

# GUIDELINES FOR HVI TESTING



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**Guidelines for HVI Testing  
Revised June 2005**

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# GUIDELINES FOR HVI TESTING

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## INTRODUCTION

Fiber property measurements made by High Volume Instrument (HVI) systems are widely used to describe cotton quality in international commerce. Standards for USDA HVI calibration cottons, laboratory conditions, and sample conditioning practices and procedures were added to the Universal Cotton Standards Agreement in 1996. The USDA standards, by being adopted under the Universal Cotton Standards Agreement, have become Universal Standards. In 2003, Universal Micronaire Calibration Cotton Standards and a reference to this publication were added to the Universal Cotton Standards Agreement.

Standardized procedures for HVI testing of cotton samples will enable all users of HVI systems to achieve common test result levels for each measured property. HVI systems equipped with Fibrosamplers can test saw-ginned and roller-ginned samples with minor adjustments in procedure for the ginning method. HVI systems without Fibrosamplers should only be used for testing saw-ginned cotton. The following procedures are essential to achieving common test result levels:

1. Follow the HVI manufacturer's instruction manual and recommendations.
2. Verify at least annually that the latest version of application software from the HVI manufacturer is being used. The software should include the USDA color grade conversion table adopted July 1, 2000.
3. Test all samples under the approved atmospheric conditions for testing as given in the next section.
4. Use USDA Color and Trash Calibration Tiles for calibrating the colormeter and trashmeter. In addition, a set of USDA Cotton Color Check Samples and "Cottons Under Glass" with established Rd/+b and Area/Count values, respectively, should be used to check the cotton testing level of the colormeter/trashmeter and to check the set-up each time repairs are made or instrumentation is brought back into production after any period of inactivity.
5. Use Universal Micronaire Calibration Cotton Standards for calibrating the micronaire measurement.
6. Use Universal HVI Calibration Cotton Standards for calibrating the length, length uniformity index and strength measurements. For testing Extra Long Staple (ELS) type cottons (1.25 inches or longer), USDA ELS HVI Calibration Cotton

Standards are recommended.

## **ATMOSPHERIC CONDITIONS**

The testing lab and the conditioning area must have an atmosphere maintained as follows:

Temperature:	70 +/- 1 degree F (21 +/- 0.6 degree C)
Relative Humidity:	65 +/- 2 percent

A suitable device should be installed to monitor and record the atmospheric conditions continuously. The sensitivity of the device should be adequate to detect short-term fluctuations in the atmospheric conditions. The output of the device should be checked periodically. At any time the conditions exceed the above tolerances, testing must cease, the controls and/or the atmospheric conditioning system must be corrected and the standard conditions re-established. When this occurs, the samples must reach conditioned moisture content before testing resumes. See Sample Conditioning.

## **SAMPLES**

A cotton sample consists of two portions. Each portion is taken from opposite sides of the bale and is drawn manually from between the ties (or bands). Each portion should be approximately 6 to 12 inches (150 – 300 mm) long and approximately 6 inches (150 mm) wide and should have approximately the same mass. The total sample submitted for testing should weigh approximately 8 ounces (225 grams), and be identified with a tag (coupon) rolled between the sides giving the bale number.

## **SAMPLE CONDITIONING**

Cotton samples must be brought to a moisture content which is at equilibrium with the approved atmospheric conditions before testing. Conditioned samples will have a moisture content between 6.75 and 8.25 percent (dry weight basis). It is preferable to start the conditioning from the dry side. Cotton can be conditioned passively or actively. Conditioning of samples in sacks, wrappers or other coverings is not permissible.

In passive conditioning, the samples are placed in single layers in trays with perforated bottoms to allow free circulation of air. The samples must be exposed to the approved atmospheric conditions until the moisture level of 6.75 to 8.25 percent is obtained. This normally takes about 48 hours.

Active conditioning is done in laboratories equipped with Rapid Conditioning

Units. The principle of rapid conditioning systems is that conditioned air is drawn through the cotton until equilibrium with the atmosphere is reached. These units dramatically reduce the time required for proper conditioning. Samples can generally reach equilibrium with atmospheric conditions in 10-15 minutes when the air being drawn through the samples has a minimum pressure drop of 3 inches (75 mm) of water. The manufacturer's instructions for the unit involved should be followed. The moisture content of the conditioned samples should be checked to verify that the appropriate moisture content has been reached. A suggested moisture meter is the Strandberg Model 200D Probe type or equivalent.

The moisture content of the samples to be tested should not vary more than one percentage point from the moisture content of the calibration cottons used.

## **CALIBRATION**

Calibration contributes to accuracy in HVI measurement levels by using the internal software to adjust for variations in such things as mechanical, electrical and cotton moisture influences. Calibration is not a substitute for maintaining the equipment in good operating condition or maintaining properly adjusted and controlled atmospheric conditions.

The level of testing can be operator sensitive on HVIs equipped with stand-alone Fibrosamplers. Therefore, HVIs equipped with stand-alone Fibrosamplers should be re-calibrated when the operators rotate from one position to another.

The instructions and recommendations in the HVI manufacturer's manual should be followed in calibrating each of the fiber property measurements. Additional recommendations for calibration are included in the following.

- **COLORMETER**

The USDA Standard colormeter tiles shall be used and the manufacturer's colormeter calibration instructions are to be followed. The colormeter Rd and +b measurements must calibrate within +/- 0.4 of the established values for each of the colormeter tiles.

The surface of the tiles must be clean to ensure accurate calibration. An effective procedure for cleaning the tiles is to spray a diluted non-abrasive liquid detergent on the tile surface, followed by wiping with a clean cloth or tissue. Detergents containing bleach, abrasive or other harsh cleaning agents may affect the color integrity of calibration tiles and therefore should not be used. Color tiles should be returned to USDA every 1 to 2 years for reevaluation to ensure accurate colormeter calibration.

In order to verify accurate cotton color Rd/+b measurements, the colormeter must be checked with USDA Cotton Color Check Samples. Tile calibration alone is not sufficient for ensuring proper cotton testing levels. Accurate cotton color Rd/+b calibration is confirmed when measurements made on USDA Cotton Color Check samples are within +/- 1.0 Rd and +/- 0.5 +b of the established USDA Cotton Color Check sample values. Such things as colormeter hand pressure, lighting and photodiode filters should be checked if cotton sample readings are out of tolerance.

- **TRASHMETER**

Accurate trash measurements are dependent upon following the setup and calibration procedures given by the HVI manufacturer. The manufacturer's procedures specify the use of USDA trashmeter calibration materials, which include the Trashmeter calibration tile and a set of six "Cottons-Under-Glass". The standard USDA trashmeter calibration tile is composed of printed dots that provide established percent area and count values. The manufacturer's trashmeter calibration instructions should be followed in performing routine calibrations. Acceptable trashmeter calibration requires calibration within  $\pm 0.05$  percent area of the established trash tile percent area.

An initial setup of the trashmeter is necessary on new HVIs or after repairs or following periods of inactivity. The setup should begin by measuring the white color tile to ensure zero area and zero count measurements. The "Cottons-Under-Glass" set should then be measured in cotton testing mode followed by any cotton slope and cotton offset adjustments necessary to obtain the proper testing level. "Cottons-Under-Glass" samples are prepared in containers that have one side made of optical glass that is sized to cover the viewing area of the trashmeter. Trash particles are placed on the side of the sample that is under the viewing side of the container. A set of six samples represents the range of trash particles normally encountered in testing cotton samples. The trash calibration tile should be measured in tile mode, and then any tile slope and tile offset adjustments indicated should be made to obtain the proper tile percent area level.

The "Cottons Under Glass" recommended for calibration of the trashmeter were developed in 1991, and these materials may not be applicable to HVI systems manufactured prior to 1992.

All trashmeter calibration materials must be kept clean. The cleaning procedure given for the colormeter tiles should be used to maintain clean measurement surfaces.

- **MICRONAIRE**

Two Universal Micronaire Calibration Cotton Standards are necessary for calibration of the micronaire measurement. Low micronaire standards have a micronaire reading between 2.5 and 3.5. High micronaire standards have a micronaire reading between 5.0 and 5.6. The low standard and the high standard used together should differ by at least 1.5 micronaire units.

The Universal Micronaire Calibration Cotton Standards should have the same conditioning as the samples being tested - a moisture content of between 6.75 and 8.25 percent. Therefore, calibration cotton standards must be kept in atmospherically conditioned space at all times.

The manufacturer's instructions should be followed in calibrating the micronaire measurement. The average of the results of the test specimens measured to calibrate the micronaire reading must be within +/- 0.1 of the values established for the standards. Calibration cotton samples may be tested immediately following the calibration to ensure that the calibration brought the system to the proper test level.

- **LENGTH, LENGTH UNIFORMITY INDEX, AND STRENGTH**

Two HVI Universal Calibration Standards, a short/weak cotton and a long/strong cotton, are necessary for calibration of the length, length uniformity index, and strength measurements. Generally, the approximate test values for the calibration cottons are:

For testing Upland cottons	HVI UHM Length (In.)	M/UHM Uniformity (Pct.)	HVI 1/8" Strength (g/Tex)	Micronaire (Rdg.)
Short Staple	Below 1.01	77 – 81	22 – 26	3.6 – 4.4
Long Staple	1.13 – 1.22	83 – 90	30 – 35	3.6 – 4.4

For testing ELS cottons	HVI UHM Length (In.)	M/UHM Uniformity (Pct.)	HVI 1/8" Strength (g/Tex)	Micronaire (Rdg.)
Short Staple	1.10 – 1.20	82 – 90	30 – 35	3.6 – 4.4
Long Staple	1.30 +	84 – 90	37+	3.6 – 4.4

The HVI Universal Calibration Cottons must have the same conditioning as the samples being tested - a moisture content between 6.75 and 8.25 percent. Therefore, calibration cotton standards must be kept in atmospherically conditioned space at all times.

The manufacturer's instructions should be followed in calibrating the length, length uniformity index, and strength measurements. The averages of the test results of the specimens measured to calibrate length, length uniformity index and strength measures must be within plus or minus 0.010 inch length, 1.0 percent length uniformity index, and 0.7 gram/tex strength of the respective values established for the standard. Calibration cotton samples may be tested immediately following the calibration to ensure that the calibration brought the system to the proper test level.

## **CALIBRATION FREQUENCY**

The micronaire, length, length uniformity index and strength should be calibrated on an "as needed" basis. If the guidelines set out in this document are strictly adhered to, and the atmospheric and other testing conditions are under control, then measurements obtained by calibration check procedures should fall within properly calculated statistical tolerances. The following is a suggested procedure for determining when an HVI should be calibrated.

A simple calibration check procedure is to utilize either a calibration cotton or cotton from a uniform cotton bale. An average and standard deviation should be calculated from 60 or more complete tests on the cotton. If a cotton other than a calibration cotton is utilized, it is best to use a cotton having midrange measurement values. In addition, the measurement standard deviations calculated from the 60 tests (1 test = 1 micronaire reading, average of 2 length/strength combs and the average of 4 color/trash readings) should be below 0.015 inches for length, 1.2 g/tex for strength, 1.0% for uniformity index, 0.12 for micronaire, 1.0 for Rd and 0.5 for +b. If the standard deviations of the 60 tests exceed these limits, either the cotton utilized is not uniform or the HVI requires servicing due to high variation in measurements.

A calibration check procedure would involve performing four complete tests for length, length uniformity index, strength and micronaire at least four times during the day. The average of the four tests of each calibration check should be within the standard deviations of the established averages. A measurement should be re-calibrated if outside these limits. Color and trash calibration checks can also be performed using this same procedure. For convenience, one cotton sample can be used as a calibration check for all HVI measurements.

Whenever the HVI system is calibrated, the calibration may be verified by testing samples of the check test cotton immediately to ensure that the new calibration is accurate. The test data may be recorded so that testing trends can be analyzed. In addition, this information can be helpful in diagnosing system malfunctions.

As an additional verification for color and trash during routine testing, periodic

checks using the central colormeter tile and the trashmeter calibration tile should be performed. If either the Rd or +b measurement differs more than +/-0.4 from the standard values established for the central colormeter tile, colormeter calibration is required. If the trashmeter percent area measurement differs more than +/-0.05 percent area from the standard value for the trashmeter calibration tile, trashmeter calibration is required.

Incandescent illumination intensity within the colormeter/trashmeter changes over time. The colormeter and trashmeter should be calibrated at least four times in an eight-hour period to correct for instrument drift in the measurement test levels. A color and trashmeter check should be performed at intervals between the regular calibration. Performance of regularly scheduled daily calibrations will have the most effect in preventing drift in color readings. For colormeters utilizing Xenon flash lighting, calibration levels are more stable over time. Therefore, less frequent calibration is required.

Atmospheric conditions should be maintained at all times in the areas where HVI systems are located. At the conclusion of testing at the end of the day HVI systems should be left in the Standby Mode. If for any reason the power is disconnected from the HVI system or if the system has been turned off, it will require a minimum period of two hours to warm up after restoring power. Operations such as checking calibration, re-calibrating or testing samples should not be attempted before the warm up is complete.

## **INSTRUMENT OPERATION**

HVI systems must be operated only in areas where the specified atmospheric conditions are maintained. Samples must be conditioned by the procedures given in the section on Sample Conditioning.

The HVI manufacturer's instruction manual and recommendations for operation of the system should be followed.

The standard test performed by USDA HVI systems for saw-ginned Upland cotton samples that represent bales consists of one composite specimen test per sample for micronaire, two tests (specimens) per sample for length, length uniformity index, and strength, and four tests per sample for color and trash. The micronaire test is from a composite specimen of equal amounts from each portion of the sample. The two tests for length, length uniformity index, and strength consist of one test from each portion of the sample; and the four tests for color and trash consist of two tests from each portion of the sample. It is the same for Extra Long Staple cotton, except that the number of specimens for length, length uniformity index and strength is increased to four, two from each portion of the sample.

Operators should be properly trained to perform calibrations, handle samples, use correct specimen preparation and testing techniques, and recognize instrument malfunctions and errors. When HVI systems require multiple operators, it is recommended that the personnel be trained to perform the tasks at each position and required to rotate positions on a regularly scheduled basis.

The entire colormeter/trashmeter window must be covered by the specimen sample in order to obtain an accurate measurement. If cotton samples are too small to cover the entire window, colormeter and trashmeter measurements should be omitted.

## **MAINTENANCE**

Maintenance should be performed on the HVI system according to the manufacturer's instruction manual. The instrument system should be thoroughly checked according to the maintenance procedure prescribed by the manufacturer. Check lists should be prepared for maintenance items to be performed daily and/or at the end of each shift, week, month, and year. At the end of the test day (or shift) all loose cotton should be cleared from the work area and daily maintenance performed.

In addition to the regular maintenance program for the HVI systems, a standard routine maintenance program should be performed on the atmospheric control system. The chiller, heater, and humidifier units should be cleaned and checked on an established schedule. The controller for the atmospheric control system should be monitored regularly and the set points independently verified on a periodic schedule.

## **TROUBLESHOOTING TIPS**

### **Colorimeter/Trashmeter**

- Is the sample window glass clean?
- How old are the lamps?
- Are the lamps properly seated and lamp socket connections tight?
- Are the calibration tiles clean?
- Are there any cracks in the tiles?
- Is the hand platen pressure properly adjusted?
- Does the sample tray stop over the window at the correct position?

### **Micronaire**

- Does the micronaire chamber seal correctly?
- Are the o-rings dirty or worn?
- Are the air pressure levels for both the micronaire air chamber and the transducer manifold set correctly?

Is the chamber size correct?  
Do the associated regulators stabilize quickly?  
Is the balance level free of air turbulence and properly calibrated?  
Does the balance respond by returning to zero every time the balance pan is empty?

### **Length & Uniformity Index Measurements**

Is the brushing pressure even?  
Do the combs open and close properly?  
Are there missing or bent teeth in the combs?  
Does the vacuum pressure ensure that fibers are being drawn into the optics window?  
Are the samples positioned for proper alignment in relation to the front of the optics window?  
Is the fibrosampler card cloth thoroughly carding the cotton fibers?

### **Strength Measurements**

Do both the front and rear jaws clamp correctly?  
Is the jaw gap set correctly?  
Are the air pressure levels for the clamping cylinders set to the proper settings?  
Are all jaws clean?  
Are electronic boards set up in accordance with manufacturer guidelines?

## **QUALITY OF DATA**

Test data from the within-laboratory check test bale should be summarized and analyzed to determine whether trends occur in the data. Trend patterns can be indicators of sources of test error such as worn parts in the HVI system, improper calibration, or malfunctions in the atmospheric control system. These analyses are invaluable in maintaining a consistent test level for the laboratory. This is especially true when the laboratory is operating more than one HVI system.

It is advantageous to participate in some inter-laboratory test such as the HVI Level Assessment or HVI Check Level programs conducted by the U.S. Department of Agriculture. Results of these tests indicate the test result level of the laboratory relative to established values for the samples and relative to other laboratories. Deviations should be analyzed carefully and appropriate actions taken when indicated. Organizations may obtain additional information about these HVI programs by writing the USDA, AMS, Cotton Program, Standardization and Engineering Branch, 3275 Appling Road, Memphis, TN 38133 or by email at [cotton.standards@usda.gov](mailto:cotton.standards@usda.gov). Other inter-laboratory tests such as the Bremen Roundtest are also available. Contact USDA for additional information.