HERCULES SIZING TESTER

TAF 310 SERIES
INSTRUCTION MANUAL

REV 3.0

THE ADERHOLD FIRM, INC.

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INTRODUCTION

The Aderhold Firm (TAF) recommends that you review the entire manual for the new, improved Hercules Sizing Tester (HST) prior to use. If you are a long time HST user, this Introduction describes the new features of the HST.

The HST was improved for two reasons:

A few parts on the existing HST are obsolete and no longer available for purchase. The microamp meter is one example.
Customer requests to update the internal electronics, to add new features, and to simplify the operation.

WHAT HAS NOT CHANGED

TAF wanted to update and improve the HST design, but it was important to maintain the basic functionality in order to continue its applicability to **TAPPI Method T 530,** historic data and specifications. Fortunately, the optical assembly, which contains the photocells, optical tube, and lamps, did not have to change in our effort to modernize the unit. Testing results show that data from the old and new units are statistically equivalent. Variability is also equivalent when compared to a well-maintained older HST. However, test result variability drastically minimized with the improved HST.

WHAT HAS CHANGED

The internal wiring, capacitors, and power supply have all been upgraded with circuit board technology. These upgrades are as follows:

Circuit board Technology
- One step sample calibration (see **Test Procedures**)
- Faster unit standardization (see **Standardization**)
- Perform your own service in your own lab (see **Maintenance**)

RS-232 serial port for automatic data transmission (see **Test Procedures** – Page 10)
Two modes allow you to collect either the final test result (time to endpoint) or continuous time and reflectance data for the entire test.
Vacuum Fluorescent Display (VFD) showing Reflectance Setpoint, current test Reflectance, time, and text messages. The messages area will provide test status or remind the user that the lamp bulbs have been in use for more than 200 hours. (See **Troubleshooting**)

The specific sections that TAF recommends reviewing are:

Operation Section

Running a Sizing Test	Section 2 - Page 7
Changing Service Mode Settings	Section 3 - Page 11
RS232 Serial Data Port	Section 3 - Page 18
Standardization Section	Section 4 - Page 23

Maintenance Section and **Troubleshooting Section**
To troubleshoot the new electronics, design, and procedures refer to these as necessary. A new **Parts list** can be found in the **Maintenance** section.

SECTION 1
DESCRIPTION OF THE HERCULES SIZING TESTER

GENERAL OVERVIEW

Developed specifically for the paper industry, the Hercules Sizing Tester (HST) enables an accurate, rapid, and highly reproducible determination of the level of sizing of paper. It can be used on all grades, from lightweight paper to heavyweight board. Use of the Hercules Sizing Tester is described in the **TAPPI Official Method T 530**.

The Hercules Sizing Tester can be used with either 110/250V, 50/60 Hz AC, power sources [(1)]

The newer Hercules Sizing Testers, illustrated in **Figure 1-1**, is a greatly improved version of the Hercules ink photometer, first developed in 1950 and subsequent green models in use since 1968. The basic principle of operation remains the same. Ink is placed on a sample of paper and a photoelectric cell registers the drop in reflectance (brightness) of the opposite side of the sheet as the ink penetrates. When the reflectance drops to a predetermined level, an automatic timer is stopped to indicate the test time. The test results are highly reproducible since the endpoint is determined automatically by the photoelectric cell.

Reflectance endpoints can be changed quickly on the instrument to accommodate the sizing level of paper being tested. Thus, a mill producing a wide range of basis weights or sheets with widely varying levels of sizing can adjust the reflectance endpoint to obtain test results within a reasonably short period of time.

The Hercules Sizing Tester measures the resistance of paper to permeation of an aqueous penetrant and is a useful general-purpose test for degree of sizing. Being a “penetration type” test, the HST is excellent for measuring the effect of increasing sizing agent addition on the paper or paperboards aqueous penetrant resistance. It is applicable to most bleached, unbleached, and colored paper or boards that are surface sized and/or internally sized. It is not applicable to transparent or translucent papers (e.g., low basis weight papers where ink affects the reflection from the measured surface), colored papers that do not contrast with the green test ink, or papers having as part of their structure an effective water barrier such as polyethylene film.

The Hercules Sizing Tester can also be used for measuring the oil resistance of paper and board. The oil penetration test is based on the same principle and is run in the same manner as the ink penetration test. Use of flammable solvents instead of ink as a penetrant is not recommended, as the sizing tester is not explosion-proof.

The HST can also be used as an excellent cost management tool and can assist papermakers to control and minimize sizing chemical usage. Using the HST in conjunction with a test like the Cobb test can be very effective. The HST is a penetration test and measures the internal sizing of paper. This is different from weight pickup tests such as the Cobb test and water immersion test. These tests measure water absorption only and do not always indicate variations in paper sizing due to changes in size dosage. **See Figure 1-2.** Using a combination of tests will further help to minimize your size dosage while optimizing the end use performance of your paper.

[(1)] Do not use any other voltage without an appropriate transformer.

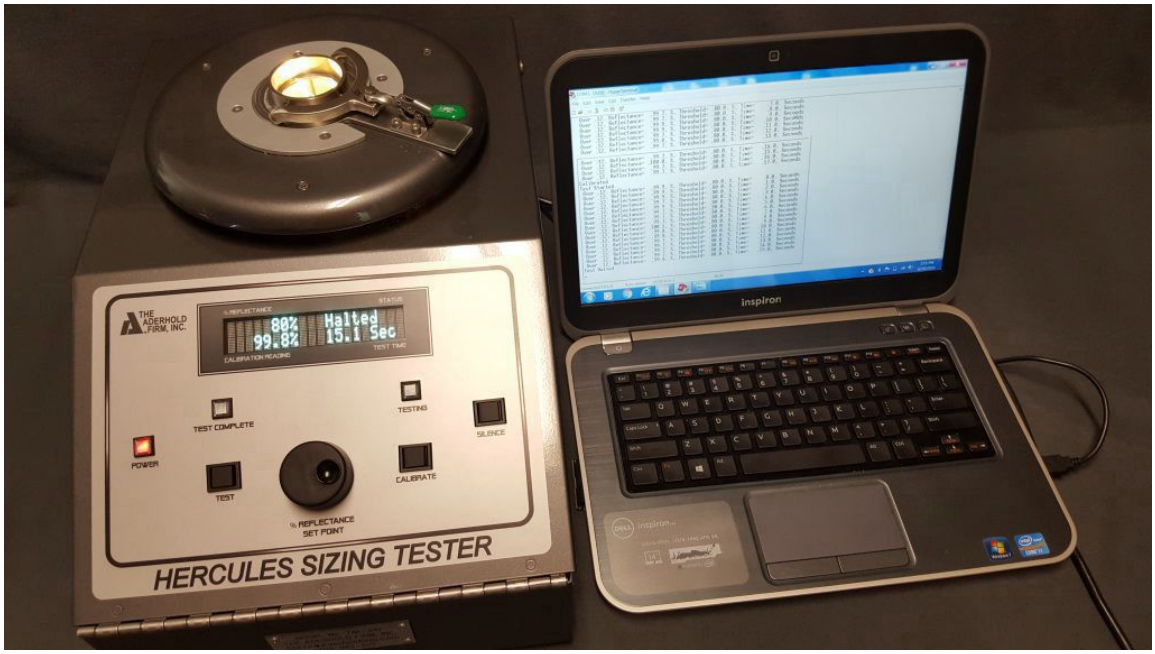


Figure 1-1: This photo of the new Hercules Sizing Tester shows the end of a test. The right side illustrates one of the features a RS-232 port for transmitting data to a computer.

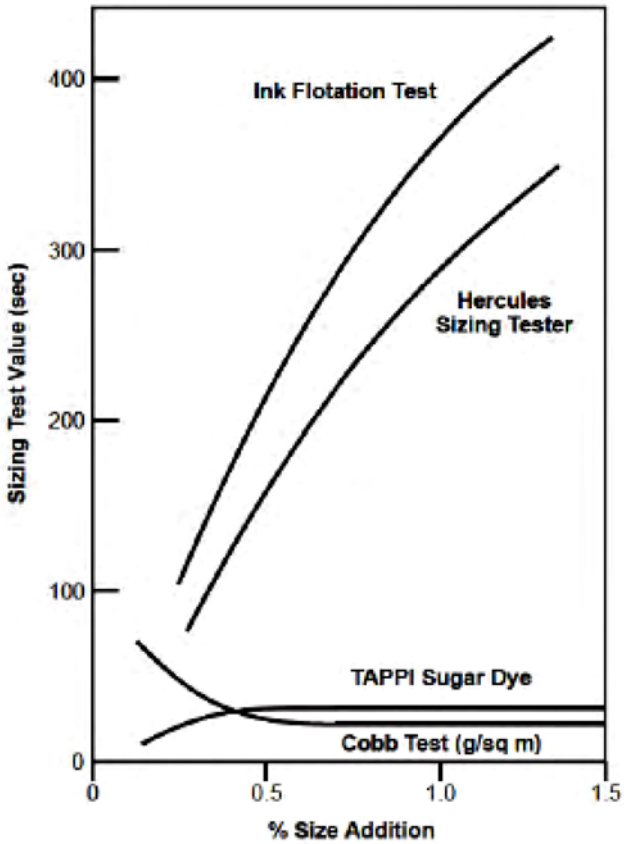


Figure 1-2: % Size Addition vs. Size Test Value

CIRCUIT BOARD DESCRIPTION

A single board, micro-controller supplies all functionality for the Hercules Sizing Tester. (See **Figure 1-3**) The unit also contains firmware with non-volatile memory, a Vacuum Fluorescent Display (VFD) and an RS-232 connector to allow a computer to gather, analyze, and display data.

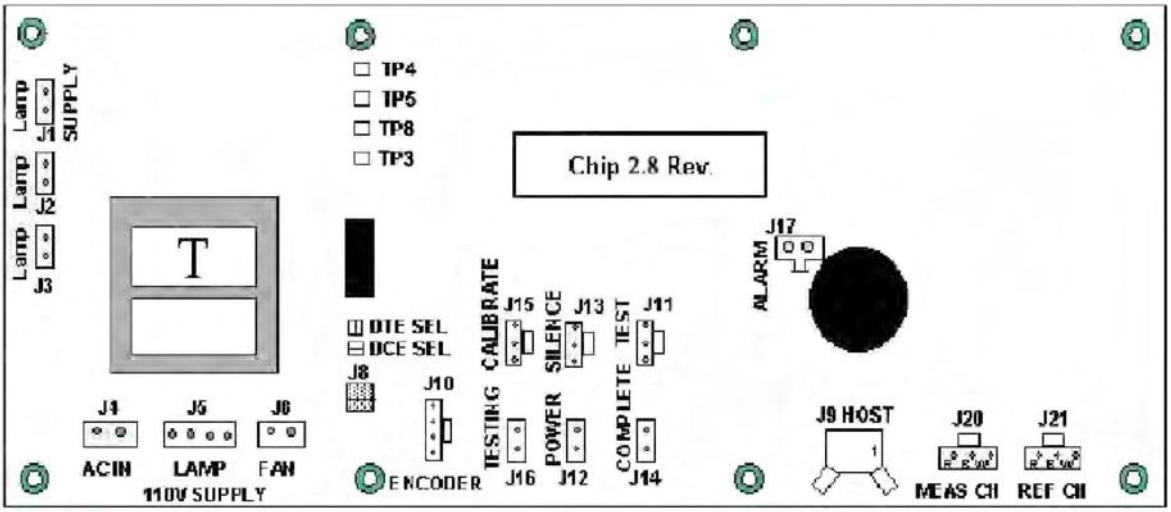


Figure 1-3

Inputs

Two photocells (Meas CH - J20 and Ref. CH - J21)
Reflection percentage threshold set control (Encoder - J10)
"Push to Calibrate" button / Timer reset switch (Calibrate - J15)
"Silence" button to halt test (Silence - J13)
"Test" start button (Test - J11)

Outputs

"Test Complete" light (Complete - J14)
"Test" in process light (Testing - J16)
"Power" light (Power - J12)
Test complete buzzer (Alarm J17)
Display unit assembly

- Real time reflection percentage — 0-100% in 1% increments
- Reflection percentage threshold or Set Point — % in 1% increments
- Seconds — 0-9999.9 in 0.1 second increments

Differences between the old unit and the new Hercules Sizing Tester

1. Reflectance percentage threshold is set by a front panel mounted soft pot.
2. All small components are assembled onto a printed wiring board assembly.
3. Reflection percentage threshold setting, test time, and real time reflection percentage is displayed on a vacuum fluorescent display assembly (VFD).

MICRO CONTROLLER AND ELECTRONICS

A Microchip PIC18F4620-I/P processor is the central element of the application. An RS-232 interface, IC, audible alarm, low current power supply, sensor amplifiers, and all connectors are on the main board. A Lambda power supply is used to power the two lamps. A non-volatile memory chip is used to hold user preferences and lamp timer data. There is a power supply section that supplies three power rails. A 5 Volt power for the digital section, and a separate filtered positive and negative 6 Volt supply for the sensitive analog measurement circuitry. The signals from the optical sensors are amplified and sent through a low pass filter. The amplified and filtered signals are then passed to a multi-channel 10 bit analog to digital (ADC) converter where the signal is converted into a form that can be used by the microcontroller.

Two 32-candlepower, 6.0V lamps (No. 1680 type) provide illumination. They are powered by a regulated DC power supply that supplies a 6.0V output relatively independent of line fluctuations. The output voltage of the power supply has been lowered to approximately 5.0 to 5.5V in order to lengthen the service life of the lamps. Optical geometry provides 45° illumination and 90° viewing of the test specimen.

A circuit having two silicon photocells measures the optical reflectance of the test specimen. One views only the bottom of the paper sample; the other views the lamp filaments. The original design included a potentiometer to compensate for differences in sensor sensitivity. The new circuit board technology is more tolerant of differences in sensor sensitivity with no need for adjustments. See Section 1, page 2 for more information.

The sizing tester relay switching circuit includes a 1/8-amp slow-blow fuse. This fuse is located on the circuit board between the isolation transformer (T2) and the rectifier and is intended to protect the transformer from burnout in case of rectifier failure. There is also another fuse on the back panel at the electrical input connection.

The lamps inside the optical housing dissipate considerable heat, and it must be removed from the sample area. To remove sensible heat, a fan (F) draws room air into the optical housing through the filter underneath the optical housing cover. The air then discharges into the cabinet and escapes through the louvers and back opening. The fan has a nominal capacity of 33 ft^3/ min at 60 Hz and 20 ft^3/ min at 50 Hz. This air volume effectively prevents sensible heat transfer to the sample area.

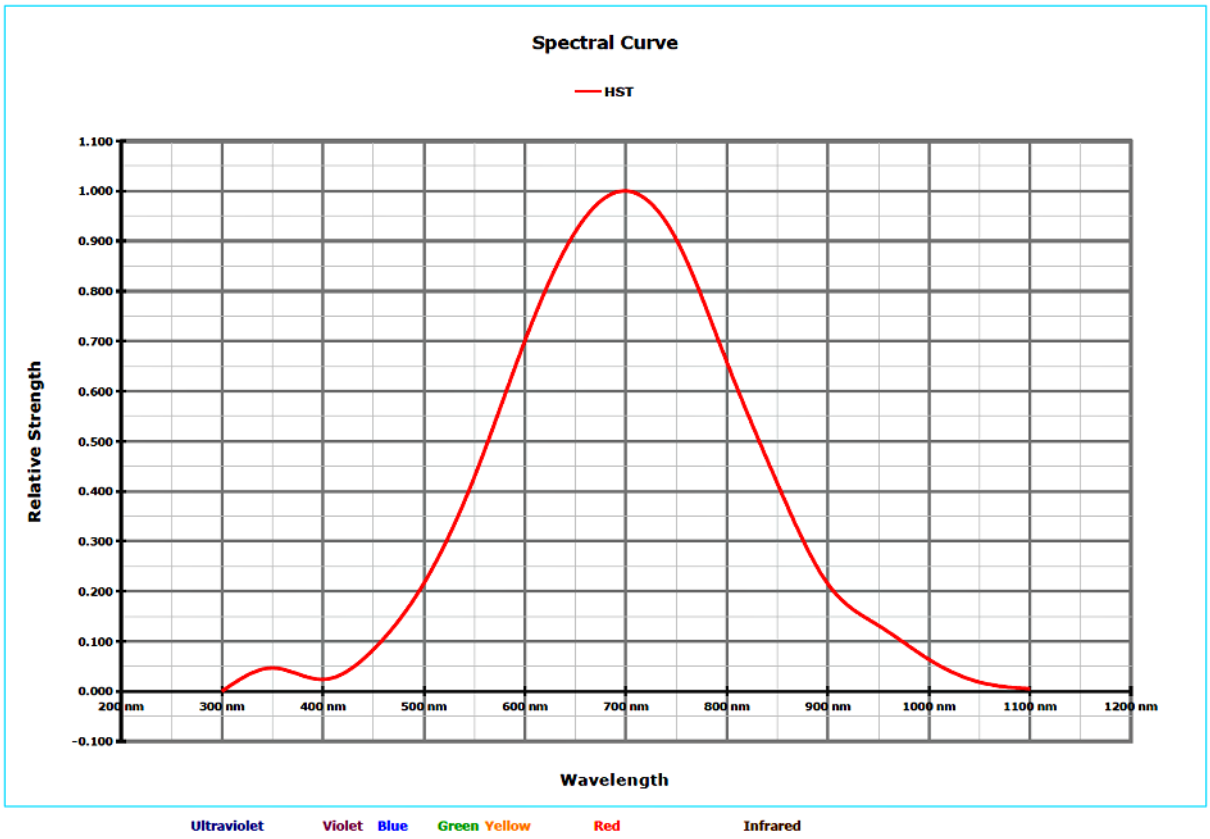
To prevent radiant heat from reaching the sample, infrared-absorbing filters are inserted between the lamps and the sample area. These heat filters, Corning CSI-75 type, are part of the optical system. Their light pass band is a factor in the overall instrument spectral response. Similar protection and light pass are provided to the reference photocell with an identical filter material (CSI-75).

SPECTRAL RESPONSE

The required sensitivity is achieved through use of silicon photocells rather than with the more commonly used selenium cells. The curve in **Figure 1-4** shows the approximate overall spectral response of the tester. This curve represents the product of light intensity, filter transmission, and photocell response, using published values for these factors. The resulting curve peaks at 700 m!J.

For optimum performance, the test liquid should absorb heavily between 600 and 800 m!J. At this wavelength, the instrument will sense maximum contrast between the penetrated and initial sample surface. A water-soluble dye (Naphthol Green B special purified dye) is available that meets this requirement very well. While this dye has near-optimum spectral properties, other test solutions will meet the spectral requirements, provided they darken the sample markedly in the region of instrument response.

See more details about ink standards and preparation in Section 5.



SECTION 2
TESTPROCEDURES

RUNNING A SIZING TEST

1. Plug the Hercules Sizing Tester line cord into a 110/250V AC outlet. (If you wish to change the "Service Mode" settings – see Section 2, page 3)

2. Set the power switch on back of the instrument to the **ON** position and allow the instrument to warm up (minimum 15 min.) before attempting standardization. The **Power** light on the front panel will illuminate. Press the "**Push to Calibrate**" button to clear the opening screen (Hercules HST V#.#). **See Figure 2-1.**

3. If the unit is used daily, standardize the unit with the reference tiles once per day, otherwise each time the tester is used. (See Section 4, **Standardization**, for details.)

4. Place the paper sample in the holder (side up will be in contact with ink). Align the machine direction of the paper parallel to the handle of the sample holder.

5. Position the sample holder in the horseshoe ring on top of the optical housing.

6. Place black block or disc supplied with the tester over the sample (on top of the holder).

7. Press the "**Push to Calibrate**" button. The **Calibration Reading** value will read 100% after the photocells are calibrated. This will also zero the time counter.

8. Set the percent reflectance for the desired endpoint using the "**Reflectance Set Point**" knob (an 80% endpoint is commonly used). A higher percent reflectance gives a shorter test and lighter endpoint, while a lower percentage gives a longer test and darker endpoint. (See Section 2, page 11 for details.)

9. Remove the black block or disc from the sample holder.

10. Pour 10 ml of test ink [1] on the sample and simultaneously press the **Test** button. The "**Testing**" light will illuminate. See **Figure 2-2**.

11. Place the black disc over the sample holder. (This step is often omitted when judged that the optical density of the ink is sufficient to resist the penetration of light. The user can determine this by viewing the reflectance output with and without the black disc.)

12. When the test is complete, the buzzer will sound [2], the "**Test Complete**" light will illuminate, and the counter or "**Test Time**" will freeze. [3]

13. Record the test time. Press the "**Silence**" button to silence the buzzer without clearing the results. The display message will read "Halted".

14. Remove the sample holder, dump the ink and sample, and rinse and dry the sample holder.

Notes:
[1] The temperature of the test ink should be held constant. This is critical for accurate and reproducible test results.
[2] The buzzer length can be set in the "Service Mode". See Section 2, page 3.
[3] The unit timer and reflectance values continue to change in the background until the **Push to Calibrate** button is pressed. The **Push to Calibrate** button, in addition to calibrating the new sample, stops the timer and data transmission to the serial port.

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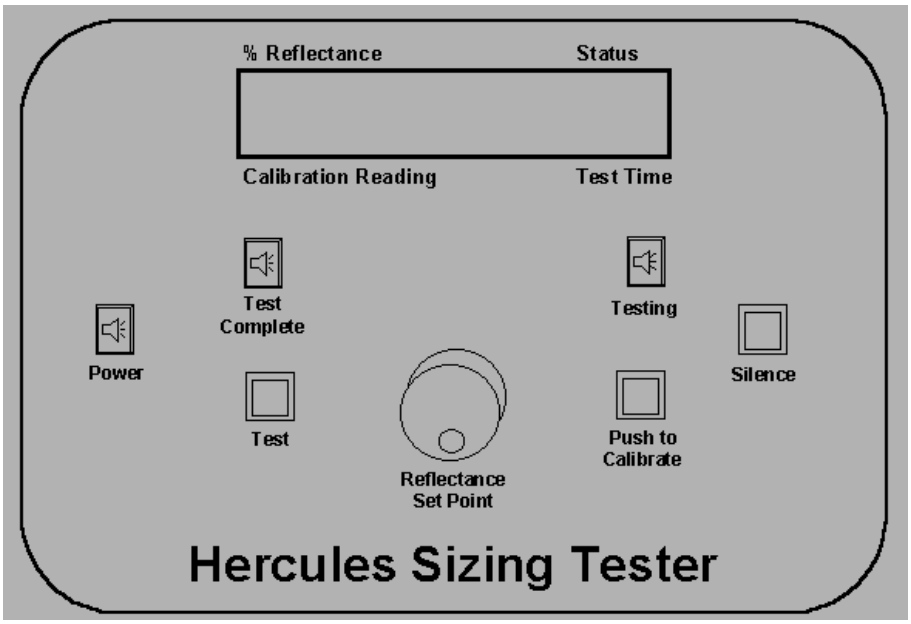

Figure 2-1: HST Operating Panel

Figure 2-2: The operator is pouring the 10-mL of test ink onto the sample and simultaneously pressing the 'Test' button to begin the test and start the timer.

Automatic or Serial Port Output Mode

1. In the Service Mode, set the **Verbose** setting to **Enabled**. This will transmit time and reflectance values every second to the serial port. If this data is collected by a spreadsheet, the spreadsheet program can generate a graph of this data. See Service Mode information in Section 3.
2. With the paper sample in place, calibrate the unit in the normal manner.
3. Set the % **Reflectance Set Point** control to the lowest value desired (between 30 to 40%).
4. Pour ink on the sample and simultaneously push the **Test** button.
5. The buzzer will sound when the reflectance drops to the value set in step 3. Press the **Silence** button to silence the test and the **Push to Calibrate** button to discontinue the data flow to the serial port. You will find the data in the spreadsheet or table used to store the Serial Port output.

SELECTION OF ENDPOINT FOR MILL CONTROL SIZING TESTS

One of the major advantages of the Hercules Sizing Tester is the provision for rapidly changing the percent reflectance endpoint to suit the sizing level of paper being tested. This means that a mill producing a wide range of basis weights, or sheets with widely varying levels of sizing can adjust the reflectance endpoint to complete the test within a reasonable period of time.

General recommendations for selecting the endpoint on a given grade of paper are as follows:

1. The reflectance endpoint should be set at a level that will give at least a 30 seconds test time in order to obtain good reproducibility. Test times of 60 seconds or higher will give maximum precision.
2. Whenever possible, reflectance endpoints in the range of 50 to 80% should be used. When using reflectance endpoints of 90% or higher the results are affected to a greater extent by paper variations or operator techniques. Reflectance endpoints below 40% should not be used because most papers are almost saturated with ink at this reflectance level. Reflectance above 90% are often used for Research purposes.
3. Given points #1 and #2 above, run a reflectance curve to determine the slope of the time-reflectance curve. From this, select a percent reflectance setting that falls on the straight-line portion of the curve. (See Section 3, page 22.)

Typical test values on various grades of paper and board are listed in **Table 2-1**. Test conditions are usually selected to give a minimum test time of 30 seconds and a maximum test time of about 10 minutes. Special inks were required to give reasonable test times on some board grades. HST Ink No. 2 (1% formic acid) is the most common type of ink used. As one can see in **Table 2-1**, it is possible to use acid concentrations up to 40% to control test length.

Table 2-1: Testing of Various Paper and Board Grades Using the Hercules Sizing Tester

Paper or Board Sample	Type of Ink Used	Reflectance Endpoint, %	Hercules Sizing Tester, sec
16-lb bond (60 g/m²)	Hercules Test Ink No. 2	80	50
20-lb bond (75 g/m²)	Test Ink No. 2	80	75
20-lb bond pink (alkaline) (75 g/m²)	Test Ink No. 2	80	143
20-lb bond blue (alkaline) (75 g/m²)	Test Ink No. 2	80	185
60-lb offset (89 g/m²)	Test Ink No. 2	80	151
40-lb unbleached bag (65 g/m²)	Test Ink No. 2	80	300
150-lb manila file folder (329 g/m²)	10% formic acid ink	80	250
18-pt plain chipboard (0.457 mm)	Test Ink No. 2	80	54
42-lb unbleached linerboard (205 g/m²)	10% formic acid ink	80	400
11-pt coated bleached board (0.279 mm)	10% formic acid ink	85	180
14-pt coated bleached board (0.356 mm)	40% formic acid ink	70	80
18-pt coated bleached board (0.457 mm)	40% formic acid ink	70	140
24-pt coated bleached board (0.610 mm)	40% formic acid ink	70	250
30-pt coated bleached board (0.762 mm)	40% formic acid ink	70	400

SECTION 3
FIRMWARE

Rev 3.0-01 firmware adds several features to the Hercules Sizing Tester.

1. Switching into Service Mode And back to Normal Mode without powering down the HST.
2. Machine History is displayed in the Service Mode.
3. Improved RS232 Communications
4. Demo Mode
5. Automatic Display Dimming
6. ReCalibration

1. CHANGING MODES:

The Hercules Sizing Tester (HST) by the Aderhold Firm, Inc. HST has two modes:

Normal Mode (used for ink and paper testing),
and **Service Mode** (used for machine setup).

Normal Mode is used for running sizing tests. **Normal Mode** has only one screen on the display, and the markings on the control panel around the display window indicate what the items shown on the display are.

Service Mode is used for altering the machine's setup, resetting the lamp timer when changing lamps, showing the machine's history, observing the machine's data, and for recalibrating the machine. Service Mode has **14 different screens** on the display. Each screen shows prompts for what to do. Read the Service Mode Screens section for details, and some extra features there was not enough room to indicate in the on-screen prompts. The markings on the control panel around the display window do not apply.

Now it is also possible to change modes without cycling power and thus without incurring a brief warm up setting period after doing so. The preferred method is to use a sequence of button presses to change modes.

When the HST is turned on it enters Normal Mode. Entering Service Mode was formerly done by holding the CALIBRATE button while turning on the HST. Exiting the Service Mode was done by turning off the HST, then turning it back on to get back into Normal Mode. Those methods still work.

HOW TO: Turn on the HST. It is in Normal Mode. **Press and hold the CALIBRATE button.** (In Rev 3.0-01-if the CHANGE LAMPS message appears, it is no longer necessary to wait 1 second for it to go away.) **While still holding CALIBRATE press & release the SILENCE button three times, then release the CALIBRATE button after the screen changes.** The front panel lights will blink while doing that, and the buzzer will signal success with a coded beep pattern. The HST will switch to Service Mode.

Service Mode begins with a "Banner Screen". The banner screen is recognizable as the only display screen that is in ALL CAPITAL LETTERS.

To switch from **Service Mode to Normal Mode**, the Service Mode banner screen must be showing. Then use exactly the same button press sequence that was used to get into Service Mode – hold CALIBRATE, press & release SILENCE 3 times. The HST switches back to Normal mode. The front panel lights will blink while doing that, and the buzzer will signal success with a different coded beep pattern.

2. SERVICE MODE SCREENS

The various Service Mode screens allow changing some things and displaying the machine's History. An important function in Service Mode is Reset the Lamp Timer. That should be done right after changing lamps (installing new light bulbs).

In the **Service Mode** the various 14 screens are seen one at a time by pressing the SILENCE button, as the banner screen prompts. SILENCE cycles through the screens forward (to the next higher numbered screen in the list below). To cycle through the screens in reverse, press the TEST button. SILENCE and TEST may be pressed in any order, such as going back and forth between two screens. TEST may be pressed first after switching to Service Mode to go directly to the last Service Mode screen.

New Service Mode screens show machine history. In those screens, nothing can be changed by the user. They are for information.

In all Service Mode screens where something can be changed, the CALIBRATE button is involved in making changes. For the Buzzer Mode and Verbose Mode screens, the knob can be used instead of the CALIBRATE button to make changes. SILENCE And TEST buttons (when pressed alone) change to another Service Mode screen.

ServiceModescreens:

1. **Banner Screen** - Normally the banner screen will say SERVICE MODE. If the DEMO MODE has been selected, then it will say DEMO MODE. Whatever it says, if it is the Service Mode banner screen, **ALL THE TEXT OF THE BANNER SCREEN IN BOTH LINES WILL BE IN CAPITAL LETTERS.** All capitals happens <u>only</u> in the Service Mode banner screen.
2. **Buzzer Mode** – Selects how long the buzzer beeps at the end of an ink and paper test. Has no effect on all the other short beeps. Buzzer mode may be changed by pressing the CALIBRATE button once or several times. New to Rev 3.0-01, it may also be changed by turning the % Reflectance knob. Turning the knob while in this screen will NOT alter the selected set point used in normal mode for sizing tests.
3. **Verbose Mode** - (Terse, Verbose 1, Verbose 2, and Verbose 3. See details below in the RS232 section). Verbose mode may be changed by pressing the CALIBRATE button once or several times. New to Rev 3.0-01, it may also be changed by turning the % Reflectance knob. Turning the knob while in this screen will NOT alter the selected set point used in normal mode for sizing tests.
4. **Power Up Count** – A history screen, shows how many times the HST has been turned on. No changes can be made in this screen.
5. **Machine On Time** - A history screen, shows how much total time that the HST has been powered up. In Rev 2.8-04 and later versions the storage space for this history is larger than in prior versions so the number accumulated during a normal machine lifetime will not exceed the storage space. The firmware also handles upgrade to the larger storage space automatically when installed in place of an earlier version. Rev 2.8-07 fixed a mistake that would occur once every 10,000+ hours of use, in the accumulated history recorded, which would make the history falsely gain an extra 10,000+ hours. No changes can be made in this screen.

6. **Lamp Changes** - A history screen, shows how many times the lamps have been replaced. This number increases by one each time the lamp timer is reset. Reset the lamp timer when lamps (light bulbs) have been replaced, To experiment with resetting the lamp timer and changing the lamp changes count without actually altering them see the Demo Mode for a way to experiment and practice with lamp timer resets without upsetting the true machine history. No changes can be made in this screen. Resetting the lamp timer is in another Service Mode screen.
7. **Lamp Time** - A history screen, shows how long the lamps have been powered up since the last lamp timer reset. No changes can be made in this screen.

NOTE: Both Machine On Time and Lamp Time are updated every ten minutes of machine operation. So, the numbers won't change for ten minutes. See the Demo Mode for a way to see the timers change with less waiting time.

8. **Lamp Changes Message** - This screen reminds a user that the lamps are good for 200 hours of use. Additionally, it tells the user that either 200 hours of lamp use has not expired yet, or that it has expired. (See the lamp time screen for how much time has expired.) No changes can be made in this screen.
9. **Reset Lamp Timer** - This screen allows a user to reset the lamp timer (or the DEMO MODE lamp timer if in Demo Mode). Press and hold the CALIBRATE button for 10 seconds to reset the lamp timer. A front panel light will blink during the 10 second wait. After the wait expires, the timer is reset and the user is prompted to push the TEST button, which takes the user back to the Service Mode banner screen. It is also possible to just turn off the power and start over after resetting the lamp timers as was done with older versions, but that method is not preferred. Lamp Timer Reset goes back to the Service Mode banner screen to enable changing back to Normal Mode from there. See CHANGING MODES, above.
10. **Detailed Version** - This screen shows the detailed firmware version, the major version with dash number and sub version. For information only, no changes can be made in this screen. Starting with Rev 2.8-07 the full major version and subversion is shown (2.8-07) in most screens that formerly displayed just the major version (2.8), including the screen seen at power up before any buttons are pressed. It also gives the date the version was completed. For this version of Firmware, it will say:

```
FIRMWARE  VERSION
3.0-01   2019-05-25
```

No changes can be made in this screen.

11. **Raw Sensor Data** - This screen shows the raw sensor data, also called raw data, Reference sensor to the left (R=), Measurement sensor to the right (M=). No changes can be made in this screen.

*The correct range of Raw Sensor Data (Raw Data) is different with Rev 2.8 (this applies to Rev 2.7 also), compared to the range shown in the Hercules Sizing Tester manual section 6 page 2, which applied to Rev 2.5 and prior versions. With the white tile placed on the HST, raw data values should be from 0800 to 2400 for both Reference and Measurement channels.

*This specification **supersedes** the spec in older HST manuals (applying to Rev 2.5 and older versions of firmware) saying "Reference channel ... should read between 3000 and 4000, and, Measurement channel ... reads between 500 and 4000".* Circuit changes made, beginning with Rev 2.6, were made that required changing the raw data spec.

Examples of good white tile raw data:

```
|  Raw Sensor Data    |     |  Raw Sensor Data    |     |  Raw Sensor Data    |
|   R=1458    M=0983  |     |   R=1634    M=1716  |     |   R=2034    M=1274  |
```

12. **Reflectance Percentage Display** - This screen is much like the Normal Mode reflectance display, with the CALIBRATE button setting whatever is on top of the HST dish window to 100.0%. It is now possible to go back and forth between raw sensor data and reflectance percentage without powering down the HST (and incurring additional warmup settling time) and without switching back and forth between Service Mode and Normal Mode. This Reflectance display in Service Mode feature is in Rev 2.7 also.
13. **Reflectance Percentage Display And Raw Sensor Data**- This screen shows both the reflectance percentage in the bottom row at the left, and shows the raw sensor data simultaneously, Reference sensor in the top row at the right (R=), Measurement sensor in the bottom row at the right (M=). The CALIBRATE button is used to set the item on the dish window to 100.0% reflectance.

    This screen works together with the next ReCalibrate screen when ReCalibrating the HST.

    This screen works has two History functions, added in Rev 3.0-01.

    History dump: Press and hold CALIBRATE, press and release SILENCE, then release CALIBRATE. This will cause the RS232 to immediately send the history list. A solid block character will appear briefly in the middle of the display's bottom row, indicating the history dump happened.

    History mode change: Press and hold CALIBRATE, press and release TEST, then release CALIBRATE. A short height capital H character will appear and stay on in the middle of the display's bottom row. The HST will stop the RS232's continuous dump of raw data readings. To resume the Service Mode continuous RS232 raw data dump just repeat the hold CALIBRATE and press TEST press button sequence, and the short height capital H character will disappear. Or switch to another Service Mode screen by pressing just SILENCE or just TEST.

    When the continuous Raw Data dump is stopped, a History dump done by the above hold CALIBRATE and press SILENCE button sequence will send a modified history list. It will have at the end 11 raw data readings, covering from 0 to 1.0 second, each reading taken 0.1 second apart. This is especially useful for capturing from the RS22 a clean history list. Note that the file captured should be copied to a file with a new name and should then be edited to include the HST's serial number, and the date, and the conditions under which the history is taken. Tiles readings can be taken and added to the end of the history capture file copy also.
14. **ReCalibrate**- The ReCalibrate screen (ReCal) is a new feature in Rev 3.0-01. It enables more accurate HST operation and improves the matching of reflectance readings of several HSTs. During Calibration and Qualification, it is no longer necessary to just record what an HST reads for it tiles values. Now the HST can be adjusted to read the correct tiles value. This screen is a bit more complex to operate than can be explained in an onscreen prompt, so its upper line says:
    `ReCal See Instructs.`
    meaning read these instructions.

This screen's lower line shows the % Reflectance reading and shows a mathematical constant in the formula that calculates reflectance called CalibrationFactor, and abbreviated CF on the screen. Turning the % Reflectance Set Point knob in this screen forces the reflectance reading to change, changing it up or down depending on which way the knob was turned, by 0.1% for each click of the knob. After each change of reflectance, the CF is recalculated to the value that will maintain that adjusted reflectance reading. The new CF value can then be saved.

The full screen looks similar to this:

```
: ReCal See Instructs.
   45.2%   CF=+0.8633
```

After the ReCal screen, the next screen is back to the #1 Service Mode Banner screen.

3. RECALIBRATION:

The #14 **ReCalibrate** screen works together with the #13 screen **Reflectance Percentage Display And Raw Sensor Data**. The SILENCE and TEST buttons switch back and forth between the two screens.

Place the calibration tiles on the HST, white side down. Go to the #13 screen Reflectance and press the CALIBRATE button to set the white tile reading to 100.0%. The next two steps may be done in either order: Turn the tiles over to green side down, and press SILENCE to go the #14 ReCal screen. The green tile reading will show. Just ahead of the CF= there will be a centered dot illuminated. If that dot is not illuminated, then adjustment cannot be done. The likely causes of that is either the tiles did not get turned over from white to green, or the green tile inadvertently got set to read 100% by the CALIBRATE button being pressed while in screen #13, Reflectance.

The ReCalibration cannot be done while reading the white tile at 100.0%. ReCalibration does not change the white tile reading. It can change the green tile reading. To do so accurately, the white tile must be reading 100.0%. If not, repeat the change to screen #13 Reflectance by pressing TEST, and set the white tile reading to 100.0% by pressing CALIBRATE. These steps may be repeated as needed to get good readings. While in screen #14, the tile can be turned over to read both the white side and the green side reflectance. However, the white side reading cannot be set to 100% by pressing CALIBRATE in screen #14 ReCal. That must be done in screen #13 Reflectance. That is why screen #14 ReCal works together with screen #13.

If just observing how screen #14 ReCal works, but not actually wanting to change the HST's calibration, the change can be abandoned by switching to another screen besides #13 or #14, by pressing SILENCE or TEST to change screens. When returning to screen #14, the prior readings including the former CF= number, will reappear.

To save the changed calibration after turning the knob in screen #14 ReCal, press the following sequence of buttons: Press and hold CALIBRATE, then press SILENCE, then release SILENCE, then release CALIBRATE. Actually, the buttons may be released in either order. They must be pressed in the correct order. Upon the release of the CALIBRATE button, the save of the new CALIBRATION factor will be done. A letter U (for User) will briefly flash where the dot was to the left of CF=. It will be saved to the UserCalibrationFactor (UCF) and will thus alter the Calibration of the HST's reflectance readings for future readings of both tiles and paper and ink. The HST will continue to use the CalibrationFactor thus set, even if powered down and powered up again later, until the CalibrationFactor is changed again. If the save didn't happen due to incorrect button pressing sequence, or the flashed U was missed, just repeat the button sequence to do the Save To UCF again.

CalibrationFactor (CF) can be changed at any time, but likely it will be most useful to do so after changing the lamps to a new set of lamps (light bulbs). Let the new lamps warm up for at least 20 minutes before Recalibrating the HST.

There are two CalibrationFactors stored in the HST's memory. The **UCF UserCalibrationFactor** set by the procedure above, and the **OCF OfficialCalibrationFactor**. The OCF is set by the manufacturer when the HST is new, and OCF will be set adjusted again when the HST is later returned for re-qualification to the manufacturer or recalibrated by an authorized agent of the manufacturer.

At the time OCF is set, via a proprietary procedure, the UCF is set to the same value. The UCF is always the active value providing the CalibrationFactor used by the HST. Users may change the UCF if they deem the HST to be out of calibration with readings of their tiles.

The OCF OfficialCalibrationFactor may be returned to use at any time by doing a Revert To OCF step. Press and hold CALIBRATE, then press TEST, then release TEST, then release CALIBRATE. Actually, the buttons may be released in either order. They must be pressed in the correct order. Upon the release of the CALIBRATE button, the save of the new CALIBRATION factor will be done. A letter (for Revert) will briefly flash where the dot was to the left of CF=. The OCF will be copied to the UserCalibrationFactor (UCF) and will thus alter the Calibration of the HST's reflectance readings for future readings of both tiles and paper and ink. The Revert step returns the HST to factory calibration. The HST will continue to use the CalibrationFactor thus set, even if powered down and powered up again later, until the CalibrationFactor is changed again. If the Revert didn't happen due to incorrect button pressing sequence, or the flashed was missed, just repeat the button sequence to do the Revert To OCF again.

The change of tiles reading and save to UCF requires the small dot to the left of CF= to be present and use of the calibration tiles. The Revert To OCF does not require the dot, nor use of the tiles.

When doing a Revert To UCF it is normal to have the tiles present, set the white to read 100.0% in screen #13, go to screen #14, turn the knob to adjust the tiles reading, do the Save To UCF step. That can be preceded or followed by a Revert To OCF step to see how much the green tile reading changes. A lot of change might indicate an HST in need of cleaning or service. If the Revert TO OCF step does not produce a good tile reading, just turn the knob and do the Save To UCF again. The Revert step overwrites any UCF set by the user. But a new UCF setting can be quickly done again after a Revert To OCF. Turn the knob for the right tiles reading and do Save To UCF.

Correct green tile reading: For tiles with a range of readings specified on the label on the tiles pouch, the correct reading is 0.5% higher that the lower number (and 1.5% less than the higher number). For example, if the tiles pouch label says 44.3% - 46.3% then the correct reading is 44.3% + 0.5% = 44.8%. Set the HST to read 44.8% in the above steps and Save To UCF. NOTE: That is true only if the HST has been recalibrated by the manufacturer with Rev 3.0-01 firmware installed, and the tiles returned with the HST for that recalibration. If a single reflectance percentage is marked on the tiles edge, that is the correct reading for that set of tiles.

4. RS232 Communications

- Attach RS232 serial cable to the RS232 port located on rear of HST (see Figure 2-2B for data port locating RS232 data port).
- Install and set terminal emulation software such as **Real Terminal (Figure 2-2A)** or **TeraTerm**

There are a pair of jumpers on the circuit board labeled "DCE / DTE" that can be used to accommodate the two kinds of cables that are popularly available. They move as a set. Remove the set and turn it 90 degrees to compensate for the two styles of 9-pin cables that are typically available. Set the jumpers for DCE for common straight through cables or set for DTE when using a common “null modem” style cable.

There is a small diagram on the circuit board to assist you. See Maintenance – **Section 5** for more details on accessing the unit interior.

RS232 communications in the HST serves two purposes. :

1. **Withthe HST in Normal Mode it gives data from sizing test, in one of three Verbose Modes**
2. **WiththeHSTinServiceModeitgivesmachine dataandhistory**

RS232 data is history outward only from the HST. The HST does not do anything with RS232 data sent to the HST. The outward data from the HST has no handshaking controls. All data sent by the HST must be captured as it happens, or it will be lost.

The RS232 data comes out at 19,200 bits per second, also called 19,200 baud (or baud rate). It's format is 8 data bits, no parity and one stop bit. These settings are not changeable. Set your data capture program to match this format and data rate.

The cable used to capture the data is a simple **RS232 extension cable**. One end of the cable will be male, the other end female. The cable connectors will have 9 contacts at each end. Several such cables may be plugged together end to end to get more length. Cables up to 50 feet total length will work. Such extension cables normally have 9 wires connected, each contact of one connector wired to the same pin number at the other connector. There are no jumpers at either connector. The cable has no crossover connections going to different pin numbers at the two ends. It is not a Null Modem cable. It is an Extension Cable. Only two of the wires in the cable are used by the HST. Pins 2 and 5 are used. Pin 2 at one end connects to pin 2 at the other end, and pin 5 at one end connects pin 5 at the other end.

The RS232 data may be captured using an terminal emulation program such as RealTerm or TeraTerm on any computer.

RS-232 SERIAL DATA PORT

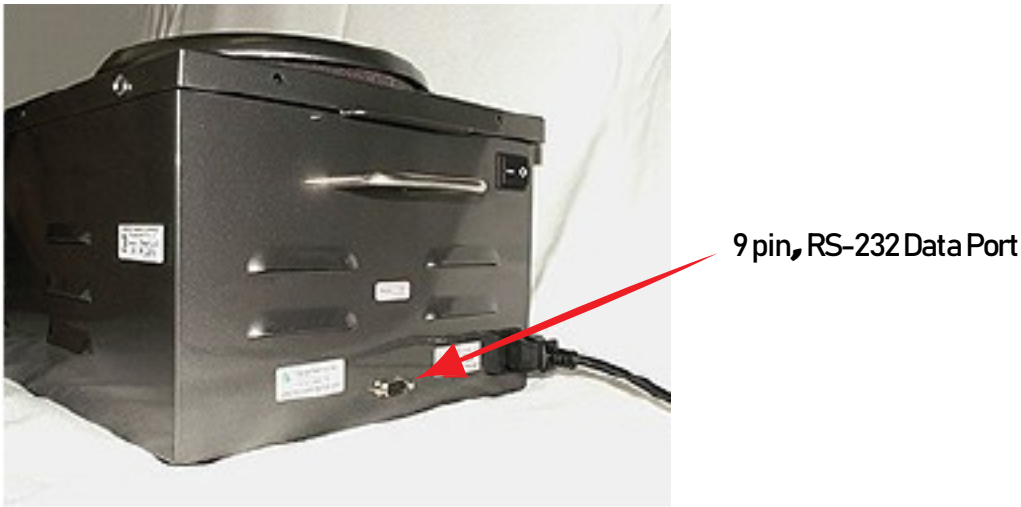

Figure2-2A: The RS-232 Data Port is a 9-pin port located on the rear side of the HST. Use only with RS-232 cables or RS232 adapters.

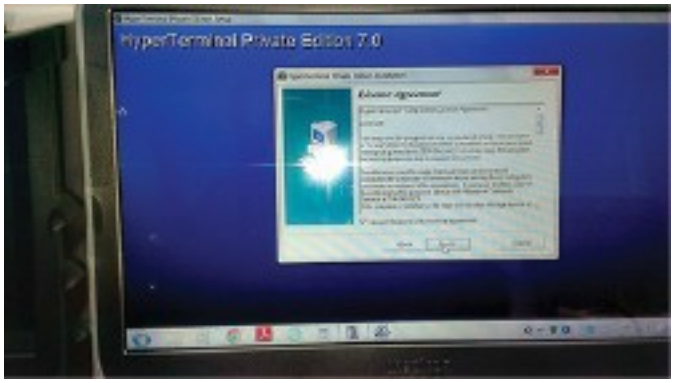

Figure 2-2B: Windows 7 or later do not come with Hyper-Terminal anymore, so it is necessary to install 3rd party software terminal emulation programs that receive serial data. TAF recommends RealTerm or TeraTerm, both are free downloads and work well with HSTs.

Figure 2-2C: Illustrates TAF-310 series connected by the use of **RealTerm** a third party terminal emulation program that allows operators to receive the necessary data needed for each test run.

5. RS232 In Normal Mode, Verbose

Modes:

What was called **Verbose Disabled** in Rev 2.5 is now called **Terse** in Rev 2.8-01 and later versions. It sends only the 'test time' at the end of test – just one number.

What was called **Verbose Enabled** is now **Verbose 1.** It is fully compatible with the Rev 2.5 Verbose mode, including the minor errors like data order mix-up in the second line and reversed Line Feed/Carriage Return sequences. It is still as shown in the previous digital HST manuals. It is there for users who already have a setup that receives data from a Rev 2.5 HST. Their setup will still work if they upgrade to Rev 2.8-01 or any later version.

Here is an example of Verbose 2 RS232 output:

```
Hercules Sizing Tester V3.0-01
www.HerculesSizingTester.com
Calibrated
Test Started
   Over ,12, Reflectance= ,100.0, %, Threshold= ,80.0, %, Time=      ,0.0, Seconds
  Over ,12, Reflectance=   ,99.6, %, Threshold= ,80.0, %, Time=      ,1.0, Seconds
  Over ,12, Reflectance=   ,95.2, %, Threshold= ,80.0, %, Time=      ,2.0, Seconds
  Over ,12, Reflectance=   ,92.7, %, Threshold= ,80.0, %, Time=      ,3.0, Seconds
  Over ,12, Reflectance=   ,91.4, %, Threshold= ,80.0, %, Time=      ,4.0, Seconds
  Trip ,11, Reflectance=   ,89.9, %, Threshold= ,80.0, %, Time=      ,4.8, Seconds
 Under ,10, Reflectance=   ,88.7, %, Threshold= ,80.0, %, Time=      ,5.0, Seconds
 Under ,10, Reflectance=   ,81.5, %, Threshold= ,80.0, %, Time=      ,6.0, Seconds
Under ,10, Reflectance=   ,78.2, %, Threshold= ,80.0, %, Time=      ,7.0, Seconds
Test Halted
```

Rev 3.0-01 adds a **Verbose 3** mode. It is the same as Verbose 2, except that for the first ten seconds, the data comes every 0.1 second (ten readings per second). After 10 seconds of the fast 10 samples per second, it changes to one sample every second, just like Verbose 2, The faster data samples during the first ten seconds of a sizing test enables more accurate graphing of the ink pour reflectance changes right at the start of a sizing test, and better graphing of sizing tests that run very quickly taking just a few seconds. It can also help with determining optimum set point for translucent papers that give a large drop in reflectance when ink is poured into the sample holder.

Below illustrates the same data in a spreadsheet with appropriate columns and with the commas removed, done by simply loading the captured file (with a **.csv** filename extension) into a spreadsheet program:

Calibrated										
Test Started										
Over	12	Reflectance=	100	%	Threshold=	90	%	Time=	0	Seconds
Over	12	Reflectance=	99.6	%	Threshold=	90	%	Time=	1	Seconds
Over	12	Reflectance=	95.2	%	Threshold=	90	%	Time=	2	Seconds
Over	12	Reflectance=	92.7	%	Threshold=	90	%	Time=	3	Seconds
Over	12	Reflectance=	91.4	%	Threshold=	90	%	Time=	4	Seconds
Trip	11	Reflectance=	89.9	%	Threshold=	90	%	Time=	4.8	Seconds
Under	10	Reflectance=	88.7	%	Threshold=	90	%	Time=	5	Seconds
Under	10	Reflectance=	81.5	%	Threshold=	90	%	Time=	6	Seconds
Under	10	Reflectance=	78.2	%	Threshold=	90	%	Time=	7	Seconds
Test Halted										

The units are included but are automatically placed in separate columns.

6. RS232 In Service Mode, History:

The service mode provides RS232 output, regardless of which Terse or Verbose mode is chosen. Here is a typical Service Mode screen.

```
-----------------------------
Hercules Sizing Tester V3.0-01
www.HerculesSizingTester.com

Times are updated every 10 minutes.

Number Of Power Ups =     398

Machine Operation Time = 43,601 Hours, 00 Minutes

Number Of Lamp Changes (= Number Of Lamp Timer Resets) =         0

Lamp Operation Time = 10,100 Hours, 10 Minutes
  Replace lamps, and reset lamp timer, when lamp time exceeds 200 hours.

Test Complete Action [Buzz Mode 35] = Flash 2 Seconds

Verbose [Mode 3] = Readable & CSV, Fast

Reflectance Setpoint = 80 %

Official Calibration Factor OCF = +1.4704    UCF can be reverted to OCF.
    User Calibration Factor UCF = +1.4704    Always Active.   UCF is adjustable.Raw

Data   R = 1442   M = 0966 ; Uncalibrated Reflectance =     96.5 %
```

The last line repeats at a fast rate, overwriting itself.

After accomplishing CALIBRATION, the last line will look like this:

```
Raw Data   R = 1442   M = 0966 ;    Calibrated Reflectance =   100.0 %
```

Whenever data shown above the dashed line changes (from timers increasing, or from a user changing a selection), after a brief delay the entire Service Mode screen is re-sent. It will be sent every ten minutes due to the lamp timer advancing every ten minutes.

7. DEMO MODE:

Because lamp resets are done so seldom, and for several other reasons, Rev 2.8-01 and later versions have a DEMO MODE as part of the Service Mode, which allow practicing resetting a dummy lamp timer instead of the real lamp timer. The real timer keeps on counting time in the background correctly while the DEMO MODE showing speeded up dummy times is in effect.

In the DEMO MODE, the 10-minute timer updates are done every 30 seconds (thus racking up an indicated 60 minutes in the demo timers in just 3 minutes of actual time). That makes it reasonable to watch the History screen timers change without a long wait.

In DEMO MODE, all history values shown are artificial and always start with the same numbers when entering DEMO MODE.

While in DEMO MODE, a short height capital D will appear in the upper left corner of most screens. The Banner Screen will say DEMO MODE.

To Exit DEMO MODE do the same steps – Go to the Banner screen with ALL CAPITALS, hold the CALIBRATE button, and press & release the TEST button three times. Demo Mode is also exited if power is turned off. Demo mode will not be active when power is turned on.

While in DEMO MODE, try all the Service Mode screens. Try a lamp timer reset and watch the effect of it. Try it again! Switch to Normal Mode and run tests or measure tiles. Switch back to Service Mode and DEMO MODE will still be in effect. Exit DEMO Mode and see the true machine history in the Service Mode screens.

The true history time record continues to be updated normally, once every 10 minutes, while in DEMO MODE, but the history screens show a false and faster advancing history while in DEMO MODE. After exiting DEMO MODE, the true history will be shown.

There is no harm in leaving the HST in DEMO MODE for a long time. Even if switching to Normal Mode while DEMO MODE remains in effect, the timing of ink and paper tests is not affected. That timer is not sped up by the DEMO MODE.

When in DEMO MODE, the ReCalibrate steps can be done, but the values of CF "saved" will not actually be used. The HST is not actually ReCalibrated while in DEMO MODE.

8. DISPLAY DIMMING:

For longer display life, Rev 2.8-01 and later versions reduce the brightness of the display after a long period of inactivity. After 30 minutes of no button presses by the user, the display brightness is reduced. That enhances the display's life in those situations where the HST is left powered up for very long times. Press any button and the display immediately goes to full brightness.

In DEMO MODE within the Service Mode, due to the sped-up demo timers, the display will go dim if no buttons are pressed for 1.5 minutes.

In the Normal Mode, the display will never go dim during a running sizing test, no matter how much time the sizing test takes. Not even if the HST was left in DEMO MODE while in Service Mode. After a sizing test is halted, the display will dim after 30 minutes of no further activity.

9. NEW BUZZER MODES:

Rev 2.8-05 and later versions has more user selectable options for the end of sizing test buzzer action than prior versions have. An option of continuous buzz (no time out of the sound) was added. For each of the available times (0.5 second, 1 second, 2 seconds, 5 seconds, 10 seconds, 20 seconds, 10 minutes, and Continuous (no time out of the sound), there are three additional choices. The original constant Beep, a new Warble sound which makes the buzzer more audible in noisy environments, and a Flash mode with the same sound as the Warble mode, but after a few seconds the display flashes brightly also to give better visual indication that a sizing test is complete. While the display is flashing, the sizing test results can still be read. For short buzzer times, the flashing starts when the beeping stops. For longer buzz times, the flashing starts after 5 seconds of beeping. The flashing runs continuously, until either the SILENCE or the CALIBRATE button is pressed. It will also stop if the reflectance set point is dialed down to a lower number to get a second sizing test time from the same start of test moment with the same inked paper sample. One choice is Flash 0Sec (No Beep). It makes no sound (zero beep time) and begins flashing immediately at the end of a sizing test and like the other Flash choices that continue to flash the display until stopped by the user. See Buzzer Mode under Service Mode Screens, above, for how to change the Buzzer Mode.

REFLECTANCE-TIMESIZINGCURVES

A significant advantage of the Hercules Sizing Tester is the provision for determining a complete reflectance vs. time curve. With the new Hercules Sizing Tester, there are two modes, by Manual mode or Serial Port Output mode. In many cases, a reflectance-time curve will show differences in the rate of ink penetration between the two sides of a sheet or between the surface of the sheet and its interior. This makes it possible to evaluate the effects of sizing two-sidedness or the effects of surface treatment on sizing. This information can be of value in certain mill-sizing problems or in selecting the appropriate reflectance endpoint to use in sheet property specifications.

Typical reflectance-time curves are plotted in **Figure 3-3**. The shape of the curve will be governed by the basis weight of the sheet as well as by possible variations in sizing between the two sides of the sheet. It is suggested that in unusual sizing problems, complete reflectance curves be run on both sides of the sheet and compared with samples of satisfactory production.

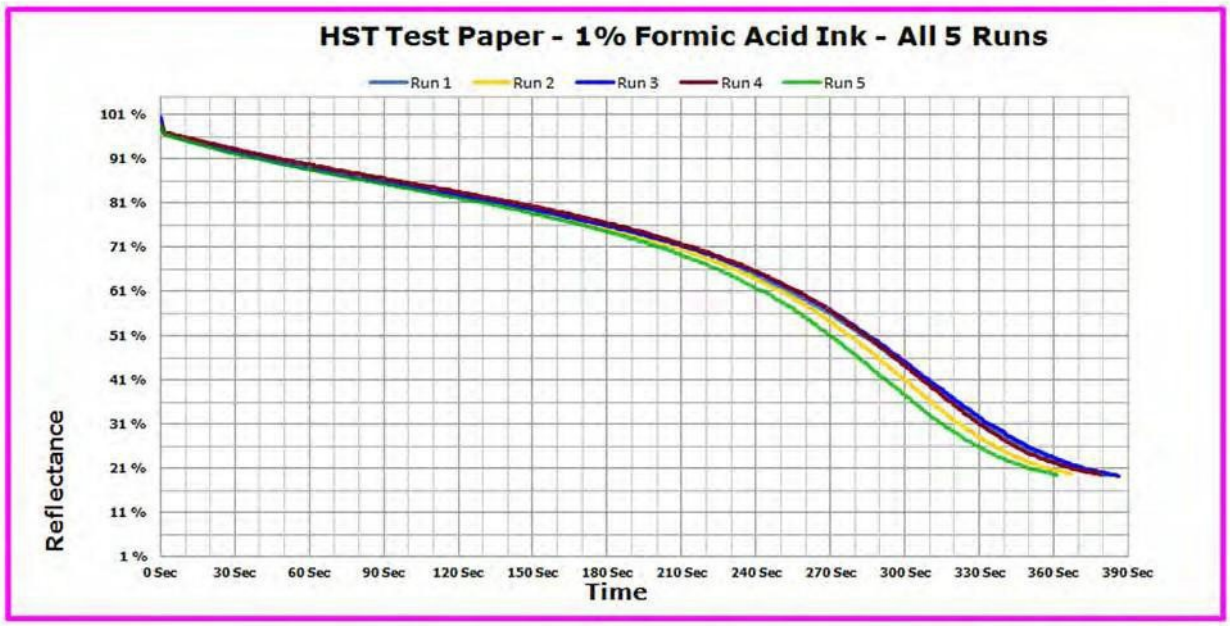

Figure 3-3: Typical Reflectance-Time curves after 5 separate runs should show an s-shaped curve.

Procedure for Running Reflectance-time Curves

Manual Mode

1. With the paper sample in place, calibrate the unit in the normal manner.
2. Set the % **Reflectance Set Point** control to the highest value required (usually 95%)
3. Pour ink on the sample and simultaneously push the **Test** button.
4. The buzzer will sound at the reflectance set point. Record the **Test Time** seconds.
5. Reset the **Reflectance Set Point** control to a lower value (usually by 5 or 10% increments).
6. Repeat steps 4 and 5, with desired frequency, down to a range of 30 to 40% reflectance. Values below 30% are usually meaningless, since the paper sample is almost completely saturated at this reflectance.

STANDARDIZATION TILES

To ensure consistent performance and agreement in readings between different instruments, permanent optical working standards (white and green ceramic tiles) are provided with the Hercules Sizing Tester. These are used to check instrument sensitivity and overall optical and electrical linearity.

SENSITIVITY

Sensitivity is the response of the instrument to a standard white ceramic tile. If the bulbs and all glass surfaces of the sizing tester are in good condition, the amount of light reflected by the standard will be high. The new Hercules Sizing Tester compensates for changes in bulb intensity during the sample calibration step in the Operational Procedure when it sets the reflectance to 100% each time. Sensor Sensitivity can be monitored in the Service Mode as described in Section 3, page 13.

LINEARITY

Linearity indicates the capability of the instrument to accurately and consistently reproduce a given reflectance relationship. Instrument linearity is checked by determining the reflectance of the standard green tile as a percentage of the white tile. Tolerance limits for the green tile are shown on the foam-shipping envelope or instrument certificate. Since detecting a reflectance relationship is fundamental to the sizing test, the reproducibility of the instrument in this respect is crucial to its performance as an ink penetration tester. The tester should be continued in service only if this check is within tolerance; otherwise, test results will be biased and will not agree with those obtained previously or with those obtained on other instruments.

STANDARDIZATION PROCEDURE

1. Turn on the instrument and allow it to warm up at least 15 minutes.
2. Thoroughly clean the face of the white tile and place it directly on the glass of the specimen opening (do not use the specimen holder). See **Figure 4-1, page 25**.
3. Press the **Push to Calibrate** button. This will set the reflectance to 100%.
4. Remove the white tile from the specimen opening. Clean the face of the green tile and place it directly on the glass of the specimen opening.
5. Read the **Calibration Reading** value from the VFD. The value should fall within the range marked for the tile shipped with the instrument.

FACTORS AFFECTING STANDARDIZATION

The following troubleshooting guidelines are to be used only if difficulty is encountered in standardizing the Hercules Sizing Tester. For detailed repair procedures, see Maintenance and Parts – Section 6 and Spare Parts Order Forms pages 42,43.

1. Lamp Aging

The inability to standardize the instrument is most frequently caused by lamp aging. With lamp aging, light intensity decreases, and spectral changes occur. The new Hercules Sizing Tester does compensate for changes in bulb intensity during its life. The Hercules Sizing Tester has set a 200-hour set point to remind the owner that the bulbs should be changed. A message "Change Lamps" will appear each time the **Push to Calibrate** button is pressed after the 200-hour set point has passed or upon startup. If the green tile reflectance value is out of the tolerance limits, first try replacing the bulbs and cleaning the glass surfaces, as described in Section 5.

2. Lamp Sockets

All lamp socket center contacts in this instrument are of solid nickel. In the event the surfaces of these contacts become oxidized, they can be renewed by polishing with a fine abrasive. With careful, periodic cleaning, the nickel contacts should last indefinitely. (Additional troubleshooting information can be found in Section 7 and Maintenance information in Section 6.)

3. Position of Heat-Absorbing Filters and Optical Assembly

If the heat-absorbing (glass) filters are removed for cleaning, be certain to replace them in the original position because improper positioning will cause incorrect readings and variable results. To check filter alignment, carefully view the lamps through the sample opening. If the lamp filaments can be seen without looking through the filters, reposition the filters to intersect the view of the filaments.

Incorrect readings can also occur if the optical assembly is not replaced properly during instrument maintenance. In replacing the optical assembly, proper placement is ensured by using the lamp bulbs as a reference point. As viewed from the front of the Hercules Sizing Tester; the bulbs should be oriented to the 4 and 10 o'clock positions. (See **Figure 6-3**)

Incorrect readings also occur if the sample-opening window is cracked or removed. This distorts the view of the photo-measuring cell and can cause heating of the sample during a test.

4. % REFLECTANCE Set Point Dial

The **Reflectance Set Point** dial does not have the same limitations or problems with slippage as the old units. Turning the dial all the way counterclockwise sets the % Reflectance reading in the LCD to 0% and stops. In reverse, the LCD value stops changing at 100%.

5. Dirty Glass Surfaces

Keep the glass surfaces clean using a soft, lint-free cloth. If the glass sample opening and the glass photocell covers become dirty, standardization and sensor sensitivity will be affected. Dirty heat-absorbing filters will also affect standardization.

Figure 4-1: This figure demonstrates the green side of the tile face down on the specimen opening prior to performing the standardization procedure.

Figure 4-1A: This figure demonstrates the white side of the tile face down on the specimen opening prior to performing the standardization procedure.

SECTION 5
PROCEDURE FOR PREPARING INKS

Inks suitable for use with the Hercules Sizing Tester must meet the following requirements:

- Must contain a dye that is not substantive to the fiber, so that the dye will penetrate the sheet together with the liquid phase.
-Must have precisely controlled composition and chemical properties.
-Should not contain coagulants.
-Should not emit corrosive gases that will attack electrical contacts in the electrical cabinet. ~Should be compatible with the acid or accelerants used in the test solution.

Most commercial inks do not meet all of the above requirements. Consequently, special inks designed for use with the sizing tester are recommended. * See "Consumables" order information on pages 41 - 43.

INK-PAKS

Ink Paks are produced by TAF to eliminate all of the problems associated with make-up and assay of the test solutions. The ink-pak consists of two parts: The Dye-pak and the Acid-pak. When mixed together in equal volumes, they produce a high-quality, optically correct ink for use with this method.

Dye-Pak

The Dye-Pak solution is produced by TAF to give specific optical properties, not total solids. When mixed accurately, the ink will have an optical density of 0.31 to 0.35 when an aliquot diluted 1000:1 with demineralized water is measured for light absorption at 705 nanometers

Most commercial inks do not meet these requirements. Inks based on naphthol green B dye do because they absorb strongly in the 600-800 nm spectral range at the peak response of the photocells. A consistent assay (solids and optical performance) naphthol green B dye is no longer commercially available. TAF has the naphthol green B dye Ink-Paks custom-manufactured. This dye is supplied in liquid (2.5% solids) form. Optical density and spectral response of all dye-paks are quality controlled by Hercules.

Acid-Pak

The Acid-Pak currently supplied by TAF contains 2% Formic Acid, (HCOOH). Formic acid strength is controlled to + 0.02 percent of target. When combined properly with the Dye-Pak, they form a 1% acid-ink.

Concentrations of 5, 10, 20, and 40% acid-inks can be prepared by combining customer purchased 10, 20, 40, or 80% formic acid and blending equally with the Dye-Pak. TAF recommends purchasing a grade of acid which specifies the exact percentage concentration, otherwise results will be affected. Store ink solutions in glass or polyethylene containers. Neutral test ink can be prepared by diluting a Dye-Pak aliquot with an equal amount of demineralized water and adding 1N NaOH solution to pH 7.0+ 0.1.

Shelf Life

Shelf lives of prepared Ink-Paks at room temperature are:

1% ("#2 Ink")	6 weeks
5%	4 weeks
10%	2 weeks
20%	1 week
>20%	2 days
Neutral pH ink	1 week

DRY DYE – ALTERNATIVE METHOD

Dry dye is no longer supplied by the manufacturer. However, for customers still using dry naphthol green B dye, the old method still applies.

Preparation of Hercules Test Ink No. 2

Materials

1. Distilled or demineralized water
2. Certified quality naphthol green B special purified dye
3. Formic acid – reagent grade

Concentrations Used

1. Dye concentration – 1.25% based on final ink
2. Formic acid – 1.00% based on final ink

Procedure – 2000 cm^3 Batch of Ink

1. Weigh out 25.0 ± 0.1 g of naphthol green B special purified dye and transfer it to a large beaker or other container suitable for mixing.
2. Add approximately 1500 cm^3 distilled or demineralized water and stir until all of the dye is dispersed.
3. Weigh out sufficient formic acid to equal 20.0 ± 0.1 g of 100% formic acid. Add this to the dye solution and mix thoroughly.
4. Transfer solution to a 2000 cm^3 volumetric flask and add demineralized or distilled water to a final volume of 2000 cm^3. Mix thoroughly.

Testing

1. % formic acid – Titrate an aliquot of the final ink solution with standardized NaOH to a pH 7.0 endpoint, using an electric pH meter.

Specification for test ink No. 2 = _____

% formic acid = 4.6 x normality of standard NaOH x cm^3 of NaOH used cm3 of ink titrated

2. Optical density – If equipment is available, determine optical density at 705 mμ. Dilute to suit equipment (usually 1:500 for test inks or 1:1000 for dye solutions). Record and establish control limits.

Shelf Life

Maximum recommended shelf life for test ink No. 2 is 6 weeks.

Preparation of 10% Formic Acid Ink

Materials

1. Distilled or demineralized water
2. Certified quality naphthol green B special purified dye
3. Formic acid – reagent grade

Concentrations Used

1. Dye concentration – 1.25% based on final ink
2. Formic acid – 10.0% based on final ink

Procedure – 2000 cm^3 Batch of Ink

1. Weigh out 25.0 ± 0.1 g of naphthol green B special purified dye and transfer it to a large beaker or other container suitable for mixing.
2. Add approximately 1500 cm^3 distilled or demineralized water and stir until all of the dye is dispersed.
3. Weigh out sufficient formic acid to equal 200 ± 1 g of 100% formic acid. Add this to the dye solution and mix thoroughly.
4. Transfer solution to a 2000 cm^3 volumetric flask and add demineralized or distilled water to a final volume of 2000 cm^3. Mix thoroughly.

Testing

1. % formic acid - Titrate an aliquot of the final ink solution with standardized NaOH to a pH 7.0 endpoint, using an electric pH meter.

$$\% \text{ formic acid} = 4.6 \times \text{normality of standard NaOH} \times \frac{cm^3 \text{ of NaOH used}}{cm^3 \text{ of ink titrated}}$$

Specification for 10% formic acid ink = 9.8 to 10.2% formic acid

2. Optical density – If equipment is available, determine optical density at 705 mμ. Dilute to suit equipment (usually 1:500 for test inks or 1:1000 for dye solutions). Record and establish control limits.

Shelf Life

Maximum recommended shelf life for 10% formic acid ink is 2 weeks.

Higher Formic Acid Concentration Inks

Inks containing 20 to 60% formic acid can be used f or testing extremely hard-sized or heavyweight paper and board samples. The preparation is the same as outlined above for 10% formic acid ink, with suitable adjustment of the amount of acid used and the percent formic acid specification.

The maximum recommended shelf life for 20 to 60% formic acid inks is 1 week.

USE OF WATER CONTAINING DYE ONLY FOR SLACK-SIZED PAPERS (NEUTRAL TEST INK)

Some slack-sized or lightweight papers may give test endpoints of only a few seconds with test ink No. 2. For these grades, TAF recommends a neutral test ink. It is a 1.25% dye solution in distilled water with sufficient NaOH added to adjust the pH to 7.0 ± 0.1. If equipment is available, measure and record optical density at 705 mμ. Maximum recommended shelf life is 6 weeks.

ALKALINE INKS

Because of poor stability of the acidic dye in alkaline solution, we do not recommend alkaline inks for use with the Hercules Sizing Tester. If an alkaline test ink is used, follow the procedure above for" Neutral Test Ink" and adjust the pH to the desired value with NaOH. Alkaline test inks should be prepared fresh each day or for each experiment.

OIL PENETRATION TESTS USING THE HERCULES SIZING TESTER

The Hercules Sizing Tester also finds application for measuring the oil resistance of paper and board. A suitable oil-soluble dye (preferably green, since this gives the best spectral response to the tester optical system) is dissolved in the oil penetrant desired. Oil penetration tests are run in the same manner as ink penetration tests.

PRODUCT SAFETY

Always refer to the **Material Safety Data Sheet (MSDS)** for the **Naphthol B green dye** and formic acid for current details regarding hazards, toxicity, first aid measures, etc.

General precautions include (but are not limited to):

No human toxicity studies have been carried out for the 2% formic acid or **Naphthol B green dye.** Neither the dye nor formic acid are listed as carcinogens by NTP, regulated as a carcinogen by OSHA, or evaluated by IARC. When preparing the HST test ink, it is recommended to use safety goggles, impervious gloves and protective clothing.

Various hazards including (but not limited to):

2% Formic Acid: (as supplied by the instrument manufacturer to prepare the most common No. 2 Test Ink or 1% formic acid concentrated ink. For higher concentrations of formic acid, see the MSDS provided by the acid supplier.)
Formic acid is a corrosive liquid and requires caution when handling. Avoid contact of the solution with skin, eyes, and clothing. Avoid breathing its vapor. Use only with adequate ventilation. May cause moderate eye and skin irritation with injury to the cornea. Inhalation of mist may cause respiratory tract irritation. Ingestion may cause gastrointestinal irritation.

Naphthol B green dye: (2.5% solution as supplied by the instrument manufacturer.
For other purchased Naphthol B dye, see the MSDS provided by the supplier.)
May cause mild temporary eye irritation. Prolonged or repeated skin contact may cause green coloration. It is not classified as hazardous under OSHA regulations.

SECTION 6
ROUTINE MAINTENANCE

AIR FILTER

Restriction of airflow to the Hercules Sizing Tester optical assembly results in heat buildup that will affect instrument standardization and eventually damage its optical components. To prevent this, the foamed plastic air filter located beneath the optical assembly cover must be inspected periodically and either cleaned or replaced as indicated.

Access to the air filter is obtained by removing the three screws located around the top outer edge of the optical assembly cover plate (this requires a 5/64 in. Allen wrench). See **Figure 6-1**. Lift the cover plate and attached optical assembly and remove the filter by working it up over the plate (**Figure 6-2**). Wash the filter in a mild detergent solution, rinse, squeeze dry, and replace it.

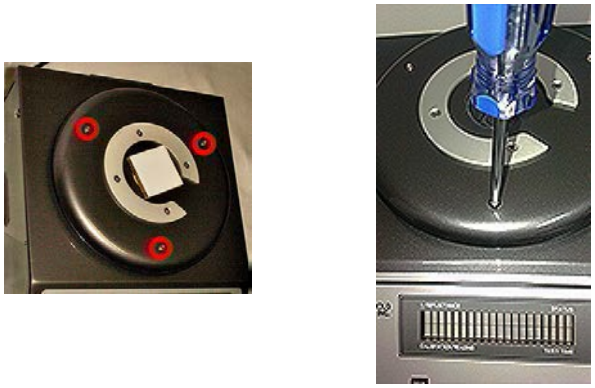

Figure 6-1: Access to the air filter is obtained by removal of three screws around the outside of the optical cover plate.

Figure 6-2: The cover plate and attached optical assembly have been lifted and the air filter foam-type filter is exposed. The can be removed for cleaning by working it up over the cover plate.

In re-assembling the unit, be sure to fasten the cover in its original location. Use the optical assembly lamp bulbs as a reference point for proper cover plate orientation. As viewed from the front of the Hercules Sizing Tester, the two lamps on this assembly should be aligned at the 4 o'clock and 10 o'clock positions. (See **Figure 6-3**.)

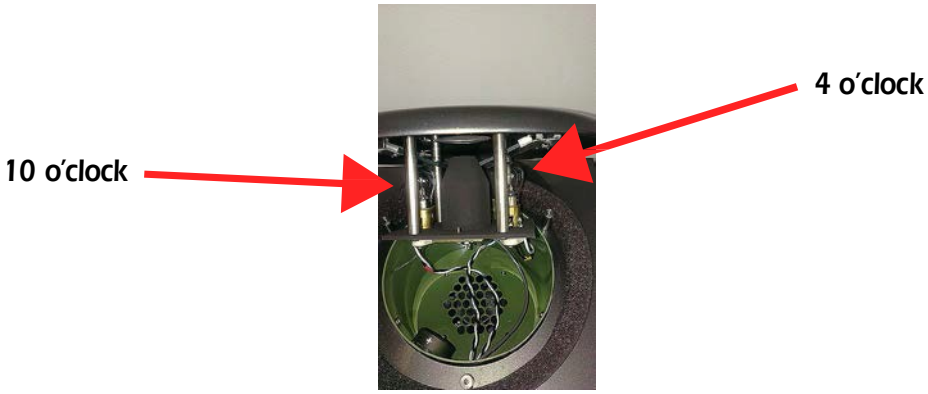

Figure 6-3: When replacing the optical assembly, be certain to position the unit in its original location. To obtain the proper position align the lamp bulbs in the **4 o'clock** and **10 o'clock** positions.

CLEANING GLASS SURFACES AND BULB REPLACEMENT

Both exterior and interior glass surfaces of the Hercules Sizing Tester should be cleaned regularly. When these surfaces accumulate dust, light is diffused, and the instrument fails the standardization and sensitivity checks.

Cleaning of glass surfaces and bulbs and bulb removal are best accomplished during inspection of the air filter - i.e. while the optical assembly is removed from its housing. At this time, remove the four Allen screws located on top the sample holder horseshoe. This will free the optical assembly from the cover plate and provide easy access to all optical components. (See **Figure 6-4** and **Figure 6-5**.) If replacing the bulbs, **remember to reset the lamp timer in the Service Mode as described in HST-2E**. **Figure 6-6** illustrates the removal of the bulbs from the socket.

Figure 6-4: Access optical components by removing the four Allen-type screws around the horseshoe. Then by removing the 3 outer Philips screws on the cover plate. **CAUTION!** Lift cover plate very gently to ensure the inner glass heat shields do not break or that any other components become scratched. Also be very careful on re-assembly, and to remember to fasten all screws back securely to avoid vibration or ink leakage.

Figure 6-5: Cover Plate Removed and Optical Assembly Components Exposed

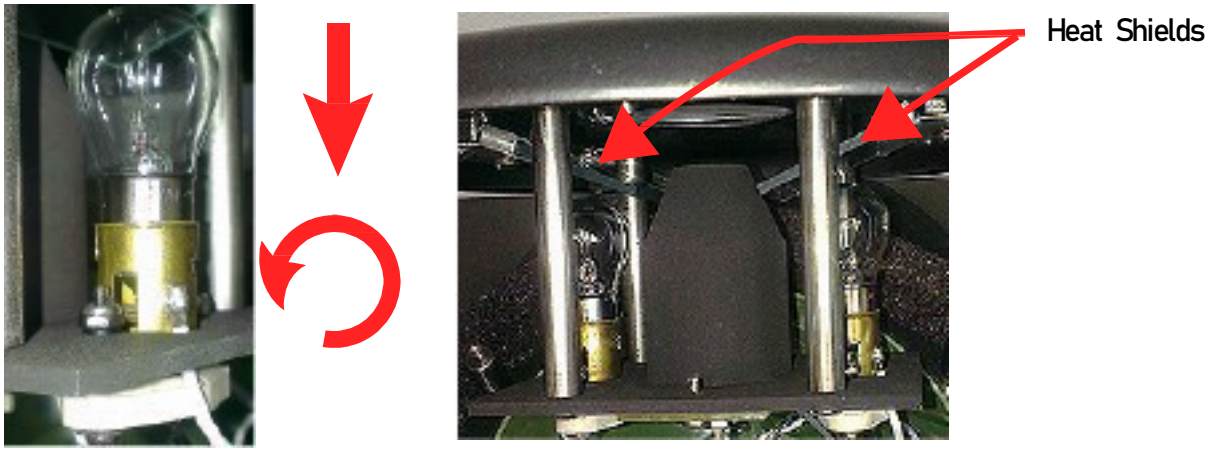

Figure 6-6: Bulb Removal **-** By pressing down and twisting the bulb counter-clockwise to remove it from its socket.

Clean both sides of the sample-opening glass, and also the two-glass heat-absorbing filters that are bracket-mounted to the cover plate using a soft lint-free cloth.

Each time bulbs are replaced; the center contact rivet of each socket should be examined for oxidation. If a black area is apparent on the face of the contact, it should be removed with a fine abrasive — i.e., No. 300 silicon carbide emery paper.

Clean the glass cover of the reference photocell. It is located on the side of the well that serves as the optical assembly housing (**Figure 6-7**).

Occasionally, it may be necessary to clean the measuring photocell located within the black optical tube. To gain access, remove the plastic-mounting block secured to the bottom of the optical assembly base plate. (See **Figure 6-8**.) Lift the photocell and clean the face by wiping it, but do not wipe the interior of the black tube. Dust and lint should be blown from the tube interior, as wiping can damage its black coating and cause faulty light absorption.

Figure 6-7: Optical Assembly Removed from Housing (Well) and Reference Photocell Exposed

Figure 6-8: Occasionally, it may be necessary to clean the measuring photocell located within the black optical tube. To gain access, remove the plastic-mounting block. Clean the face of the photocell by wiping it, but do not wipe the interior of the black tube. **Note: This is not a routine maintenance procedure**

LAMP BULB PROCUREMENT

Two **TAF1680X** bulbs are used in the Hercules Sizing Tester. These bulbs are not widely used and hence are not generally stocked by all distributors. For this reason, a number of spare bulbs are supplied with the tester. The bulbs can be purchased by calling TAF, Inc. at **770-962-5111** or by visiting **www.aderholdfirm.com.**

ACCESS TO WIRING AND ELECTRICAL COMPONENTS

The top panel of the Hercules Sizing Tester cabinet is hinged to the front panel. After removal of 4 Allen-type screws near the top edge of the cabinet, it can be lifted from the rear and swung open for easy access to all wiring and circuit components. **Figure 6-9** shows the front panel swung open, exposing the cabinet interior.

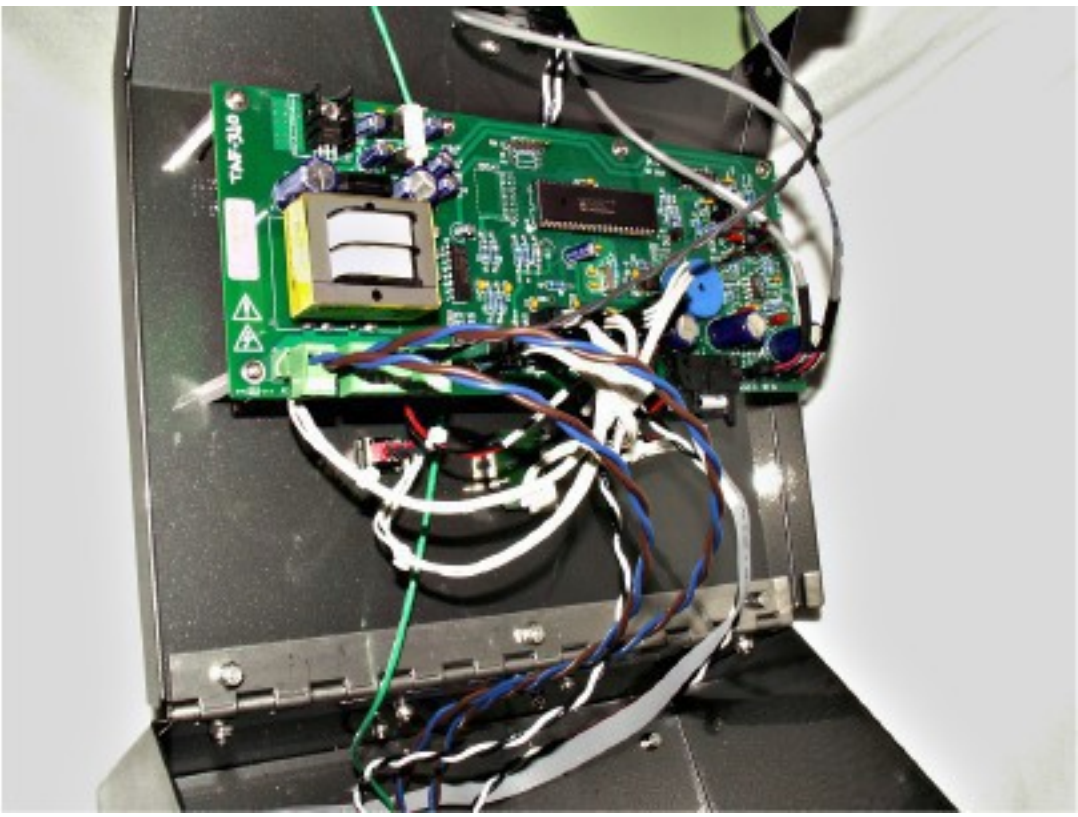

Figure 6-9: Interior View of the New Hercules Sizing Tester Note the optical housing, which is the same as the previous models, the circuit board, and the power supply inside of the base.

CIRCUIT BOARD DISASSEMBLY

If it is determined that the circuit board should be replaced, these instructions describe the points to follow.

Open the unit per the instructions in the previous paragraph.
Unscrew the eight mounting screws in the printed circuit board.
Remove the switch connectors from the top side, disconnect the cable from J9 (RS-232 connection), and carefully unplug the (VFD) from the bottom side of the circuit board.
Reverse these steps to install a new board. Be certain that the wires are plugged into the appropriate socket on the board. For instance, the cable from the Power light plugs into the socket labeled Power on the circuit board. Also, ensure that the stripe on the cables align with Pin 1 on the sockets.

SECTION 7
TROUBLESHOOTING

Only a qualified instrument technician should use the following troubleshooting guide. To use this guide, follow the checklist for each symptom. Faulty parts should be replaced only with **exact replacements only.** Normal safety precautions should always be maintained. Refer to **Section 6** for maintenance instructions and access to the electrical components. **Figure 1-2** in Section 1 contains a schematic diagram of the circuit board.

GENERAL UNIT TROUBLESHOOTING

If the display is blank or the unit is dead, there are only a few areas to check. There are no user-serviceable parts inside. The following will help narrow the problem down from the sub-assembly.

A. Is the unit plugged into a good outlet?
B. Is the power switch turned to the ON position?
C. Check the fuse on the rear panel next to the socket for the electrical cord. (See Parts List in pages 41 and 42

1. There should be 110VAC + 20V on the input terminals of the lamp supply.
2. There should be 6VAC + ~~1V~~ on the output terminals of the lamp supply.
3. There should be 6VAC ~~+~~ 1V on J1 on the controller circuit board assembly.
4. There should be 110VA~~C~~ + 20V on J4 on the controller circuit board assembly
5. There should be +5VAC + ~~0~~.2V between TP3 and TP8 on the controller circuit board assembly.
6. There should be +6VAC + 0.2V between TP4 and TP8 on the controller circuit board assembly.
7. There should be -6VAC + 0.2V between TP5 and TP8 on the controller circuit board assembly.

E. There should be a cable plugged into each connector on the controller circuit board assembly.
F. Check VFD display by substituting with a known good unit.
G. Check circuit board assembly by substituting with known good assembly.
H. Check cables by substituting with known good ones.
I. Check whether the cable from the VFD display is connected properly to the socket on the bottom of the board. (Reminder: Colored stripe on the cable should match up with Pin 1 on the socket.)
J. After all checks, replace the circuit board if necessary.

LAMPS NOT LIGHTED, EVERYTHING ELSE FUNCTIONING

A. Check DC regulated power supply. See C #1-7 above.
B. Check lamp sockets.
C. Check the sockets with new bulbs.

TROUBLESHOOTING WHEN UNABLE TO STANDARDIZE INSTRUMENT

If the specified standardization is not obtained, the following corrective measures are recommended. (Experience has shown these to be the most likely causes of difficulty.)

1. Bulb Aging

Replace bulbs following the directions given under the paragraph Cleaning of Glass Surfaces and Bulb Replacement, page 1 of this section. Occasionally, there may be bulbs that were manufactured with the filament improperly oriented in relation to the base pins. Discard this type of bulb, as it will adversely affect sensitivity.

2. Lamp Orientation

Improper positioning of the optical assembly sometimes occurs when it is replaced after having been removed for cleaning of the air filter or for other maintenance procedures. Using the lamp bulb as a reference point ensures proper positioning of this unit. As viewed from the front of the instrument, lamps should be located at approximately the 4 o'clock and 10 o'clock positions. **(See Figure 6-3)**

3. Glass Surfaces

Inspect all glass surfaces and clean them in accordance with the instructions given in the previous paragraphs.

4. Lamp Socket Replacement

Remove the three screws near the outer edge of the optical cover plate and lift the cover plate and attached optical assembly from the optical housing. Remove the four screws securing the cover plate to the four long posts. The screws holding the lamp sockets to the bottom plate are then easily accessible. After removing the sockets, disconnect the wires, attach them to the new sockets, and reassemble the unit. **(See Figures 6-1- 6-8)**

5. Voltages

Check Voltages as described in Section 6. Also check the unit for broken or faulty wires on the inside.

6. Sensor Sensitivity Readings (Raw Sensor Data)

Anytime the circuit board or photocell sensors are replaced, start up the HST unit in Service Mode. Verify that the Raw Sensor Data values fall in the target range. (See Section 3, page 13.) If they do not, see Troubleshooting, Section 7.

INDICATOR LIGHTS NOT ILLUMINATING OR BUTTONS ON THE FRONT PANEL NOT WORKING PROPERLY

Ensure that the wires coming from each button or indicator light connects to the appropriate socket. For example:

Measuring Channel photocell wire to Meas CH on circuit board
Reference Channel photocell to Ref CH
Test button to Test
Test Complete light to Complete
Push to Calibrate button to Calibrate
Testing light to Testing
Silence button to Silence
Power light to Power

VFD DISPLAY SAYS "CHANGE LAMPS"

The message signifies that the light bulbs have now been in use for over 200 hours. To change the bulbs,

A. Remove the 3 screws located around the top outer edge of the optical assembly cover plate (this requires 5/64-inch Allen type wrench). See **Figure 6-1.**
B. Lift the cover plate and attached optical assembly (**Figure 6-2**).
C. If the bulbs cannot be removed easily at this point, remove the four screws located on the sample holder ring of the optical assembly cover plate. This will free the optical assembly from the cover. (**Figure 6-4 and Figure 6-5**)
D. Replace bulbs and reset timer. (See Section 3 on "Changing the "Service Mode" Settings"). Before reassembling, it is a good idea to clean the glass surfaces. (Section 6, page 31)

SENSOR SENSITIVITY (RAW SENSOR DATA) NOT WITHIN RECOMMENDED RANGES

Review the following example:

Sensor Data	(Reference)	(Measuring)
Target Range	**3000 – 4000**	**500 – 4000**
Example	3940	0950

The recommended readouts in the VFD should be within the expected ranges of 3000 – 4000 (the left value must be the Reference sensor) and 500 – 4000 (the right value must be the Measuring sensor).

If one value reads 0000 (zero):

1. Verify that the Measuring photocell wire connects to the **Meas CH** socket. Reference photocell wire connects to the **Ref CH** socket.

2. Verify the positive lead wire (red) connects to the positive post of the photocell. Negative wire (black) to the negative post. The user may need to remove the photocell to view the (+) or (-) markings. Refer to Section 6 (**Figure 6-8**). Free the photocell by removing the nuts securing the lead wires and then removing the second set of nuts holding the photocell in place. In **Figure 1-3**, the drawing shows the socket locations for "Meas CH" and "Ref CH" in the bottom right portion of the figure. While reading the label, the drawing also signifies the colors of the lead wires: R = Red; B = Black; and W = white or pale blue (in that order, left to right).
3. To determine where the error may be occurring, completely switch the photocell wires (keeping the positive wire to positive and negative to negative on the photocells) to see whether one wire is damaged. If the problem switches sides, replace the faulty wire. If the problem does not move to the other channel, then the problem is in the photocell sensor or the main board assembly.
4. Switching only the sockets on the circuit board will also cause the readings to switch sides, however during standardization, the green tile will give a reading of 100% instead of the value indicated during certification.
5. Replace the circuit board or photocell sensor as indicated.

If one value is outside of the target range as illustrated above…

1. If the photocells were recently replaced, an incorrect photocell might have been used. Verify that the correct photocell is placed in the correct location. The Measuring photocell sensor is used inside the black optical tube. The reference photocell sensor is located on the side of the optical assembly housing.
2. Verify that the Measuring photocell wire connects to the **Meas CH** socket and the Reference photocell wire connects to the **Ref CH** socket.
3. Clean all glass surfaces as described in the Maintenance section.
4. Swap wires as described in "If one value reads 0000 …" above.
5. Replace lamp bulbs.
6. If still not reading correctly, contact TAF for instructions. A new photocell sensor, an adjustment to the circuit board, or replacement of the circuit board may be needed.

SHORT TEST TIMES ON SAMPLES OF KNOWN VALUE WHEN INSTRUMENT IS WITHIN STANDARDIZATION SPECIFICATIONS

A. Check test ink for:
   1. High temperature
   2. High acidity
   3. Low surface tension

B If specimen is heated during the test:
   1. Check the air filter for dirt.
   2. Check for intermittently operating or inoperative fan.
   3. Check for missing or cracked sample opening window.
   4. Check for missing or misaligned heat filters.
   5. Check the reference photocell for missing or broken cover glass.
   6. Check temperature of sample holder to be sure it has not been heated when the test is started.

C. Check the test timer for accurate counting of time.
D. In Service Mode, verify the Sensor Sensitivity as described above and Section 3, page 13.

LONG TEST TIMES ON SAMPLES OF KNOWN VALUE WHEN INSTRUMENT IS WITHIN STANDARDIZATION SPECIFICATIONS

A. Check test ink for:
   1. Lowtemperature
   2. Low acidity
   3. Low optical density (dye concentration)
   4. High surface tension
   5. Expired shelf life
   6. Check temperature of sample holder to be sure it has not been chilled when the test is started.
B. Check the test timer for accurate counting of time.
C. Check if the machine direction of the specimen is parallel with the line of illumination.
D. In Service Mode, verify the Sensor Sensitivity as described in Section 3.

CONSUMABLE MATERIALS OR PARTS

New HST units are supplied with a standard package of parts and materials. Spare parts and consumables can be obtained from **The Aderhold Firm, Incorporated PO Box 1551 Lawrenceville, GA 30046**. See Spare Parts Forms, pages 41 and 42.

(Consumables are those used during normal use. The user purchases these materials for routine replacement of inventories.)

Lamp Bulbs

- TAF1680X Type
- Part Number: 122855500003600-S

Ink-Paks (For ink criteria and details, see Section 4.)

- Dye-Pak (2.5% solution of naphthol green B dye)
- Acid Pak (2% solution of formic acid supplied by The Aderhold Firm, Inc.)
- Formic Acid – Higher concentrations of formic acid must be purchased from a lab chemical supplier.

Spare Parts Order Form

To Order: The Aderhold Firm, Inc.
PO Box 1551, Lawrenceville, GA 30046
U.S. Phone 770-962-5111 U.S. Fax 770-962-6995

P.O. No.: **Sold to Address:**	**Date Required:** **Ship to Address:**
Contact Name:	**Telephone No.:**
Instrument Serial Number:	

Order Qty	Part Number	Description
		6V POWER SUPPLY, AC INPUT CABLE 6V POWER SUPPLY, DC OUTPUT CABLE
		9DF TO 10 HDRF CABLE
		AC INPUT CABLE
		AC POWER CABLE
		AC POWER CABLE, 6FT, #05910641
		AIR FILTERSL-1520645GRAY Z SC IND
		ALLEN KEY5/64" SHORT ARM
		BLACK TILE
		CALIBRATION TILE SET
		CERAMIC BASE SOCKET ASSEMBLY
		D.C. POWER SUPPLY EWS50-6,P/N90B7652
		ENCODER WITH NUT
		FAN ASSEMBLY
		FRONT PANEL DISPLAY CABLE
		FRONT PANEL ENCODER CABLE
		FUNCTION SWITCH AND CABLE
		FUSE, 2 AMP SLOW-BLOW
		GLASS DISC FOR SAMPLE OPENING
		GREEN LED AND CABLE
		HEAT ABSORBING GLASS IN FILTER
		KNOB P/N PT-FD-15, PURE TOUCH
		MEASURE-MATIC DISPENSING PIPETTE
		MEASURING PHOTOCELL SUB-ASSY #4453-2
		ON/OFF SWITCH, P/N RS2021A
		POWER CORD
		PRINTED CIRCUIT BOARD W/CHIP REV.2.8
		RED LED AND CABLE
		REFERENCE PHOTOCELL SUB-ASSY #4453-1
		SAMPLE HOLDER RETAINING RING
		SENSOR CABLE, SET OF 2
		STANDARD SAMPLE HOLDER
		VFD INCLUDES DISPLAY ASSY P/N DA2018A
		YELLOW LED AND CABLE

Spare Parts Order Form

To Order: The Aderhold Firm, Inc.
PO Box 1551, Lawrenceville, GA 30046
U.S. Phone 770-962-5111 U.S. Fax 770-962-6995

P.O. No.: Sold to Address:	Date Required: Ship to Address:
Contact Name:	Telephone No.:
Instrument Serial Number:	

Order Qty	Part Number	Description
	TAF-NGB1	NAPHTHOL GREEN B DYE PAK
	TAF-2FA	2% FORMIC ACID
	TAF-1680X	HST Bulbs 10 per box (5 changes)