Appendix A. Operating Instructions for Instron Model 4400-Series Load Frames

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SAFETY FIRST

The Instron® 4400 load frame generates high forces. The capacity of the frame is 100 kN (that is, 22.5 kips or 11.3 tons). The frame does not know the difference between a steel plate and your hand. Always follow instructions. NEVER WORK ALONE.

Be aware that the large amount of energy stored in a specimen during elastic deformation may be released suddenly when fracture occurs; small fragments may be launched.

SAFETY GLASSES MUST BE WORN AT ALL TIMES IN THE AREA.

Protect yourself and the equipment always. Leave the mechanical limit stops as set.

STAY CLEAR OF MOVING PARTS.

Improper use of the equipment may cause damage and IS HAZARDOUS. Use the fixtures as instructed and within specified limits. For example, bending a steel bar well beyond yield produces excessive lateral forces on the bending fixtures. If in doubt, ASK. Report any hazards or injuries immediately to the personnel in charge of the lab.

![Instron 4400-series load frame (original controller shown).](image)

Figure 1. Instron 4400-series load frame (original controller shown).
Introduction

The Instron Model 4483 load frame (Figure 1) applies tensile and compressive forces by means of a moving crosshead. The frame is designed as “a rigid, stable structure with a high stiffness value.”

In Figure 2, the protective curtain has been temporarily removed to show one of the counter-rotating ball screws that raise and lower the crosshead. In the base, the motor drives the ball screws through a series of belts and pulleys. An encoder senses motor rotation for crosshead speed control, crosshead positioning, and position data acquisition. Do not remove the protective curtains.

Figure 2. Instron 4400-series load frame with protective curtain removed.

Force is sensed by a 100 kN (22.5 kip) load cell bolted to the crosshead. The specimens are loaded by fixtures that are pinned into the frame base plate below the specimen test area and the load cell above the specimen test area. An extensometer may be used to measure deflection of the specimen. The outputs of the load cell force transducer and extensometer are voltages that are converted to engineering units by the frame controller and displayed on a computer.

Load Frame Control

The ON-OFF switch on the frame panel (Figure 3) controls power to the frame. DO NOT switch the power off. If the switch is off, consult your TA. All lab tests are run with the clutch speed control in the LOW position. In LOW, the maximum crosshead speed is 50 mm/min (2 in/min) and the maximum load range of the frame is 100 kN (22.5 kips). In HIGH, rates up to 500 mm/min (20 in/min) are possible; however, the load limit is reduced to 25 kN (5.6 kips).

Figure 3. Frame panel with emergency stop.

To the left of the clutch speed control is the emergency stop; press it only when there is danger to personnel or a risk of damage to the frame, specimen, or fixtures.

Several machine functions may be controlled manually using the control console (Figure 4), including crosshead positioning.
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Figure 4. Control console.

Machine status indicators are located on the control console. At the top are frame power and frame readiness status indicators. Just below those, on the right, are the GL RESET (gage length reset) button and status indicator, crosshead FINE POSITION thumbwheel, and crosshead jogging buttons. The grey sections, at the middle left to lower left, contain crosshead test direction indicators, a red crosshead STOP button and indicator, and a crosshead RETURN button and indicator. Use the JOG UP and JOG DOWN buttons and the FINE POSITION thumbwheel to position the crosshead. Pressing GL RESET will define the present crosshead position as zero. Pressing RETURN will return the crosshead to the zero gage length crosshead position if it is not there already. Obviously, great care must be exercised in its use.

For laboratory experiments, the control functions are performed by Instron Bluehill® software running on a computer, which is interfaced to the load frame controller. Real-time extension (crosshead position), load, and strain numerical readouts are located across the top of the computer screen.

The indicated load during the test should be the load transmitted to the specimen, thus load cell balancing (zeroing) is performed without the specimen installed. Selecting the load-cell balance function on the computer screen does this. The load reading (at the top of the screen) should then be nearly zero. It should be necessary to balance the load cell only once during any lab period.

Tensile Test Setup and Conduct

The appropriate Bluehill® test method (the test type with specific routine and parameters) is typically started before setup and operated during setup, so that the on-screen directions may be followed to assist in test setup (see Appendix B.) Measure the specimen dimensions as shown in Figure 5. First, slide the blades of the digital calipers together against each other; then press ON/ZERO to zero the display. Check that the dimensions are in mm. If not, press the mm/inch button above the display. Hold the specimen in the left hand and the calipers in the right hand. Use the thumb to slide the blades against the specimen. (NOTE: This is a precision instrument, not a C-clamp.) Standard practice is to measure a dimension at three to five locations and use the numerical average.

The specimen dimensions, along with other pertinent test information, are entered into the running Bluehill test method (see Appendix B.)

Place the specimen in the lower grip (Figure 6), but do not tighten. Hold the upper grip away from the specimen and use the jog button to raise the crosshead until the specimen can be inserted into the upper grip. Locate the specimen so that approximately 5 mm of the grip end of the specimen extends out of the upper grip.
Figure 5. Measuring specimen dimensions using digital calipers.

Figure 6. Placing tensile test specimen in lower grip.

Figure 7. Tightening the upper grip.

Tighten the upper grip first (Figure 7). (NOTE: The upper grip swivels on a U-joint; therefore, the specimen could get bent if the lower grip is tightened first.) Using the jog button, lower the crosshead to center the specimen between the grips. Tighten the lower grip (Figure 8).

The grip inserts are shaped to provide wedge action so that they grip more firmly as the test progresses. The gripped ends of the specimen should be free of scale and oil. The grip should be tightened “firmly”, or snugly, without forcing.

Figure 8. Tightening the lower grip.
A small load may be introduced when the grip is tightened; however, this load (typically 0.5 to 1.0 kN for metal specimens) is small compared with the testing loads. If the load is not small, loosen the grip and tighten it again.

Press GL RESET to initialize the crosshead position and set the extension display on the computer screen to zero. The green LED lights to indicate zero extension position.

If an extensometer is not used, proceed to the final check. Otherwise, continue with extensometer installation.

**Extensometer Installation**

Slide the extensometer (Figure 9) off the yellow cleat on the load frame. Press the knobs to engage the cones to set the gage length of the extensometer. (NOTE: Hold the extensometer with the knobs at the top and the signal wire at the bottom.)

![Figure 9. Extensometer, showing knobs to set gage length.](image)

Continue to hold the knobs and open the spring clips only enough to slide the extensometer knife-edges onto the specimen (Figure 10). The body of the extensometer must be oriented to the front (or back) of the load frame to avoid contact with the grips. Center the extensometer vertically within the specimen gage section. Ascertain that the clips seat the extensometer firmly on the specimen and aligned axially. Release the knobs.

![Figure 10. Placing extensometer on tensile test specimen.](image)

The strain indicator on the computer screen should display a value within the range of ±5%. If it is outside this range, consult your TA.

All the physical setup is now complete. On the computer, click on BALANCE STRAIN in the running Bluehill® test method. The strain indicator on the computer screen should display nearly zero. (NOTE: The displayed strain is usually not exactly zero. The extensometer is extremely sensitive and even very small changes, including those caused by vibrations, are detected.).

**Final Check**

Perform a final check of the entire setup:

- Verify that the load, extension and strain readouts on the computer screen are displaying reasonable numbers.
- Verify that the fixtures and the specimen are properly installed.
- Verify that the test area is clear of tools, cables, body parts, etc.
• Verify that the safety shields are in place.

    If these final check conditions are satisfied, then the Instron 4400 is ready to run the test. Click START on the computer screen to begin the test. (See Appendix B.)

After the Test

The appearance of the specimen fracture surfaces is important for the analysis of test results. Be careful to protect these surfaces.

• Be certain that the machine has stopped. If not, press the red STOP button on the control console.
• Carefully remove the extensometer from the specimen and place it back on the yellow cleat. Use the hole in the body of the extensometer to hang it.
• Loosen the lower grip (using the opposite rotation of Figure 8).
• Swing the upper grip out of line and carefully slide the lower portion of the specimen up from the lower grip.
• Support the upper portion of the specimen, and then loosen the upper grip (using the opposite rotation of Figure 7). Remove the specimen upper portion.
• Measure the final specimen dimensions and enter the data onto your data sheets and into the running Bluehill test method on the computer.
• Finish the test sample in the Bluehill software (see Appendix B).

The frame is now ready for another test.

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