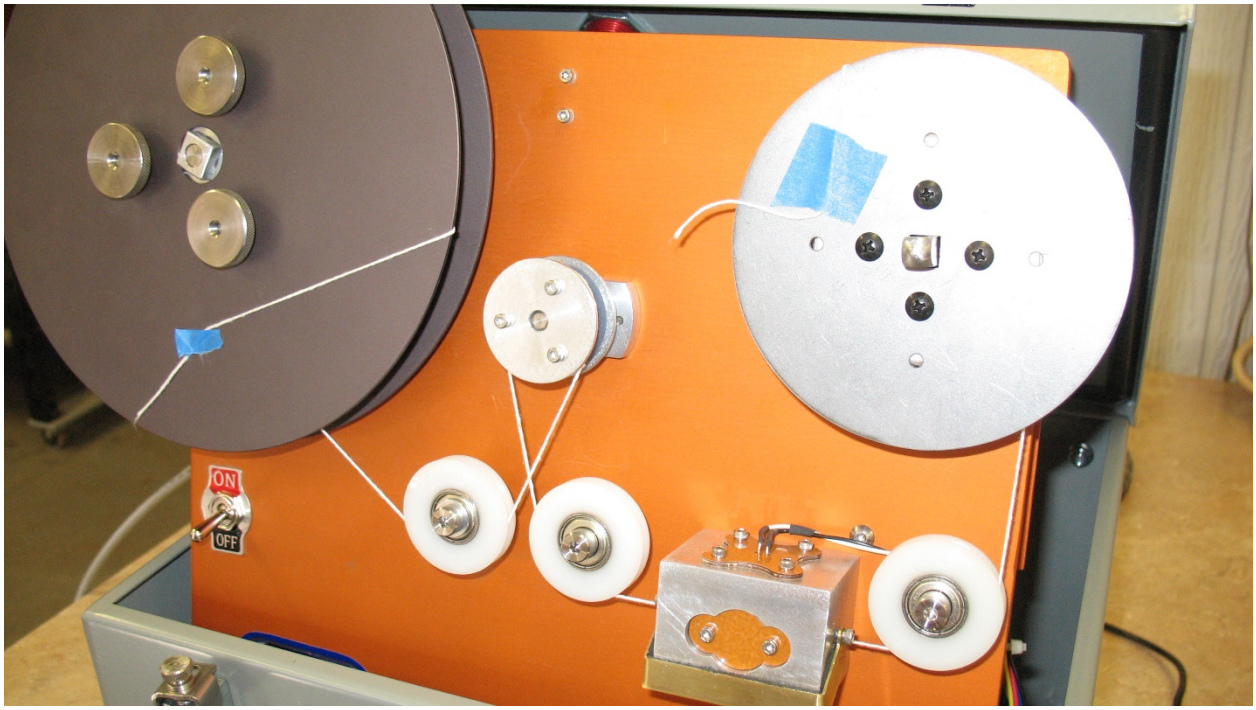
WRK STRING SPECTROMETER

OPERATIONS MANUAL



WRK of Oklahoma

Stillwater, Oklahoma

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Please note: This document is intended as a guide for the WRK String Spectrometer user. It is also expected that the user will have access to the AccuPatt™ User Manual.

DESCRIPTION

The **WRK String Spectrometer** consists of a **Case Enclosure** which supports the **Main Frame** and the internal **Electronics Panel**.

Case Enclosure

The **Case Enclosure** contains the entire electro-mechanical system. With the continuously-hinged lid closed, except for clearances around mounting screws, is nearly air and dust tight. The case is 14-in long

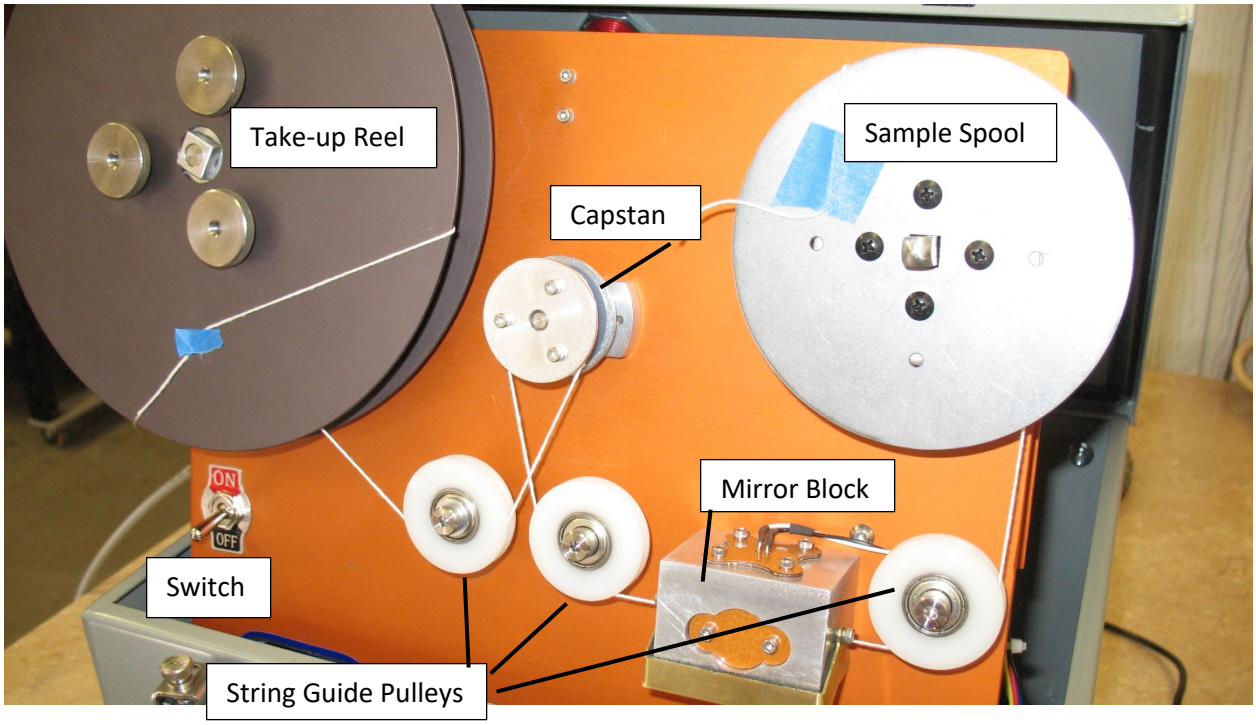

Figure 1. WRK String Spectrometer Main Frame components

x 12-in wide x 8-in tall (0.36 m x 0.3 m x 0.2 m). It has "scratch-resistant" foot pads which extend approximately 3/8-in (1-cm) to each side. The CASE is powder coated ANSI-61 gray, inside and out and is equipped with a carrying handle attached to the lid. The total weight of the operational unit is approximately 29 pounds (13 kg).

Main Frame

The **Main Frame** is a 3/16 in (4.5 mm) thick aluminum panel which supports all the mechanical components. It is hinged to the inside-front of the case so that it can be rotated up and locked to the case lid for operation. The front of the panel presents the **Sample** reel and **Take-up** shafts, **Capstan**, **Mirror Block**, **String Guides**, and the **Power Switch**. See Figure 1. Attached to the back of the **Main Frame** are the **Stepper Motors**, **Slip Clutches**, and the **Ocean Optics Spectrometer**. When the panel is unlatched, and rotated downward, all the components are moved into the case and the case lid can be closed, readying the unit for transport or storage.

Electronics Panel

The **Electronics Panel** is mounted on four studs on the inside bottom of the case. Attached to this panel are the **Power Supply**, **LED** driver, and the **Stepper Motor** drivers. The power cord and the USB cables are anchored to the **Electronics Panel** and are deployed from inside the case during operation.

Connections

The WRK String Spectrometer is equipped to operate on either 115 VAC or 220 VAC. Users who intend to use 220 VAC, must supply the correct adapter plug to connect the standard 115 VAC plug to a 220 VAC receptacle. Switching from either voltage requires moving the slider switch on the side of the power supply to the proper voltage. **Ensure that the correct voltage has been selected prior to use. All units for use in the US are shipped with the voltage set to 115 VAC. 220 VAC will be pre-selected upon purchaser's request.**

Do not connect the USB connectors to the computer before installing the Ocean Optics software. If not already completed, do that now.

Without Ocean Optics software installed on your computer, the computer will automatically search for and locate and install incorrect and unworkable drivers. Remedy for this mistake is time consuming.

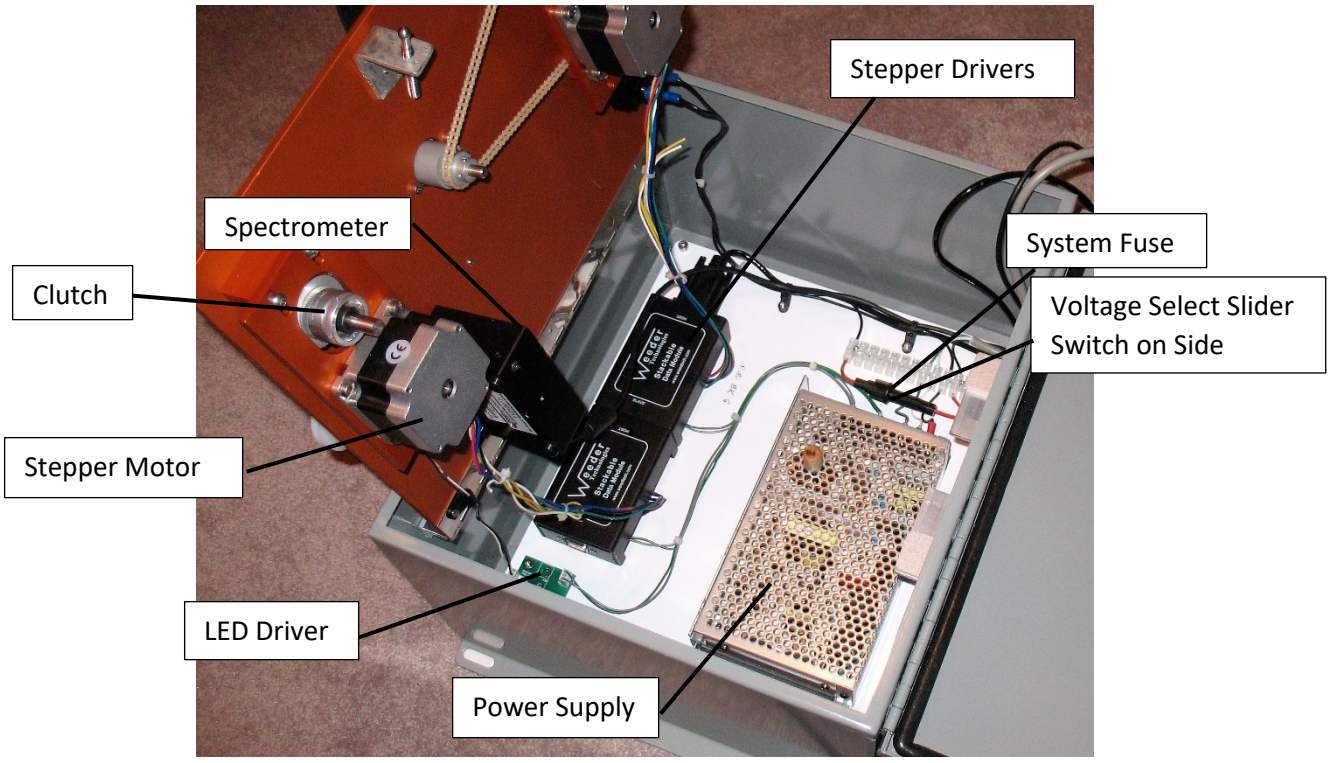

Figure 2. WRK String Spectrometer Interior.

There are two USB cables, one for the stepper motor drivers and the other for the Ocean Optics spectrometer. These must be connected to the controlling PC using a common USB hub, supplied with the WRK String Spectrometer.

The WRK String Spectrometer is controlled with the software package **AccuPatt™** available as a

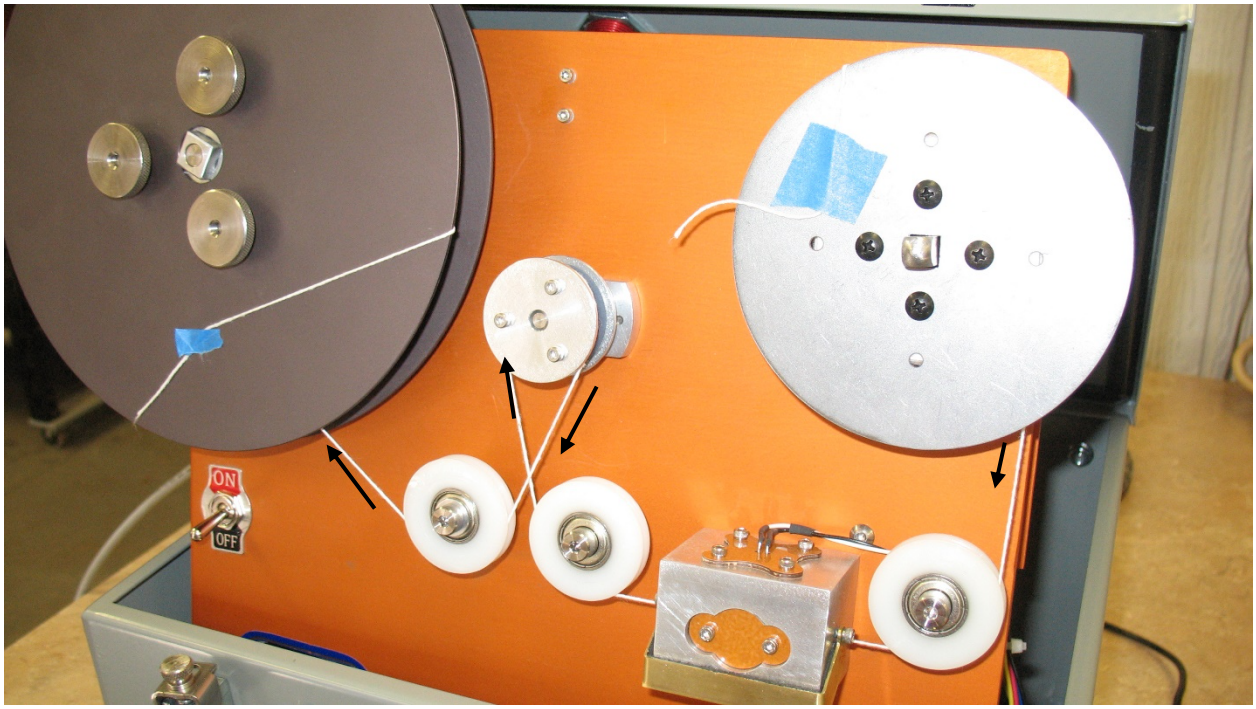

Figure 3. Threading the String

download installation at the time of purchase. A color printer, compatible with the PC, is recommended to provide complete interpretation of the printed PDF output.

START UP

Mechanical Set Up

Open the **String Spectrometer** lid against the holding magnet and remove the **Take-up** reel from within the case. The power supply has a wooden dowel stud to position and restrain the reel. Remove the electrical and control cords from inside the case.

Be especially careful to avoid letting the main frame fall back freely into the case, as these items are removed. Attach the case lid to the attachment stud on the back top of the main frame by inserting the stud into the latch hole until it “clicks”. Disconnect the latch when ready to store the unit by pressing down the latch button on the top of the lid and separating the lid from the frame.

Assemble the **Take-up** reel, if not already done, by removing the knurled thumb nuts, positioning the opposing reel face on the studs and fastening with the knurled thumb nuts.

Installing Stepper Drivers

Insure the computer is connected to the internet. Open the Control Panel, select Device Manager, Scan to find the USB Ports line. While at this location, and with the USB hub connected to the computer, plug the Stepper Driver USB into the USB Hub. Watch as the USB Serial Port pops up showing "Ports (Comm & LPT) along with a number associated with that port. Double click on that line which will bring up information about that port. Select "Update Driver". Select "Search Automatically for Updated Driver". The correct driver will be found on the internet and installed on your computer. When complete, the USB port information should show "Mfg. FTDI" under the port General Properties. This driver will remain installed on the computer and used to operate the stepper motors whenever connected. You may need to restart the computer to initiate the driver connection.

Threading the String

The **Take-up** reel is pushed onto the square spindle (upper left of Frame) and the **Sample** reel is mounted over the smaller square spindle on the right side. Figure 3 shows the correct string path. The **Mirror Block** light shield may be lifted to insert the string and should be closed during string analysis. Several turns of string should be wound onto the **Take-up** reel, using a piece of painter's tape to secure the end to the outside of the reel.

Analyzing a String

Prepare for a treated string analysis by connecting the USB cords to the computer via the USB hub, correctly threading the string on the **String Spectrometer**, closing the light shade on the **Mirror Block**, and switching the power on. At this point, refer to the **AccuPatt™** software manual and proceed with the analysis.

SYSTEM INFORMATION AND OPERATING TECHNIQUES

Mirror Block

The **Mirror Block** is designed to illuminate the entire circumference of the string cross- section as it passes through the light chamber, and simultaneously expose the entire string circumference to the spectrometer. This is accomplished by two concave mirrors, each opposite the **LED** and spectrometer light entry window, respectively. The mirrors may be accessed by removing the two socket-head screws and removing the hold-down plates. Extreme care should be followed if these mirrors are removed. Never physically wipe the mirrors or contact their mirror surfaces with any object. Dust may be blown from the light chamber using compressed gas, but even this procedure should be done carefully. Ensure, if replacing these mirrors that they are installed correctly with their concave reflecting surfaces facing into the chamber and that they are seated against the internal supporting ledge. Reuse the soft expansion pads between the mirrors and their hold-down plates to maintain light pressure of the mirrors against the ledge.

The **Mirror Block** also contains an **LED** having the correct excitation wavelength for the dye tracer to be used. Beneath the **LED** is a **Band-pass** filter with wavelength transmission selected to pass the desired

excitation wavelength. Ninety degrees to the light source is the **Spectrometer** window, covered by a **Boron** glass lens.

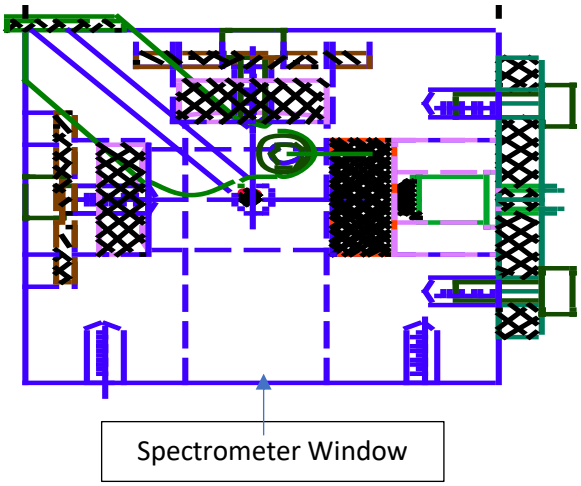

Figure 4. Mirror Block Cross-section

The **LED** and **Band-pass** filter may be changed to accommodate other tracer dyes. The suggested procedure is as follows:

(1) Obtain the correct **LED** and **Band-pass** filter for the desired dye tracer. (Suggestions)

Rhodamine WT:	Green LED 525 nm / WP71113ZGC by King Bright 525 nm Band Pass Filter / 86-939 / Edmund Optical Use 575 nm for emission wavelength
Pyranine:	LED LVX3330, 430 mm: PN 138691 Jameco.com 425 nm Band Pass Filter: PN 86-937, Edmund Optics Use 495 nm for emission wavelength
Topline Pigment:	Same as Pyranine above, except use emission wavelength 502 nm.
PTSA Dye:	LED 370E Size T-1 ¾, 5.5 mm dia, ThorLabs Filter: 357nm x 44nm BP 75% T 12.5 Dia, PN 86-973 Edmund Optics

(These settings may not be optimum. Experimentation or spectral analysis is recommended to determine the optimum wavelengths.)

(2) Unplug the **LED** power leads from the driver board and pull the LED power leads through the face frame.
(3) Remove the four socket-head screws located on top of the **Mirror Block**.

(4) Lift out the LED assembly and separate the **LED** from the aluminum cylinder. *(clamp the aluminum cylinder in vice or fixture and gently tap the led to release it from the aluminum cylinder, if necessary)*
(5) Loosen the two 4-40 socket-head screws that attach the mirror block to the frame, remove the **Mirror Block** and invert it to remove the filter.
(6) Install the desired filter, orient it with the correct direction of light passage (side arrow).
(7) Insert the **LED** into the **LED** cylinder and the assembly into the **Mirror Block** above the filter
(8) Thread the LED wires through the frame and plug it onto the driver board. If the polarity is correct, a green LED light on the board will illuminate. If not, exchange the wire positions in the connector and retry.
(9) Replace the cover and four screws.
(10) Switch power on to verify the **LED** is functioning.
(11) Check that the correct emission frequency is set in **AccuPatt™** before analyzing a string.

Clutch Adjustment

(Prior to this procedure, set the string speed to approximately 1.5 ft/sec (0.46 m/s). Do this by bringing up the "Edit String Drive" window in AccuPatt™. Enter "AV35" in the Command Line box and click "Send". Enter "BV45" into the Command Line box and click "Send". This action will set the desired rpm for each stepper motor. The settings will remain in nonvolatile memory until changed.)

The clutches have been adjusted and operated prior to delivery, but may need slight adjustment, as they wear. Increase the torque for the clutch by clockwise rotation of the knurled rim while preventing rotation of the clutch housing. The following procedure may be used to adjust the clutch torque settings to their approximate working values should the adjustment become necessary. Note that the adjustments must be dynamic (the shaft must be turning at the time of testing).

The mechanical drive clutches must be adjusted to permit both forward and reverse string directions, while using only one-way rotation for each stepper motor. The **Sample** reel motor is locked during

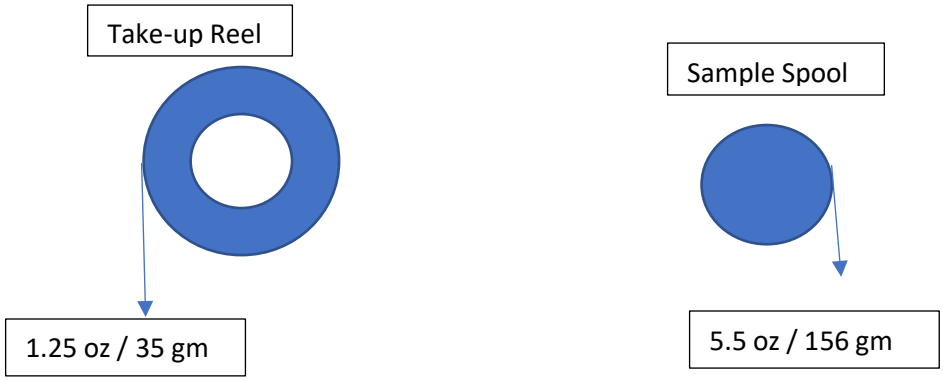

Figure 5. Clutch Adjustment

analysis to provide tension on the string, as it is being pulled through the **Mirror Block**. Likewise, the **Take-up** motor is locked during rewinding, so that clutch must slip, as it provides tension to the string during the rewind. The **Take-up** clutch must also slip during analysis to accommodate the slowing Take-up reel, as the string is wound. These clutch torque settings must also be within the limits of the stepper motors. Too much torque will cause the motors to exceed their capability and cause stalling.

Too little torque will allow the **Sample-reel** motor to turn during rewinding but simply slip the shaft, resulting in no motion of the string. Too much torque on the **Take-up** reel clutch will stall the **Sample-reel** motor.

Do the following one reel at a time. See Figure 5.

(1) Tape a length of string to the periphery of each reel and hang the designated weight on the respective string, 1.25 ounce (35 gm) for the **Take-up** and 5.5 ounces (156 gm) for the S**ample** reel. The sample reel used had a diameter of 4.25 inches (108 mm).
(2) Switch on the power to the unit and bring up the ***"Edit String Drive"*** window in **AccuPatt™**. Restrain the adjusting reel and start the motor. If using **AccuPatt™** use ***Advance*** for the **Take-up** reel, ***Reverse*** for the **Sample** reel. Alternatively, send direct ascii commands "AD+\r" for the **Take-up** reel, "BD-\r" for the **Sample** reel.
(3) Setup and adjust each clutch, one at a time, until the designated weight barely prevents the rotation of the reel, as the respective shaft slips in the clutch. Start with the clutch too tight to slip and gradually relax the tension by turning the knurled clutch ring counterclockwise until the weight just barely hangs in a stationary position.

Rewinding the String

The string may be rewound from the **Take-up** reel back onto the **Sample** reel. To rewind, remove the string from the **Capstan**. The string may be left in the **Mirror Block** while rewinding but be sure to keep it mounted on the guide pulleys while doing so. In **AccuPatt™**, use the ***Reverse*** button on the Capture/Edit Pass window to rewind.

If suggested limits have been exceeded with respect to **Take-up** or **Sample** reel capacity, rewinding may result in some slippage of the clutches resulting in slowing of the string during rewinding. Hand assistance may be provided to complete the rewind, or the clutch may be tightened for the rewind. If the clutches are tightened, mark the location of the adjusting ring with respect to the clutch barrel prior to adjustment, so that the clutch may be reset to the former position before analyzing. Even though the clutch tension is returned to the mark, some adjusting may be necessary to return operation exactly as it was prior to the adjustment.

Limitations

The constraints described previously regarding the clutch settings and stepper motor available torque at selected speeds, results in certain limits on the mechanical system performance. Operational testing over a range of stepper motor speed has shown that a good operating velocity for the string is about 1.5 Ft./s (0.46 m/s). At this speed, and with the clutches set at the approximate values of Figure 5, the slippage of the string on the **Capstan** is within 0.3% to 0.5% and is not a factor during analyses.

The following parameter settings are recommended when using the WRK String Spectrometer for aircraft pattern deposition analyses: (Deviations from these suggested settings may be used but should be verified acceptable)

String speed approximately	1.5 Ft./s	0.46 m/s
Sample length approximately	0.2 Ft.	0.08 m
Max Take-up reel capacity	1350 Ft.	410 m
Normal Sample reel volume	3 Passes (150 Ft/pass)	3 Passes (50 m/pass)
Max Sample reel volume	6 Passes	6 Passes

Questions or comments regarding this manual and/or the WRK Spectrometer hardware may be addressed to whitney3451@att.net or text (405) 714-0095.

Linearity Test

Serial Number FLMS18515 (This number unique to each Ocean Optics Spectrometer Unit) and also serves as the serial number of the WRK String Spectrometer on which it is originally mounted.

This page supplied with the WRK Spectrometer Unit