Technical Committee

HVI USER GUIDE

ITMF Standard Procedures for HVI Calibration and Operation for Testing Cotton / 2001

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FÉDÉRATION INTERNATIONALE DES INDUSTRIES TEXTILES
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Preamble

HVI testing of cotton is carried out widely today and continues to increase, there being some 1400 HVI systems in place in more than 60 countries worldwide. In order to obtain reproducible and accurate results, which are comparable for different laboratories, it is essential that correct and standardised calibration, testing and sampling procedures as well as best laboratory practices are followed. These Standard Procedures have been prepared as part of the continuing efforts of the HVI Working Group (formed in 1988) of the ITMF International Committee on Cotton Testing Methods which has been established under the Federation's Technical Committee to place the HVI testing of cotton on a sound international foundation.

It should be noted at the outset, that HVI strength results cannot be regarded as equivalent to those obtained on the traditional laboratory instruments.

General

In order to obtain international uniformity of HVI results it is essential that:

- HVI instrument manufacturer's instruction manual and recommendations be followed;
- Universal HVI Calibration Cotton Standards (HVI CCS) be used for length, strength, and length uniformity;
- International Calibration Cotton Standards (ICCS) - micronaire only - be used for micronaire;
- USDA (see note below) Colour and Trash Calibration Cottons and Tiles be used;
- Standard Test Methods, such as ASTM D-5867-95 (see note below) for the measurement of the Physical Properties of Cotton Fibers by High Volume Instruments, be followed;
- The latest application software from the HVI manufacturer is used (to be verified at least annually).

NOTE: Contact addresses

USDA-AMS, Cotton Program
325 Apling Rd., Memphis, Tennessee, 38133 USA

ASTM
100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA

If users deviate from the recommended calibration standards, then it is their responsibility to justify and inform users of their data accordingly, since, for example, the strength results with ICCS will be at a different level (Stelometer) to that with the Universal HVI Calibration Cotton Standards.

Laboratory and Conditioning Room

The following atmospheric conditions must be maintained for HVI testing (according to ASTM D 1776-98):

- Temperature: 21°C ± 1°C (70°F ± 2° F);
- Relative Humidity: 65 ± 2%.

These conditions are to be monitored by a suitable monitoring device, fitted with a daily or weekly chart, which is to be checked at regular intervals. This instrument should be certified by an external party according to the calibration and maintenance schedule and should preferably be sufficiently sensitive to detect and record short term fluctuations. If the conditions fall outside the above limits, the air conditioning personnel must re-establish the correct atmospheric conditions.

The HVI system should at all times be kept in the conditions stated above and at the conclusion of each day's testing left in the Standby Mode and the work area cleared of all loose cotton. Should the HVI be switched off, it should be warmed up for at least one hour and a calibration check performed before testing commences.

Samples for testing

Samples should be drawn from each side (opposite sides) of the bale and identified with a ticket (tag) giving the bale number. The test sample should weigh from 100 to 170 grams, depending on the HVI model, and have the following approximate dimensions: length 22 cm (9"), width 15 cm (6''), height 10 cm (4").

For samples conditioned passively under the standard atmospheric conditions, stated above, conditioning time should be at least 48 hours or until their moisture content (dry basis) reaches equilibrium with that of the laboratory atmosphere. The samples should be placed in single layers in trays which allow the free circulation of air, forced conditioned air moving across the surface of the samples being preferable. Conditioning of samples in sacks, wrappers or other coverings is not permissible.

In the case of ''Rapid Conditioning'', the manufacturer's instructions for the unit being used, should be followed. Air at the prescribed temperature and relative humidity for conditioning should be drawn (forced) through the samples with a minimum pressure drop of 3 inches (75 mm) of water, for at least 15 minutes.

NOTE:

- It is preferable that both the test samples and standards should achieve the correct moisture content starting from the ''dry'' side, ie from a moisture content significantly below 6.75 percent.

- It is important to note that the moisture content after equilibration with the prescribed standard atmosphere depends on several factors, including the average maturity of the fibres and the presence of impurities, such as trash and sugars. Thus the moisture content may be different for different samples, even when they are properly conditioned. Normally the average moisture content of properly conditioned samples will fall within the range of 6.75 to 8.25% (dry basis). It is important to make regular checks of sample moisture content. Records should be maintained to establish the normal range of moisture content and to establish tolerances. Samples that are out of tolerance should be given extra conditioning time until the moisture content does not change significantly on re-measurement.

- Normally, the moisture content of a properly conditioned sample should not vary by more than one percentage point from that of the Calibration Cotton. If it does, then more time should be allowed for conditioning, until the moisture content does not change from the previous measurement. If the difference is still more than one percentage point then the sample should be marked as exceptional. Ideally the bale should be re-sampled to confirm the result.

- Moisture content should be measured using the ''oven dry'' method or moisture meters calibrated strictly according to the ''oven dry'' method.

- If a fully controlled ''Routine Check Testing'' programme is used (page 8), then this can also show that the samples are at the correct moisture level if they fall within the established tolerances.

Calibration Standards

The Calibration Standards should be kept permanently in the conditioned area. The standards should have a moisture content within 6.75 to 8.25 percent on a dry basis (see recommendations on conditioning and comments on moisture content in the previous section).

It is recommended that the following Calibration Standards be used:

- For Micronaire - Two standards of the International Calibration Cotton Standards (ICCS) are necessary for calibration, with the value for the low micronaire between 2.5 and 3.8 and that for the high micronaire between 4.6 and 5.6. A difference of at least 1.5 micronaire units between the low and high micronaire cottons is recommended.

- For Length, Length Uniformity Index (UI) and Strength - Two boxes of Universal HVI Calibration Cotton Standards are necessary for calibration; one box representing short-weak (s/w) cotton and the other long-strong (l/s) cotton. Universal HVI Calibration Cotton Standards are recommended for HVI testing of all cottons except for Extra Long Staple (ELS) type cotton, 1.25 inches (31,8 mm) or longer. For testing of ELS cottons, USDA ELS Pima Calibration Cotton Standards are recommended. Examples of values of the Universal HVI Calibration Cotton Standards are given below.

- For Trash -- USDA Calibration Tiles

- For Colour – USDA Calibration Tiles.

Examples of Universal HVI Calibration Cottons				
Property	**Short-Weak**		**Long-Strong**	
	Designated Values	Standard Deviation (SD)	Designated Values	Standard Deviation (SD)
Micronaire	4.04	0.08	4.32	0.08
Strength (g/tex)	23.2	0.74	33.9	0.94
UHM (inch)	0.975	0.012	1.167	0.012
UI (%)	79.8	0.64	84.0	0.71

Note:

- **The above Designated Values and Standard Deviation (SD) values (also printed on the Universal HVI CCS boxes) are typical for the Calibration Cotton Standards. Nevertheless, values will vary somewhat from bale to bale of calibration cotton since the values are independently established for each bale.**

- **It is also possible to use the ELS Pima Calibration Cotton as the long-strong (l/s) calibration cotton. The Universal HVI standards and the Pima HVI standards are prepared in the same way and are calibrated to the same level. Therefore it is acceptable for example, to use the Pima standard in place of the long-strong Universal standard.**

- **It is important to note that roller ginned cottons have standard deviations for length and strength, significantly higher (about 1.5 times higher) than those for saw ginned cottons. The ELS Pima HVI CCS are prepared from saw ginned cottons.**

The Colour and Trash calibration tiles should be cleaned with a damp cloth weekly and replaced if the surface is damaged in any way. USDA recommends that colour calibration tiles be returned to the USDA every one to two years for re-establishment of standard values to ensure accurate colour-meter calibration. This service is provided at a nominal cost by the USDA.

USDA offers calibration check cottons for verification of colour and trash measurements on actual cotton. For colour, a colour check box consisting of six cotton samples representing a range of colour, with established Rd and +b values is available. For trash, a set of six cotton samples mounted under glass representing a range of trash contents, with established percent area and count values is available.

Instrument Operation

Level Checking The instrument should be checked at the beginning and end of each test period to ensure that the test level has not drifted out of calibration. Test level checking may be performed using either the Calibration Standards or specially developed internal standards. If the level is found to have drifted, then the instrument may need to be recalibrated -- see the sections on **Routine Check Testing** and **Calibration**.

Procedure The HVI Manufacturer's Instruction manual and recommendations must be followed and standard test methods, such as ASTM D-5867-95, must be observed. See also final paragraph under **Laboratory and Conditioning Room**.

Number of Tests At least one test (preferably two) per sample should be carried out for micronaire and at least two tests (preferably four) for length, length uniformity, strength, colour and trash. In the case of non-uniform cotton, the number of tests should be duplicated (doubled).

Operators Operators should be properly trained to work on all the positions of the HVI and should periodically rotate. They should also be able to perform calibrations, handle samples, use correct specimen preparation and testing techniques, and recognise instrument malfunctioning and errors.

Quality Control Laboratories should participate in regular interlaboratory ''Round Trials'' or ''Check Test'' programmes, such as those run by the Bremen Fibre Institute and the USDA. Results should be carefully documented and analysed for trends, the use of control charts being important.

Maintenance Routine maintenance should be performed according to the HVI manufacturer's manual and according to a prepared check list.

A thorough mechanical check, according to the maintenance procedure described by the manufacturer, is recommended on a regular scheduled basis, particularly for HVI units which test volumes of 700 bales per day or more. This is essential for maintaining regular running and consistent results.

A regular maintenance programme should be performed on the air-conditioning units in order to maintain constant and standard atmospheric conditions.

Routine Check Testing

HVI test results are influenced to a greater or lesser extent by, for example, the testing environment, the specimen preparation and the mechanical and electronic condition of the instrument. These factors can change over time and with different operators. Therefore, it is necessary to check at intervals that the instrument is still testing at the correct level. This is done by making routine check tests on one or more standard cottons and comparing the results with those that should be obtained for that material. In order to make this comparison it is necessary to know the expected mean test values for the standards and to calculate tolerances around the mean. The expected mean test values are determined from many tests carried out on the standards. The tolerances have to be calculated from the standard deviations of those means and the number of specimens that was used for the check test.

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 routine check testing procedures should fall within properly calculated statistical tolerances.

Standard Materials

There are two options

- The Universal Calibration Standards
- Internal Standards

The advantage of using the Calibration Standards is that there is no need to determine the expected mean values and the standard deviations. These have been established by USDA and are printed on the packet. Furthermore, the uniformity of the bales has been rigorously checked. The advantage of internal standards is the reduced consumption of Calibration Standards and the ability to utilise cottons for check testing that are similar to those that are generally tested.

Development of Internal Standards

The recommended procedure for developing internal standards is as follows:

- Select a bale of even running cotton with low deviation of HVI values. The properties of the bale should be representative of

the general type of material that is tested routinely. Two bales would actually be preferable -- one of relatively long-strong and one of relatively short-weak cotton.

- Establish the mean and standard deviation by testing at least 60 samples with **x** specimens per sample, the samples being taken from throughout the bale. The value of **x** should be the same as that which will be used for routine check testing.

- These tests should be made at a time when it is known that all systems, including the conditioning, are functioning correctly. It is advisable that the samples be conditioned for at least 48 hours before testing.

Tolerances for Length, Strength and Micronaire

The tolerances indicate the range within which the check test results are expected to lie. They are calculated from the established standard deviation and the number of specimens that were tested per sample in the check test.

In general, the tolerance, **T**, is calculated as follows

$$T = Z \bullet S / \text{sqrt}(n)$$

where

- **S** is the established standard deviation

- **sqrt(n)** is the square root of the number of specimens per sample **n** for the check test

- **Z** is the so-called Student's **t** statistic. It takes the value 1.96 for a 95% confidence limit when the standard deviation has been determined on a large number of samples. In such a case:

$$T = 1.96 \bullet S/\text{sqrt}(n)$$

In the case of an internal check-test standard material, the value of **n** will most likely be the same as the number of specimens per sample that was used to establish the standard deviation. However, in the case of the Universal Calibration Standards, it usually is not the same. Because the established standard deviation depends on the number of specimens per sample, it

is necessary to make a correction to the calculated tolerance. If the number of specimens per sample was actually **x**, then the corrected tolerance is calculated as follows.

T = Z • S / sqrt(N)

Where

- **N** is the corrected number of specimens, given by **n / x**
- **n** is the number of specimens per sample in the check test (as above)
- **x** is the number of specimens per sample when establishing the standard deviation

For example, the number of specimens per micronaire check test **n** would normally be 3, but the number of specimens **x** used by USDA in establishing the standard deviation of the Calibration Standards (printed on the packet) is 1. In this case, therefore, the correction is **N** = 3 / 1 = 3. If the published standard deviation for micronaire is 0.08, then the calculated tolerance for the check test is:

T = 1.96 • 0.08 / sqrt(3) = 0.09

Thus, for a three-specimen test, if the declared mean micronaire is 4.32, then the expected range for the check test result is 4.32 plus/minus 0.09 i.e. from 4.23 to 4.41. Any result outside that range indicates that the system may have drifted out of calibration.

The following table shows the current values for **x**, the number of specimens per sample used by USDA in establishing the published standard deviations for the Universal Calibration Standards.

	Universal		**Pima**	
	S-W	**L-S**	**S-W**	**L-S**
Micronaire	1	1	1	1
UHM, UI, Strength	2	2	2	4

The next table gives examples of tolerances calculated for a Long-Strong Universal Calibration Cotton Standard, using typical values for **n**, the number of specimens per sample in the check test. Note that the micronaire example is the same as the one worked out earlier.

Examples: Long-Strong Universal Calibration Cotton Standard						
	Declared/Designated					Calculated Tolercance
	Value	SD	x	n	N	
Micronaire	4.32	0.08	1	3	3	± 0.09
Strength	33.9	0.94	2	12	6	± 0.75
UHM	1.167	0.012	2	12	6	± 0.010
UI	84.0	0.71	2	12	6	± 0.57

Check Test Tolerances for Colour and Trash

Routine level checks for colour and trash should be performed by measuring the five colour calibration tiles and the one trash calibration tile. All Rd and +b values obtained for each colour tile should be within plus/minus 0.4 of the established tile values in order to be acceptable. The trash meter calibration is acceptable only if the percent area value obtained for the trash measurement is within plus/minus 0.5 percentage points of the established trash tile percent area value.

Check Test Procedure

- Undertake check tests in accordance with the latest recommendations of the HVI instrument manufacturer.
- Each day, run at least four complete tests on the check test standards using **n** specimens per sample. A minimum of 3 micronaire determinations and 10 for length, length uniformity, strength etc. are required to check each sample (short-weak and long-strong).
- If **n** is different from **x**, then calculate the required tolerances for this cotton using the formula given in the section on **Check Test Tolerances**.

- For additional security, the check test can be run again at intervals of two to four hours. If the laboratory is (or intends to be) certified under ISO 9000 then it is advisable to run the check test at the end of each testing session (otherwise there is a risk that all tests since the last check could be declared invalid).

- If three out of four tests are within the established tolerances then proceed with normal operation. If not, then another set of four tests should be performed. If a total of six out of the eight tests do not pass then a full calibration is required.

- If a full calibration is indicated, check whether any other aspect of the process may be out of control – such as the conditioned atmosphere or the level of maintenance of the instrument.

- It is important that the test data obtained from routine check testing should be carefully documented and analysed routinely for trends, using control charts.

Calibration

At the outset, it is necessary to point out that calibration is merely a way of re-setting the level of testing by internal software adjustment and is not a substitute for maintaining the equipment in a good operating condition or constant attention to maintaining the specified standard atmospheric conditions. Furthermore, when the instrument appears to need re-calibration, the first action should be to check that nothing mechanical is amiss and that the atmospheric conditions are correct, followed by a repeat of the check tests. Unnecessary re-calibration will serve only to increase the overall variability of test results. Finally, calibration test results should be systematically documented and examined for trends. If a sequence of calibrations is all in the same direction, this could be a sign of mechanical problems which need attention. The use of control charts is recommended, for both mean and standard deviations.

Method

Follow the instructions and recommendations in the HVI manufacturer's manual.

Frequency

Although daily check tests are important, full re-calibration should be performed only when strictly necessary. If the check tests are out of tolerance it may be because some other aspect of the process is out of control – for example, the atmospheric conditions.

Acknowlegement

This HVI User Guide has been prepared by the HVI Working Group (Chairman: L. Hunter) of the ITMF International Committee on Cotton Testing Methods.