

Using the Instron Compression/Tensile Tester in Conjunction with the Environmental Control Chamber

Introduction:

The Instron compression machine and associated environmental control chamber are capable of performing compressive and three point bend tests at temperatures ranging from below negative twenty-five to over two hundred degrees centigrade. These tests require careful preparation by the operator to return useful data, but can be used to collect complete data for several test samples in a short period of time.

Definition of Terms:

Rams:

These are the parts of the compression tester that press on the sample. The upper ram is mobile and is connected to the load cell for the measurement of the load on the sample. The lower ram is stationary and this is where the ram thermocouple is attached. This thermocouple is used to ensure that the ram temperature is equal to that of the environmental chamber during testing.

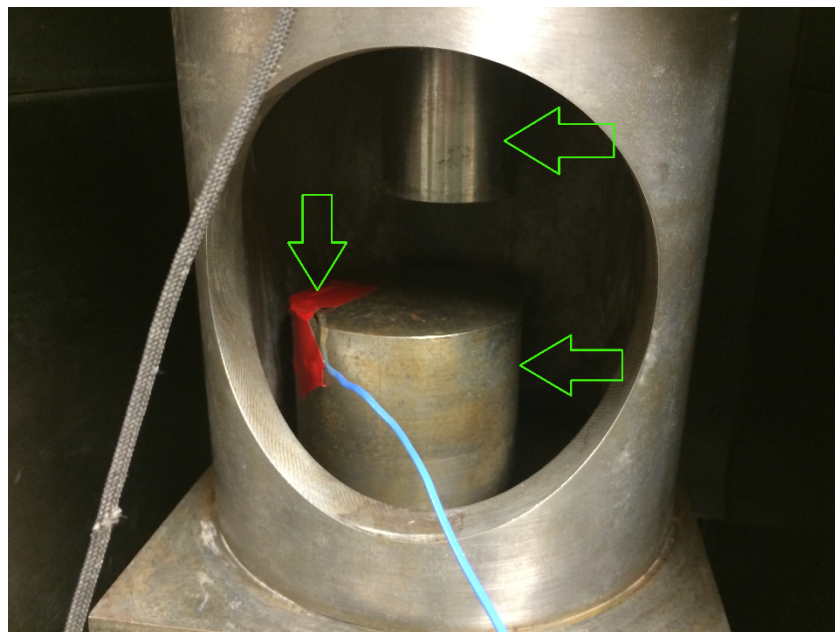


Figure 1: The labeled objects are the upper ram, the ram thermocouple, and the lower ram.

Load:

The load reading for the Instron compression/tensile tester is measured by a load cell attached to the upper ram. For compression tests the load will read as a negative value during compression. This is because with the compression yielding negative change in length (the sample is being squashed) the stress data will be positive with a negative load measurement.

During tensile tests the load and elongation are both positive, which yield a positive stress. This procedure will always refer to the load in the correct frame of reference (i.e. a greater negative load is below a smaller negative load).

Environmental Control Chamber (ECC):

This is the compartment that surrounds and controls the temperature of the test area. It has an individual start up procedure for tests above and below room temperature (25 degrees C). The upper and lower rams penetrate the ECC on the upper and lower face of the fixture, these areas have no environmental seal, but the specific testing area is partially secluded from the rest of the environment by a thick enveloping steel structure. Inside this structure the sample is placed on the face of the lower ram, and the upper ram is lowered from above by the operator. The upper ram is susceptible to freezing when the temperature nears 0 C because the ram actually moves through a tightly fitting steel sleeve in the upper region of the environmental chamber.

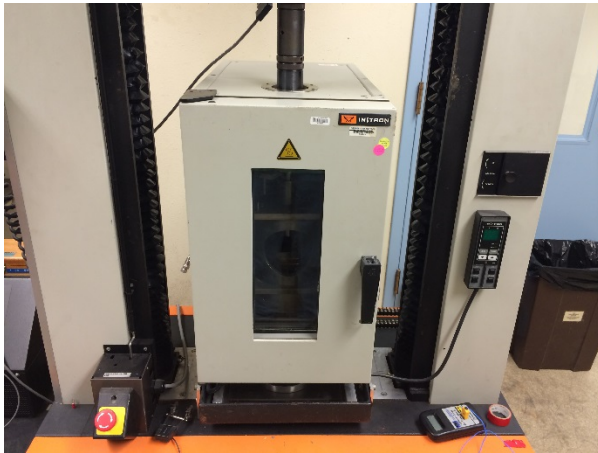


Figure 3: ECC closed.



Figure 2: ECC open.

Strain Gauge:

The strain gauge measures the motion of the upper ram relative to the lower ram. The strain gauge device is located inside the upper left hand portion of the ECC on the edge of the plate where the upper ram passes through the sleeved area. The strain gauge has a limited traverse and if the upper ram is moved too far it will detach from its supports and will need to be reattached and reset.

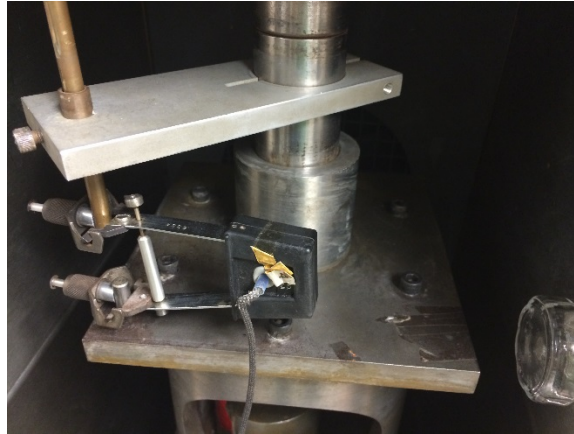


Figure 4: This is the strain gauge.

Relative directions:

All directions will be given assuming the operator is on the side of the setup with the ECC's door. This is the 'front'. The Instron control and data collection computer is to the left side and the exit of the room is on the right.

Test Shield Assembly:

This is the enclosure inside the ECC where the sample sits between the two rams. This partially protects the ECC from explosive fracture events, and keeps fragments of the test sample from

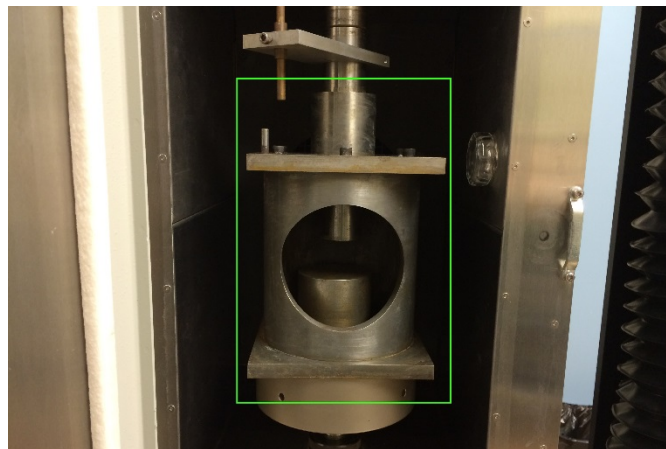


Figure 5: TSA is outlined in Green.

being flung into the heating elements and fan.

Special Considerations: Temperature

Mid-range temperatures:

In the temperature ranges from five to forty degrees Celsius no particular considerations need to be taken. Burns and frostbite are actually impossible in this region so simple laboratory gloves should be worn to keep from contaminating the sample. Whenever the cooling feature is being used on the ECC a ventilation fan should be set up to circulate fresh air into the test room. It is possible that the excess nitrogen could displace more of the oxygen in the air and unsafe conditions could be generated. A fan mitigates this risk.

Freezing:

When the temperature inside the environmental chamber drops very close to zero, condensation of water and freezing of components becomes an issue. To combat this it is prudent to plug the top opening of the chamber with paper towels. This is best done as the chamber cools, which for temperatures such as these takes a long period of time. The problem of frozen components is unfortunately unavoidable at this temperature, when the test is being preloaded the load cell cannot differentiate in between load on the sample and load used to break the ice in the sleeved ram segments. This load usually stays around fifteen pounds of negative force while the ice is being defeated and when the load suddenly jumps below thirty pounds of negative force the ram is likely compressing the sample.

It is preferable to not do tests at precisely 0 degrees because the water in the environmental chamber will constantly be freezing and melting at the slightest provocation which makes data collection difficult. The upper ram freezing in its sleeve can cause problems at the end of a freezing test because the sleeve is attached to the test shield assembly which is not permanently anchored to any structure. As upper ram is pulled upward it can actually bring the shield assembly upwards with it, which does not actually free the sample because the lower ram rests inside the shield assembly. If the shield assembly is allowed to be pulled upward slightly, then a bare hand grasps the sleeved upper ram segment the transfer of heat will very rapidly (less than five seconds) melt the ice adhering the ram to the sleeve and the assembly will drop free. This can only be done at freezing temperature, any colder and frostbite will set in in seconds. Fortunately this has not been observed to be a problem at lower temperatures.

Sub Zero:

For temperatures substantially cooler than freezing the condensing water actually freezes before reaching the sleeved upper ram section. It does, however, start fogging very heavily inside the chamber. After closing the door to the chamber wait for the air to clear of before proceeding. The chamber will likely detect an increase in temperature and trigger the nitrogen injection system (possibly while the door is open) and the sample will not be visible for several seconds. It goes without saying that at these temperatures it is important to wear thermally protective gloves. Not only does it protect the operator from the bitterly cold

surfaces (they will freeze fingers to them nearly instantly) but also protects the sample from thermal effects of being handled. If a polymer sample is being tested in this region it is possible to observe explosive fracture of samples. These will manifest as a very loud, percussive 'bang' as the sample partially disintegrates and spreads itself about the chamber. It is necessary to thoroughly clean the chamber after such events. The fragments will have scattered all over the chamber and all of the seals and crevices must be cleaned out.

High:

At temperatures above forty Celsius the interior surfaces will become hot enough to induce burns. It is now important to use tongs or gloves when handling the sample as the ECC has many steel surfaces that interfere with hand motion. Do not touch the sample with bare hands, it is too hot to handle safely. Consideration must be given to the fact that polymer samples will expand substantially during heating. Do not rest the upper ram just above the sample, allow several millimeters of separation or high positive loads will build up on the sample. At these temperatures explosive fracture is unlikely.

Operating the Environmental Control Chamber (ECC): At or above room temperature

1. The ECC's power switch is located on the rear (opposite of the door) face on the lower left hand side. Flipping this to the 'on' position provides power to the chamber.
2. The chamber is controlled by a digital readout/control panel magnetically attached to the right side support column of the Instron machine. It has eight buttons:
 - a. Up and down arrows: Control the temperature setting of the ECC. Use these to set the desired temperature for the test.
 - b. 'Enable': This activates the ECCs temperature control program. Either heating or cooling the test chamber until the desired temperature is reached.
 - c. 'Fan': This activates the circulating fan inside the ECC. It is probably advantageous to use this for any test not at room temperature.
 - d. 'Light': there is a small light inside the test chamber for illumination during the test. It is helpful, but the light is blocked by the shield assembly. A flashlight with a very small source is helpful for observing the test area itself.
 - e. 'Cool': This allows the ECC to draw coolant from an attached liquid nitrogen (LN) tank and cool the chamber.
 - f. 'A/M': This toggles the control of the temperature between automatic and manual. This should be left on automatic.

- g. "PAR": This toggles the parameter displayed on the LCD screen. This is unnecessary for most operations and should be left alone.



3. The readout/controller also has two rows of LCD display. The top one shows the actual temperature inside the chamber, the bottom shows what the temperature is set to.
4. To heat the test chamber, turn it on and input the temperature you wish to test at. Then press 'Enable' and 'Fan' to start the heating process. When the lower ram thermometer reads the test temperature the test can proceed.
5. After the tests are complete press the 'Enable' button to deactivate the ECC and flip the power switch to off.



Figure 6: This is the back of the ECC. On the left is the power switch. On the right the Coolant Inlet, where the liquid nitrogen transfer hose is connected.

ECC Operation: Low temperature

1. Acquire another person to help move the liquid nitrogen container. Completely full it can weigh over two hundred kilograms (four hundred and forty pounds) and cannot be moved safely by a single person. Move the tank near to the rear of the machine and rotate it so the output hose connection is facing the back of the ECC.
2. Using a large adjustable ('shifting' or 'crescent') wrench attach the liquid nitrogen transfer hose to the liquid nitrogen container. Tighten this connection firmly, but put no excessive load on it.
3. Attach the other end of the liquid nitrogen transfer hose to the brass coupling on the lower right side of the rear face of the ECC. Tighten this connection firmly as well.
4. Open the valve by twisting the handle above the LN transfer hose counter-clockwise. Turn the valve through several full rotations to assure it is fully open.
5. Turn on the ECC and input the desired test temperature.
6. Press 'Enable', 'Fan' and 'Cool' to start the cooling process.
7. Allow the lower ram thermometer to come to temperature (this can take hours), and the test can proceed.
8. When the test series is complete press the 'Cool' button to stop the flow of nitrogen from the tank.
9. Using a thermally protective glove close the liquid nitrogen valve.
10. Set the temperature on the controller to above sixty degrees and allow the ECC to heat up. During this time water will be condensing inside the ECC, this must be wiped out to prevent rusting of the steel components. The chamber must be attended until all components have warmed to above the dew point and stop condensing water. The nitrogen transfer hose also condenses water and risks dripping onto electrical connections behind the Instron machine.
11. When the chamber has warmed up and been dried, detach the nitrogen transfer hose from the ECC then from the nitrogen tank.
12. Shut down the ECC as before.

Running the Instron testing machine:

1. Power on the control computer. It is located to the left of the Instron machine on the desk.



Figure 7: It is running Windows XP.

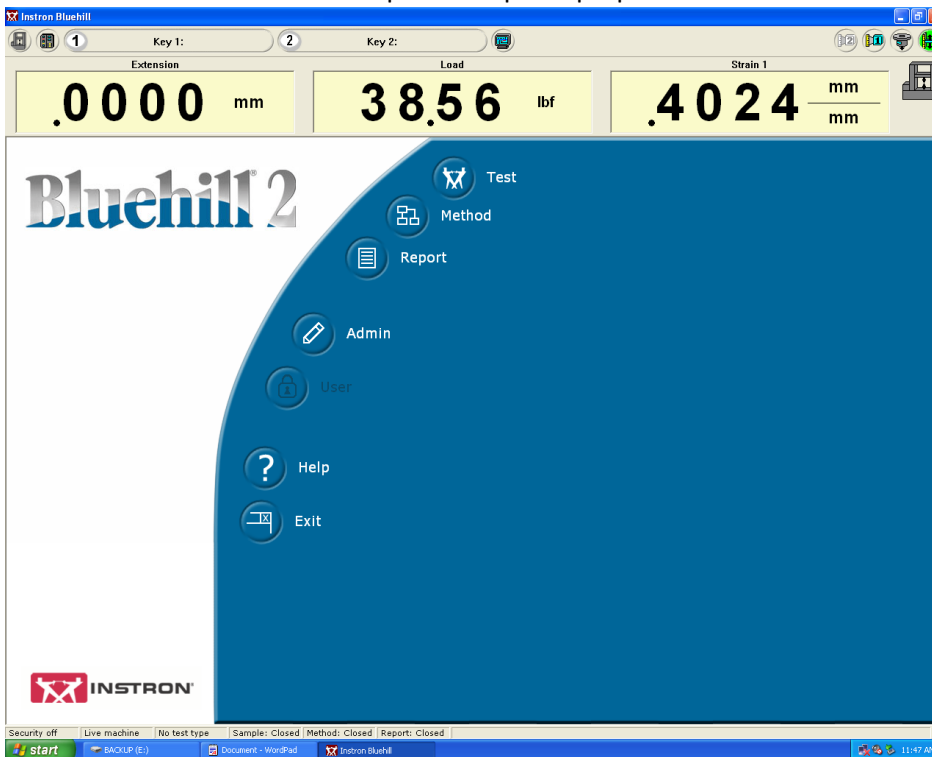
2. Power on the Instron machine by switching the Instron Power Box to 'on'. The selector switch should be set to 'low clutch'.



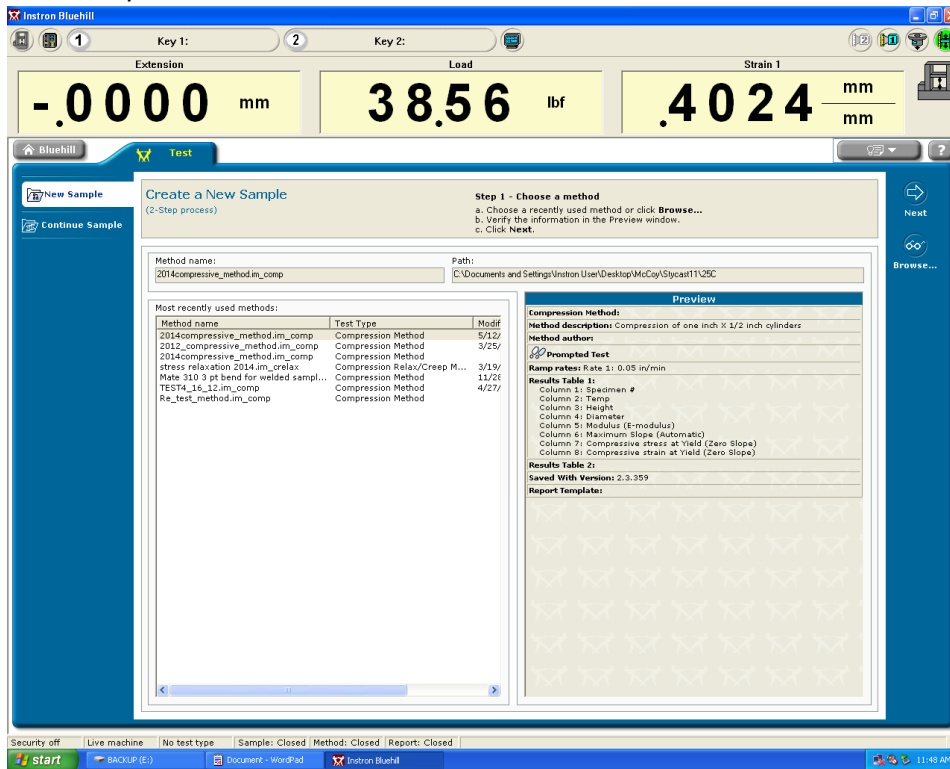
3. Open the 'Bluehill' shortcut on the desktop. This will start the Instron machine.



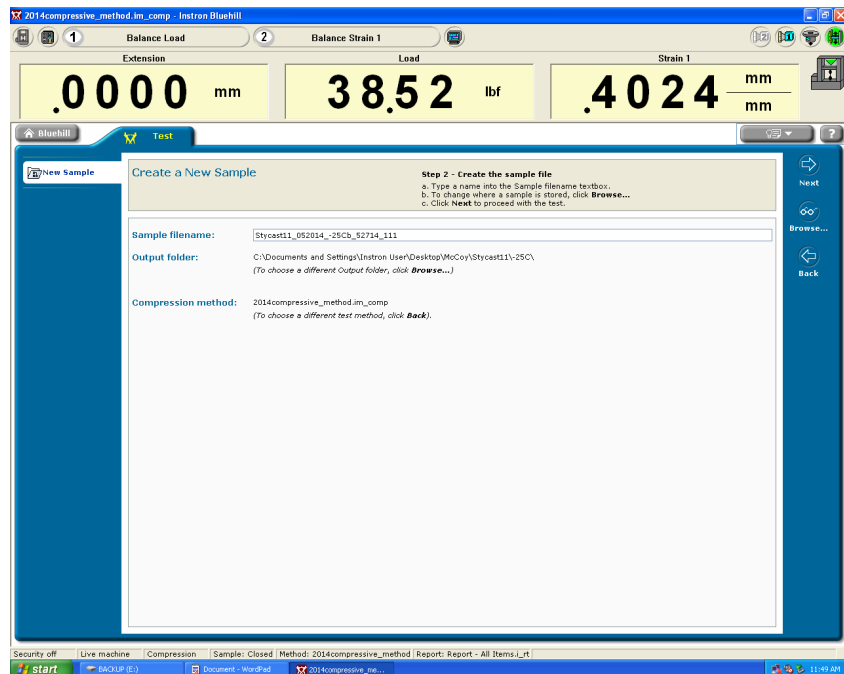
4. On this screen select the 'test' option to open a prepared test or 'method' to create a new test.



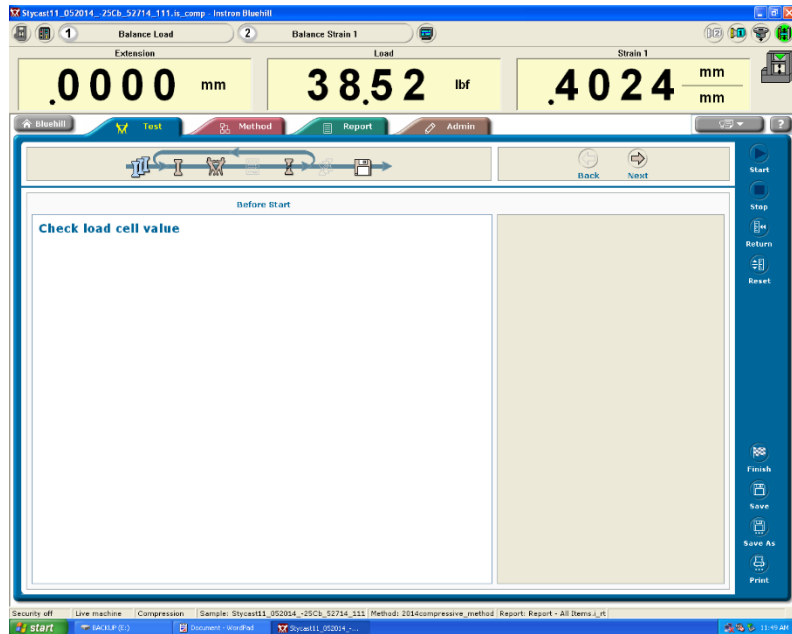
5. This screen allows you to select which test you wish to run from a list of premade procedures. This is available after selecting 'Test' on the previous screen. Selecting a test and pressing 'Next' advances you to the next screen.



6. This screen is where you set the save location of the test you are about to do. The standard notation is "material_date of test_temperature of test_BatchIDnumber_specific test number".

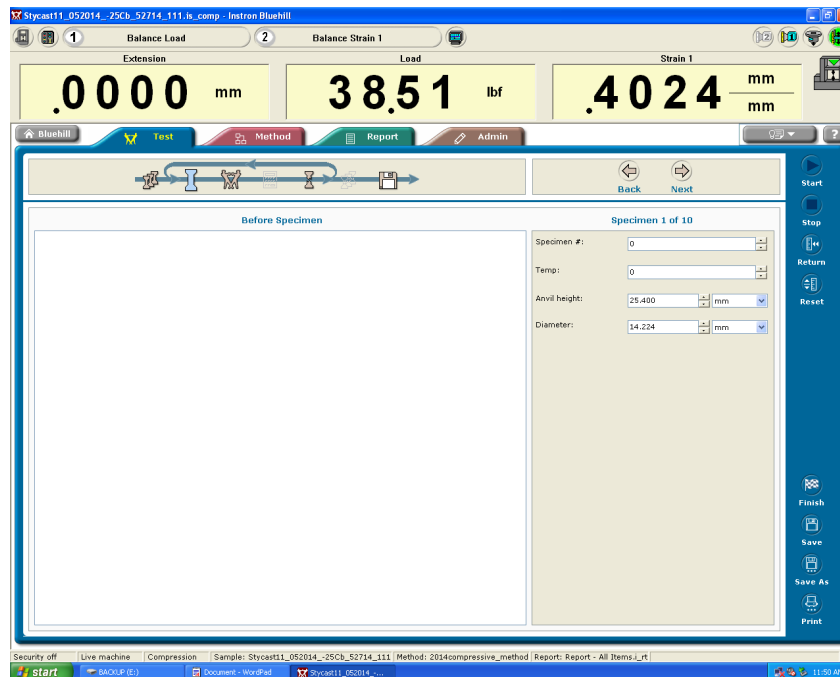


7. This screen shows you the first step of the test process. Here you should look at the load indicated and see if it is insane. If it reads nine thousand, there are problems. Here it reads thirty-eight which is fine. If you click the 'balance load' button it will be set to zero, but this is not necessary. If it does say some extreme number (over two hundred) consult someone for

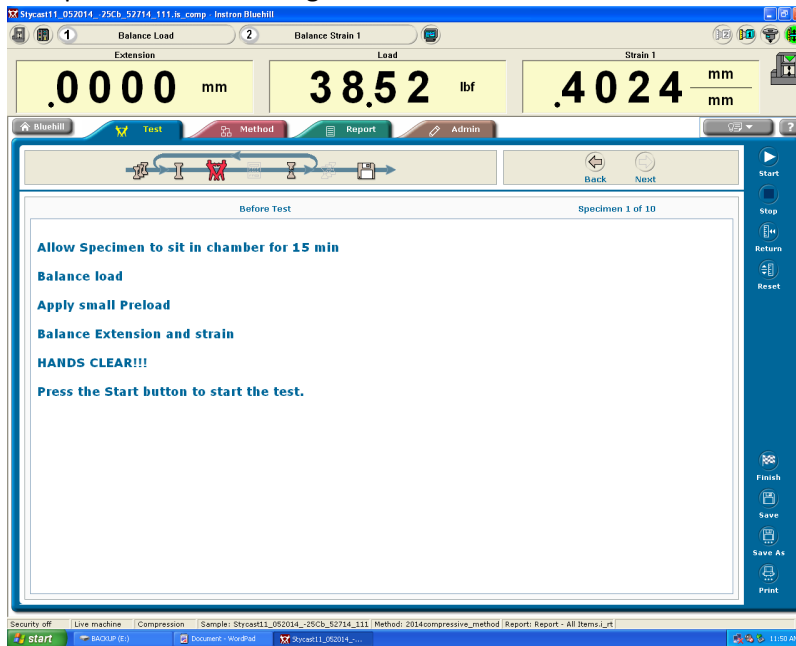


help with the machine. Press next.

8. This is where you input the specimen data. The length and diameter are possible inputs, with the drop down menus selecting the units of measure (inches or millimeters). You can also identify the sample by number. Inputting the data allows you to start the test.



9. The next screen contains test specific instructions. Follow them to complete the test.
 - a. 'Balance load' zeroes the load and allows you to accurately apply a small preload to the sample before continuing the test.



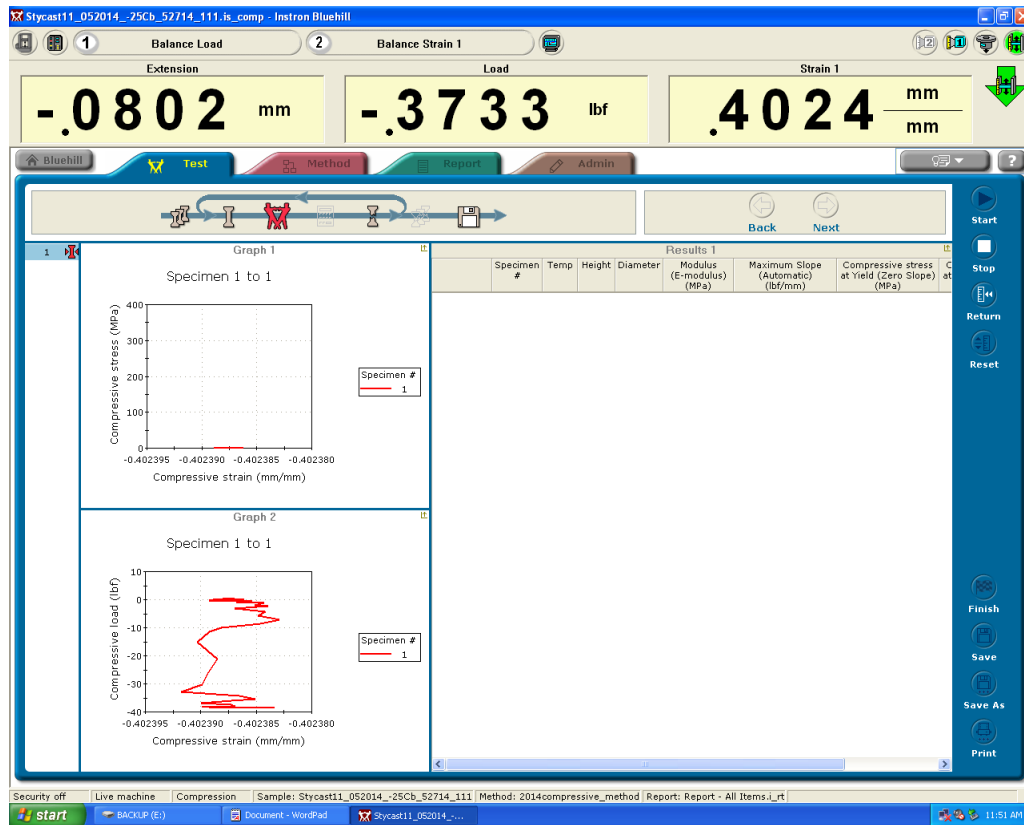
10. Applying preload.

- a. Using the Control Panel attached to the left arm of the Instron machine slowly lower the upper ram until it makes contact with the top surface of the sample. It is advisable to use the 'Jog down' button to make the upper ram drop quickly. Care is required, however, because this feature involves a "spool up time" where the ram starts moving slowly, then speeds up very quickly. UNDER NO CIRCUMSTANCE WILL ANYONE EXCEPT FOR THE PERSON OBSERVING THE SAMPLE EVER USE THE RAM MOVEMENT CONRTOLS! This is for safety.
- b. The 'Fine Position' wheel moves the upper ram fractions of millimeters per tick. This is used to apply the small preload [approximately 9-20 pounds downward force].
- c. 'Stop Test' This button does exactly what is expected of it. It stops the test immediately



and allows the program to finish collecting data normally.

11. Once the strain is zeroed, the load zeroed and the sample is under the small preload, the test can proceed. The next photo shows the interface that is on screen during a test. It features a



real time load versus strain and a stress vs strain graph. On the right the results of previous tests will be shown and on the graphs the previous tests' data will be displayed. If at any time the test needs to be stopped pressing the 'Space Bar' on the keyboard, left or right clicking the 'Stop' button, pressing 'Stop Test' on the control panel, or pressing the large red emergency stop button on the front of the Instron will all stop the test immediately. The emergency stop button can generate a loss of data and will crash the program, but if the situation requires it, no damage will be done to the machine by using it.



Figure 8: Only press it if you need to, but don't hesitate if you do.

12. When test is complete (gathered the intended data) press 'stop' to stop the test and then 'next' to move onto the specimen notes screen.

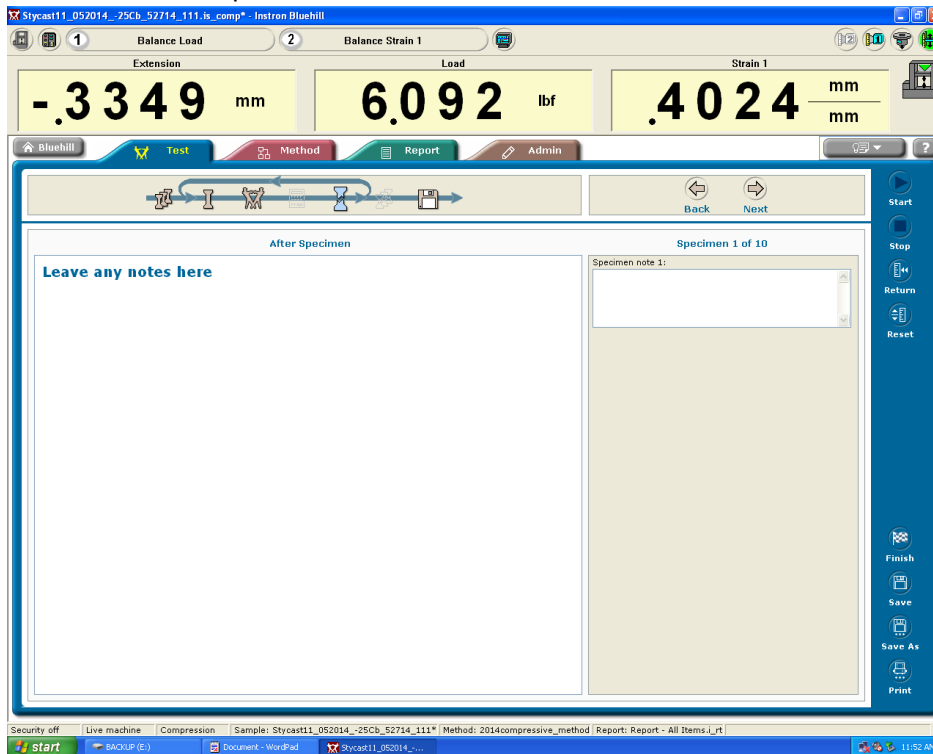
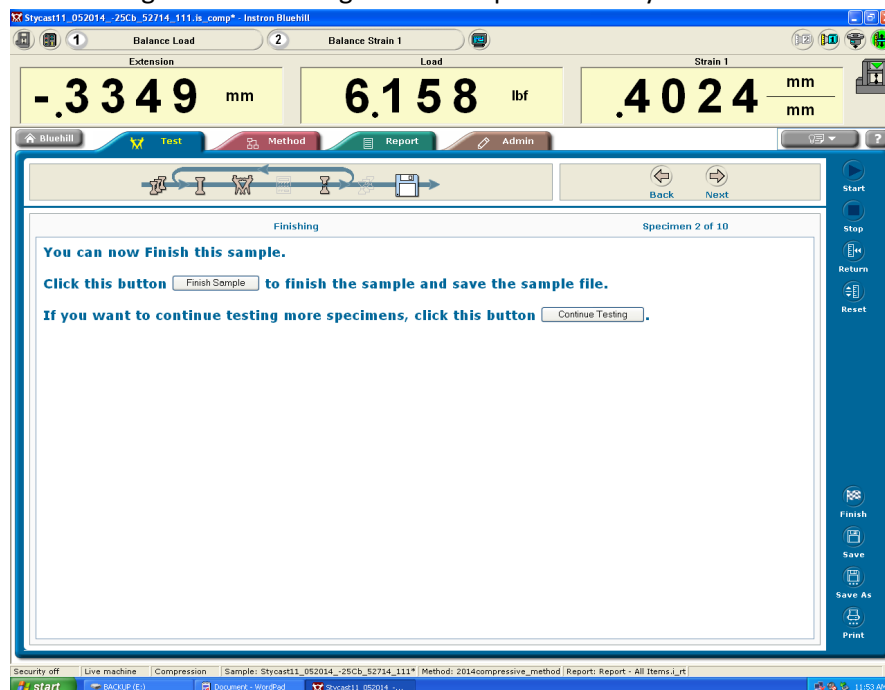


Figure 9: If something went horribly wrong, this is where you would make note of it.

13. At this point you can either press 'Next' which will take you back to step 8 and let you run another test or, if you are finished with collecting data you can press 'Finish' which will take you to the following screen. Pressing 'Finish Sample' will end your test series and allow you to quit.



14. To operate the Instron in conjunction with the Environment Control Chamber, read the ECC instructions and apply them as necessary to the Instron testing procedure.



Figure 11: Nitrogen Transfer Hose.

Figure 10: This is the wrench needed to attach the nitrogen transfer hose to the tank and ECC.

Reference Photos:

