

UNIVERSAL TENSION/COMPRESSION TESTER MODEL TCD-200 OPERATING MANUAL

WARNING INSTRUCTIONS

**FAILURE TO ADHERE TO THE FOLLOWING INSTRUCTIONS
COULD RESULT IN SERIOUS BODILY INJURY
OR PROPERTY DAMAGE.**

- Allow only **qualified operators** to use the TCD-200.
- **Do not** permit distraction of the operator while equipment is in use.
- **Do not** permit individuals wearing loose articles such as ties and jewelry near the equipment while it is running.
- **Do not** allow unqualified individuals to adjust, service, or repair this equipment.
- **Maintain** a firm footing around the equipment.
- **Switch off** the equipment when it is not in use.
- Keep the equipment **clean** and in **good operating condition**.
- **When servicing unit**, disconnect the line cord before removing the cover. To discharge voltage on capacitors, depress the OFF/ON push-button after disconnecting the line cord. Some procedures require the use of high voltage. Take care to prevent contact with high voltage circuits which could cause electrical shock resulting in severe injury or death. Use an insulated tool when making adjustments. Do not exceed the maximum allowable input voltage limits. Instrument damage may occur.
- **CAUTION:** This instrument contains CMOS components which can be damaged by static discharge. To prevent damage, take the following precautions when troubleshooting and/or repairing the instrument.
 1. Perform all work at an anti-static work station that is properly grounded.
 2. Wear static ground straps.
 3. Handle the P.C. boards by the edges. Refrain from touching the metal leads on integrated circuits even with proper grounding.
 4. Use a grounded, temperature-regulated soldering iron.

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1. General Description

THE MODEL TCD-200 is a self-contained, motor-driven tension and compression tester designed for testing the resiliency, yield points and breaking strengths of various products and materials up to its capacity of 200 lb. (100 kg, 1000 N). It is designed for use with any of the Chatillon digital or analog force gauges in the DPP, DPPH, DFIS or DFGS Series up to 200 lb. capacity.

The front panel contains a twenty eight element key pad and two LCD displays. The upper LCD displays the platform travel distance in inches or mm, as well as deflection set point values when required. The lower LCD displays speed in in/min or mm/min, up/down direction and cycling functions when required. All machine controls are accomplished through the key pad. Speed is adjustable from 0.5 to 12.5 in/min using the key pad and digital display. A rotary encoder is attached to the ball screw to provide precise measurement of deflection. Adjustable limit switches are also provided at both ends of travel.

An ON/OFF switch and an EMERGENCY STOP button are conveniently located on top of the console to the right of the column.

The test stand employs a DC gearmotor with dynamic braking for driving the ram through a vertical travel of 18". It is designed with a precision ball screw mounted between two columns. This combination provides precision linear motion and positive motor control. The controls incorporate a solid state S.C.R. drive with closed loop feedback for maintaining constant speeds at varying loads.

A. Accessories

The tester is supplied with a 2 3/4" X 2 3/4" compression plate that is mounted to the fixed base. Two gauge mounting plates, with attaching screws, are also provided to facilitate installation of the Chatillon force gauges. The small plate is used to mount either the DPP Series analog gauges or the DFGS Series digital gauges. The large plate is used to mount the DPPH Series analog gauges or the DFIS Series digital gauges. (Please consult the factory for information on mounting older Chatillon force gauges.)

B. Options

MODEL TCD-200-SS: SLOW SPEED MOTOR (0.02 to 0.5 in/min)

MODEL TCD-200-MS: MEDIUM SLOW SPEED MOTOR (0.1 to 2.5 in/min)

MODEL TCD-200-MH: MEDIUM HIGH SPEED MOTOR (1 to 25 in/min)

MODEL TCD200-HS: HIGH SPEED MOTOR (2 to 50 in/min)

MODEL TCD-200-EC: 60 inch column (no increase in travel)

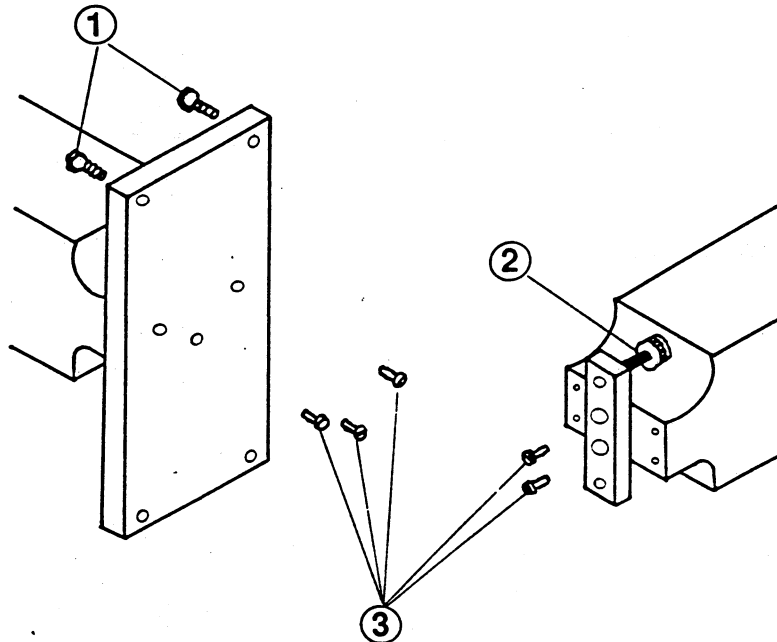
MODEL TCD-200-220V: 220 volt operation

2. Instructions

A. Setup

Unpacking - Carefully unpack the stand and inspect for damage. **Report any damage promptly to the appropriate transportation company.**

1. Place the stand on a firm, flat and level working surface that is free from vibration to ensure accurate readings. The tester has four adjustable feet to facilitate leveling. Place a bubble level on the lower compression plate to check for levelness. Then secure the feet using the lock nuts.
2. Fasten the appropriate gauge mounting plate to the ram using the screws provided.
3. Install the selected force gauge to the mounting plate using the screws provided.



MOUNTING PLATE - DFIS & DPPH

MOUNTING PLATE - DFGS & DPP

ITEM NO.	PART NO.	DESCRIPTION
1	21162	Screw, BHSC - 1/4-20 X 1"
2	21050	Screw, Knurled Head - 10-32 X 3/4"
3	3572	Screw, Socket Head Cap - 10-32 X 1/2"

B. Digital Force Gauge Connection

1. DFGS Series Digital Force Gauge

To utilize the complete capabilities of the TCD Test Stand, connect the output from the gauge into the input port on the back of the test stand using cable Part No. NC000647 or equal. This will permit the data from the gauge to pass through the test stand to both the analog output jacks and the bidirectional RS232 port. With the gauge connected in this manner, the gauge may be used to control the test stand or both the test stand and gauge functions can be controlled by a peripheral computer. To ensure proper communication between the gauge and stand check the following:

- a. Set the DFIS Gauge communication parameters to:

Baud rate = 19.20 (19,200)
Units = 0 1 or 0 2 (either works)
Word length/Stop bits = 8 - 1
Parity = - P

- b. Turn the TCD Stand "OFF".

- c. Turn the gauge "ON" then turn the TCD Stand "ON".

- d. Check the deflection display. "GAUGE" should appear in the upper right corner of the display indicating that the gauge is connected. If "GAUGE" is not illuminated, recheck the set-up and verify the cable connections. If the problem persists, please contact the factory.

2. DFIS Series Digital Force Gauge

To utilize the complete capabilities of the TCD Test Stand, connect the output from the gauge into the input port on the back of the test stand using cable Part No. NC000647 or equal. This will permit the data from the gauge to pass through the test stand to both the analog output jacks and the bidirectional RS232 port. With the gauge connected in this manner, both the test stand and gauge functions can be controlled by a peripheral computer. To ensure proper communication between the gauge and stand check the following:

- a. Set the DFIS Gauge communication parameters to:

Baud rate = 19.20 (19,200)
Units = 0 1 or 0 2 (either works)
Word length/Stop bits = 8 - 1
Parity = - P

- b. Turn the TCD Stand "OFF".

- c. Turn the gauge "ON" then turn the TCD Stand "ON".

- d. Check the deflection display. "GAUGE" should appear in the upper right corner of the display indicating that the gauge is connected. If "GAUGE" is not illuminated, recheck the set-up and verify the cable connections. If the problem persists, please contact the factory.

3. Controls

A. Test Stand Control Functions

On/Off: A rocker switch located on the top surface of the test stand base. Press toward the front to turn on; switch is illuminated when the power is on.

Emergency Stop: A palm switch located adjacent to the on/off rocker switch. Turns off power to the stand and controls when pressed in an emergency situation. Rotate the cap clockwise to restore the power.

B. Keypad Control Functions

Up: Moves ram up.

Down: Moves ram down.

Stop: Stops ram movement.

MAX Speed: Press once to move ram at max speed, again to return to set speed (if no speed is set, min speed is default).

MIN Speed: Press once to move ram at min speed, again to return to set speed (if no speed is set, min speed is default).

Limit: Engages the Limit Function in conjunction with programmable deflection set points. "LIMIT" will be displayed on the upper LCD when engaged. Press again to disengage. If no set points are entered, the high and low deflection values will default to zero.

Set: Used in conjunction with other keys in programming speed, deflection set points, cycles and communication parameters. "SET" will be displayed in both LCD's when engaged. Press again to return to normal display.

Cycles/Speed: Used together with "Set" key to program speed. Also used to display number of completed cycles run during cycle mode. Press once to display cycles completed. Press again to return to speed display.

NOTE: Programmed speed remains in memory when the TCD is turned off.

DEF High: Used together with "Set" key to program deflection high set point. Also used to display current deflection high set point value. "HI" will be displayed adjacent to "DEFL" in the upper LCD display when pressed. Press again to return to normal display. If no set points are entered, the set point value will default to zero.

DEF Low: Same function as "DEF High" but used for deflection low set point.

NOTE: Programmed deflection set point values remain in memory when the TCD is turned off.

Cycle: Used together with "Set" key to program cycle count (1 to 1000). Also used to enter cycle mode. "CYCLES" will be displayed in the lower LCD when pressed. Press again to disengage cycle mode.

Cycles Set: Displays the number of cycles programmed along with the word "CYCLES" in the lower LCD when pressed. Press again to return to previous display.

Clear: Used to clear an incorrect value during programming (before the value is entered). Also used to clear the completed cycles run. Press "Clear" and then "Cycle" to clear the cycle counter memory.

— and 0 to 9: Used for programming speed, high and low deflection set points and cycles to be run.

Enter: Used to enter programmed values.

Zero DEF: Used to zero the deflection display.

Units: Used to select units of measurement: in and in/min or mm and mm/min.

NOTE: Selected units remain in memory when the TCD is turned off.

Xmit: Used to transmit deflection value to a peripheral RS232 device. Will transmit both force and deflection values when the test stand is equipped with a Chatillon

DFGS digital force gauge and appropriate interface cable.

NOTE: Once the values of Units, Cycles, Speed and Set Points are entered into memory, they will remain in memory, even when the unit is turned off. To change any of the programmed values, enter new values via the keypad.

C. Keypad Functions During Ram Movement

1. Keys That **STOP** The Ram Movement When Pressed:

Stop

Up - when the ram is moving down

Down - when the ram is moving up

Set (also locks out all nonprogramming keys)

2. Keys That **DO NOT STOP** The Ram Movement When Pressed:

MAX Speed - Overrides the set speed and the stand runs at MAX.

MIN Speed - Overrides the set speed and the stand runs at MIN.

Cycles/Speed - Displays cycles run then set speed.

Cycles Set - Displays the number of cycles programmed.

Zero DEF - resets the deflection display to zero.

Xmit - sends the value(s) displayed at the moment the key is pressed.

DEF High - overrides the running value and displays the deflection high set point.

DEF Low - overrides the running value and displays the deflection low set point.

3. Keys Which Are **INACTIVE** During Ram Movement:

Limit

Cycle

4. Deflection Set Points

A. Operating Characteristics

The Set Points may be either positive values (ram moves up from zero deflection) or negative values (ram moves down from zero deflection). The negative key on the keypad may be pressed either before or after entering the numeric value, but must be pressed before "Enter" to program a negative value.

The Def High Set Point stops the ram while moving up and Def Low stops the ram while moving down. Therefore, Def High must always be the higher or more positive value. For example:

-10.000 in = Def Low and -2.000 in = Def High

-7.000 in = Def Low and 0.000 in = Def High

-5.000 in = Def Low and 3.000 in = Def High

4.000 in = Def Low and 6.000 in = Def High

0.000 in = Def Low and 8.000 in = Def High

If the Deflection Set Points are entered in reverse order, the test stand will not respond properly in the Limit or Cycle modes.

If only one Deflection Set Point is entered, the other will default to zero. The relationship between the High and Low values noted above must be considered in such applications.

The test stand has an automatic damp function when set points are utilized. When approaching a set point, the motor controller will automatically reduce the speed to minimum to avoid overshooting the programmed value. The point at which the damp engages depends on the test speed.

Set point values higher than the full travel of the TCD stand may be entered. However, this only applies when using the force set points in the DFGS Force Gauge as noted in Section 5D, p.9. Otherwise, it is not recommended. The electromechanical limit switches in the stand will prevent the ram from driving into the top or bottom but no protection is provided for the gauge/load cell or fixtures.

The programmed Set Point values are retained in memory even when the stand is turned off.

B. Setting Deflection High Or Low Set Point

Press "Set" then "DEF High" or "DEF Low", top display will show SET DEFL HI or SET DEFL LO. Enter the desired set point using the keypad, set point values may be positive (ram moves up from 0.000) or negative (ram moves down from 0.000), then press "Enter".

5. Test Stand Operation

A. When Not Using "LIMIT" Or "CYCLING" Mode

1. Position the upper and lower adjustable travel limits to avoid possible injury to personnel and damage to the test stand and or fixtures. The travel limits are located at the rear of the column and may be positioned by moving the slides up or down until the desired position is reached.
2. Turn the stand on and run the ram up or down as necessary to provide space for mounting the gauge, fixtures and test specimen. ("Max speed" may be used for this operation.)

NOTE: Ensure that the test stand, gauge and fixtures are all of sufficient capacity for the expected force range of the specimen.

3. When the gauge and fixtures are secure, reposition the safety limits and ram as required to install the test specimen ("Min Speed" is recommended).
4. If the gauge and/or test stand are to be interfaced with a peripheral device (PC, Printer, etc.), make sure that the appropriate cables are connected and communication has been established. (Refer to the individual operation manuals for instructions on setting the communication parameters.)
5. Select the desired Units of Measurement, and then set the desired speed:
 - a. Press "Set" then "Cycles/Speed", bottom display will show SET SPEED. (Speed digits on the display will go blank.)

- b. Program the desired speed using the keypad, then press "Enter".

The "Clear" key will erase an incorrect value during programming (before pressing "Enter"). If the errant value is entered, merely repeat steps a and b above. If a speed value below the minimum, or above the maximum speed is entered, the set speed will automatically default to the Minimum or Maximum speed respectively.

6. Zero the deflection display ("Zero Def") and press "Up" or "Down" as required to start the test. The ram will stop when it reaches the safety limit or when "Stop" is pressed.

B. In "LIMIT" Mode With Deflection Set Points

1. Position the upper and lower adjustable travel limits to avoid possible injury to personnel and damage to the test stand and or fixtures. The travel limits are located at the rear of the column and may be positioned by moving the slides up or down until the desired position is reached.
2. Turn the stand on and run the ram up or down as necessary to provide space for mounting the gauge, fixtures and test specimen. ("Max speed" may be used for this operation.)

<p>NOTE: Ensure that the test stand, load cell and fixtures are all of sufficient capacity for the expected force range of the specimen.</p>

3. When the gauge and fixtures are secure, reposition the safety limits and ram as required to install the test specimen ("Min Speed" is recommended).
4. If the gauge/load cell and/or test stand are to be interfaced with a peripheral device (PC, Printer, etc.), make sure that the appropriate cables are connected and communication has been established. (Refer to the individual operation manuals for instructions on setting the communication parameters.)
5. Select the desired Units of Measurement, and then set the desired speed:
 - a. Press "Set" then "Cycles/Speed", bottom display will show SET SPEED. (Speed digits on the display will go blank.)
 - b. Program the desired speed using the keypad, then press "Enter".

The "Clear" key will erase an incorrect value during programming (before pressing "Enter"). If the errant value is entered, merely repeat steps a and b above. If a speed value below the minimum, or above the maximum speed is entered, the set speed will automatically default to the Minimum or Maximum speed respectively.
6. Program the desired Deflection Set Points:
 - a. Press "Set" then "DEF High" top display will show SET DEFL HI. (Deflection digits on the display will go blank.)
 - b. Program the desired set point using the keypad, then press "Enter".
 - c. Press "Set" then "DEF Low" top display will show SET DEFL LO. (Deflection digits on the display will go blank.)

- d. Program the desired set point using the keypad, then press "Enter".

The "Clear" key will erase an errant value during programming (before pressing "Enter"). To confirm the set point values entered, press "Def High" and "Def Low" individually to view the programmed values. Press again to return to normal display. If an incorrect value is found, merely repeat Step 6 above.

7. Press "Limit" ("LIMIT" will appear in the upper LCD).
8. Zero the Deflection (if required) then press "Up" or "Down" to begin the test. Upon stopping, the upper stand LCD will identify the limit reached ("HI" or "LO") and the lower stand LCD will display "STOP".

C. In "CYCLE" Mode With Deflection Set Points

1. Position the upper and lower adjustable travel limits to avoid possible injury to personnel and damage to the test stand and/or fixtures. The travel limits are located at the rear of the column and may be positioned by moving the slides up or down until the desired position is reached.
2. Turn the stand on and run the ram up or down as necessary to provide space for mounting the gauge, fixtures and test specimen. ("Max speed" may be used for this operation.)

<p>NOTE: Ensure that the test stand, gauge and fixtures are all of sufficient capacity for the expected force range of the specimen.</p>

3. When the load cell and fixtures are secure, reposition the safety limits and ram as required to install the test specimen ("Min Speed" is recommended).
4. If the gauge and/or test stand are to be interfaced with a peripheral device (PC, Printer, etc.), make sure that the appropriate cables are connected and communication has been established. (Refer to the individual operation manuals for instructions on setting the communication parameters.)
5. Select the desired Units of Measurement, and then set the desired speed:
 - a. Press "Set" then "Cycles/Speed", bottom display will show "SET SPEED". (Speed digits on the display will go blank.)
 - b. Program the desired speed using the keypad, then press "Enter".

The "Clear" key will erase an incorrect value during programming (before pressing "Enter"). If the errant value is entered, merely repeat steps a and b above. If a speed value below the minimum, or above the maximum speed is entered, the set speed will automatically default to the Minimum or Maximum speed respectively.

6. Program the desired Deflection Set Points:
 - a. Press "Set" then "DEF High" top display will show SET DEFL HI. (Deflection digits on the display will go blank.)
 - b. Program the desired set point using the keypad, then press "Enter".
 - c. Press "Set" then "DEF Low" top display will show SET DEFL LO. (Deflection digits on the display will go blank.)

- d. Program the desired set point using the keypad, then press "Enter".

The "Clear" key will erase an errant value during programming (before pressing "Enter"). To confirm the set point values entered, press "Def High" and "Def Low" individually to view the programmed values. Press again to return to normal display. If an incorrect value is found, merely repeat Step 6 above.

7. Program the desired number of test cycles (1000 max):

- a. Press "Set" and then "Cycle" (SET CYCLES" will appear in the bottom LCD and the digits will go blank.)
- b. Program the desired number of cycles using the keypad, then press "Enter".

The "Clear" key will erase an errant value during programming (before pressing "Enter"). To confirm the number of cycles entered, press "Cycles Set" to view the programmed cycles. Press again to return to normal display.

8. Press "Cycle" ("CYCLES" will appear in the lower LCD). Press "Cycles/Speed" to display cycles run.

9. Zero the Deflection (if required) then press "Up" or "Down" to begin the test. At the end of the cycle test, the upper stand LCD will display the end of test limit ("HI" or "LO"). The lower stand LCD will display "STOP" as well as the number of cycles run.

10. To repeat the same cycle test on a new sample:

- a. Replace the specimen as required.
- b. Press "Clear" and then press "Cycle" to clear the number of cycles run. (Although the number of cycles run does not need to be displayed to erase this value, it is advisable to confirm that the register has been cleared.)

<p>NOTE: The TCD will not cycle if the cycles run register is not cleared prior to repeating a cycle test.</p>

If a cycle test is stopped prior to reaching the programmed number of cycles, the test may be resumed without clearing the cycles run. The test will continue until the total number of cycles run equals the programmed value.

D. With Force Set Points Using a DFGS Force Gauge

When utilizing the Chatillon DFGS Digital Gauge as the force indicator on the TCD Stand, the DFGS force set points may be used in conjunction with the test stand limit or cycling functions. This requires the proper cabling to connect the gauge to the test stand (Chatillon Part No. NC000647) and setting of the correct communication parameters within the gauge (Refer to the DFGS Manual and Section 9, p. 18 of this manual).

The "HI" force set point in compression will stop the test stand ram while moving down. The "LO" set point in compression will stop the ram while moving up. This order is reversed in tension testing, as is the force set point programming order within the DFGS gauge.

If the TCD-200 test stand has the extended column option installed, refer to Section

5E, p. 12 for instructions on how the force set point relationship with the UP/DOWN ram movement may be altered within the TCD.

Unlike the TCD stand, negative values are not displayed and are not programmable in the DFGS gauge. Instead, force values are denoted as "T" for tension and "C" for compression forces. (Tension forces are, however, identified with a minus sign in data transmission to peripheral devices.)

When combining one force and one deflection set point, it is even more important to understand the relationship of the set points to the up/down direction of the ram travel. A trial run is recommended in any set point test to verify correct set point entry.

As in deflection set point testing, the TCD incorporates an automatic damp function when utilizing the DFGS force set points. When approaching the set point, the motor drive will automatically revert to minimum speed in order to avoid overshooting the programmed value. The point at which the damp engages is based on a small percentage of the capacity of the DFGS gauge being used. It is recommended that the capacity of the DFGS gauge be checked for suitability to each application. Force set point testing which utilizes only the very low end of the gauge's capacity may cause the damp function to engage during most or even all of the test travel distance.

The TCD/DFGS system provides the versatility of a self-contained tester. The limit or cycling functions of the TCD may incorporate three different set point testing possibilities:

1. High and Low Force Set Points,
2. One Force and One Deflection Set Point and
3. High and Low Deflection Set Points. (Ref. Section 5B, p.7 or Section 5C, p.8.)

1. High and Low Force Set Points

In force set point testing applications, the TCD deflection set points must still be entered and activated via the limit (Section 5B, p.7) or Cycling (Section 5C, p.8) set-up procedures. Since the stand contains the motor and motor controller, it still must move the ram and stop the ram at the set points. When programmed properly, the force set points occur before the deflection set points are reached and therefore override the deflection set points.

- a. Program force set point values and signal transmission parameters as described in the DFGS Gauge Manual.
- b. Enter and activate TCD deflection set point values which are beyond the travel distance required to reach the force set points using the Limit Procedure (Section 5B, p.7) or the Cycling Procedure (Section 5C, p.8). To minimize set-up time, you may enter deflection values which the ram cannot achieve in its full travel (i.e. 50.00 high and -50.00 low).

NOTE: The adjustable travel safety limits should still be positioned to avoid damage to the load cell and fixtures.

c. A trial test should be performed using the Limit Procedure (Section 5B, p.7) or the Cycling Procedure (Section 5C, p.8) to ensure that the following conditions exist:

- (1) The gauge to stand cable is connected and the word "GAUGE" appears in the upper stand LCD (Section 2B, p.2).
- (2) Gauge force set points are entered and activated, and signal transmission is active.
- (3) Proper deflection set points have been entered and activated using the Limit or Cycling Procedures.

2. One Force and One Deflection Set Point

This procedure is similar to testing with high and low force set points, in that both of the force set points and both of the deflection set points must be entered. When both sets of set points are programmed and activated, the TCD stand will respond to either the force or the deflection value, whichever is reached first.

- a. Enter the desired test force set point as described in the DFGS Gauge manual. The other "dummy" force set point should be set at a value which will not be reached during the test. (This may be a force value which would be reached beyond the test deflection set point, or a force in the opposite mode as the test, for example, Tension vs Compression).
- b. Enter the desired test deflection set point using the procedure in Section 5B, p.7. The other "dummy" deflection set point must be set at a value which is beyond the travel distance required to reach the test force set point. (To minimize set-up time, you may enter deflection values which the ram cannot achieve in its full travel (for example, 50.00 or -50.00).

NOTE: The adjustable travel safety limits should still be positioned to avoid damage to the gauge and fixtures.

c. A trial test should be performed using the Limit Procedure (Section 5B, page 7) or the Cycling Procedure (Section 5C, p.8) to determine the expected travel range during the test.

3. Setup Check List

The following is a set-up check list to quickly verify that the TCD test stand and DFGS digital force gauge are properly connected and programmed to control the TCD Test Stand prior to running a test.

- a. Is the gauge to test stand interface cable (Chatillon Part No. NC000647) connected?
- b. Is the DFGS gauge programmed to communicate with the TCD? "GAUGE" will be displayed in the upper LCD of the TCD stand when communication is established. If "GAUGE" does not appear, check for the following gauge settings in the DFGS flashing display:

Baud Rate: 19.20 (19,200)

Units: 0 1 or 0 2 (either works)

Word Length-Stop Bits: 8-1

Parity: -P

- c. Are the DFGS force set points entered? Are they ACTIVATED and PROGRAMMED TO TRANSMIT THE STOP SIGNAL to the TCD? "L LO" and "S SP" should flash on the DFGS display when these respective program steps are viewed.
- d. Are the TCD deflection set points entered? Are these values beyond the expected travel to reach the DFGS force set points?
- e. Is the TCD Limit or Cycle Mode engaged? "LIMIT" will be displayed in the upper LCD of the TCD stand prior to testing when the Limit Mode is engaged. "CYCLES" will be displayed in the lower LCD of the TCD stand prior to testing when the Cycle Mode is engaged.

NOTE: When using the Cycle Mode, this should be verified while the speed value is displayed. If the cycle counter is displayed, (by pressing the "CYCLES/SPEED" key) "CYCLES" will be displayed whether or not the Cycle Mode has been engaged.

- f. Are the mechanical limit stops on the TCD adjusted to prevent overtravel in the event of a programming omission?

Please refer to the DFGS Operating Instructions and the appropriate sections of this manual for the detailed procedures on programming and set-up.

E. With Extended Column

When the TCD-200 has the extended column installed, it is possible to perform tests either below the ram like the standard TCD-200 or above the ram utilizing the longer sample test length capabilities. Testing samples below the ram, the stand functions as a standard TCD, that is DOWN is COMPRESSION and UP is TENSION. Operating with samples installed above the ram, the functions are reversed i.e. DOWN is TENSION and UP is COMPRESSION.

If a DFGS Series Digital Force Gauge is being used to control the motor, it is necessary to program the stand to accept the proper stop signal from the gauge. The gauge sends a "stop down" signal when a compression set point high is reached and a "stop up" signal when a tension set point high is reached. When operating above the ram, the stop functions must be reversed. To select the proper mode, proceed as follows:

1. Press "SET", then press "STOP". The display shows "0".

NOTE: If the "0" is blinking, the stand is programmed to operate as a standard TCD-200. If the "0" is steady, the stand is programmed to operate in the extended column mode.

2. If the standard mode is desired, press "ENTER".
3. To change to the extended column mode press "CLEAR", the display will show "1". Press "ENTER" to select the extended column mode.

NOTE: This program change affects only the DFGS force set point relationship with the UP/DOWN ram movement. The TCD deflection set point relationship with the UP/DOWN ram movement remains as described in Section 4A, p.5.

6. Operating Problems

SYMPTOM	PROBLEM	REMEDY
Ram will not move when "Up" or "Down" is pressed. In NORMAL mode:	If "LIMIT" is displayed: Ram may be stopped at adjustable safety limit.	Reposition adjustable safety limit.
	Or digital limit mode has been engaged with both limits at zero default.	Disengage limit mode.
	If "SET" is displayed: Stand is in programming mode which locks-out other controls.	Disengage Set Mode.
In LIMIT or CYCLE mode:	Ram is at safety limit.	Reposition safety limit.
	"SET" is displayed.	Disengage Set Mode.
	Deflection set points entered in reverse order or both at same value.	Reprogram deflection set points.
With DFGS force set points:	Force set points entered in reverse order or not compatible when combined with deflection set point.	Reprogram force and/or deflection set points as required.
Ram will not stop at programmed deflection set points.	Limit or cycle mode not engaged as needed for the application.	Engage limit or cycle mode as required. ("LIMIT" or "CYCLES" displayed)
Ram will not stop at programmed force set points. (DFGS gauge installed)	Gauge is not communicating with the stand. ("GAUGE" not displayed in stand LCD)	Check cable connection and gauge communication parameters.
	Force set points and/ or signal to stand not activated.	Program set points for TCD stand communication.
	Limit or Cycle Mode in TCD not engaged as needed for the application.	Engage Limit or Cycle Mode as required. ("LIMIT" or "CYCLES" displayed)

NOTE: Refer to Section 5D3 of this manual for the Setup Check List to quickly verify that the TCD Test Stand and DFGS Digital Force Gauge are properly connected and programmed to control the TCD Test Stand. (If the TCD Test Stand has the Extended Column option installed, refer to Section 5E for an explanation of the force set point relationship with Up/Down ram movement.)

SYMPTOM	PROBLEM	REMEDY
Deflection display does not update while ram is moving.	"Def High" or "Def Low" key is engaged.	Disengage appropriate key.
In cycle mode: Ram moves to initial test limit and stops, without cycling back.	Cycle counter contains a count from a previous test.	Clear cycle counter.

IF PROBLEMS PERSIST, CONTACT YOUR CHATILLON DISTRIBUTOR.

7. Typical Test Procedures

A. Tension Test

Test Parameters:

Sample length = 4.0"

Test Speed = 10.0 in/min

Pull the sample to a load of 50.0 lb. then stop the test.

Record the deflection at 50.0 lb.

Return the ram to its original starting position.

Digital Force Gauge = DFGS-100

1. Install and connect the Digital Force Gauge as described in Section 2B1 (page 2). Be sure to turn the gauge on first, then the test stand. Attach any necessary tension fixtures to support and hold the sample.
2. Position the ram so the test specimen can be installed in the gripping fixtures.
3. Depress "Zero DEF", the deflection display should show 00.000 .
4. Enter a Deflection Low value selected (0.0") by depressing "Set", then "DEF Low". The deflection display will be blank. Using the keypad press "00.000", then depress "Enter". The starting position of the ram is now in memory.
5. Estimate the amount of sample elongation that should occur at the 50 lb. load then add 1 inch to this estimated value (if 3.250" elongation is expected + 1.00" = 4.250"). Enter this as a Deflection High value by depressing "Set", then "DEF High". Remember, movement up from zero (0.000) is positive (+). The deflection display will be blank. Using the keypad press "4.250", then depress "Enter". A position of the ram beyond the expected elongation is now in memory. This set point will act as an override in the event the sample breaks before the 50 lb. test load is reached or any other reason that would allow the ram to pass the expected travel.
6. Enter the selected test speed (10.0 in/min) by depressing "Set", then "Cycles/Speed". The speed display will be blank. Using the keypad, press "10.00", then depress "Enter".
7. Enter a HIGH force set point of 5.00 lb. in Compression using the instructions

for the gauge (para. B.II.), then enter a LO force set point of 50.00 lb. in Tension. Make sure the set points are activated (L LO flashing on the gauge display). The 5 lb. compression set point will allow the deflection reading to control the return to the starting position and the 50 lb. tension set point will allow the gauge to control the stopping of the ram at the desired load.

8. Press "Limit" (the LIMIT indicator on the deflection display will come on).
9. Install the first test sample. Zero the force gauge by pressing "ZERO".
10. Start the test by depressing "Up". The ram will travel up until the measured load reaches 50.00 lb. The ram will then stop.
11. Record the deflection value displayed (the value at the 50.00 lb. load).
12. When the required readings are recorded, press "Down" and the ram will return to its starting position with the deflection display reading 0.000 to prepare for the next test.
13. To run the same test again, repeat steps 9 thru 12.

B. Compression Test

Test Parameters:

Sample Height before test = 6"

Test Height = 2.5"

Start with ram 1/2" above the top of the sample to allow room for sample installation.

Test Speed = 8.5 in/min

Record the final load at the 2.5" height plus max load during the test.

Return the ram to its original starting position. Digital Force Gauge = DFIS 200

1. Install and connect the Digital Force Gauge as described in Section 2B2, page 3. Attach any necessary compression fixtures to support and hold the sample.
2. With no sample installed, carefully bring the ram down until the compression plates touch being careful not to overload the gauge. Run the stand at minimum speed when the plates are close to touching and stop the motor as soon as the force gauge begins to register a value.

CAUTION

When the plates touch, it will take approximately 1 second for the tester to overload and/or damage the load cell.

3. Depress "Zero DEF", the deflection display should show 00 .000 .
4. Enter the Deflection High value selected (6.5") by depressing "Set", then "DEF High". The deflection display will be blank. Using the keypad press "6.500", then depress "Enter". The starting position for each test is now in memory.
5. Enter the Deflection Low value selected (2.5") by depressing "Set", then "DEF Low". The deflection display will be blank. Using the keypad press "2.500", then

depress "Enter". The sample test height for each test is now in memory.

6. Enter the selected test speed (8.5 in/min) by depressing "Set", then "Cycles/Speed". The speed display will be blank. Using the keypad, press "8.50", then depress "Enter".
7. Press "Limit" (the LIMIT indicator on the deflection display will come on).
8. Press "Up", the ram will move up at 8.5 in/min until the Deflection High set point is reached and then stop. The opening between the compression plates should be 6.5 in.
9. Install the first test sample. Zero the force gauge by pressing "ZERO".
10. Start the test by depressing "Down". The ram will travel down until the space between the compression plates reaches 2.5". The ram will then stop.
11. Record the force value displayed (the value at the 2.5" height) then press "PEAK" on the gauge until the display shows "C PEAK" and a value. Record this as the Highest force that occurred during the test.
12. When the required force readings are recorded, press "Up" and the ram will return to its starting position with the compression plates 6.5" apart to prepare for the next test.
13. To run the same test again, repeat steps 9 thru 12.

C. Cycle Test in Compression

Test Parameters:

Sample length = 4.0"

Test Speed = 2.0 in/ min

Cycle the load on the sample from 5 to 75 lb. through 300 cycles, then stop the ram.

Measure the deflection between 5 lb. and 75 lb.

Digital Force Gauge = DFGS-100

1. Install and connect the Digital Force Gauge as described in Para 2B1 (page 2). Be sure to turn the gauge on first, then the test stand. Attach the upper and lower compression plates to the gauge and test stand.
2. Position the ram so the test specimen can be installed between the plates.
3. Depress "Zero DEF", the deflection display should show 00 .000 .
4. Enter the Deflection High value selected (0.0") by depressing "Set", then "DEF High". The deflection display will be blank. Using the keypad press "0.000", then depress "Enter". The starting position for each test is now in memory.
5. Estimate the deflection required to produce the 75 lb. load (est. 2.0" approx). Add 0.5" for margin. Use a deflection set point Low of -2.5" (2.0" est + 0.5" margin). Remember, movement down from zero (0.000) is negative (-). Enter the Deflection Low value selected (-2.5") by depressing "Set", then "DEF Low". The deflection display will be blank. Using the keypad press "-2.500", then depress "Enter".

6. Enter the selected test speed (2.0 in/min) by depressing "Set", then "Cycles/Speed". The speed display will be blank. Using the keypad, press "2.00", then depress "Enter".
7. Enter the required number of cycles (300) by depressing "Set" then "Cycles". The speed display will be blank. Using the keypad press "300", then depress "Enter". The programmed number of cycles is now in memory. To check the programmed cycles at any time press "Cycles Set".
8. Enter a HIGH force set point of 75.00 lb. in Compression using the instructions for the gauge (Section B2), then enter a LO force set point of 5.00 lb. in Compression. Make sure the set points are activated (L LO flashing on the gauge display).
9. Deactivate the Buzzer, activate the machine control function and deactivate the auto shut-off per Section B3 in the gauge instructions. If the buzzer is activated, the buzzer will remain on any time the load is outside the 5 to 75 lb. range which will be during removal and installation of test samples.
10. Press "Cycle" (the CYCLES indicator on the speed display will come on).
11. Install the first test sample. Zero the force gauge by pressing "ZERO" on the gauge keypad.
12. Start the test by depressing "Down". The ram will travel down until the load reaches 75 lb. The ram will then reverse direction and travel up until the load reaches 5 lb. The ram will continue to cycle between these two loads until the programmed number of cycles (300) is completed. The ram will then stop at the 5 lb. load position.
13. To determine the deflection between the 5 lb. and 75 lb. loads, depress "Zero DEF" on the stand keypad (deflection display reads 00.000), then "Cycle" (CYCLES indicator is off), then "Limit" (LIMIT indicator is on), then "Down". The ram will travel down until the load reaches 75 lb. then stop. The deflection between 5 lb. and 75 lb. can be read directly from the deflection display.
14. Depress "Limit" then "Up" and the ram will travel up to permit removal of the sample. When the ram is high enough to permit removal of the sample, press "Off" to stop the ram.

8. Analog and Digital Outputs

A. Analog Outputs

Analog force and deflection outputs for chart recorders are provided by binding posts on the rear of the test stand. The Deflection analog output is 0.056 Vdc/inch. Check the digital force gauge operating instructions for the Force analog output.

B. Digital Outputs

The TCD-200 is a bidirectional communications device. The transmitted data are equivalent to the values set or on the displays at the moment the transmission is initiated. Data transmission may be initiated:

1. By depressing the XMIT key on the TCD-200 key pad (if a digital force gauge is connected to the TCD-200, the force value will also be transmitted).

2. On request from the peripheral device through transmission of a ASCII "x" (lower case). This command will request data from the test stand only. To request data from a connected gauge, refer to the operating instructions manual for the appropriate command.
3. On transmission of an ASCII "n" (lower case) to the stand from a peripheral computer. This command will cause the stand to send both the deflection reading and the force reading in the following format:

-XX.XXX ^ in <CR> <LF>
 or
 ^ XX.XXX ^ in <CR> <LF>
 -XXX.XX ^ mm <CR> <LF>
 or
 ^ XXX.XX ^ mm <CR> <LF>

For DFGS-10, the format is

-XX.XXX ^ lb <CR> <LF>
 or
 ^ XX.XXX ^ lb <CR> <LF>

x = 0 thru 9; no zero blanking

- is down from zero

^ is up from zero

9. Communications

To check/set communication parameters press "SET" then press "XMIT". The display will show 19.20. You are now ready to review or change the communication settings.

To step through the parameters press "CLEAR". Each key operation will change the display to the next available parameter. A flashing display indicates the currently programmed value. To change the current value press "ENTER" when the desired value appears on the display. The following sequence will be observed:

Baud 19.20 = 19,200
 9600 ^{Note 1}
 4800
 2400
 1200
 600
 300

Units 0 1 = Transmit with units ^{Note 1}
 0 2 = Transmit numerical value only

Word length/Stop bits 7 2 = 7 bit word/2 stop bits ^{Note 1}
 8 1 = 8 bit word/1 stop bit

Parity EP = Even parity
 -P = No parity ^{Note 1}

^{Note 1} Factory settings

After parity the display will return to the normal operating mode.

The above settings are for the computer/terminal port only. The gauge port is Autobauding (automatically sets to the gauge baud rate) from 4800 to 19,200.

NOTE: To achieve the fastest communication between the gauge and test stand and minimize the measurement error, the CONNECTED GAUGE must be set for: 19,200 baud, 0 1 or 0 2 units, 8 bit word/1 stop bit, No parity

10. External Control Via RS232 Port

The functions of the test stand and gauge can be controlled from an external device such as a computer or terminal. The stand is controlled by using lower case ASCII characters. Upper case ASCII characters are sent to control the gauge. The following ASCII commands control the test stand:

NOTE: When programming set points, all leading and following zeros must be entered into memory

- a -Request for speed (see p. 22)
- b -Set units = inches
- c -Enter cycle mode
- d -Move the ram down
- e -Set speed (e.g. e10.00 = set speed to 10.00 in/min) (see p. 22)
- f - Set cycles (e.g. f0200 = set 200 cycles)
- g -Set software down limit (for example, g04.567 = set down limit to 4.567 in)
- h -Set software up limit (for example, h12.345 = set up limit to 12.345 in)
- i - Set units = mm
- j - Set ram speed to max speed
- k -Set ram speed to min speed
- l - Enter limit mode
- m-Enter manual mode
- n -Transmit deflection and force readings (see p. 18)
- o -Set ram speed to programmed speed
- p -Request stand status (see Section 11)
- q -Request number of cycles completed
- r - Request number of cycles set
- s - Stop ram
- t - Reset cycle counter to zero
- u -Move ram up
- v -Request software up limit
- w- Request software down limit
- x -Request deflection value
- z - Reset deflection to zero

Check the gauge operating instruction manual for the appropriate commands to control the gauge functions. All upper case ASCII characters are sent directly to the gauge.

11. Stand Status

The transmission of an ASCII "p" (lower case) by the peripheral device will return the stand status. The following are the return codes and their respective definitions:

Ram status	U = ram moving up D = ram moving down S = ram stopped
Operating mode	C = Cycle mode L = Limit mode M = Manual mode
Limit switch status*	UL = ram at upper limit DL = ram at lower limit

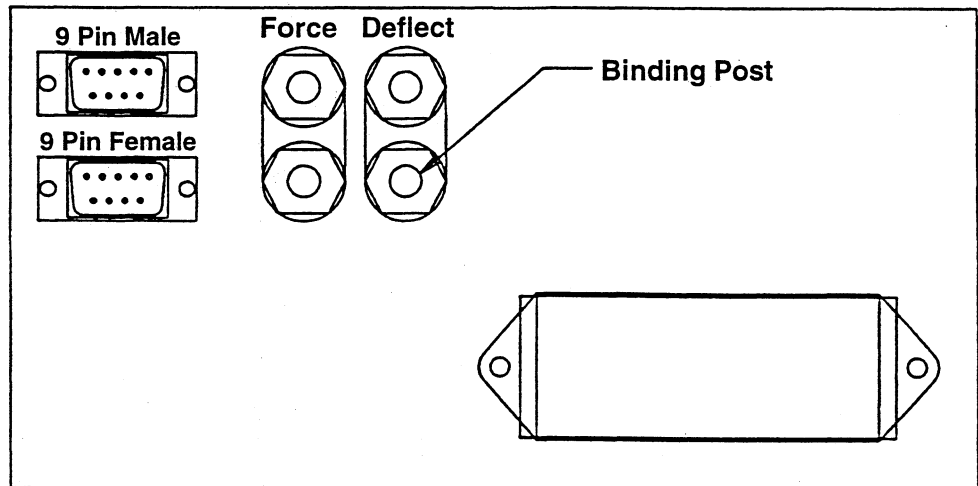
The status will be returned in the following format: (Ram status) (Operating mode) (Limit switch status)

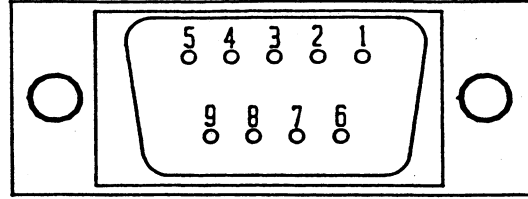
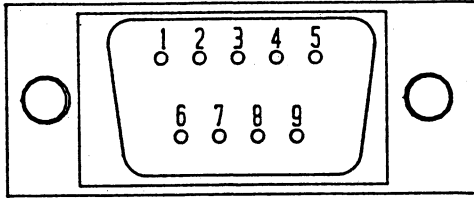
Therefore, S M UL* means the ram is stopped, manual operating mode, and ram at upper limit switch

*This indicator is transmitted only when the ram is at a limit switch.

12. Interconnecting Cable Setup

The TCD-200 is equipped with 2 sets of binding posts for analog outputs and 2 nine pin sub-miniature "D" connectors for I/O operations.





TEST STAND I/O PORT (9 pin male)

PIN # and DESCRIPTION

- 1 Not Connected
- 2 RXD = Receive Data from External Device
- 3 TXD = Transmit Data to External Device
- 4 Not Connected
- 5 GND = Signal Ground
- 6-9 Not Connected

GAUGE I/O PORT (9 pin female)

PIN # and DESCRIPTION

- 1 Receive Data From Gauge
- 2 GND = Ground
- 3 - 5 Not Connected
- 6 TXD = Transmit Data To Gauge
- 7 Analog Force Input From Gauge
- 8-9 Not Connected

13. Lubrication Recommendation

CAUTION

DO NOT USE OIL ON THE COLUMNS OR BALL SCREW
APPLICATION OF OIL MAY CAUSE SEVERE DAMAGE

Approximately every six months, lubricate the ball screw and columns with a light coating of Lithium based grease:

- A. Move the ram to the full up position. If the ball screw is dirty, remove all contamination possible using a lint free cloth.
- B. Apply a #2 grade Lithium grease lightly to the entire length of the ball screw and columns. The unit was lubricated at the factory with Lubriplate Brand, No. 630-2 manufactured by Fiske Brothers, Newark, NJ.
- C. With the speed set at approximately 5 in/min, cycle the ram through its full travel. Wipe off any excess grease that collects.
- D. Continue to cycle through full travel 10 to 15 cycles wiping off any excess grease that collects.

14. Troubleshooting

CAUTION

DISCONNECT ALL POWER BEFORE SERVICING

- A. Power indicator light is not on.
 - 1. Ensure that power is available to the tester.
 - 2. Check that the emergency stop button is UP. (Rotate the button 1/4 turn clockwise.)

3. Check the main fuse located inside the power entry module located on the right rear of the tester. Use a small screwdriver to remove the access cover on the module. Replace any fuse with one of the same size and type.
- B. Power indicator light is on but the ram does not move. Check the fuses on the motor controller. To obtain access to the motor controller, remove the rear panel. The motor controller is located to the left when viewed from the rear of the tester. Replace any fuse with one of the same size and type.
 - C. If fuses blow repeatedly or problems persist, consult the factory or your local distributor.

15. Specifications

Capacity: 200 lb. (1000 N)

100 lb. (500 N) with High Speed Motor

Speed Resolution:

STANDARD 0.50 to 12.50 X 0.01 in/min (12.7 to 317.5 X 0.1 mm/min)

SLOW SPEED 0.020 to 0.500 X 0.001 in/min (0.51 to 12.70 X 0.01 mm/min)

MEDIUM SLOW SPEED 0.10 to 2.50 X 0.01 in/min (2.5 to 63.5 X 0.1 mm/min)

MEDIUM HIGH SPEED 1.0 to 25.0 X 0.1 in/min (25 to 635 X 1 mm/min)

HIGH SPEED 2.0 to 50.0 X 0.1 in/min (51 to 1270 X 1 mm/min)

Speed Accuracy: $\pm 5\%$ of max speed

Deflection Resolution: 0 to 18.000 X 0.001 in (0 to 457.20 X 0.01 mm)

Deflection Accuracy: $\pm 0.1\%$ or ± 0.004 in (± 0.10 mm) whichever is greater

Analog Output: 0 to 18 in = 0.056 Vdc per inch $\pm 3\%$

Digital Output: Bidirectional RS232 via 9 pin "D" connector

Maximum Specimen Size (Compression):

<u>GAUGE</u>	<u>CLEARANCE</u>
DFIS	18" (455 mm)
DFGS	19 1/2" (495 mm)
DPP (inverted)	20" (505 mm)
DPPH	18 1/2" (470 mm)
DFGS-R (remote load cell)	19" (480 mm)

Power Requirements: 110 Vac STANDARD

220 Vac OPTIONAL

Instrument Weight: 42 lb. (19 kg)

Format and Response Commands (p. 19)

	Format of "e" command	Response to "a" command
Standard speed	exx.xx	^ xxx.xx ^ in/min <CR> <LF>
	exxx.x	^ xxxx.x ^ mm/min <CR> <LF>
Slow speed	ex.xxx	^ xx.xxx ^ in/min <CR> <LF>
	exx.xx	^ xxx.xx ^ mm/min <CR> <LF>
Medium slow speed	exx.xx	^ xxx.xx ^ in/min <CR> <LF>
	exxx.x	^ xxxx.x ^ mm/min <CR> <LF>
Medium high speed	exxx.x	^ xxxx.x ^ in/min <CR> <LF>
	exxxx*	^ xxxxx. ^ mm/min <CR> <LF>
High speed	exxx.x	^ xxxx.x ^ in/min <CR> <LF>
	exxxx*	^ xxxxx. ^ mm/min <CR> <LF>

*(Decimal point is ignored in command)

16. Parts Lists

SYM.	DESCRIPTION	PART #	QUAN.
1	Load beam	NC000407	1
2	Support channel	NC000769	2
3	Column	NC000403	2
4	Ballscrew	NC000402	1
5	Compression plate	NC000413	1
6	Ram/gauge mount	NC000406	1
7	Tie bar	NC000411	1
8	Electronic support plate	NC000771	1
9	Motor support plate	NC000410	1
10	Motor	See Table A	1
11	Pulley HTD 32-5M-15	NC000389	1
12	Belt, HTD	See Table A	1
13	Leveler 1/4-20	NC000057	4
14	Washer, Fender 1/4 x 1/2	NC000448	1
15	Rod guide	NC000446	3
16	Spring	NC000401	2
17	Spacer, 2-3/4 long	NC000436	1
18	Spacer, 1/2 long	NC000436-1	1
19	Faston receptacle	NC000683	4
20	Rod 31"	12139-D	1
21	Collar	17234	2
22	Lock nut N-01	NC000394	2
23	Lock washer W-01	NC000405	2
24	Screw #10-32 x 1/2 SHCS	3572	15
25	Angular contact bearing	NC000385	2
26	Motor controller	NC000400	1
27	Power supply	ENC0160	1
28	Bearing, deep groove	NC000386	1
29	Screw, #6-32 x 3/8 SHCS	NC000486	29
30	Set screw #10-32	3127	2
31	Nylon bearing	NC000390	4
32	Limit switch	NC000397	2
33	#10 lockwasher	3355	10
34	Screw, #6-32 x 1 BD HD	8156	4
35	Bottom cover	NC000766	1
36	Top console	NC000765	1
37	Column cover	NC000416	2
38	Rear cover	NC000767	1
39	Cap	NC000415	1
40	Nylon shoulder washer	NC000492	4
41	Display cover	NC000433	2
42	Overlay	NC000770	1
43	Rocker switch	See Table A	1
44	P.C. board	NC000363	1
45	Screw, 6-32 x 5/8 SHCS	21105	1
46	Screw, #10-32 x 5/8 SHCS	3573	2
47	Flexible coupling	NC000384	1
48	Power entry module	EL9-1080	1
49	Power cord	See Table A	1
50	Encoder Mount	NC000434	1

SYM.	DESCRIPTION	PART #	QUAN.
51	Screw, 1/4-20 x 1 1/4 SHCS	3113	2
52	Screw, 1/4-20 x 1 SHCS	2761	2
53	Screw, #6-32 x 3/8 BHS	NC000472	15
54	#6-32 standoff	21598	4
55	#6 teeth lockwasher	10390	33
56	Screw, #6-32 x 1/4 SHCS	13945	4
57	Nut, 1/4-20 hex	7970	6
58	not used		
59	Fuse, 3 amp	NC000487	2
60	Gauge mounting plate, DFI	NC000447	1
61	Mounting adapter	NC000412	1
62	Screw, #6-32 x 1/2 SHCS	21104	3
63	Hp resistor	See Table A	1
64	Keypad	NC000768	1
65	Screw, 1/4-20 x 1 BHS	21162	4
66	Nut, #6-32 hex	3168	5
67	Nylon bearing	NC000498	2
68	4-pin connector	NC000500	2
69	Rod holder	NC000494	2
70	Rod clip	NC000495	2
71	9-pin connecting cable, male	NC000431	1
72	Cable clamp	EL10-1024	1
73	Cable, power supply to PCB	NC000429	1
74	E-PROM (not shown)	NC000122	1
75	9-pin "D" connector	NC000432	1
76	Standoff #4-40	NC000461	4
77	Nut #4-40 hex	3184	4
78	Mounting tab	15455	6
79	Binding post	15542	2
80	Terminal, female	15596	8
81	#4 lockwasher, teeth	2761	4
82	Cable, P.C. board to motor C	NC000482	1
83	not used		
84	Tie wrap	EL10-1011	10
85	Spade lug	15023	7
86	Encoder	NC000395	1
87	Terminal, male	15595	2
88	#10 flat washer	2538	6
89	#6 brass flat washer	10716	2
90	Set screw #10-32 x 1/4	21137	1
91	#6 lockwasher	13927	2
92	Stop button	NC000604	1
93	Contact block	NC000605	2
94	Allen key, 5/32	NC000846	1
95	not used		
96	Caution label	NC000669	1
97	Warning label	NC000670	1
98	Warning label	NC000671	1
99	not used		
100	Pulley	See Table A	1

SYM.	DESCRIPTION	PART #	QUAN.
101	Ring terminal	EL10-1017	3

Exceptions for TCD 200-220V

29	Screw, #6-32 x 3/8 SHCS	3572	34
58	220V transformer	NC000807	1
91	#6 lockwasher	13927	3
101	Ring terminal	EL10-1017	4
102	Pin	NC000620	6
103	6-pin connector	NC000636	1
104	Cable assembly, 220V	NC000798	1

Exceptions for Extended Column Stands

3	Column 60"	NC000453	2
37	Column cover, right	NC000464-1	1
37	Column cover, left	NC000464-2	1
52	Screw, 1/4-20 x 1" SHCS	2761	4
105	Screw, #6-32 x 1/4 BUT	21305	4
106	Top support	NC000463	1

Table A

MODEL	10 MOTOR	12 BELT	43-ROCKER SWITCH	49-POWER CORD	63-HP RESISTOR	100 PULLEY
TCD 200	NC000391	NC000890	NC000606	EL9-1079	NC000470	NC000891
TCD 200-220V	NC000391	NC000890	NC000638	EL9-1084	NC000470	NC000891
TCD 200-HS	NC000393	NC000890	NC000606	EL9-1079	NC000471	NC000891
TCD 200-HS-220V	NC000393	NC000890	NC000638	EL9-1084	NC000471	NC000891
TCD 200-SS	NC000392	NC000890	NC000606	EL9-1079	NC000470	NC000891
TCD 200-SS-220V	NC000392	NC000890	NC000638	EL9-1084	NC000470	NC000891
TCD 200-MH	NC000393	NC000580	NC000606	EL9-1079	NC000471	NC000579
TCD 200-MH-220V	NC000393	NC000580	NC000638	EL9-1084	NC000471	NC000579
TCD 200-MS	NC000506	NC000890	NC000606	EL9-1079	NC000470	NC000891
TCD 200-MS-220V	NC000506	NC000890	NC000638	EL9-1084	NC000470	NC000891