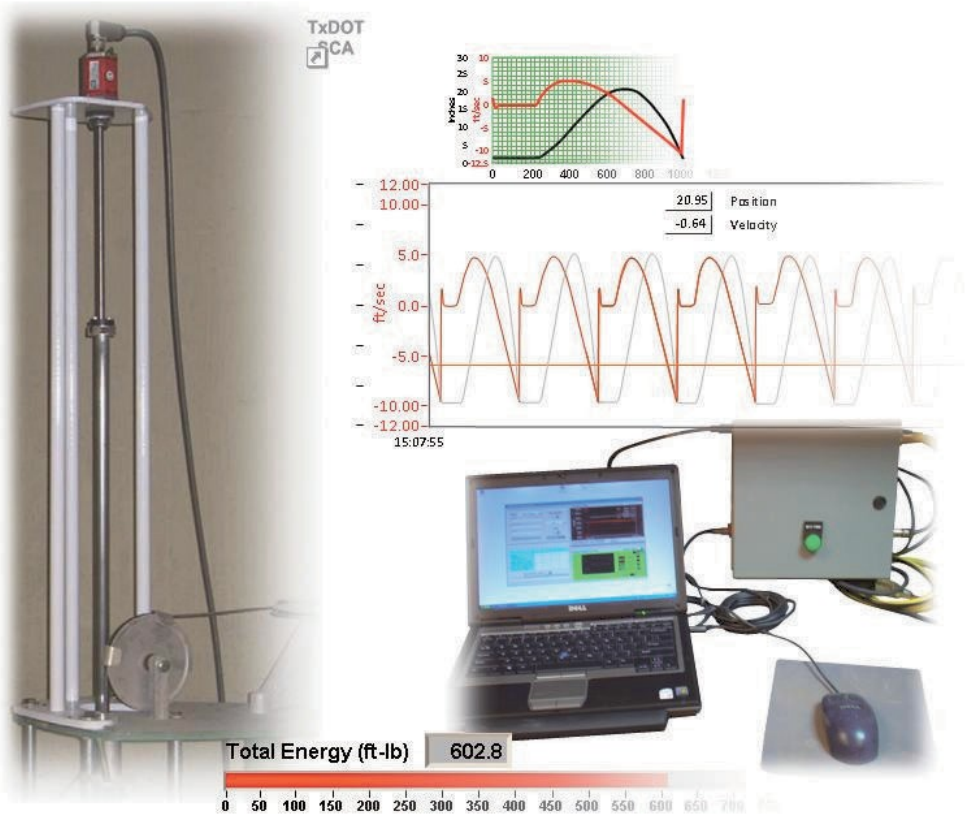
Soil Compactor Analyzer (SCA) Reference Guide



Materials & Tests Division
Geotechnical, Soils & Aggregates Section

November 2018

TABLE OF CONTENTS

INTRODUCTION 1

SCA COMPONENTS 2

REQUIRED TOOLS 4

INSTALLATION 5

MOUNTING SCA UNIT 9

SCA ADJUSTMENT 13

VERIFICATION OF SENSOR READING 16

SOFTWARE OVERVIEW 20

CREATING AND REVIEWING DATA FILES 27

INTRODUCTION

This document provides hardware and software installation and operation instructions for the Soil Compactor Analyzer (SCA).

The SCA mounts on the Rainhart Series 662 automatic tamper currently required for TxDOT Test Method Tex-113-E; and, for all other test methods referencing Tex-113-E. The SCA determines the impact velocity achieved per blow using rapid sampling of the rammer's position during operation. The energy delivered to the specimen is determined using this velocity and the known mass of the rammer. For technical assistance or information regarding hardware or software updates, please contact the following:

Joe Fiello, P.E.
Transportation Engineer, Geotechnical, Soils, & Aggregates
(512) 506-5857
Joe.Fiello@TxDOT.gov

Richard Izzo, P.E.
Section Director, Geotechnical, Soils, & Aggregates
(512) 506-5907
Richard.Izzo@TxDOT.gov

Buddy Williams, P.E.
Division Director, Materials & Tests
(512) 506-5808
Buddy.Williams@TxDOT.gov

SCA COMPONENTS

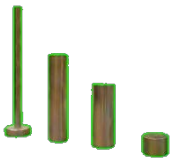
Each SCA is packed with the following components. Please verify that all components have been delivered. The quantity of each component is provided in parenthesis.

Part	Quantity	Image
Sensor	1	
Sensor Frame	1	
Sensor Mounting Hardware		
Neoprene Washers	2	
Locking Nut	1	
Frame Mounting Hardware		
Bolts	3	
Washers	3	
Sensor Magnet	1	
Magnet Mounting Hardware		
Magnet Bolts	2	
Magnet Mount	1	
Magnet Mount Bolt	1	
Control Computer (with TxDOT SCA software installed)	1	
Computer Power Cable and Adapter	1	

Data Acquisition/Control Box with Power connection for Compactor	1	
Data Acquisition/Control Box Power Cable	1	
Sensor Cable	1	
Emergency Stop & Cable	1	
USB Cable	1	

REQUIRED TOOLS

The following tools will be required to install the SCA.

Adjustable (Crescent) Wrenches	Open-Ended Wrenches
Ratchet & Sockets	Hex (Allen) Wrenches
Interlocking Joint (Channel Lock) Pliers	Rubber Mallet
Inspection Mirror	Standard Height Block(s) 

INSTALLATION PREPARATION

The installation of the SCA is fairly straightforward; however, appropriate care must be taken to ensure that the SCA is not damaged during installation. In addition, time must be taken to ensure that the SCA does not inhibit the proper operation of the compactor. Figure 1 provides an exploded view of the components and assembly of the SCA and compactor.

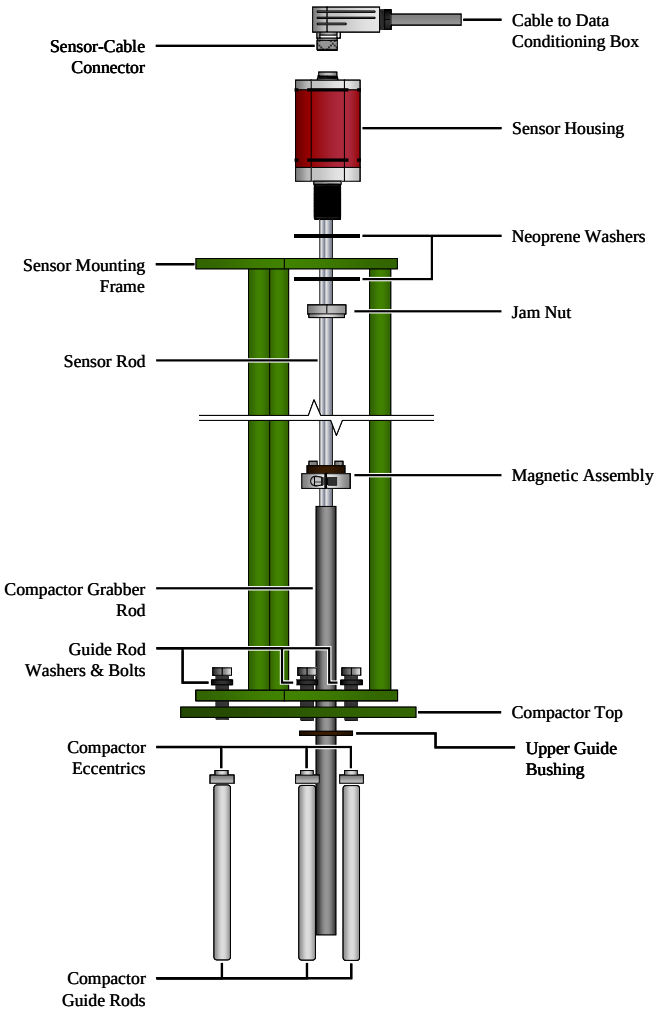


Figure 1 – Exploded View of Components and Assembly of SCA and Compactor

When a position on the compactor is provided in this document, follow the convention shown in Figure 2.

Designation	Description
Front (of compactor)	The side of the compactor directly across from the motor.
1, 2, 3 ,4	The position of the guide rods, guide rod brackets, and eccentrics on the compactor.

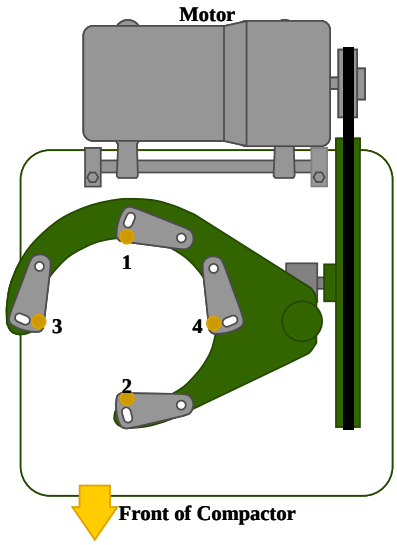


Figure 2 – Reference Drawing of Compactor

Perform the following steps prior to installing the SCA sensor and frame on the compactor.

1. Verify that a minimum clearance of 3 feet, 8 inches exists between the top of the compactor to the ceiling. This space is required to install and adjust the SCA with attached sensor cable.

2. Remove the compaction mold from the compactor.

3. Disconnect the power to the automatic tamper. This can be accomplished either by disconnecting the compactor motor from the rear of the counter or disconnecting the counter from its power supply.

4. Ensure that the compactor is level. First, check the levelness of the compactor base plate. This is best checked where the compaction mold is typically mounted. Second, check that the top of compactor is level. Both of these should be checked and corrected if necessary to ensure that the SCA does not inhibit the operation of the compactor.

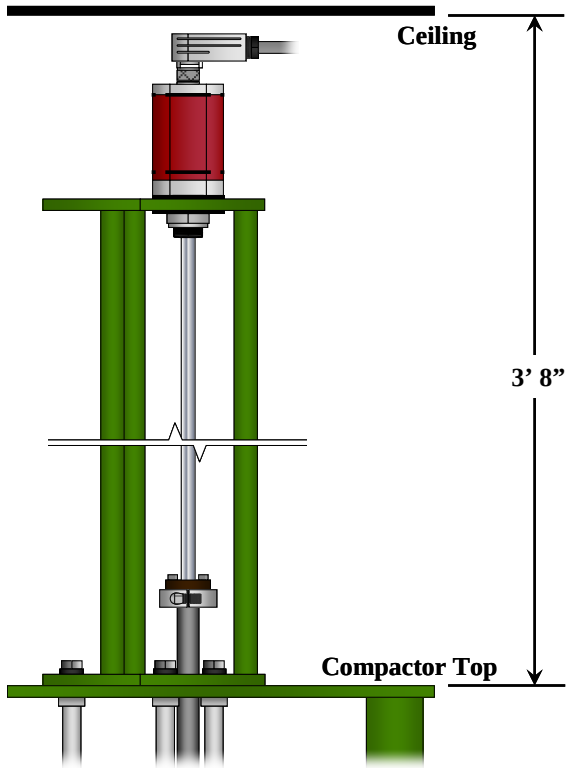


Figure 3 – Required SCA Clearance

5. With a waterproof marker, draw reference marks to denote the position of the eccentrics on the compactor. The reference mark/line should start on the underside of the compactor top and continue, unbroken, down to the guide rod as shown in Figure 4. These marks should be as clear as possible, as they will be used as reference points during the installation and adjustment of the SCA.

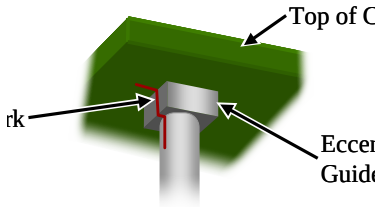


Figure 4 – Marking Eccentric Position

6. For ease in future adjustments to the compactor, transfer the upper guide bushing from the upper side of the compactor top to the underside of the compactor top. This will require the removal of the rammer head and tamper shaft. Failure to perform this step will require the entire SCA frame to be removed and reinstalled each time the guide bushing is replaced. If the upper guide bushing is worn, replace it at this time.

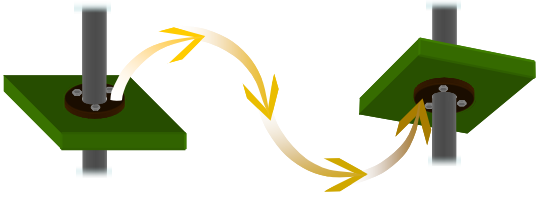


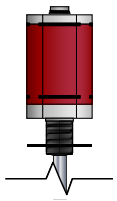
Figure 5 – Transfer of Upper Guide Bushing

MOUNTING SCA UNIT

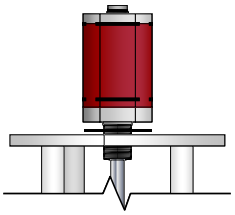
Mounting the Sensor into the Frame

The SCA sensor is typically delivered mounted within the sensor frame. If not, use the following procedure:

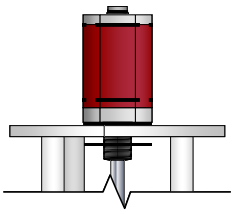
1. Place a neoprene washer over the threads of the SCA's sensor housing.



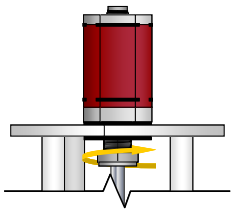
2. Insert the sensor (with neoprene washer) into the sensor frame.



3. Place the second neoprene washer over the threads of the SCA's sensor housing.

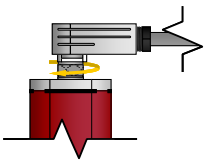


4. Secure the sensor to the frame using the lock nut provided. Carefully install the lock nut onto the SCA sensor housing; taking care not to cross thread the locknut when tightening the lock nut to minimize damage to the threads on either the sensor or nut. Do not to over-tighten the nut; a slight amount of play is normal between the sensor and frame to account for shock and vibration experienced during the operation of the tamper.



5. Secure the sensor cable to the sensor. The cable can only be connected properly by seating the slot on the connector with the alignment pin on the sensor housing connection.

   Be sure to properly tighten this connection.

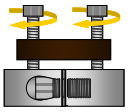


Be sure to store the SCA sensor and frame on its side, after installing the sensor in the frame, to avoid damaging the sensor. **Do not rest the sensor and frame on the sensor rod.**

Mounting the Sensor Magnet on the Compactor Tamping Shaft

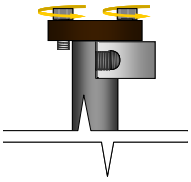
The sensor magnet assembly is the first item that will need to be installed on the compactor. Take care when installing to avoid cracking the magnet. Follow the steps below to install the magnet each time the tamper shaft is removed from the compactor.

1. If not already connected, secure the magnet to the magnet mount using the 2 smaller hex bolts provided. If already connected, loosen the top two hex bolts to allow a slight amount of play between the magnet and the magnet mount.



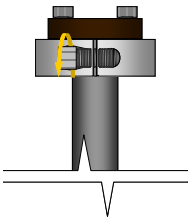
2. Loosen the hex bolt on the side of the magnet mount to allow the mount to "open."

3. Slide the magnet and magnet mount over the top of the tamper shaft. The bottom of the magnet should sit flush with the top of the tamper shaft.
   The two hex bolts located on top of the magnet can now be hand-tightened. Do not over tighten or the magnet may crack when the magnet mount is secured to the tamper shaft.



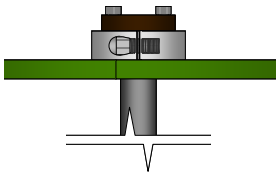
4. Secure the magnet mount to the tamper shaft. Be sure that the bolt is tightened enough to ensure the magnet/magnet mount will not come loose during normal operation of the compactor.

   The two hex bolts located on top of the magnet can now be tightened.



5. Gently lower the tamper shaft, with magnet assembly, to its lowest position. The magnet mount should be resting on the top of the compactor.

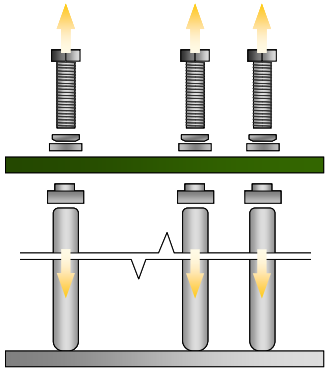
   If properly tightened the magnet mount should support the weight of the shaft, rammer and extra weight. However, a porous stone may be placed beneath the rammer foot to support the entire assembly.



Mounting the SCA Sensor and Frame on the Compactor

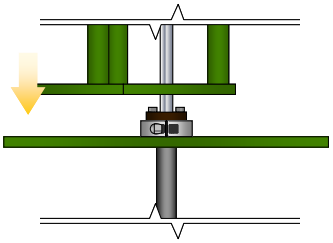
For ease in leveling the SCA frame later, ensure that each set of leveling screws at the base of the sensor frame (three per alignment rod) are flush with the underside of the SCA frame base.

1. Remove bolts and washers 1, 2, and 3 from the compactor. These three bolts and washers secure the guide rods and eccentrics to the compactor top. As each is removed take care not to lose the eccentrics or washers. Mark or store each eccentric to ensure the proper guide rod and eccentric are matched up during reassembly. To avoid damaging the guide rods or guide rod brackets carefully lower the rods and allow to rest on the compactor base.



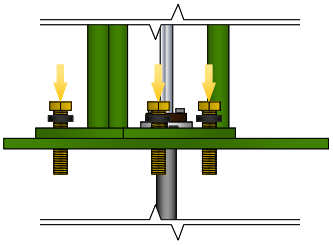
2. Clean the top of the compactor to remove debris that may cause the SCA to sit irregularly; including dust or oily residue.

3. Carefully lower the SCA sensor and frame onto the top of the compactor; guiding the sensor rod into the center of the magnet and into the tamper shaft. Align the bolt holes in the base of the SCA sensor frame with those of the bolts removed in Step 1.



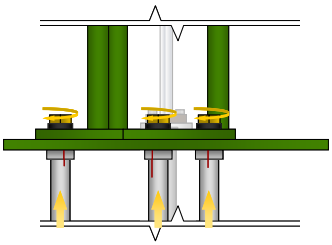
4. Longer bolts and washers are provided with the SCA that are of an adequate length to properly secure the guide rods, eccentrics, washers and SCA frame.

   Do not reuse the bolts that were removed in step 1.
   Place the new bolts with the new washers into the holes corresponding to guide rods 1, 2, and 3.



5. Re-install the eccentrics and guide rods one at a time. Be sure that the eccentrics and guide rods are in their original locations. After reinserting each eccentric realign each guide rod and eccentric with the previously made reference mark.

   Hand-tighten each bolt/guide rod to temporarily secure the entire assembly to the compactor frame.



Connecting the SCA Sensor to the Data Acquisition/Control Box

Once mounted, the sensor, emergency button, and computer can be connected. Each cable can only be connected to the corresponding connection on the control box. Each cable connector must be properly seated ensure that proper contact is made and no damage occurs to the various components. Take care to ensure each cable and connection is properly tightened.

Rest the guide disc on the catcher arm of the compactor prior to continuing.

1. Place the SCA control computer and mount the SCA data acquisition/control box in a suitable location.
2. Connect the sensor cable to the control box.
3. Connect the compactor motor to the control box.
4. Connect the emergency stop cable to the control box and mount the emergency stop button and housing in an appropriate location.
5. Connect the USB cable to the box and computer.
6. Connect the power cable to the control box.
7. Connect the power cable to the computer.

CAUTION

Do not startup the computer or software at this time.

Engage the emergency stop to ensure the compactor does not start.

SCA ADJUSTMENT

The goal of adjusting the SCA is to ensure that the compactor's operation is not inhibited by the SCA during normal operation. The following steps may require multiple iterations. The number of iterations will depend on the condition of the compactor and its various parts, as well as the installer's familiarity with the compactor and its operation.

The following items can affect not only the compactor's operation, but the SCA's ability to properly collect data. Correct these items prior to adjusting the SCA:

- Compactor or foundation that is not level or rigid
- Tamper shaft and guide disc that are not centered within guide rods
- Upper guide busing that is excessively worn
- Improper clearance between the guide disc and guide rods.
- Guide rods that are excessively worn
- Guide rod brackets that are excessively worn
- Guide disc that is excessively worn
- Mold that is misaligned, resulting in the mold being impacted during operation

When adjusting the SCA, the primary goal is to ensure that the magnet and sensor rod do not rub against one another during operation of the compactor.

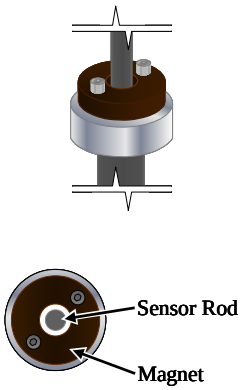


Figure 6 – Centering of Sensor Rod within Magnet

The following steps may be easier to perform with two people: one to perform the adjustments and the other to manually operate the compactor, as needed. In addition, the compactor and SCA may need to be adjusted in tandem to obtain the desired results.

1. Raise the tamper shaft and rest the guide disc on the catcher arm of the compactor.

2. Using an inspection mirror; or other means, verify that the magnet is centered within the magnet. If not, one of the following methods can be used to center the rod:

   a. The frame can be slid on the top of the compactor. The movement is limited and may not result in the desired clearance.

   b. The sensor can be turned using a wrench placed at the base of the sensor rod's electronics housing. The amount of movement you may be able to obtain may be affected by clearance and accessibility to the sensor electronic housing. The movement is limited and may not result in the desired clearance.

   c. If a significant amount of adjustment is needed to obtain the proper clearance, then it will be necessary to adjust one or more of the leveling screws to obtain the necessary clearance. Through trial and error the nine leveling screws can be adjusted as necessary to bring the SCA into alignment.

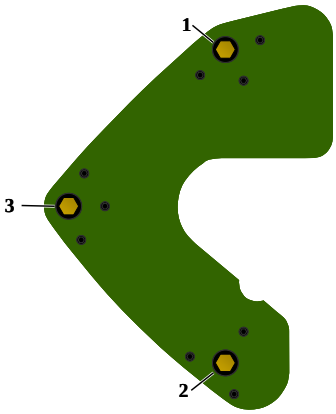
3. Raise the tamper shaft to the highest position it will travel during normal operation and repeat the centering procedure. In this position the amount of "play" between the SCA sensor rod and magnet is minimal. Attention must be made to ensure the sensor rod sits as close to center within the magnet as possible in this position.

4. Once centered, manually toss and catch the rammer shaft at various heights and verify that there are no indications that the shaft is binding. If there appears to be some binding, manually raise the rammer to the position where the binding occurred and recenter the assembly.

5. Repeat steps 1 through 4 until the sensor rod is properly centered.

6. Once centered, the three guide rod bolts can be tightened. However, care must be taken to ensure that the frame is not "pulled" one way or the other while tightening. If none of the nine leveling screws were adjusted during the centering procedure this is unlikely to occur.

   However, if the leveling screws were used then the three bolts should be tightened in an alternating pattern. First, rest the tamper shaft guide disc assembly on the compactor's catcher arm. Next, slightly tighten all the leveling screws so that they are in contact with the top of the compactor. Do not over tighten any of the screws or the alignment of the SCA sensor may need to be corrected. Next, begin tightening the guide rod bolts in an alternating fashion (starting with 1 and ending at 3). Tighten each bolt a quarter of a turn then alternating to the next. Between tightening each bolt use an inspection mirror to ensure that the sensor rod remains centered.

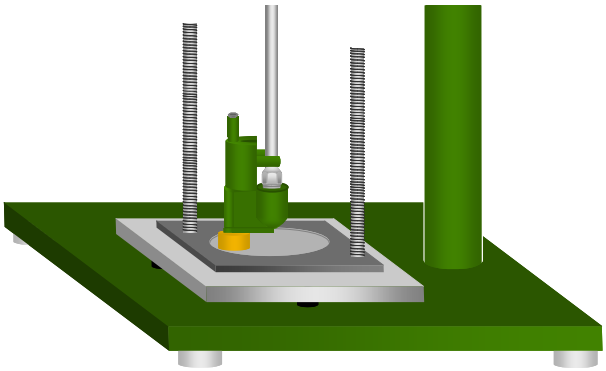


7. Return the compaction mold to the automatic tamper, and prepare a mock sample of flexible base; or place dampening material (such as sample bags or towels) into the mold. Manually cycle the automatic tamper through various heights of material to simulate the heights of the various lifts constructed during compaction of an actual specimen. Check for any signs of binding in the system at each height.

VERICATION OF SENSOR READING

Once properly installed the SCA can be used to operate the compactor; however, the sensor readings need to be verified. This can be accomplished by following the steps below.

1. Place the mold base plate; without the mold, in position within the compactor. Once in place, set a standard height block, greater than 1 inch in height, on the mold base plate and bring the face of the rammer to rest on the block. The block should rest within the base plate's mold inset.



2. Open the software by double clicking the icon on the desktop.

3. The software will provide a height reading in the "Trajectory Data" window; as shown below. The reading will not be constant; however, a reading within ±0.01 inches is acceptable.

If the reading is correct, then the verification is complete and the SCA can be placed into operation. If the reading varies from that of the block in use then continue with the correction by following the steps that follow.

A 2-inch block has been used as an example in the figure above. As can be seen the SCA sensor reading is off by 0.15 inches.

4. Press and hold CTRL+SHIFT+F9. When released, several tabs will appear in the upper left hand corner of the software window.

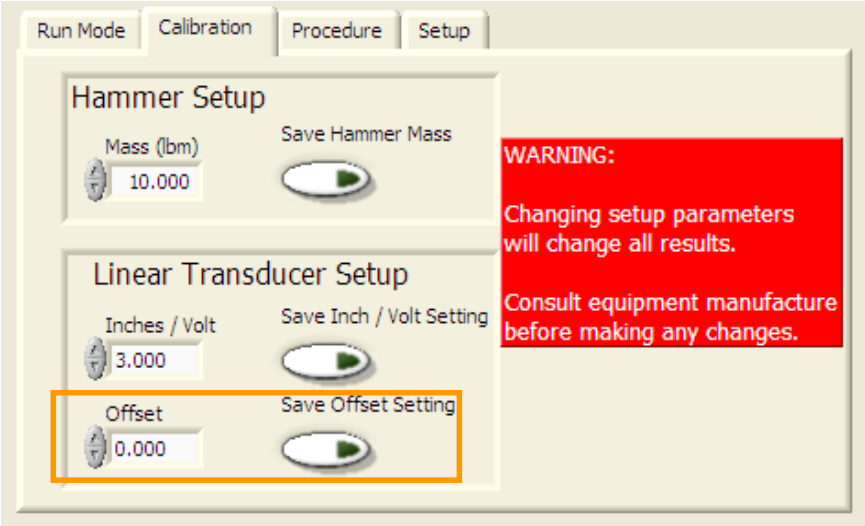
5. To correct the reading click on the tab labeled "Calibration."

CAUTION

Changes to any items described following steps may alter the sensor's readings and provide erroneous results in the during the compaction process.

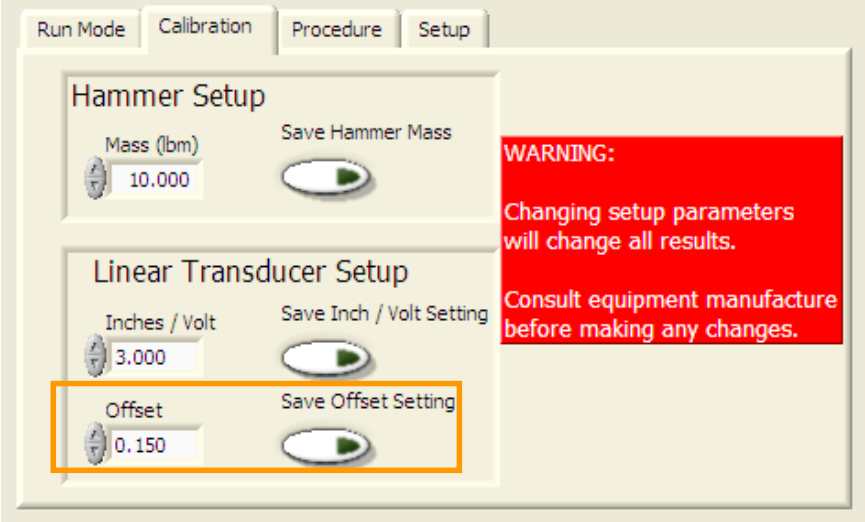
Be sure to follow the directions provided.

6. Locate the data field labeled "Offset" under the "Linear Transducer Setup" section. The default value is set at 0.000 inches.



7. The correction should be entered as follows:

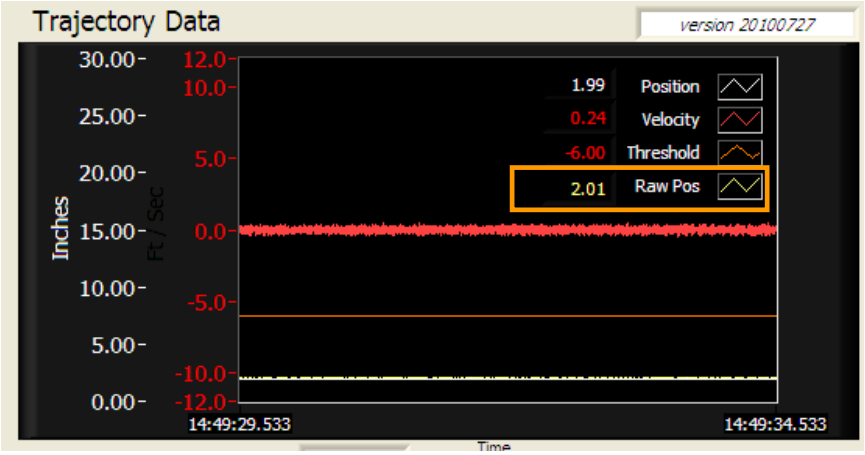
If the reading is greater than the height of the block used then enter the difference between the two as a positive number. (In this example, enter the value 0.150 in the "Offset" data field.)



If the reading is less than the height of the block used then enter the difference between the two as a negative number. For example if the SCA height measurement had been 1.85 inches, then the value entered in the "Offset" data field would have been -0.150.

8. After entering the correction value click on the "Save Offset Setting" button located to the right of the "Offset" data field.

9. After saving the offset value the software will automatically be updated and the correct value displayed in the “Trajectory Data” portion of the window. Remember, the reading will not be constant and may vary by ±0.01 inches.



10. Repeat steps 6-9 for a more accurate reading if necessary.

11. Lift and place the rammer on the catcher arm of the compactor. For future reference, note the height of the rammer while resting on the catcher arm. This height can be verified quickly each time the software is opened to ensure the sensor is reading correctly.

SOFTWARE OVERVIEW

This section provides a quick overview of the software. **Please review before operating**. The TxDOT Soil Compactor Analyzer software was developed to compact flexible base specimens in accordance with the parameters defined in Tex-113-E. The software does not allow for operation of the compactor for specimens compacted according to AASHTO or ASTM.

The TxDOT SCA software allows for powering the compactor on and off, the collection of data during operation of the compactor, and data recall. The specific data collected, per lift, is the number of drops required to attain the required energy, total energy, the average energy delivered per drop, the average sample height, and average drop height.

To launch the software, the data acquisition box must be connected to the control computer via the provided USB cable. Double click the icon shown in Figure 7 to launch the software.

Figure 7 - Software Icon (found on desktop)

The basic sequence of operation is:

1. Verify the sensor's operation (if you are using the system for the first time, set the sensor offset)
2. Collect data
3. Review data

Upon launching the software, the window shown in Figure 8 will appear. The software is designed to provide the operator a single window in which to perform all the basics operations required to compact a specimen and record data, while maintaining a user-friendly interface. The window has five main sections. Each section is described below, followed by an image of the software window with pertinent information.

1. The upper left-hand portion of the window enables the user to identify the method of compaction and enter basic information pertaining to the specimen being compacted.

2. The upper right-hand portion of the window provides a graphical representation of the real-time position and velocity of the rammer as it is lifted and dropped.

3. The lower left-hand portion of the window provides a summary of data collected for each lift, upon completion of the lift. During operation this portion of the window provides a more detailed graphical representation of the rammer's movement and velocity per drop.

4. The lower right- hand portion of the window provides a summary of four data sets (energy, velocity, lift height, and drop height) as well as a counter for the number of drops delivered to the material.

5. Total Energy bar graph – This portion of the screen provides a means to visually observe the amount of energy delivered to the specimen per lift. The energy is summed with each blow. A numerical value for the total energy delivered is also given.

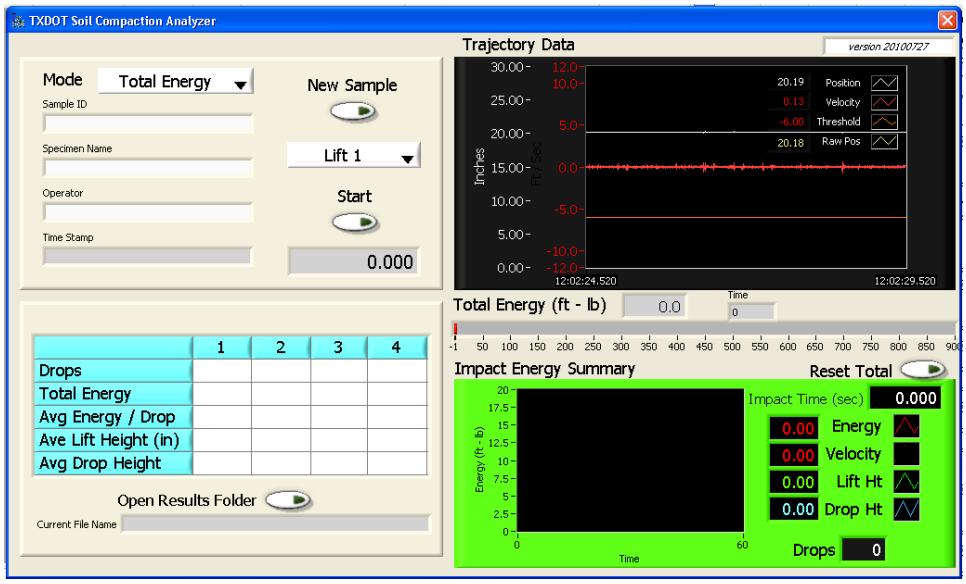
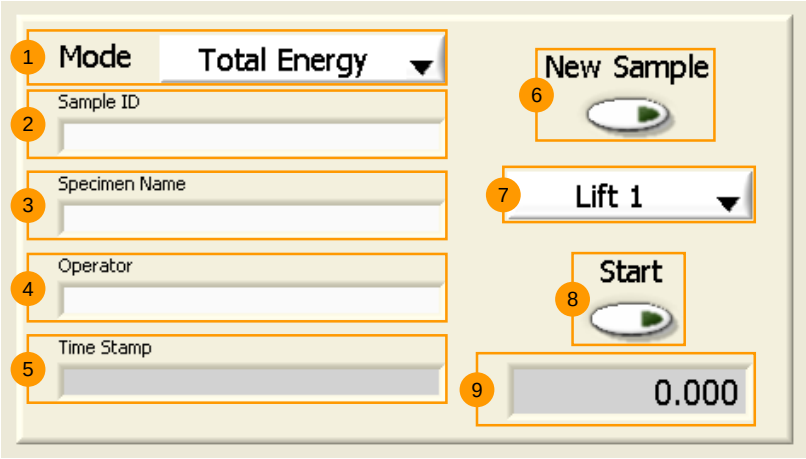


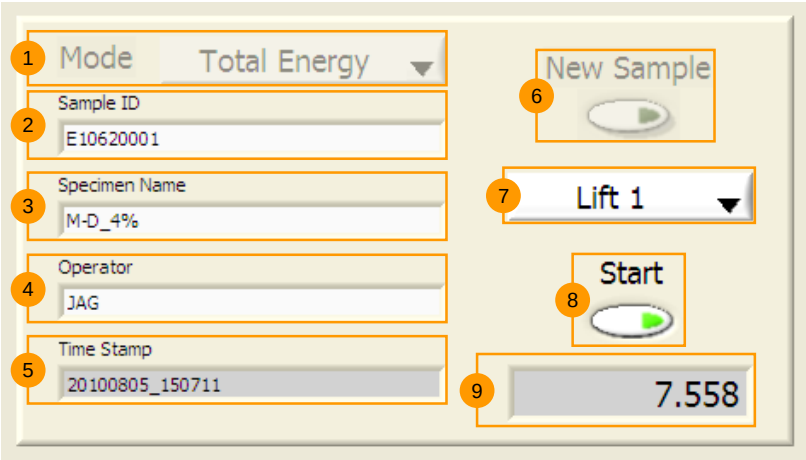
Figure 8 - Software Window

See below for a more in-depth description of the various sections.

When the software is first initiated the following screen appears:



While the compactor is running the following is shown:



1. Mode – Provides two options for running the compactor. The default, "Total Energy," has a target total energy of 750 ft-lbs per lift. The second option, "Number of Drops," has a target of 50 drops per lift.

2. Sample ID – Identifies the sample being compacted. It is suggested that this field remain constant for each sample set for M-D curves and/or triaxial tests. The value entered in this field is used in naming the data file.

3. Specimen Name – Identifies the specimen being compacted. It is suggested that this field be used to distinguish each specimen compacted for M-D curves or triaxial tests. The value entered in this field is used in naming the data file.

4. Operator – This field should be used to identify the person operating the compactor/preparing the sample.

5. Time Stamp – Provides the date and time at which compaction was started for each specimen. Automatically filled in when the Start button is clicked. This value is used in naming the data file.

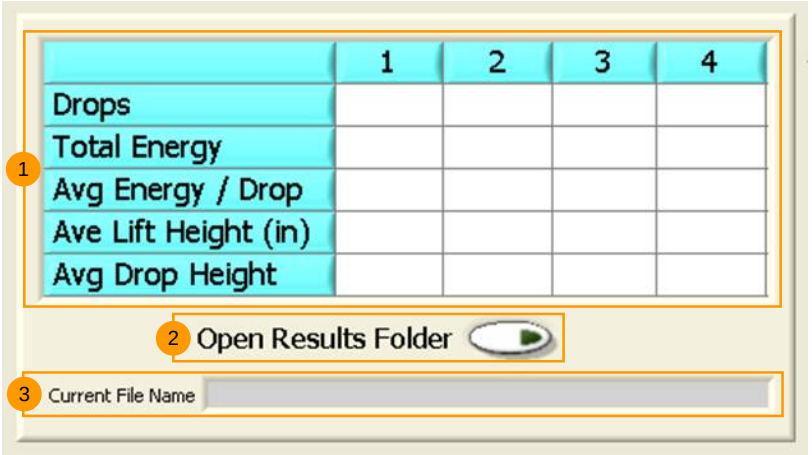
6. New Sample Button – Clicking this button will begin a new data file.

7. Lift – Indicates what lift is being compacted.

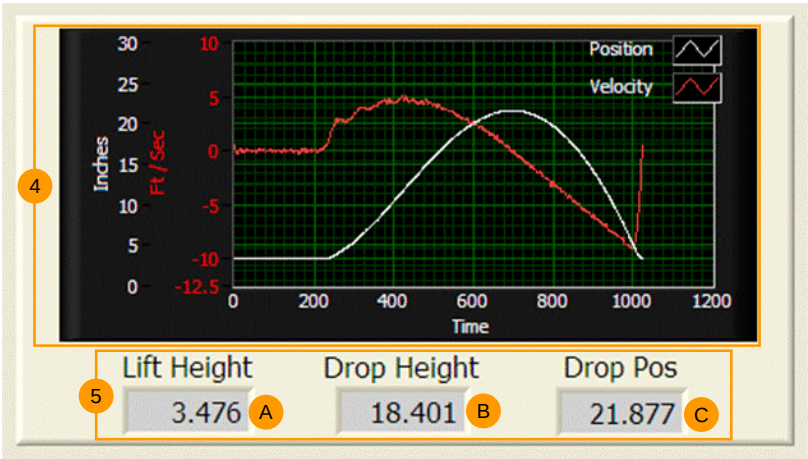
8. Start button – Initiates the operation of the compactor. Once clicked the file name is created and data collection is begun. The green indicator lightwill "turn on" when the compactor is running.

9. Run Time – Indicates the time that the compactor has been running.

When the software is first initiated the following screen appears:



While the compactor is running the following is shown:



1. Summary Table – Provides a summary of the data collected for each lift. A summary of the data is given below; average values are determined for all drops delivered to each lift.
   Drops – Total drops required to obtain desired energy
   Total Energy – Total energy delivered to the lift
   Avg Energy/ Drop – Average energy delivered per drop
   Avg Lift Height – Average height of specimen
   Avg Drop Height – Average freefall height of rammer per drop

2. Open Results Folder – Will automatically open folder where data files are stored.

3. Current File Name – Provides the file name for the specimen currently being compacted. File name is created when the Start button is clicked. File name follows the following format:
   yyyymmdd_hhmmss_SampleID_Specimen Name.txt

4. Current Drop Graph – Provides visual graph for the real-time position (white line) and velocity (red line) of rammer.

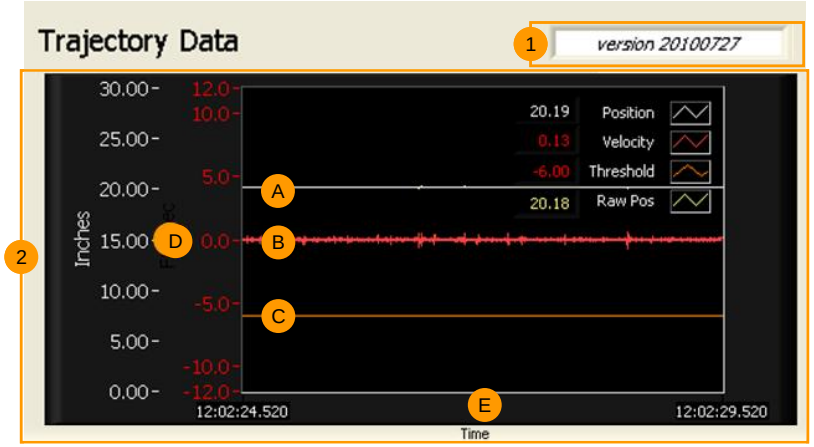
5. Summary Data – Provides data pertaining to the drop just completed.

   A. Lift Height – Position of rammer at maximum compaction of specimen.

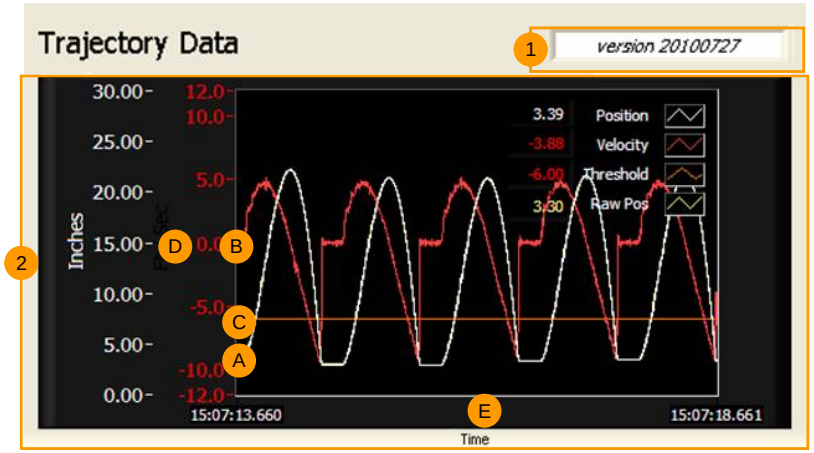
   B. Drop Height – Height of free-fall of rammer.

   C. Drop Position – Position of rammer just prior to release and free-fall.

When the software is first initiated the following screen appears:



While the compactor is running the following is shown:



1. Version – Provides the version of software currently in use. Should be in line with the version identified in Tex-113-E.

2. Trajectory Graph – Provides visual representation of the position and velocity of the rammer throughout the operation.

   A. Position – Denoted by the white line; indicates the position of the rammer throughout compaction.

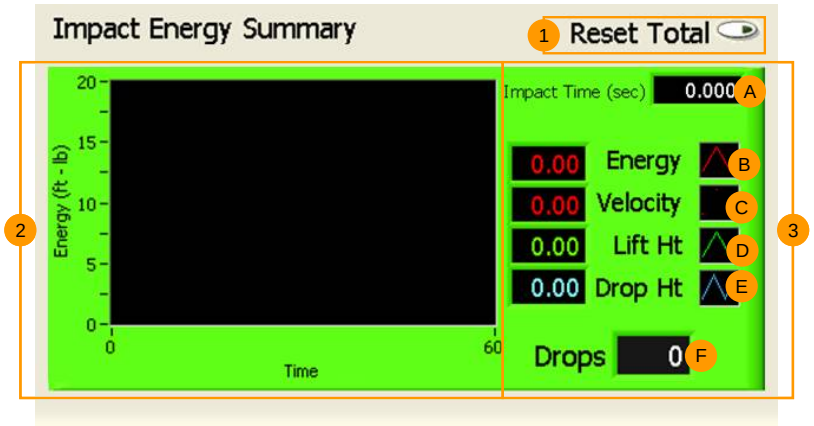
   B. Velocity – Denoted by the red line; indicates the velocity of the rammer throughout compaction.

   C. Threshold – Denoted by the orange line; indicates the minimum velocity that must be obtained by the rammer to produce a drop that is recorded.

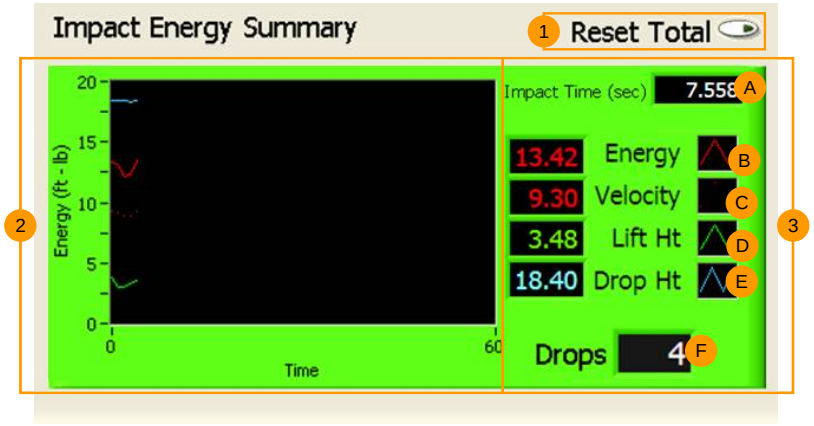
   D. Y-Axis – Scaled axis for the position (white) and velocity (red); the threshold shares the same scale as the velocity axis.

   E. X-Axis – Time scale, a minimum of 5 seconds is shown at all times while the software is active.

When the software is first initiated the following screen appears:



While the compactor is running the following is shown:



1. Reset Total – If clicked this button will reset the summary graph, total energy graph and individual data shown to the right of the summary graph.

2. Summary Graph – Provides visual representation for the data collected for each drop.

3. Individual Drop Data – Provides real-time values of data obtained for each drop. The data shown is described below:

   A. Impact Time – Time, in seconds, at which rammer impacted material being compacted.

   B. Energy – Denoted by a solid red line; indicates the energy delivered to the material by the rammer.

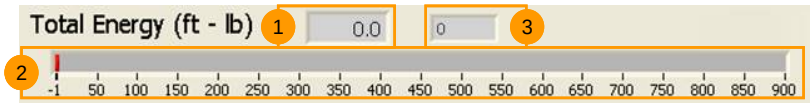
   C. Velocity – Denoted by a dotted red line; indicates the velocity of the rammer at time of impact.

   D. Lift Height – Denoted by a solid green line; indicates height of the specimen after compaction.

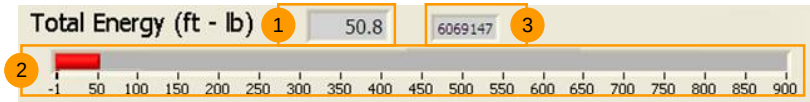
   E. Drop Height – Denoted by a solid blue line; indicates the free-fall drop height of the rammer.

   F. Drops – Provides the cumulative number of drops delivered to the material; acts as a counter for the rammer.

When the software is first initiated the following screen appears:



While the compactor is running the following is shown:



1. Total Energy Delivered – Displays the cumulative energy delivered to the material.

2. Total Energy Graph – Displays, graphically, the cumulative energy delivered to the material.

3. N/A

CREATING AND REVIEWING DATA FILES

This section provides an overview of the data files created by the software.

Data File Creation and Naming Convention

The SCA software was developed to make data file creation, data collection, and data retrieval as easy as possible. As previously described in the "Software Overview" section, the creation of the data file, collection of data, and powering up of the compactor are started simultaneously when the "Start" button is clicked. Each file created by the software is a tab-delimited text file with a unique name based on the date and time that the "Start" button is clicked. The actual file name can take two forms, as described below.

If desired, the operator may simply load material into the mold, lower the rammer onto the material, and click "Start." In this case, the data file that is created will simply consist of the date and time that the "Start" button is clicked. It will take the following form: yyyymmdd_hhmmss .txt.

However, to make differentiating files easier, the default file name format includes the Sample ID and Specimen Name and takes the form: yyyymmdd_hhmmss_SampleID_Specimen Name.txt. To ensure that the file name created provides adequate identifying information, take the following actions prior to starting the compactor. First develop a naming convention for samples and specimens. Second, prior to loading material into the mold, enter the "Sample ID" and "Specimen Name" into the corresponding data fields. These fields will accept any characters—alphabetical, numerical, or symbols; however, not all characters entered can be used in creating the file name. Any characters Windows does not allow in filenames will not be included in the file name. As an example, the % sign is not typically allowed; therefore, if "5.5%" is entered in the "Specimen Name" data field, the file name will only include the following characters: "55". The file naming convention is shown in Figure 9.

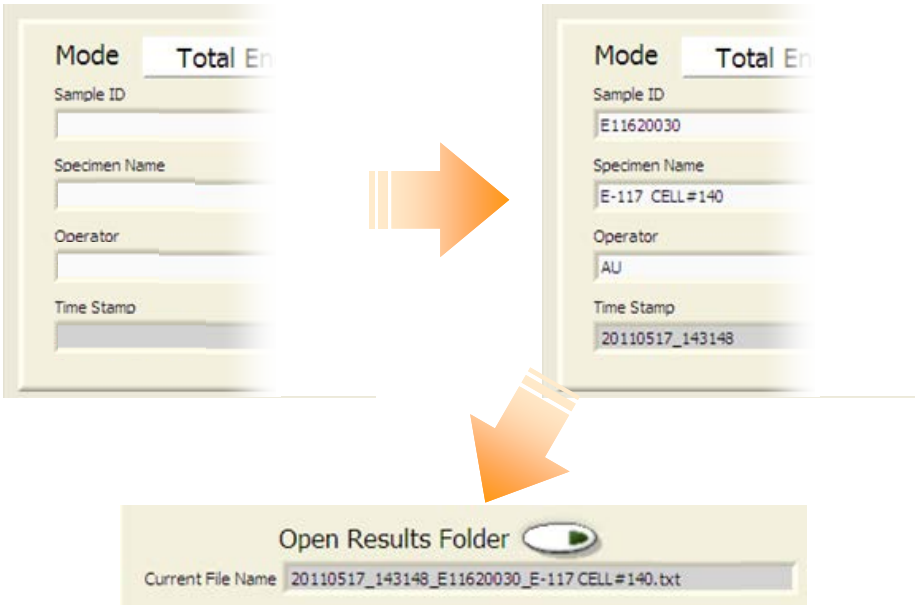


Figure 9 – File Name Data Fields

Data Collection

As previously described, data collection is initiated by clicking the "Start" button. The file created will be a tab-delimited text file.

Data Retrieval and Review

Data can be retrieved after having completed the compaction process. If desired after completion of a lift, the user may review the results from each drop of that lift by clicking the "Open Results Folder" shown in Figure 10. The "Current File Name" can be used to identify the recent file created for the specimen being compacted. The data folder is shown in Figure 11.

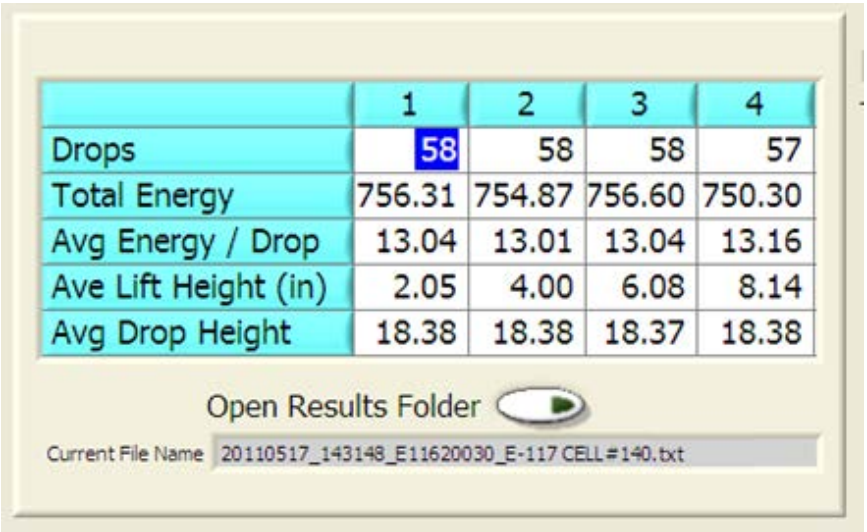


Figure 10 – Data Retrieval

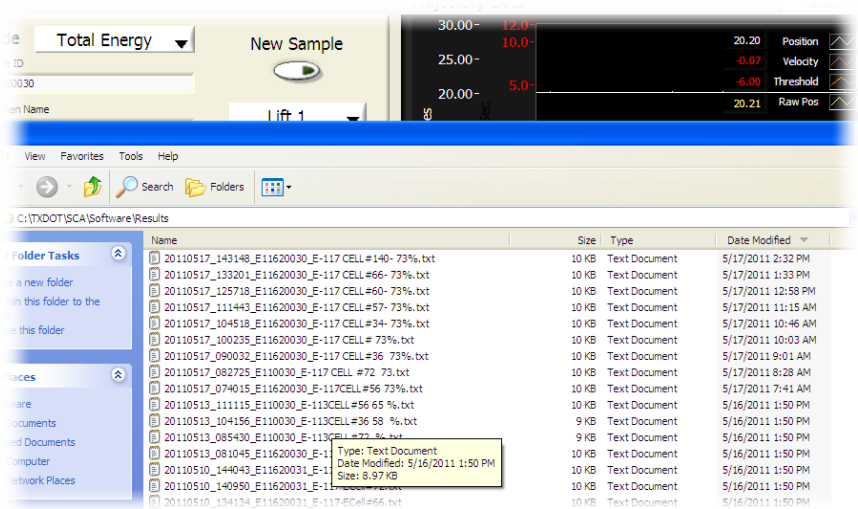
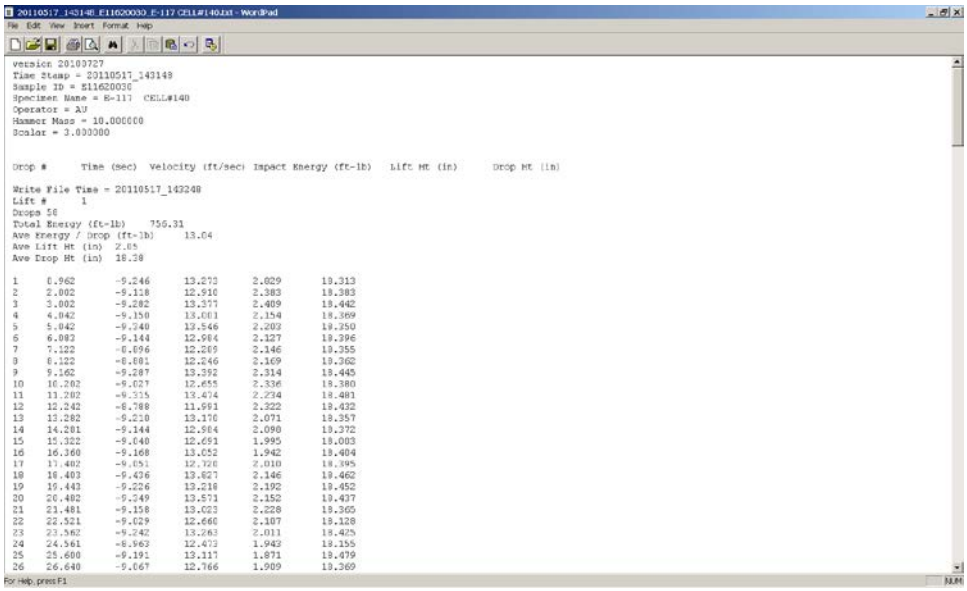


Figure 11 – Location of Data Files

Any file can then be opened by double clicking the desired file. Each file has a header with the basic sample and specimen data. The header is followed by a summary of the first lift's data. This is followed by the data for each drop. Each subsequent lift follows the same format. An example of this format is shown in Figure 12.



```
20110517_143148_E11620030_E-117 CELL#140.txt - WordPad
File  Edit  View  Insert  Format  Help

version 20100727
Time Stamp = 20110517_143148
Sample ID = E11620030
Specimen Name = E-117  CELL#140
Operator = AU
Hammer Mass = 10.000000
Scalar = 3.000000


Drop #      Time (sec)  Velocity (ft/sec)  Impact Energy (ft-lb)   Lift Ht (in)      Drop Ht (in)

Write File Time = 20110517_143248
Lift #      1
Drops 58
Total Energy (ft-lb)     756.31
Ave Energy / Drop (ft-lb)      13.04
Ave Lift Ht (in)  2.05
Ave Drop Ht (in)  18.38

1     0.962       -9.246      13.273      2.029       19.313
2     2.002       -9.118      12.910      2.383       19.383
3     3.002       -9.282      13.377      2.409       19.442
4     4.042       -9.150      13.001      2.154       18.369
5     5.042       -9.240      13.546      2.203       19.250
6     6.082       -9.144      12.984      2.127       19.396
7     7.122       -8.896      12.289      2.146       19.355
8     8.122       -8.881      12.246      2.169       19.362
9     9.162       -9.287      13.392      2.314       18.445
10    10.202      -9.027      12.655      2.336       18.380
11    11.202      -9.315      13.474      2.234       18.481
12    12.242      -8.788      11.991      2.322       18.432
13    13.282      -9.210      13.170      2.071       18.357
14    14.281      -9.144      12.984      2.090       18.372
15    15.322      -9.640      12.691      1.995       18.003
16    16.360      -9.168      13.052      1.942       18.404
17    17.402      -9.051      12.728      2.010       18.395
18    18.403      -9.436      13.827      2.146       19.462
19    19.443      -9.226      13.218      2.192       19.452
20    20.482      -9.249      13.571      2.152       19.437
21    21.481      -9.158      13.023      2.228       18.365
22    22.521      -9.029      12.660      2.107       18.128
23    23.562      -9.242      13.263      2.011       18.425
24    24.561      -8.963      12.473      1.942       18.155
25    25.600      -9.191      13.117      1.871       18.479
26    26.640      -9.067      12.766      1.909       18.369
For Help, press F1                                                                          NUM
```

Figure 12 –Data File Format