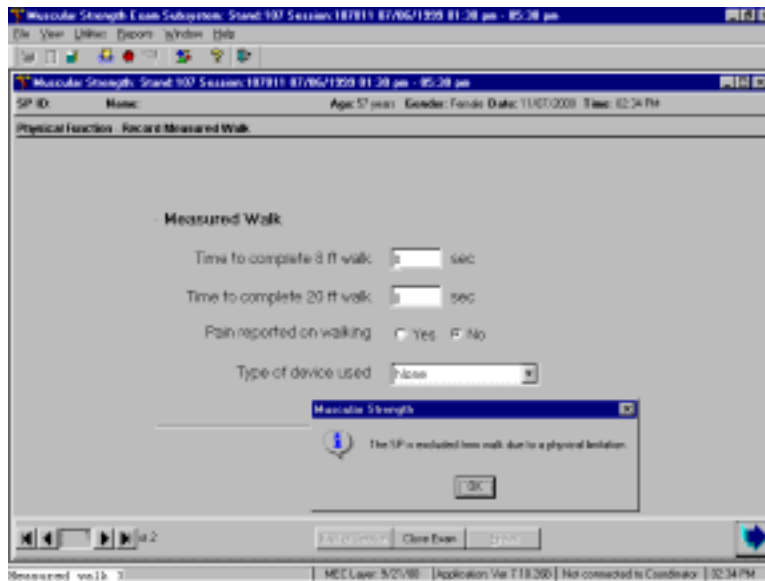
SCRIPT: In this room we are going to ask you to do two tests to see how well you are able to carry out daily activities. These tests are a short walk and a test to measure the strength of your leg muscles.

3. Wand the SP into the ISIS system.

3.2 Measured Walk

3.2.1 Procedures

1. Observe the SP to see if he/she is able to walk without assistance. If the SP requires assistance, ask if he/she is able to walk alone without holding onto another person. They may use a walker or cane. If the SP is unable to walk without the assistance of another person, the Measured Walk will not be completed. This will be recorded in ISIS as 0 seconds in both time fields of the Measured Walk screen. The system will then display a pop-up message saying:



Press **OK** to continue. Then press the arrow, which will take you to the component status screen. The component status will default to:

Status Not Done
Comment: Physical Limitation

Proceed with the Isokinetic Testing portion of the examination.

2. If the SP is able to walk without assistance from another person, proceed with the Measured Walk. The walk will be timed using a hand-held stopwatch. Start, split, and stop times are defined below.

START TIME: When the SP's first foot touches the floor across the start line.

SPLIT TIME: When the SP's foot touches the floor across the 8-foot line.

STOP TIME: When the SP's foot touches the floor across the finish line.

3. Explain the Measured Walk to the SP.

SCRIPT: I am going to time you as you walk along the corridor. Please begin with your toes behind this line. Walk at your usual pace. I will tell you when to start and stop. Please do not stop until I tell you to stop. This will be at the bench at the end of the hallway.

Are you ready? OK, Begin.....Stop.

4. Use a hand-held stopwatch to record the time.
5. Start the timer when the SP's first foot touches the floor across the start line.
6. Press the split button when the SP's foot touches the floor across the 8-foot line.

7. Stop the watch when the SP's foot touches the floor across the finish line.
8. If the test needs to be repeated, you will need to bring the SP back to the original start line. Do not time the SP on the return; you will not be able to get the 8-foot time.
9. If the SP mentions having pain during the Measured Walk, this should be recorded in the ISIS system. Do not ask if they experienced pain during the walk.
10. If the SP uses the MEC wall for assistance, have them repeat the walk asking them not to use the wall. If they use the wall the second time, record the device as "wall/other."

The screenshot shows the ISIS software interface for recording a Measured Walk test. The window title is "Muscular Strength Exam Subsystem: Stand 107 Session 187811 8/26/2008 01:38 pm - 05:38 pm". The interface includes a menu bar (File, View, Utilities, Reports, Windows, Help) and a toolbar. Below the menu bar, there is a header section with the following information: "Muscular Strength: Stand 107 Session 187811 8/26/2008 01:38 pm - 05:38 pm", "SP ID: Male", "Age: 57 years", "Gender: Female", "Date: 1/01/2008", and "Time: 02:04 PM". The main content area is titled "Physical Function - Record Measured Walk" and contains the following fields and controls:

- Measured Walk:** A section header.
- Time to complete 8 ft walk:** A text input field followed by "sec".
- Time to complete 20 ft walk:** A text input field followed by "sec".
- Pain reported on walking:** Radio buttons for "Yes" and "No".
- Type of device used:** A dropdown menu with the following options: "Wall/Other Device", "None", "Cane", "Walker", and "Wall/Other Device". The "Wall/Other Device" option is currently selected.

At the bottom of the window, there is a status bar with the following information: "V6.1.1", "MCT Layer: 5/21/08", "Application Ver: 1.18.200", "Not connected to Coordinator", and "12:30 PM".

3.2.2 Documentation of Measured Walk in ISIS System

The Measured Walk portion of the examination requires completion of four data fields.

Muscular Strength Exam Subsystem: Stand 107 Session 187811 8/7/06/1359 81.28 am - 85.28 pm

File View Utilities Diagram Window Help

Muscular Strength Exam Subsystem: Stand 107 Session 187811 8/7/06/1359 81.28 am - 85.28 pm

SP ID: Name: Age: 57 years Gender: Female Date: 11/01/2005 Time: 02:34 PM

Physical Function: Record Measured Walk

Measured Walk

Time to complete 8 ft walk: sec

Time to complete 20 ft walk: sec

Pain reported on walking: Yes No

Type of device used:

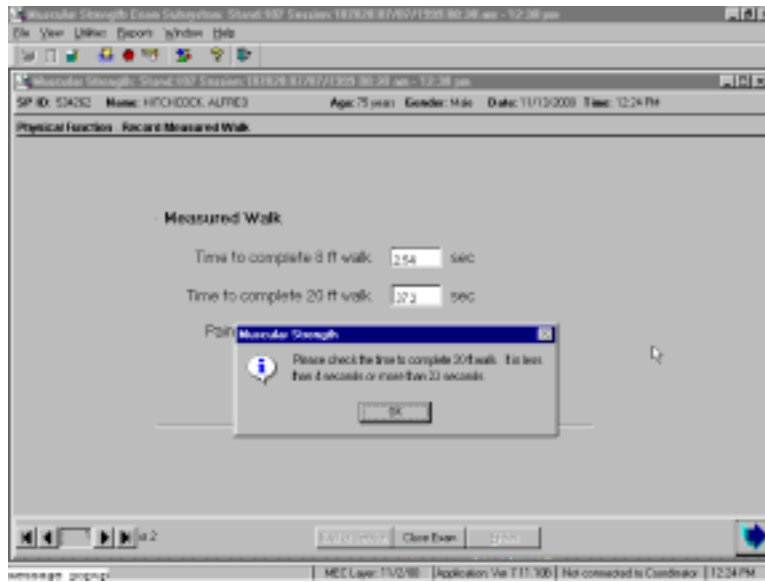
Measured walk: 2 | MEC Layer: 3/2/06 | Application Ver: 1.18.200 | Not connected to Coordinator | 12:34 PM

1. Time to complete the 8-foot walk: enter the time in seconds to the 100th place (i.e., 3.56).
2. Time to complete the 20-foot walk: enter the time in seconds to the 100th place (i.e. 5.04).
3. Pain reported on walking: this field defaults to **No**; if the SP reports pain, change the response to **Yes**.
4. Type of device used: The default is **NONE**. If the SP used a device, change the response. The ISIS system displays a drop down menu with the following options:

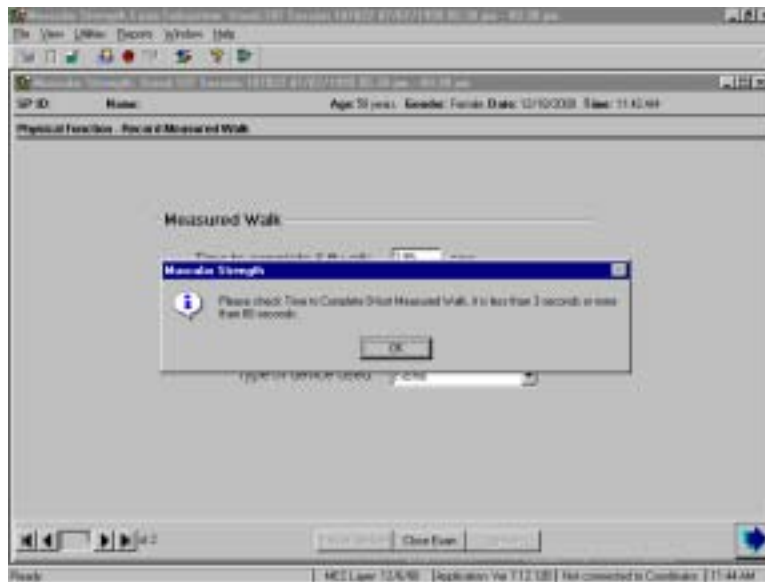
Cane
Walker
Wall/Other

5. Press the advance arrow to move to the Measured Walk status screen.

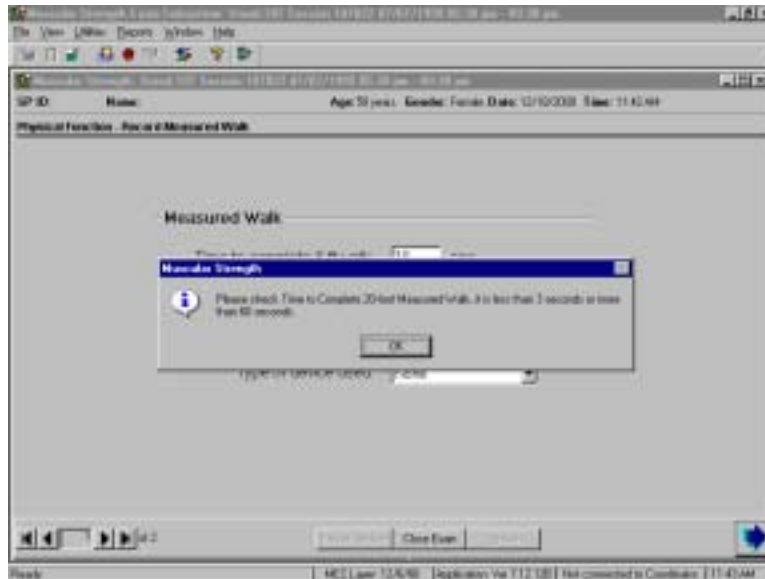
6. If the 20-foot walk time is less than the 8-foot walk time the following message will appear:



7. If the 8-foot walk time is more than 60 seconds or less than 3 seconds (other than 0), the following message will appear:



8. If the 20-foot walk time is more than 60 seconds or less than 4 seconds (other than 0), the following message will appear:

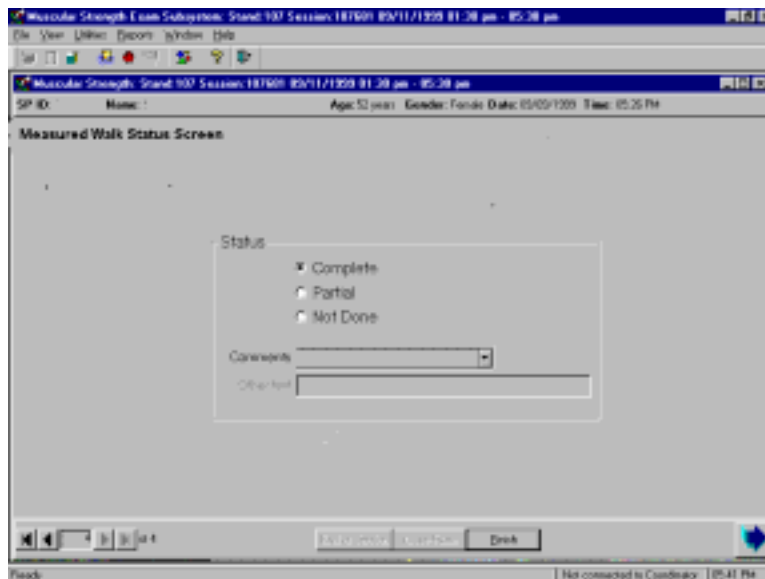


9. If you put a 0 in the timed walk fields, the status screen will say the following:

Status: Not Done
Comment: Physical Limitation

10. If you put a time in the timed walk field, the status screen will say the following:

Status: Complete



11. Press the arrow button to advance to the Safety and Exclusion questions for Isokinetic Testing.

3.3 Isokinetic Testing

3.3.1 Shared Exclusion Questions

Shared exclusion questions are safety and exclusion questions that exclude SPs from several components. These questions may be asked in the household interview. If the SP is not excluded on this question, the response to the question will be displayed and the field will be disabled.

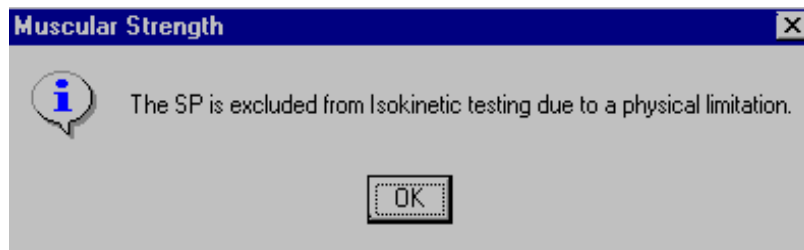
There is one shared exclusion question for the Isokinetic Testing section. If the shared exclusion question was not answered in the household interview, the field will be enabled and the question should be asked prior to doing the Isokinetic Testing. The question will be the first field on the ISIS screen and is as follows:

1. **Do you have any amputations of your legs and feet other than toes?**

If yes, ask, the following:

On which leg do you have the amputation?

If the amputation is on the right side or both sides, the SP is excluded from the Isokinetic Testing, and the following message appears:



2. You will need to press **OK** to continue.
3. Press the advance arrow. Do **not** press the Close Exam button.
4. The ISIS system will display the Component Status Screen. The status will default to:
Status: Not Done
Comments: Physical Limitation
5. If the answer to the shared exclusion question is no, or only the left leg is affected, continue with the exam.

3.3.2 Exclusion Questions

There are a number of safety questions that need to be asked prior to doing the Isokinetic Testing. First, give a brief introduction to the test. The following suggested script should be used:

“I would like you to sit up on this chair.

We are going to do a test where you push out and pull back against this pad. This will measure the strength of your leg muscles. When I tell you to go, I want you to push out and pull back as far as you can go – like this (Technician will demonstrate).

First, I am going to ask you some questions.”

Muscular Strength Exam Software: Stand 107 Session 187622 8/16/2009 9:28 pm - 9:28 pm

File View Utilities Devices System Help

Muscular Strength Exam Software: Stand 107 Session 187622 8/16/2009 9:28 pm - 9:28 pm

SP-ID: Name: Age: 51 years Gender: Female Form Date: 12/10/08 Size: 11.42 MB

Safety and Exclusion Questions

Is it difficult for the SP to get on the dynamometer chair with minimal or no assistance?

Shared Exclusion Questions

Do you have any amputations of your legs and feet other than toes?

Do you have severe neck or back pain today?

Do you feel you could complete the exam if instructed to do so?

Is it difficult for you to either bend or straighten your knees fully for any reason?

Do you have any knee or hip pain?

Do you have any condition complete the exam?

Have you had a myocardial infarction (or heart attack) within the past six weeks?

Has a doctor ever told you that you had an aneurysm in the brain or have had a stroke?

In the past three weeks have you had any surgery on your chest or abdomen?

Have you had knee replacement or hip replacement where all or part of your joint was replaced?

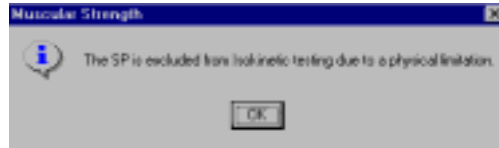
Do you have any other conditions that you think are relevant?

Previous Question Next Question Close Exam

Ready | MSN Live 12/6/08 | Application Ver 11.2.1.0 | Not connected to Controller | 11:45 AM

1. Is it difficult for the SP to get on the dynamometer chair with minimal or no assistance?

- If the answer is **No** (the default), proceed with the safety and exclusion questions.
- If the answer is **Yes**, the SP is excluded from the Isokinetic Testing. Select **Yes** on the ISIS screen.
 - The system will gray out the remaining fields on the screen.
 - The system will display the following message:



- Press OK and then press the advance button. The system will go to the component status screen. The screen will display the following:

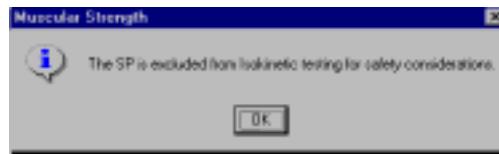
Status: Not Done
Comment: Physical Limitation

2. Do you have severe neck or back pain today?

- If **No**, proceed with next question.
- If **Yes**, ask the following question:

2a. Do you feel you could complete the exam I described to you?

- If **Yes**, proceed with the next question.
- If **No**, the SP is excluded from the examination. The ISIS system will gray out all remaining questions and display a message that says:



- Press **OK** and then press the **advance button**. The system will go to the component status screen. The screen will display the following:

Status: Not Done
Comment: Safety Exclusion

3. Is it difficult for you to either bend or straighten your knee fully for any reason?

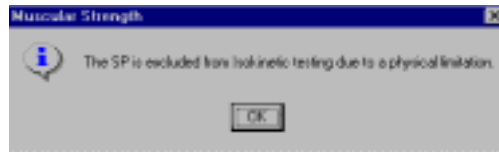
- If **No**, proceed with question 4.
- If **Yes**, ask the following question:

3b. On which knee do you have this problem?

- If the left knee, proceed with question 4.
- If the right knee or both knees, ask the following question:

3c. Do you feel you could complete the exam I described to you?

- If **Yes**, go to the next question.
- If **No**, the system will gray out the rest of the questions and display the following message:

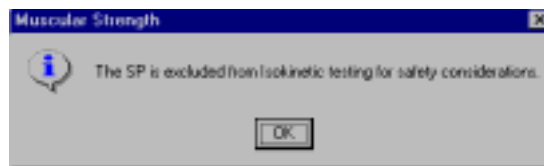


- Press **OK** and then press the advance button. The system will go to the component status screen. The screen will display the following:

Status: Not Done
Comment: Physical Limitation

4. Have you had a myocardial infarction (or heart attack) within the past 6 weeks?

- If **No**, proceed with the next question.
- If **Yes**, exclude from Isokinetic Testing. The system will gray out the remaining questions and display the message:

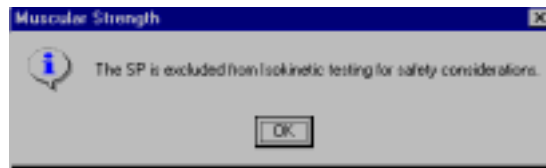


- Press **OK** and then press the advance button. The system will go to the component status screen. The screen will display the following:

Status: Not Done
Comment: Safety Exclusion

5. **Has a doctor ever told you that you had an aneurysm in the brain or have had a stroke?**

- If **No**, proceed with the next question.
- If **Yes**, exclude from Isokinetic Testing. The system will gray out the remaining questions and display the message:

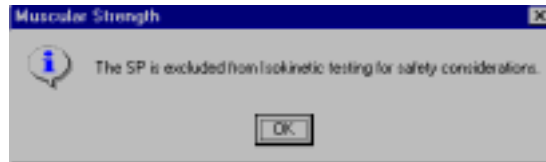


- Press **OK** and then press the advance button. The system will go to the component status screen. The screen will display the following:

Status: Not Done
Comment: Safety Exclusion

6. **In the past 3 weeks have you had any surgery on your chest or abdomen?**

- If **No**, proceed with the next question.
- If **Yes**, exclude from Isokinetic Testing. The system will gray out the remaining questions and display the message:



- Press **OK** and then press the advance button. The system will go to the component status screen. The screen will display the following:

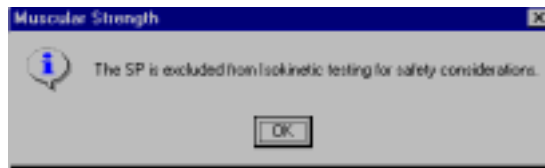
Status: Not Done
Comment: Safety Exclusion

7. **Have you had knee replacement or hip replacement where all or part of your joint was replaced?**

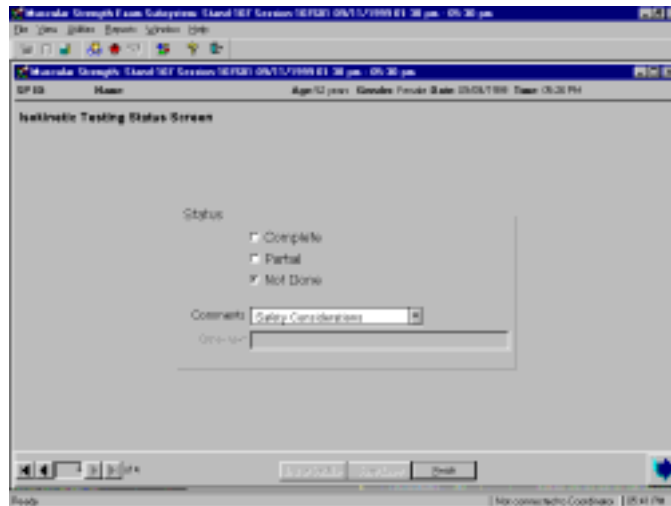
- If **No**, proceed with the Isokinetic Testing.
- If **Yes**, ask the following:

7a. **On which side did you have the surgery?**

- If the surgery was on the left side, proceed with the Isokinetic Testing.
- If the surgery was on the right side, or both sides, exclude from Isokinetic Testing. The system display the following message:



- Press **OK** and then press the advance button. The system will go to the component status screen. The screen will display the following:



3.3.3 Isokinetic Testing Procedures

3.3.3.1 SP Preparation

Once all safety and exclusion questions have been completed, make sure the SP is sitting in the chair with their back supported. Proceed with the rest of the introduction. The following is a suggested script:

I'm going to attach these straps to help stabilize you in the chair. The straps will feel quite snug but they should not be uncomfortable or make it difficult for you to breathe."

(TIGHTEN THIGH STRAP)

"We will do a total of 6 tests but we will only do one at a time. Please keep your hands in your lap during testing.

If you experience any pain, tell me and we will stop."

1. Attach the stabilizing strap across the pelvis. You must walk around the chair to attach the straps. Do not reach over the SP.
2. Attach the two stabilizing straps across the chest. The thigh strap and shin pad will be attached after setting up the examination session.

3.3.3.2 Start Session

The following procedures need to be followed exactly in order to set up the Kin Com session. The computer has been set up with Touch Screens, so you can either use the keyboard or touch the appropriate place on the computer monitor to proceed. The directions in the manual use the keyboard.

1. Press **Enter** on the Kin Com main menu.



2. Press **E** for Evaluation to access the evaluation program.



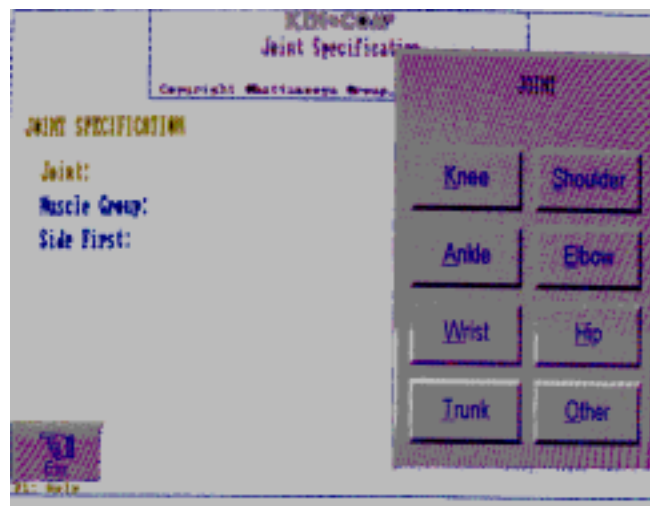
3. The **Select Patient** screen appears. Press **F2** to enter the SP ID (still on the **Select Patient** screen).



4. Type the SP ID Number in the **Last Name** field.

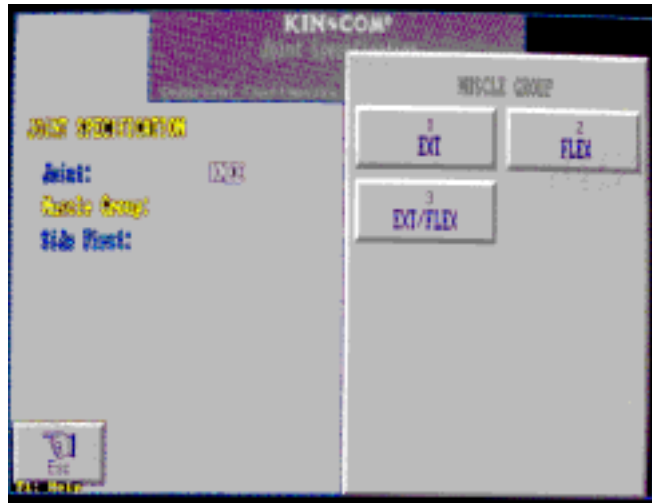


5. Press **Enter** to move through all fields on the screen until you get to the last field.
6. Press **Enter** to go to the **Joint Specification** screen.

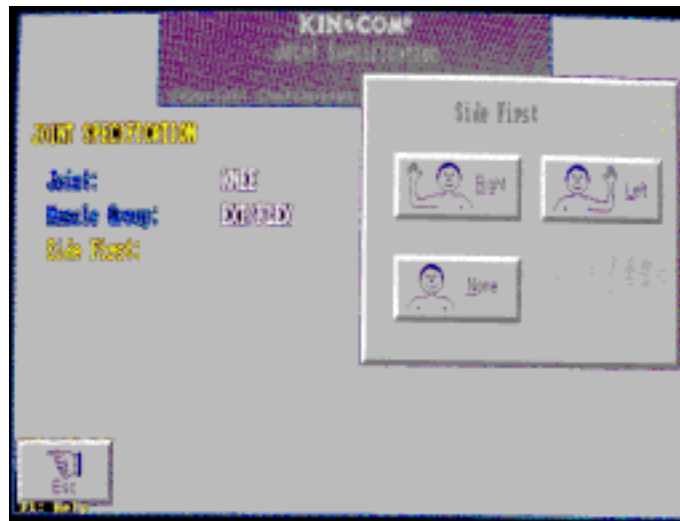


7. Press **K** for **Knee** on the **Joint Specification** screen.

8. Press **3** for **Extension/Flexion**.



9. Press **R** for **Right** to test the right side.

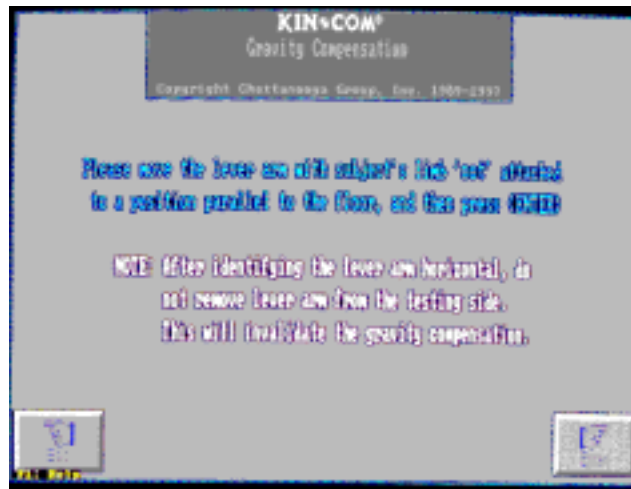


10. Press **G** to turn on the **Gravity Compensation**. This will account for the weight of the pad. The weight of the leg will be taken into account later. After turning the gravity compensation on, you will see a button at the bottom of the screen that says **“TURN OFF GRAVITY COMPENSATION.”** Verify this is at the bottom of the screen.



11. Move the lever arm to the horizontal position by pulling on the shin pad.
12. The shin pad should **not** be attached to the SP's leg yet.
13. Using the **level**, make sure the lever arm is horizontal.

14. Press **Enter**.



15. The **Joint Specification Screen** appears. Check again to make sure “**TURN OFF (not on) GRAVITY COMPENSATION**” is at the bottom of the screen. Press **ENTER** to proceed.



16. Press **I** for **Isokinetic**.



17. Press **C** for **Continuous**.



18. The **Lever Arm Length Screen** will appear.



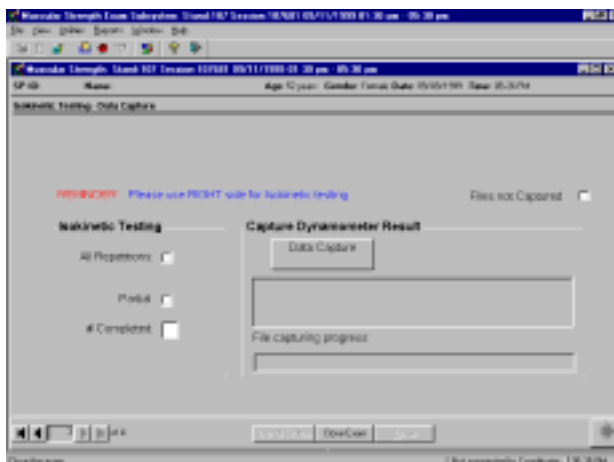
19. Attach the stabilizing strap to the right thigh (above the knee). Attach this very loosely at this time. It will be tightened after the gravity compensation adjustment is complete.

20. Make the following adjustments, so the SP can be taken passively through the range of motion without the shin pad moving up and down the shin:

- A. Align the lateral femoral epicondyle of the SP's knee joint with the rotational axis of the lever arm on the dynamometer (bolt). Use the alignment marker (stick) to make necessary adjustments

NOTE: If the SP has very long limbs, it may be impossible to align the knee. The maximum amount the knee joint may be off is 1-½ inches. Do not complete the examination if the knee joint alignment is off by more than 1-½ inches. When this occurs, proceed to the ISIS screen and do the following:

- a. Check the **FILES NOT CAPTURED** box.
- b. Press the forward arrow and proceed to the **Status Screen**.



- c. The exam will be coded as follows:

Status: Not Done
Comment: Safety Exclusion

- B. Move the dynamometer head up or down by pressing the up/down switch on the Kin Com monitor stand.

- C. Move the dynamometer head in or out from the knee by using the foot pedal to unlock the dynamometer and pushing it in or out on the track. Be sure to lock the dynamometer into place when you are finished with the positioning.

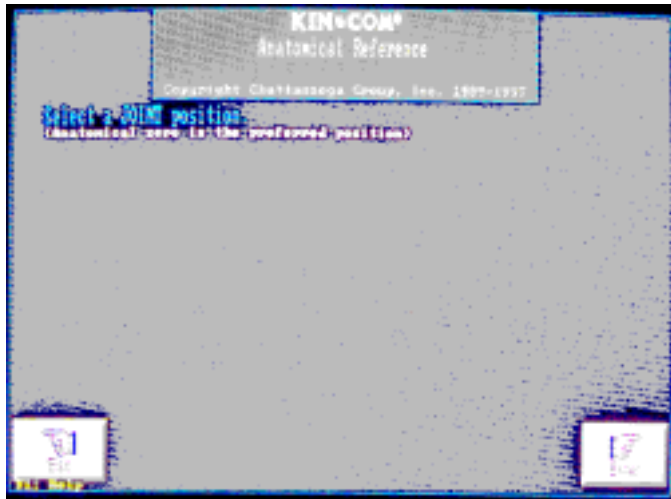
NOTE: If the SP is very tall or very short you may need to slide the seat bottom depth backward or forward to allow the knee to bend. For a tall SP, if you can get two fingers between the edge of the seat and the back of the SP's knee, adjust the seat from 18 to 21. For a short SP, if the back of the SP's knee is on the seat (more than a 90° angle), adjust the seat from 18 to a lower depth. **If you move the seat bottom depth, return it to 18 after the exam.**

- D. Place the shin pad at the end of the lever arm, approximately two finger widths above the SP's malleolus (bony protuberance of the ankle).
- E. Attach the SP's leg to the pad on the lever arm with the shin pad in front and Velcro wrapped around the back of the leg.
- F. Tighten the shin pad at this time. Check the position by placing your right hand in back of the SP's leg, and your left hand in front of the SP's leg, then pull forward and push backward. The SP's leg should not slide within the shin pad.
- G. Check the lever arm length. This is the distance from the axis of rotation to the pin on the pad near the end of the load cell. Read the number from the round shin pad attachment piece. Round up if located between two numbers. For example, if located between 30 and 31, enter 31. If the lever arm length is greater than 39, use the goniometer to measure the additional centimeters.

21. Type the **lever arm length** on the numeric pad of the computer. If you mistype, hit **C** for **Clear** and retype the correct number.



22. Press **Enter** to get to the **Anatomical Reference** screen.



3.3.3.3 Anatomical Reference

The computer joint angle is adjusted to the anatomical angle by referencing the machine at a specific degree when the SP's knee is at approximately a 90° angle. The actual joint angle will be measured with a goniometer.

1. At the **Anatomical Reference** screen, press **Enter**. This takes you to the **Actual Joint Angle** screen.



2. Select the **joint position**.
 - Push the shin pad to move the lever arm all the way back – as far as it will go. Then pull on the shin pad to move the lever arm forward to a vertical position of 90 degrees.
 - Check the angle of the SP's knee joint with the goniometer set at 90 degrees.
 - Line the goniometer up with the lateral femoral epicondyle of the knee. Hold the lower portion of the goniometer parallel to the front of the shin and the upper portion of the goniometer in line with the greater trochanter.
 - Make sure the goniometer and the SP's knee joint are both at 90° angles.
 - If an SP is obese, you may not be able to get the joint to 90°. If this is the case, use the actual angle. The angle used should never be less than 90°, but could be more.
3. Type **90** (or the actual angle) for the measured **Actual joint angle**. If you mistype the joint angle, hit **C** for **Clear** and retype the value.

4. Press **Enter**.



- Move the joint angle positive by pulling the **shin pad** forward. This moves the knee towards extension.

5. Press **Enter** to record the direction as positive.



The anatomical reference is now set.

NOTE: If extending the knee direction is recorded as **NEGATIVE**, you must **Esc** out of the screen, go back to the Main Menu, and begin the complete set-up again.

This time, type in the SP ID in the Last Name field as before, but add a seventh character 'X' to the end of the SP number.

6. Press **Enter** to advance to the **Gravity Compensation** screen.

3.3.3.4 Gravity Compensation

To correct for gravity, the SP's limb is weighed at approximately 150 degrees. If the gravity compensation screen does not come up, you must go back to the beginning and set up again. **The gravity compensation is needed for data quality.**

1. Pull the shin pad to move the lever arm to 150 degrees.
2. Press **Enter**.
3. Ask the SP to **relax the limb**. Check to make sure the limb is relaxed.
4. Hold the lever arm.
5. When the weight reading stabilizes on the computer screen, press **Enter**.
6. The measured limb weight will be displayed.
7. When you are sure the SP has relaxed the limb, press **Enter**.

Gravity compensation is complete.

8. Press **Enter** and the **Range of Motion** screen will appear.

3.3.3.5 Set the Stop and Start Angles

1. Set the Stop Angle
 - Confirm the lever arm is at 150 degrees.
 - Press **Enter**.



The Stop Angle is recorded

2. Set the Start Angle
 - Grasp the shin pad and move it to 90 degrees.
 - Press **Enter**.



The Start angle is now set.

3. Tighten the strap on the thigh.
4. Check to make sure all straps are snug.
5. Remind the SP to keep their hands in their lap.

3.3.4 Demonstration and Practice Tests (Tests 1, 2, and 3)

Before starting the practice tests, tell the SP:

STANDARD SCRIPT: We are going to do a test where you push out and pull back against this pad. This will measure the strength of your leg muscles. We will do a total of six tests, but we will only do one test at a time. If you experience any pain, tell me and we will stop.

If the machine locks up during any of the tests, the SP probably did not push out to the full range of motion before pulling back. Try to have the SP continue the pushing motion. If they cannot, press **Enter** to Stop the test. Press **No**, to delete the curve. Explain to the SP that they must push all the way out before pulling back. Press **Enter** again to repeat the test. You should still complete (save) 6 tests.

If the lever arm moves up or down in a ratcheting motion the SP is probably not pushing or pulling with enough force. Ask the SP to push harder. If the lever arm continues to move up and down in

a ratcheting motion, press **Enter** to Stop the Test. Press **Yes**, to save the data. Ask the SP to use more effort if possible. Press **Enter** to start a new test.

If the participant complains of pain during the practice tests, determine how severe the pain is and whether they can continue the testing.

Does it hurt enough that you want to stop?

If the SP says **Yes**, do not continue with the testing. If at least one test was complete, transfer the data. If no tests were complete, check the box on the ISIS screen that says, FILES NOT CAPTURED and complete the Status Screen as:

Status: Not Done
Comment: Other; SP reported pain while doing test

1. TEST 1

For Test 1, let the force line move all the way across the computer screen before beginning the test.

“Let’s do the first warm-up.

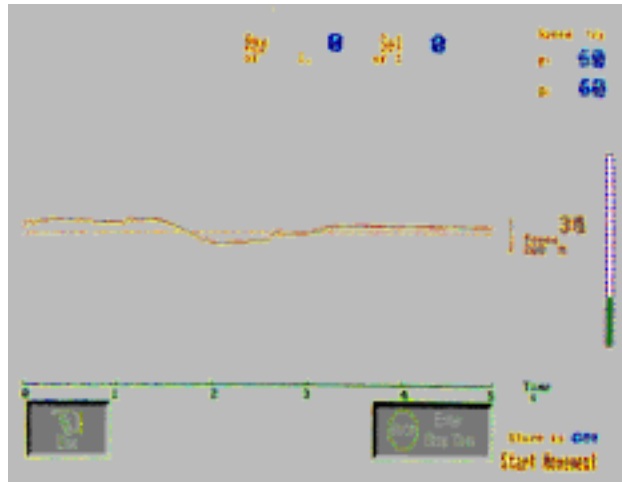
When I tell you to go, I want you to push out and pull back through the full range of motion in one movement – like this (Technician will demonstrate).

When I say go, I want you to push out and pull back to get a feel for the machine. So, you will push out, pull back and then stop. Start the movement when I say Go.”

- a. Press **Enter**, then push lightly on the shin pad to the start position. Say the following:

GO. Push out and pull back.

- b. When the lever arm stops, press **Yes** to save the data.



Isokinetic Testing Screen

2. Test 2

STANDARD SCRIPT: Good. I want you to do the same thing again. This time use just a little more effort than the last time. When I say GO, I want you to push out and pull back in one movement.

- a. Press **Enter**, then push lightly on the shin pad to the start position. Say the following:

GO. Push out and pull back.
- b. When the lever arm stops, press **Yes** to save the data.

3. Test 3

STANDARD SCRIPT: Good. This is the last warm-up. I want you to do the same thing again. This time use a little more effort than the last time. When I say 'GO', I want you to push out and pull back in one movement.

- a. Press **Enter**, then push lightly on the shin pad to the start position. Say the following:
GO. Push out and pull back.
- b. When the lever arm stops, press **Yes** to save the data.

3.3.5 Actual Test Repetitions (Tests 4, 5, and 6)

1. Test 4

STANDARD SCRIPT: Good. That is the end of the warm-ups. This time I want you to use your maximum effort. When I say 'Go', I want you to push out and pull back as hard as you can.

- a. Press **Enter**, then push lightly on the shin pad to the start position. Say the following:
GO. Push, push, push, pull, pull, pull
- b. When the lever arm stops, press **Yes** to save the data.

2. Test 5

STANDARD SCRIPT: Good. I want you to do another repetition using your maximum effort. When I say 'Go', I want you to push out and pull back as hard as you can.

- a. Press **Enter**, then push lightly on the shin pad to the start position. Say the following:
GO. Push, push, push, pull, pull, pull
- b. When the lever arm stops, press **Yes** to save the data.

3. Test 6

STANDARD SCRIPT: Good. This is the last effort. Once more, I want you to use your maximum effort. When I say 'GO,' I want you to push out and pull back as hard as you can.

- a. Press **Enter**, then push lightly on the shin pad to the start position. Say the following:
GO. Push, push, push, pull, pull, pull
- b. When the lever arm stops, press **Yes** to save the data.

3.3.6 Special Considerations With Isokinetic Testing

1. If the Kin Com locks up, do not save the test. The test is not considered “good” unless the SP is able to push out and pull back.
2. If the SP is not able to complete a full range of the test (push out and pull back), do not continue. This data is not valid, and we may risk injuring the SP. Please have them try, but if they are not strong enough, stop the test. For example, an SP is able to push out, but cannot pull back and is not able to complete the test. Stop the test, and code the exam as:

Physical limitation.

3. If the SP experiences a muscle cramp, stop the test. The test will not be able to capture muscle strength if the muscle is cramping. In addition, we risk injuring the SP. Transfer any tests you completed to the ISIS program. If this is less than 4, you will be asked why the examination is a partial. Code this exam as:

Safety Exclusion.

4. The gravity compensation screen is really easy to miss, please check when you get to the Joint Specification screen; there is a button at the bottom that says:

“Turn OFF Gravity Compensation.”

If it says **“Turn ON Gravity Compensation”** you will not get the screen to weigh the limb.

5. If an SP is obese, you may not be able to get the joint angle to 90°. Please enter the angle you get (the furthest you push the lever arm back). **This does not apply to someone who is very short. If an SP is short, you must move the seat.**
6. It is very important for the SPs to perform 3 sub-maximal warm-ups. Maximal effort during warm-ups can lead to cramping and injury.
7. When setting the direction of the machine, it is very important to **pull on the load cell** (shin pad). If you pull on the lever arm, the direction of force could be negative instead of positive.

8. When obtaining the gravity correction, it is very important to **hold the lever arm**, and **not** the load cell when weighing the limb. Also, please make sure the SP is letting the leg hang so that the weight is correct. Tell the SP to let the leg hang down or be heavy.
9. When coaching the SP during the last 3 kicks (after the warm-ups), it is very important to be **loud and encouraging**. This is an important variable effecting performance.
10. Make sure the stabilizing straps and seat belt are secure. These should be quite snug, but not uncomfortable.
11. If the Kin Com Screen blacks out or you have trouble transferring files to ISIS, contact the data manager or Chief Tech before you proceed. This can avoid data loss.
12. If you have an equipment failure notify the Chief Tech and data manager before the end of the day. The home office should be notified by Tiger Log and/or phone call of all failures with this equipment.

3.4 Data Capture

1. On the Kin Com, after completing 6 tests:

- Press **Esc** to end the test. The screen will indicate the number of tests completed and stored.



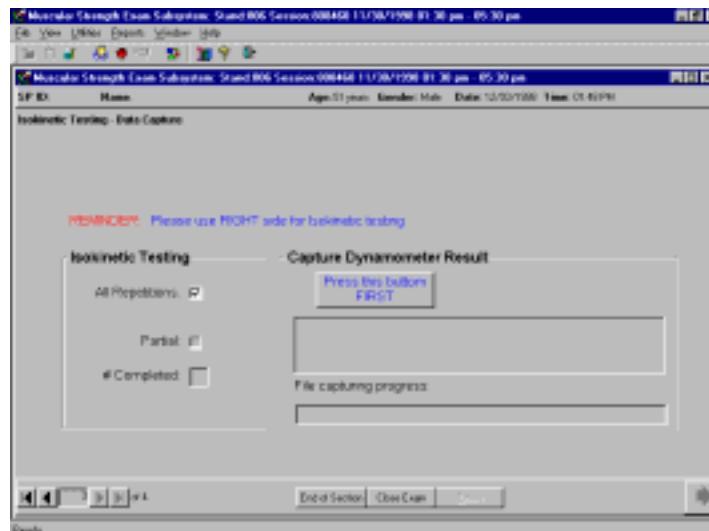
- Press **Esc** until you are at the Kin Com Main Menu screen. This is the one with the Utilities button in the lower right corner.
- Press **U** for **UTILITIES**.



- Press **U** for **System Utilities**. The System Utilities screen will appear.

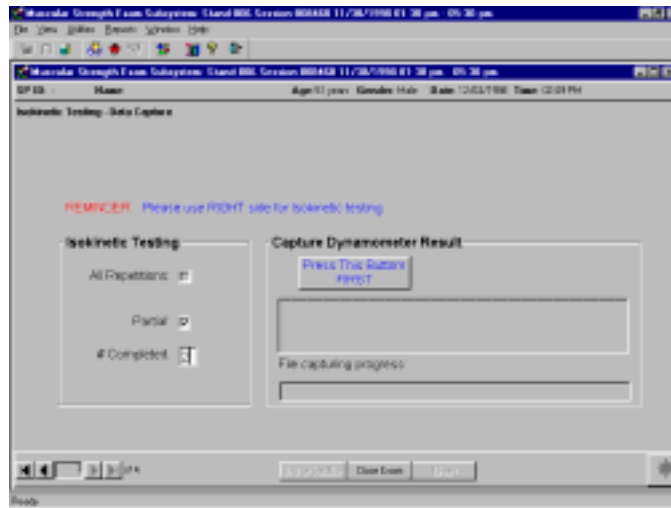


2. Go to the ISIS computer screen and make sure you are on the Isokinetic Testing screen.
 - If all six repetitions were completed:
 - Click the **All Repetitions** box to indicate that all six repetitions were completed.
 - The ISIS system will gray out the remaining options in that block.
 - Click on the button that says: Press **this button first** before returning to the Kin Com computer. The system will now look for six files to be transferred.



- If less than six repetitions were completed:
 - Click **Partial** to indicate that less than six repetitions were completed.
 - The ISIS system will gray out **All Repetitions**.

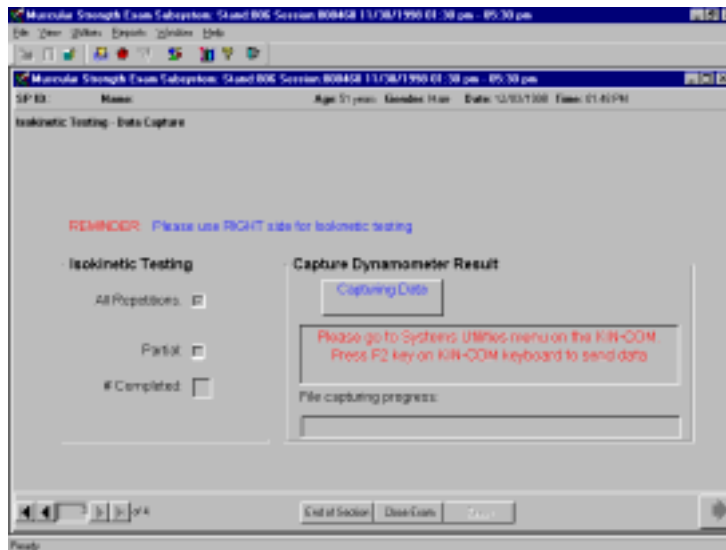
- Enter the number of repetitions completed in the **# completed** field.



- Click on the button that says **Press this button first** before returning to the Kin Com computer. The system will now look for the number of files entered on the ISIS screen to be transferred. If you press this button prior to entering the number of repetitions the system will display the following message:

Please enter the number of repetitions completed.

- The ISIS system will display the following message:



- Press F2 on the Kin Com to **Send Text Files**.

The Kin Com screen will display the progress of the files being sent. It will take approximately 2 minutes for all files to transfer.



As each of the files are sent to the ISIS database, the Kin Com screen will show the percent complete as shown below:

Sending file (XXX.kcx)

Percent complete: ____%

5. While the data files are transferring:
 - Remove the stabilization straps from the SP.
 - Assist the SP in getting off the dynamometer.
 - Thank the SP for their participation and cooperation.

6. When all files have been sent, the following message will be displayed on the Kin Com screen:

SERIAL has completed normally

7. Press **Esc** to return to the Kin Com Logo screen.
8. ISIS will display a progress bar indicating the number of files captured. When all files are captured, the system will display the following message:
6 files have been transferred to the ISIS PC

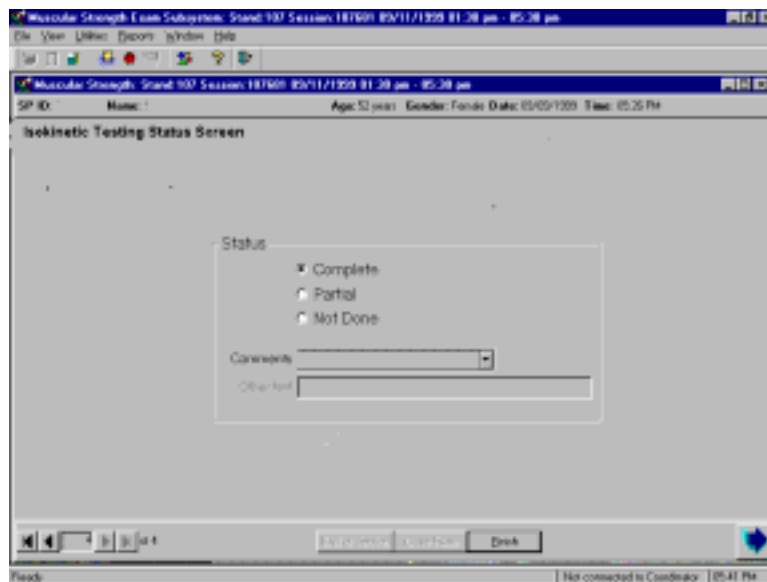
9. When the ISIS system indicates the file transfer is complete, click on the **arrow button** to move to the Isokinetic Testing Status Screen. Do not press the close button.
10. The status screen will indicate a status of **Complete** if at least 4 files were transferred.
11. Press the **finish button** on the ISIS screen to complete the exam.

3.4.1 Component Status

The component status for Isokinetic Testing is considered **Complete** if 4 or more repetitions were completed.

The component status for Isokinetic Testing is considered **Partial** if 1-3 repetitions were completed.

The component status for Isokinetic Testing is considered **Not Done** if no files were completed.



APPENDIX A

Measured Walk Scripts

APPENDIX A

MEASURED WALK SCRIPTS

SUGGESTED INTRODUCTION TO THE COMPONENT (NOT A REQUIRED SCRIPT)

"In this room we are going to ask you to do some tests to see how well you are able to carry out normal daily activities. This includes a short walk test and a test to measure the strength of some muscles in your legs."

SUGGESTED MEASURED WALK SCRIPT (Not a required script)

"I am going to time you as you walk along the corridor. Please begin with your toes behind this line. Walk at your usual pace. I will tell you when to start and stop. Please do not stop until I tell you to stop. This will be at the bench at the end of the hallway. Are you ready? OK, Begin.....Stop.

SUGGESTED INTRODUCTION TO ISOKINETIC TESTING (Not a required script)

"I would like you to sit up on this chair. This test measures the strength in your legs. For the test, you will kick out and pull back against the pad to measure the strength of some of your leg muscles. First, I am going to ask you some questions."

Suggested Explanation of Isokinetic Test (NOT A REQUIRED SCRIPT)

"Please keep your hands in your lap during testing. I'm going to attach these straps to help stabilize you in the chair. The straps will feel quite snug but they should not be uncomfortable or make it difficult for you to breathe."

(TIGHTEN THIGH STRAP)

"We will do a total of 6 tests but we will only do one at a time. If you experience any pain, we will stop."

STANDARD SCRIPT FIRST WARM-UP (Required script)

"Let's do the first warm-up. When I tell you to go, I want you to kick out and pull back through the full range of motion in one movement like this. (Technician will demonstrate). When I say go, I want you to push out and pull back to get a feel for the machine. You will push out, pull back, and then stop. Start the movement when I say Go. (Press Enter, Push on pad). Go. Push out and pull back."

STANDARD SCRIPT SECOND WARM-UP (Required script)

Good. I want you to do the same thing again. This time use a little more effort than last time. When I say Go, I want you to push out and pull back in one movement. (Press Enter, Push on pad). Go. Push out and pull back."

STANDARD SCRIPT THIRD WARM-UP (Required script)

"Good. This is the last warm-up. I want you to do the same thing again. This time use a little more effort than the last time. When I say Go, I want you to push out and pull back in one movement. (Press Enter, Push on pad). Go. Push out and pull back."

STANDARD SCRIPT FOURTH REPETITION (Required script)

"Good. That is the end of the warm-ups. This time I want you to use your maximum effort. When I say Go, I want you to push out and pull back as hard as you can. (Press Enter, Push on pad). Go. Push, Push, Pull, Pull, Pull, Pull."

STANDARD SCRIPT FIFTH REPETITION (Required script)

"Good. I want you to do another repetition using your maximum effort. When I say Go, I want you to push out and pull back as hard as you can. (Press Enter, Push on pad). Go. Push, Push, Push, Pull, Pull, Pull."

STANDARD SCRIPT SIXTH REPETITION (Required script)

"Good. This is the last effort. Once more, I want you to use your maximum effort. When I say Go, I want you to push out and pull back as hard as you can. (Press Enter, Push on pad). Go. Push, Push, Push, Pull, Pull, Pull."

APPENDIX B

Set-up Procedures for Cardiovascular (CV) Fitness and Muscle Strength Room

APPENDIX B

SET-UP PROCEDURES FOR CARDIOVASCULAR (CV) FITNESS AND MUSCLE STRENGTH ROOM

Advance Arrangements team:

Tie down material removal:

- Remove tie-down straps from Kin Com cart.
- Remove tie-down straps from Kin Com and dynamometer.
- Remove tie-down straps from ISIS computer/CV fitness monitor cart.
- Remove all wall anchors (6) and place in container with tie down straps.
- Store tie-down material container in CV Fitness supply box.

Data Manager:

Computer equipment and cart set up:

- Pull Kin Com cart away from wall, and CPU cart away from shoe rack.
- Unpack Kin Com, CV fitness, and ISIS monitors from boxes.
- Place all monitors on carts.
- Unpack Kin Com keyboard, ISIS keyboard, and mouse and set up on CPU carts.
- Connect all monitors to CPU.
- Connect cable to programmable monitor and treadmill.
- Unpack speakers, thermometer, and connections and set up on CPU cart.
- Remove travel pad from between CPU and UPS on lower level of Kin Com cart.
- Label all boxes used for computer equipment "CV Fitness" and store in MEC belly throughout stand.
- When STBP monitor is set up, connect computer cable to STBP monitor.
- At the start of the stand, delete the previous stand's data files from the Kin Com hard drive.

To do this:

- From the Main Menu, select Utilities.
- Select System Utilities.
- Select Exit to DOS
- Copy the files that end in .kbc to another location (diskette or Zip cartridge)
- Delete files that end in .kbc and .cnt
- Reboot the computer to return to the KinCon program.

Technician:

STBP monitor set up:

- Remove STBP monitor, power cable, and ECG cable from STBP box.
- Place STBP monitor on CPU cart and connect ECG cable and power cord.
- Remove a blood pressure cuff from blood pressure cuff container and connect to both STBP monitor and hanging cable.

Kin Com set up:

- Remove wooden block wedges used to secure foot pedals for Kin Com chair and dynamometer.
- Store wooden block wedges in CV Fitness supply box.
- Unlock dynamometer part A.
- Unlock dynamometer part B.
- Move dynamometer away from Kin Com chair.
- Unlock Kin Com chair and relocate to center.

Supply set up:

- Remove blood pressure cuffs from blood pressure cuff container and hang on wall next to treadmill.

- Connect telephone receiver to telephone and connect telephone to wall jack.
- Remove grid baskets from CV Fitness supply box and hang on wall grid.
- Restock grid baskets where needed.
- Unpack four 10-pound weights from muscle strength box and place on floor behind Kin Com.
- Restore trash can and foot stool to upright position.

APPENDIX C

Pack-up Procedures for Cardiovascular (CV) Fitness and Muscle Strength Room

APPENDIX C

PACK-UP PROCEDURES FOR CARDIOVASCULAR (CV) FITNESS AND MUSCLE STRENGTH ROOM

Technician:

- Remove wall anchors and tie-down straps from the CV Fitness supply box stored in MEC belly.
 - Attach all wall anchors to walls.
 - Pack the four 10-pound muscle strength weights into the bottom of the CV Fitness supply box
- (NOTE: The box should be positioned on the floor before the weights are added. Do not try to move the box once the weights are packed).*
- Pack miscellaneous supplies for both components on top of the weights in the CV Fitness supply box.
 - Disconnect blood pressure cuff from STBP monitor.
 - Wrap hanging blood pressure cuff cable extension with Velcro strap to the inside top bracket of the CPU cart.
 - Loosely wrap all blood pressure cuffs lengthwise and pack into BP cuff container.
 - Disconnect ECG cords from STBP monitor and wrap loosely lengthwise.
 - Disconnect computer cable from STBP and drape it across treadmill.
 - Wrap STBP monitor in packing material (foam or bubble wrap) and pack into STBP box.
 - Store ECG cords in plastic bag and pack into STBP box.
 - Unplug telephone from phone jack and unplug receiver from telephone.
 - Wrap receiver in packing material and pack in the CV Fitness supply box.
 - Place all boxes on floor of the room.
 - Move Kin Com chair on slide to setting all the way to the left against wall, facing the shoe rack.
- Seat rotation E to be set at 0, seat set at 0

- Gently slide dynamometer up against the Kin Com chair.
 - Set dynamometer tilt (A) to 90 and lock it
 - Set dynamometer rotation (B) to 0 and lock it
- Secure wooden block wedges with Velcro under foot pedals on dynamometer and Kin Com chair to keep them in a locked position throughout travel and prevent any movement of the dynamometer or Kin Com chair.
- Attach one end of tie-down strap to wall anchor on shoe rack wall in front of Kin Com, and attach ratchet extension to other wall anchor on the other side of the Kin Com.
- Wrap tie-down strap around base of chair, inside both front and back pistons (The tie-down strap must not be wrapped around the hydraulic pistons for the Kin Com. Make sure the strap is wrapped snugly around the base of the chair).
- Wrap tie-down strap around base of dynamometer twice and attach securely to ratchet extension.
- Leave wall seat in open position so seat does not fall open during travel.
- Place trash can on its side or secure between equipment/box and the wall.
- Place foot stool upside down and secure between equipment/box and the wall.

Data Manager:

- Unplug all electrical equipment.
- Disconnect Kin Com, CV fitness, and ISIS monitors from CPU.
- Pack monitors in boxes labeled "CV fitness" with packing material.
- Disconnect Kin Com keyboard, ISIS keyboard, speakers, and mouse, and pack in boxes with packing material.
- Disconnect cable that connects programmable monitor to treadmill and store in box with computer equipment.
- Disconnect speakers and thermometer.
- Wrap speakers and thermometer with packing material and pack in box.
- Store any disconnected cables and wires in boxes with their equipment.
- Store packed boxes securely on the floor.
- Check that the travel pad is inserted between CPU and power box on lower level of Kin Com cart.

- Push Kin Com cart against wall and secure to wall anchors with tie-down strap.
- Push ISIS computer and CV fitness monitor cart against shoe rack and secure to wall anchors with tie-down strap.
- Treadmill remains standing and does not need to be secured for travel.

Chief Technician/MEC Manager:

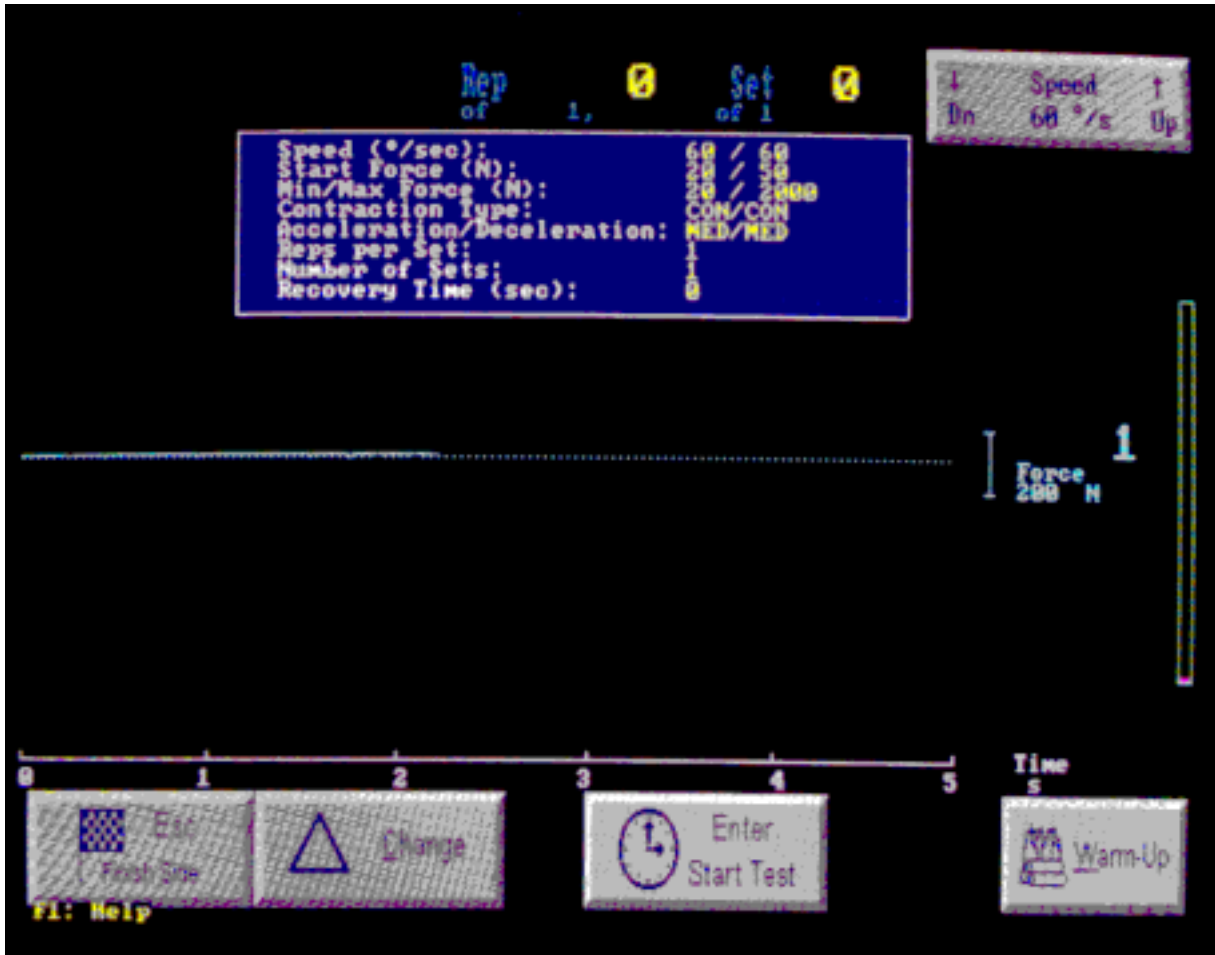
- Make final check on pack-up of the room with the technician.

APPENDIX D

NHANES Isokinetic Settings for the KIN COM Machines

APPENDIX D

NHANES ISOKINETIC SETTINGS FOR THE KIN COM MACHINES



KC21-G2: Kin-Com Settings

These settings appear on the Kin Com screen before beginning Test 1 of the Isokinetic Testing. Unless the force limits are changed for a particular SP they are to remain the same throughout the entire study.

If these settings are somehow changed from what is shown on the screen above, the **Chief Health Tech** should be notified. The Chief Health Tech will need to return the setting to those specified

for the NHANES protocol. The protocol name is '**ISOKINETIC**' and should be set to the following:

- Speed forward: 60
- Speed backward: 60
- Start force forward: 20
- Start force backward: 50
- Minimum force: 20
- Maximum force: 2000
- Contraction type: Con/Con
- Acceleration: Medium
- Deceleration: Medium
- Reps per set: 1
- Number of sets: 1
- Recovery time: 0

To return any changed setting back to what is listed above you must first take off the Protocol Lock. Do this by selecting Utilities from the Main Menu. Select System Setup. Change the Protocol Lock (#5) from ON to OFF by pressing 5. Escape back to the Main Menu. Now the protocol settings may be changed from the Isokinetic Test Screen. You will have to enter a dummy SPID and go through a virtual exam to get to this screen. Once on the Testing Screen, press C for Change. The Isokinetic Change Settings Screen appears. Change the necessary settings and Save the settings as 'ISOKINETIC'. DO NOT rename the protocol. You will get a message reminding you that the 'ISOKINETIC' protocol already exists and asking you if you want to replace it. Enter YES. Once you have changed the settings and saved the protocol as 'ISOKINETIC', escape back to Utilities, System Setup and turn the Protocol Lock back ON by pressing 5.