Standard Operating Procedure For The Instron Machine

I. Introduction

This standard operating procedure is designed as a reference tool to help students and faculty become familiar with the Instron machine quickly and easily. After reading through this manual you should be able to use the machine to run simple tensile and compressive loading experiments. The system manual, which is written by the Instron Corporation, contains a comprehensive description of the machine and should be read before attempting experiments outside the scope of this standard operating procedure.

After using the Instron always remove all grips and fixtures and store them in the cabinet where they were found. Also, clean up any other mess that may have been created. If you must reserve use of the system please check with Chris Schilling to obtain permission and then leave a note on the machine describing this arrangement.

II. Caution and Warning Statements

The Instron machine can be severely damaged if used improperly. Specifically, the load cells are very expensive components and are easily damaged if loaded beyond their maximum allowable limits. For this reason it is recommended that you seek advice from experienced faculty when unsure of any procedure. Also, if any part of the machine appears to be in use or out of place, seek assistance from authorized faculty and do not attempt to use or repair the equipment. Pay special attention to all caution statements and notes.

Emergency Shutdown: The system can be shut down for any emergency by moving the main power switch to the off position.
III. System Components

You should familiarize yourself with the following components before reading the rest of this manual or attempting to use the machine.

LOADING FRAME (figure 1)

1. Loading Frame - the superstructure containing the testing area and the drive mechanisms that supply the testing loads.

2. Crosshead - element within the loading frame which holds the load cell and moves vertically to apply the load.

3. Load Cell - a finely calibrated transducer which is attached to the crosshead and provides precise measurement of the applied load. This is a very expensive and fragile component. Special care should be taken to ensure the load limits of a particular cell are not exceeded.

4. Upper Grip Coupling - allows connection of sample mounting grips and fixtures to the load cell.

6. Leadscrews - threaded rods located within the loading frame which transfer movement from the electric motor to the moving crosshead.

9. Preload Nuts - located on the underside of the crosshead. These must be set properly for a tensile or compressive load (see section VI).

12, 13, 14. Adjustable Upper and Lower Limit Stops and Limit Switch Rod - the combination of these components allows the operator to set manual limits to the travel of the moving crosshead. Setting upper and lower limits provides a safeguard against damage to the Instron or any specific components because programmed limits were incorrectly set or malfunctioning (see section V).

15. Base Grip Adapter - couples sample mounting grips and fixtures to the base of the testing area.

26. Load Frame Control Panel - this panel contains the Main Power switch and JOG buttons. The JOG buttons allow the operator to move the crosshead up and down when installing grips and fixtures and test samples.

Caution: When using the JOG buttons to move the crosshead be very careful not to damage the load cell by inadvertently loading the cell incorrectly.
The CONTROL CONSOLE (figure 2) is divided into 4 parts

- **Limit Panel** - this section contains keys which are used to set electronic limits for the load, strain, and crosshead extension.

- **Display Panel** - this section contains displays of the load, extension, and strain. The keys in this panel allow the operator to choose options related to these displays.

- **Recorder Panel** - the keys in this section of the control console allow the operator to customize the output signal sent to peripheral recording devices such as a strip chart recorder or a computer.

- **Basic Control Panel** - this section includes keys that are used to stop and start a test. Pay special attention to the location of the STOP and the RETURN keys. These keys can be pressed at any time to stop a test and ultimately stop the crosshead movement.
IV. Display Units

The Basic Control Panel has an indicator that displays the load, extension, and speed with user-specified units. The SI system is usually already selected, however, metric or English units can be selected by adjusting the toggle switch on the back of the console when the console power is off. The following table shows the units displayed by the Control Console for each unit selection:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>English Units</th>
<th>Metric Units</th>
<th>SI Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>Pounds (lb)</td>
<td>Grams Force (GF)</td>
<td>Newtons (N)</td>
</tr>
<tr>
<td>Extension</td>
<td>Inches (in)</td>
<td>Millimeters (mm)</td>
<td>Millimeters (mm)</td>
</tr>
<tr>
<td>Speed</td>
<td>Inches/Minute</td>
<td>Millimeters/Minute</td>
<td>Millimeters/Minute</td>
</tr>
<tr>
<td>Strain</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
</tbody>
</table>
V. Getting Started: Controlling the Crosshead

The operator should be confident in the knowledge and practice of moving the crosshead. After reading this section practice moving the crosshead using the JOG keys and the Basic Control Panel keys. If you are not comfortable with this aspect of the Instron do not try to use the machine and ask an experienced user for more help.

Turn On the Instron

Both the control console and loading frame units are turned on with the power switch on the front of the loading frame. When turned on the Instron will automatically perform a Self Test Routine which should be monitored to be sure the system is operating properly. During the self test the operator should observe the following sequence of events:

1. All of the LED indicators should light and the displays should read ",-1.8.8.8,'.
2. All of the indicators and displays should go out or blank.
3. The main display will show 9393, which is an indication that the self-test was successfully completed.
4. The indicators and displays will show the conditions of the system stored in memory since the last time it was used.

Caution: If a number other than 9393 appears for step #3 above then there is a malfunction in the system. In this case do not attempt to use the Instron and refer to section 6.5 of the Instron Manual to determine the cause of the self test failure.

Set the Gage Length

This sets the display for the crosshead extension to zero. This zero position is the position that the crosshead will return to when the RETURN command is initiated either electronically or manually. The AT G.L. indicator flashes whenever the gage length is not set and remains on when the crosshead extension is zero.

To set the gage length first note the current position of the crosshead and then press the G.L. RESET key. The EXTENSION Display should now read zero and the AT G.L indicator will stop flashing and remain lit.

Set the Upper and Lower Limit Stops

Caution: This is a very important safety precaution that should be taken before starting any test.

The upper and lower limit stops protect the system against improperly set limits or malfunctions that could severely damage the load cell or the test sample.
The upper limit stop should be set just beyond the expected maximum travel of the crosshead for tension testing and just above the actuator when compression testing. The lower limit stop should be set just below the actuator when tension testing and just beyond the maximum expected travel of the crosshead when compression testing. Be sure the limit stops are tightened securely to the switch rod.

**Set Electronic Limits**

The upper panel on the control console allows the user to electronically set test limits for one or more of the following: the load, the strain, or the crosshead extension. In general the action of the crosshead can be controlled by setting maximum and minimum process variables. For example the crosshead can be set to stop moving if a certain maximum load is reached. The limits can be set for a maximum or minimum value of load, extension, and strain. The crosshead action can be set to one of four selections: off, stop, return to the gage length, or cycle between a minimum and maximum value. The operator has the option of setting all of the limits or none at all. Another available option is the BREAK key. When pressed the operator can select the action to occur if the sample breaks.

To set an electronic limit first select the limit by pressing the corresponding key. The indicator will light and the main panel display will show a previously stored value. Use the numeric keypad to set the desired limit value; the display will begin flashing. When finished press enter; the display will stop flashing and show the limit value. Next choose the crosshead action by pressing the desired key. The indicator lights below the break and limit keys will remain lit when a limit in any of these areas has been set.

See the practice exercise at the end of this section for an example of setting a maximum extension limit.

**Set Crosshead Speed**

This function sets the speed at which the crosshead travels in millimeters per minute (or inches per minute if English units are selected) only when the Basic Panel Control keys are used to control crosshead movement.

To set the speed press the key labeled SPEED on the Basic Controls Panel. A previously set value will be shown in the Basic Panel Display. Use the numeric keypad to enter a desired rate. The new rate will be flashing in the display. Finally press enter and the new rate will stop flashing and remain in the display indicating a successful change. This crosshead speed can be changed at any time during a test.

The range of allowable crosshead speeds is 0.05 - 500mm/min (0.002 - 20in/min).
Using the JOG Keys

**Warning:** Pay close attention to the crosshead position when using the JOG keys to avoid damaging the Instron.

The crosshead can be moved manually by pressing the JOG buttons on the Load Frame control panel.

To move the crosshead press the up or down JOG button. The crosshead will begin to move very slowly at first and then accelerate to a maximum speed.

Using the Basic Control Keys

**Note:** Be sure that all manual and electronic limits have been set and a reasonable crosshead speed has been entered before using this method to move the crosshead.

The keys marked STOP, RETURN, UP, and DOWN located on the Basic Control Panel are specifically used to control the starting and stopping of a tensile or compressive loading test but can also be used to move the crosshead at any other time.

Movement is started by pressing the UP or DOWN keys and will proceed at the set speed until the STOP or RETURN key is pressed or a manual or electronic limit is reached.

**Caution:** The crosshead will return to the gage length when the RETURN key is pressed.

Practice Exercise

The following exercise is intended to show how the Instron reacts to electronic and manual limits and provide a step by step example of using the Basic Panel Control keys.

**Note:** The Instron should not be loaded with a sample when following these instructions.

1. Turn the system on and check the Self Test routine for any malfunction.

2. Move the Limit Stops to the ends of the Limit Switch Rod.

3. Use the JOG buttons to move the crosshead up and down noticing how the crosshead responds. The position the crosshead in the center of the load frame.

4. Press the G.L. Reset key. The AT G.L. indicator should stop flashing and the Extension Display in the Display Panel should read zero.
5. Set the Limit Stops about 2cm above and below the Limit Switch Actuator.

6. Press the EXTENSION MAX. key on the Limits Panel. Use the numeric keypad to make the Basic Panel Display read 10mm (10.00) and then press enter.

7. Select the crosshead action by pressing the RETURN key on the Limits Panel.

8. Press the SPEED key on the Basic Control Panel. Use the numeric keypad to make the Basic Panel Display read 5mm/min (5.00) and then press enter. The display should stop flashing and continue to read 5.00.

9. Press the UP key on the Basic Control Panel and notice that the crosshead begins to move up and the extension display shows an increasing value. Press the STOP key on the Basic Panel Display before it reaches an extension of 5mm. Notice that the crosshead stops and the Extension Display shows the distance traveled.

10. Press the UP key again and notice that the crosshead begins moving upward and the extension display begins to increase again from the point where it was stopped. Press the RETURN key on the Basic Controls Panel before reaching an extension of 10mm. Notice that the crosshead moves back to the gage length position and that the extension display again reads zero.

11. Press the UP key again and allow the crosshead to move past 10mm. The crosshead should return to the gage length when the extension reaches 10mm corresponding to the electronic limit set previously. If it does not press the STOP key and check to see that the limit was set correctly. If a reason can not be found then seek help.

12. Reset the extension limit to a distance beyond the Limit Stops.

13. Press the UP key and let the crosshead move until the actuator runs into the Upper Limit Stop. The crosshead should stop.

14. Press RETURN on the Basic Controls Panel. The crosshead should return to the gage length.

This concludes the exercise in moving the crosshead.
VI. Setting Up a Test

Selecting and Installing a Load Cell
The MSE Department currently has a 1kN and a 50kN load cell.

**Caution:** Selecting the proper load cell is of paramount importance because these components are very fragile and especially expensive. Be very careful to be sure the load cell you select has a maximum load limit above the expected maximum load desired for a test.

The maximum tensile (or compressive) strength of the sample should be calculated to determine the required capacity of the load cell. This can be done for most materials by multiplying the ultimate strength by the cross sectional area of the sample. An appropriate load cell should then have a maximum load capacity greater than the maximum strength of the sample.

If more than one load cell is available that can handle the required maximum load then the following considerations can also help select the best cell:

1. choose a higher-capacity load cell whenever a minimum of deflection is desired.
2. choose a lower-capacity load cell whenever a maximum long term balance or stability is desired.

**Caution:** Be very careful when handling a load cell outside of its storage case or the crosshead.

To install a load cell carefully set it in the cell hole in the crosshead. It is suggested that the bolt holes be aligned so that the pin holes for connecting sample grips at the bottom of the cell are at 90 degrees to the front of the crosshead. This will make installing grips and samples easier. Thread and tighten the allen bolts in a star pattern only until snug. It is not necessary to torque these bolts very much so do not over tighten. Finally, plug the signal cord from the load cell into the DIN socket marked "To Load Cell" on the backside of the moving crosshead. Load cells should always be stored in their plastic cases when not in use.

**Setting Preload Nuts**
The preload levers must be set correctly for a tension or compression test (a Tommy bar is used to loosen or tighten the preload nuts). On the underside of the moving crosshead are the preload nuts and indicating arrows which show the direction to turn the nuts for each test. When setting for a compression test the preload nuts should be snugged slightly in the direction indicated. When setting for a tension test turn the preload only until loose in the direction indicated. Refer to section 6.11 of the Instron Manual Supplement for model #4204.
Selecting and Installing Grips and Fixtures

There are several options available for mounting samples. The style of grips and fixtures is selected based upon the geometry of the sample and the type of test to be performed. See the Instron Manual for help in selecting and installing the different types of grips.

VII. Conducting a Test

Caution: Do not assume that the Instron is already setup properly to do the test you want to do or that a load cell already installed in the crosshead is appropriate for the conditions of your test. Take the time to check the machine so that it is not damaged. Also, calculate the expected maximum tensile strength of the sample before attempting a test to be sure the load cell capacity is not exceeded.

Calibration and System Balance

It is recommended that the load cell be calibrated before doing a test.

The cell is electronically calibrated by pressing the LOAD CAL key. The indicator above this button will light and the main panel display should show the maximum capacity of the installed load cell. Next, the ENTER key is pressed and after a few seconds the LOAD CAL indicator will go out and the display will go blank. The electronic calibration is now complete. There are weights located in the accessories cabinet that can be hung from the cell to check the calibration. The Load Display on the control console should be correct within a few percent.

Note: The Instron does not need to be re-calibrated if grips and fixtures are installed or changed after calibration of the load cell. However, a system balance should be performed to cancel out the tare weight of the grips and fixtures. This balance is automatically performed when the system is calibrated with the grips and fixtures in place.

To balance the system after installing or changing the grips and fixtures press the LOAD BAL key. The indicator should light. Next, press enter and after a few seconds the balance will be completed and indicated by the LOAD BAL lamp going out and the load display reading zero.

See section 7.7 of the Instron Manual if the calibration or balance procedures do not proceed as described above.

Installing the Sample

The JOG buttons on the front of the loading frame are used to position the crosshead when installing a test sample. It is important that the operator be very careful...
when moving the crosshead in this way so that the sample, grips and fixtures, or load cell are not damaged.

**Note:** When installing the sample it is acceptable (and probably beneficial) to leave some slack in the assembly.

**Set Display Panel Functions**

The display panel shows values of load, extension, and strain. These displays can be set by the operator to show very specific values depending on the display option selected. A description of the most useful options is as follows:

- **TRACK** - displays instantaneous values of the process variables.
- **PEAK** - displays the peak values that occur after a test.
- **BREAK** - displays values of variables that were detected just prior to break.

**Set Recorder Panel Functions**

The function of these controls is to adjust the output of the load cell to increase or decrease the sensitivity. The Load Cell provides a 0-10V output signal that can be used to control data recording instruments such as a chart recorder or a computer. Maximum sensitivity is achieved when the largest percentage of this output signal is used to send data. Therefore, it is desirable to set the load range at a value just above the maximum expected load for a test.

For example, consider a test where the expected maximum load on a sample is only 20kN and a 50kN load cell is being used. The appropriate load range setting would be 50% because this sets the maximum load value at 25kN. The next lowest range setting is 40% which would put the maximum load value at 20kN. If this is chosen and the maximum test load exceeds 20kN then the data will go off scale.

To set the load range press the LOAD RANGE key and then the key corresponding to the desired range; the main panel display should show the maximum load value of the load cell output signal. If 100% is selected then the maximum capacity of the load cell will be displayed.

**Start Test**

**Note:** A test can be aborted at any time by pressing the STOP key or the RETURN key. If the stop key is pressed the crosshead will remain at the position it reached when the key was pressed. If the return key is pressed the crosshead will return to the gage length position.

Once all of the setup and limits are completed the test can be started by pressing the up key for a tension test or the down key for a compression test. The test will then continue until an electronic limit is reached, a limit stop is reached, or the operator stops the test.