# INTERNATIONAL WOOL TEXTILE ORGANISATION

**TECHNOLOGY & STANDARDS COMMITTEE** **ISTANBUL MEETING**

**Sliver Group** **November 2003**

**Chairman: J. TURK (Australia)** **Report No: SG 03**

Report on Equivalence Round Trials for the Almeter AL2ooo.

By

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## BRIEFING PAPER

### SUMMARY OF FINDINGS

Papers have been presented to IWTO Nice (2002) and Buenos Aries (2003) providing background to the results of recent activity, in conjunction with and on behalf of The Woolmark Company, the owners of the Almeter technology, to re-develop the AL100 to up-grade some redundant electronic componentry, no longer available commercially for the manufacture of this instrument.

The information presented in Buenos Aries demonstrated equivalence between the AL100 and its replacement, the *AL2ooo*, when perspex trapeziums were used. These perspex trapeziums are used in the commercial calibration and QC actions for the AL100. Confirmation of any such equivalence using wool was sought and this paper describes details of a second series of international round trials undertaken in that respect.

This paper provides results of wool trials using three *AL2ooo* instruments in four different laboratories and comparing them against existing AL100 instruments in the same laboratories. Results indicate there is no significant difference between instrument types AL100/*AL2ooo* and thus equivalence is demonstrated. This has led to a submission (in this meeting) to incorporate the Almeter *AL2ooo* into IWTO 17 as a suitable instrument for the measurement of top length and its distribution parameters.

### COMMERCIAL IMPLICATIONS – CURRENT AND FUTURE

The acceptance of the *AL2ooo* as an equivalent instrument for the purposes of IWTO17 allows for the continuation of this technology as the primary test method for fibre length and distribution statistics for tops and LAC measurements. In addition, equivalence is necessary to ensure current raw wool to top prediction and top length parameters used by spinners to set spinning frames remain relevant. The industry also chooses to trade tops on the basis of the Almeter statistics and thus equivalence is an important commercial trading consideration. Such a change was necessary as some of the electronic components of the existing AL100 are no longer being manufactured and replacement components had to be sourced and incorporated.

These studies show that the *AL2ooo* is equivalent to the AL100 in the measurement of top length and length distribution parameters allowing the wool trade to accept results from either instrument in trading. The findings will require an editorial alteration to the text of IWTO 17 to identify the equivalence status of the *AL2ooo* instrument.

**NOTE** The paper and submission will be discussed in the Sliver Group meeting 12.30 PM Sat. 29th November 2003**.**

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## SUMMARY

Papers have been presented to IWTO Nice (2002) and Buenos Aries (2003) providing background to the results of recent activity to re-develop the AL100 to upgrade some redundant electronic componentry, no longer available commercially for the manufacture of this instrument.

The information presented in Buenos Aries demonstrated equivalence between the AL100 and its replacement, the *AL2ooo*, when perspex trapeziums were used. These perspex trapeziums are used in the commercial calibration and QC actions for the AL100.

IWTO at its Nice (2000) meeting sought confirmation of any such equivalence using wool and this paper describes details of a second round trials undertaken in that respect.

Preliminary data presented results of initial wool trials at Buenos Aries showed a small degree of variation for single test comparisons and there was considerable discussion on the degree of similarity required for 40 statistics (2 lengths; Hauteur and Barbe and 19 distribution statistics for each length type) provided by the Almeter for acceptance of equivalence. One approach was to seek “target” range data from the only formal comparison testing being undertaken; the Interwoollab Round Trial series. This paper reports on such investigations and uses that as a basis for defining the “target” ranges for equivalence testing of the 2 Almeter instruments the AL100 and the *AL2ooo*; a schematic diagram of which is provided below:-

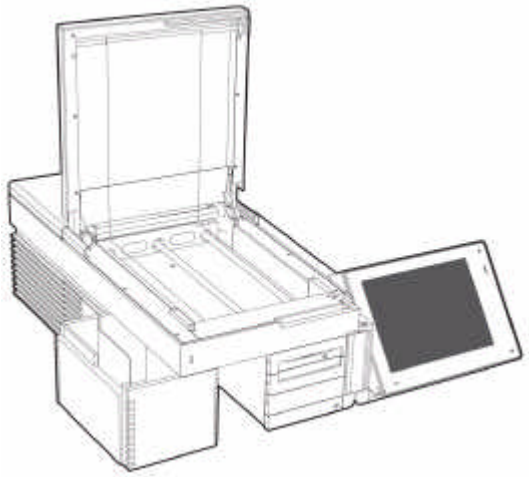


**Fig. 1. Schematic Diagram of the *AL2ooo*.**

Apart from the case design and external configuration features, this machine differs little from the existing AL100 in so far as the *AL2ooo* scanning head moves across the sample whereas the existing AL100 has a fixed scanning head and the sample moves between the sensing plates. The new design therefore reduces the operational space in a laboratory required for undertaking this test.

**Target Ranges - Interwoollab Round Trial Statistics.**

In a bid to obtain “target ranges” data for the Almeter 100 output values, summary data from the last 6 Interwoollab round trials were interrogated. The results of this interrogation are reported below. It is perhaps important however to re-cap here on the Interwoollab round trial procedures to assist in understanding the data presented and the separation of the variation that is observed.

**Interwoollab's Round Trial Procedures**

Each round trial series has 4 different tops. Each lab receives 2 samples of each top, an A and a B sample, each drawn at random, from different parts of the original top.

Sample A treatment:-

- Each sample is squared in the Fibroliner.
- Draw 1 is taken and tested
- 20 draws are then taken and discarded
- Draw 2 is then taken and tested

Sample B treatment:-

- Each sample is squared in the Fibroliner.
- Draw 1 is taken and tested
- 20 draws are then taken and discarded
- Draw 2 is then taken and tested

This means that the results for e.g. Top 1/Sample A/Draw 2 is 20 Fibroliner draws away from Draw 1

and Sample B could be from anywhere in the length of the Top.

The results from each of these 4 tests are then averaged and reported.

These tops have been selected as being even in the 1st place then re-gilled twice to make them even more even, The CV of the Ha readings averages around 1.2 – 1.3%, as compared to commercial tops where a commercial top is regarded as being good if it has a CV of the Hauteur readings <3% over the entire length of the top. This value is normally derived from tests every 2 tonnes or every 2 hours of production and is calculated as the sd/mean of the Ha readings taken over the entire production batch.

The Interwoollab model is described above; 4 tops, 2 samples (A & B) and 2 draws (tests) per sample. Reported results represent the mean value of 4 tests on each top for approx. 80 labs worldwide.

Interwoollabs sets 2 critical tolerance values:-

- Outside an Interwoollabs tolerance for Ha and Barbe
- Outliers are identified according to Grubbs statistical test for outliers (ISO 5725-2), for all values reported.

**Table 1. Interwoollab Round Trial Top Length Tolerances**

| Mean Value | Automatic Grips | |
|---|---|---|
| | **Hauteur** | **Barbe** |
| <40mm | 1.0 | 1.3 |
| 40.1 – 50.0mm | 1.1 | 1.4 |
| 50.1 – 65.0mm | 1.4 | 1.8 |
| 65.1 – 80.0mm | 1.8 | 2.3 |
| >80.0mm | 2.3 | 2.9 |

A lab is considered to have passed if it has <2 results outside the tolerance limits. Grubbs Outlier statistic is:-

$$( Y_1 - \bar{Y} )/s$$

where $Y_1$ is the suspected outlier and s is the sample standard deviation.

In effect Grubbs statistic accounts for the sample size associated with the amount of variation exhibited by the sample data set.

The data presented below has retained the outliers to be able to demonstrate the range of results that are experienced and the effect they have on overall results.

**"Target Results" obtained from Interwoollab Round Trial Data**

Investigation of the Interwoollab summary statistics shows the distribution of results for the past 6 round-trials. These have been normalised to show deviations from the mean value of the 80+laboratories (and therefore machines) to allow data from all tops in the trials to be combined to increase the data set. Normalisation undertaken was as follows:-

$( Y_1 - \bar{Y} )$ for each top.

To assist in interpretation of the data presented below terms used have been defined as follows:-

**Terminology used:-**

*Reading* = the output from a single scan (forward and back in the Almeter with one Fibroliner sample).

*Result* = the mean value of 4 *readings*. This is the value reported in the Interwoollab Summary reports.

*Mean Top Result* = the value derived by averaging the results of all labs (n= approx 80)

*Mean Lab Result* = the value derived by averaging the results obtained in one laboratory for the 4 tops measured.

Where a lab is mentioned it is synonymous with a single instrument or machine.

**Between Lab (Machine) AL100 Variation**

The normalized data presented below represents the combined deviations from the mean value of each of the 4 tops used in the Interwoollab round trials for the past 6 series involving around 80+labs (machines) in each round trial.

These data (Table 2) provide an indication of the "target" values sought at the Buenos Aries meeting to assist researchers determine equivalence that has commercial relevance. The data indicate that there can be a considerable range in results with a small number of results in each top and/or round trial contributing significantly to the high range of results. Despite this the spread of the values, as indicated by the relatively low sd values (in *italics*), is quite tight.

To illustrate this point the frequency table and distribution plot for Series 227-230, for Hauteur, is provided in Table 3 and Figure 2, below.

**Table 2. Observed Deviations in Interwoollab AL100 Round Trials**

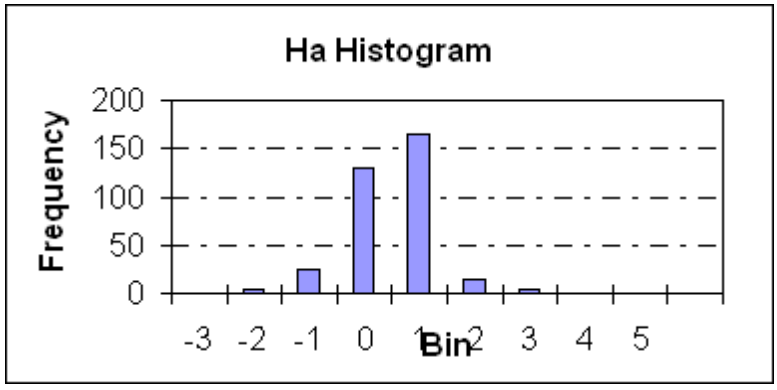
| | | | Mean deviation | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Series** | **n** | | **Ha** | **CVHa** | **Barbe** | **K20** | **K30** | **K40** |
| 227-230 | 344 | Range | 1.5 | 12 | 11.1 | 5.6 | 13.4 | 21.9 |
| | | sd | *0.8* | *0.9* | *0.9* | *0.6* | *1.3* | *1. 2* |
| 231-234 | 335* | Range | 8.3 | 9.2 | 7.2 | 2.9 | 4.8 | 26.4 |
| | | sd | *0.9* | *0.9* | *0.7* | *0.4* | *0.7* | *1.7* |
| 235-238 | 344 | Range | 9.8 | 8.2 | 12.1 | 8.4 | 15.0 | 11.1 |
| | | sd | *0.8* | *0.8* | *1.2* | *0.7* | *1.3* | *1.1* |
| 239-242 | 327* | Range | 6.30 | 5.00 | 4.53 | 5.94 | 7.22 | 11.85 |
| | | sd | *0.7* | *0.7* | *0.8* | *0.5* | *0.8* | *1.7* |
| 243-246 | 336 | Range | 6.99 | 6.00 | 5.21 | 3.12 | 5.83 | 7.88 |
| | | sd | *0.8* | *0.8* | *0.7* | *0.4* | *0.7* | *0.9* |
| 247-250 | 332 | Range | 5.7 | 8.6 | 10.2 | 5.9 | 11.6 | 18.2 |
| | | sd | *0.8* | *0.9* | *0.8* | *0.5* | *1.0* | *1.6* |

** outlier removed*

**Table 3. Frequency Distribution of Hauteur Residuals – Interwoollab Series 227-230**

| ***Bin*** | ***Frequency*** | ***Cumulative %*** |
|---|---|---|
| -2 | 4 | 1.2% |
| -1 | 24 | 8.1% |
| **0** | **130** | 45.9% |
| **1** | **165** | 93.9% |
| 2 | 15 | 98.3% |
| 3 | 4 | 99.4% |
| 4 | 1 | 99.7% |
| 5 | 1 | 100% |

**Fig. 2. Frequency Histogram for Ha Residuals – Interwoollabs Series 227-230**



It is clear from these results that whilst there is a considerable range in results from the AL100 between labs, the majority of results fall within quite close limits, within Top samples. In the majority of cases, 80-90% of the mean top results fall within ±1 unit of the mean recorded by the 80+ laboratories in each trial.

**Within Lab (Between Sample & Measurement) AL100 Variation**

The within lab (or machine) differences are again small but there is a range of results. Individual results (average of 4 readings) from the 4 tops tested were 1st normalised by subtracting the result from the mean top result for each top, to remove individual top length differences between tops, and thus allow combination of data and to compare between top and between laboratory (machine) differences. Table 4 below shows the maximum and minimum difference values for the lab results for mean of each of the 4 tops tested in each laboratory (each machine) for the reported values in the Interwoollab Summary report i.e. each of these reported values for each top is itself an average of 4 results.

The values in Table 4 are provided as an example of the ranges observed between laboratories for the 4 tops tested in Series 227-230. For Hauteur, for example, the 80+ labs had a range in the mean lab result values of 4.4mm Ha. i.e. one lab had a difference from the mean lab result 2.7mm another has a mean lab result difference of -1.7mm Ha.

Put simply, the question can be asked… if 4 tops are tested in the one lab, what amount of variation and what range of results is likely to be seen between the top sample results if they were all normalized back to the same length ? These data are presented in Table 4.

**Table 4. Distribution and Range Data for AL100 Residuals.**

| | Ha | Barbe | CVHa | K20 | K30 | K40 |
|---|---|---|---|---|---|---|
| **sd** | 0.64 | 0.66 | 0.73 | 0.49 | 0.81 | 1.07 |
| **max** | 2.68 | 2.20 | 4.11 | 1.00 | 1.93 | 4.74 |
| **min** | -1.69 | -2.18 | -1.91 | -2.27 | -3.72 | -4.41 |
| **range** | 4.38 | 4.38 | 6.03 | 3.28 | 5.65 | 9.15 |
| **Series** | 227-230 | | | | | |

The data from the above summary is reasonably representative of the observations in the 5 other round trial outcomes. For simplicity, the results of only one such analysis has been included here.

IWTO 17 provides 95% MPD values for within and between lab variation for Hauteur and Barbe using the automatic grip preparer as follows:-

**Table 5. IWTO 17 95% MPD Values**

| | Within Lab Variation | Between Lab Variation |
|---|---|---|
| Hauteur | 1.80% | 1.30% |
| Barbe | 1.36% | 1.36% |

As discussed previously, each value in these summary tables represents the average of scanning head results from samples from 2 different parts of the top and 4 Fibroliner draws ( 2 from each top sample). These are drawn with a sampling regime that discards 20 draws between the 2 selected draws. As a consequence, there is a considerable amount of averaging that occurs.

In a bid to understand the within top, sample and test variation, results from three laboratories were obtained for a number of round trial series. This provided the opportunity of looking deeper into the underlying variation that occurs and is being masked by the averaging effects described above.

AL100 files were drawn from these labs and the data recovered using the more compressed “display” format rather than the full print routine available with the AL100 software. This resulted in the analysis of slightly different distribution statistics from that provided in the Interwoollab report. It did however provide additional L1 and L5 values used commercially by spinners. These values are not provided in the Interwoollab summary reports.

**Table 6. Absolute Differences Normalised for Top Means (AL100)**

| | | Ha | K15 | L5 | Barbe | CVH | K25 | L1 | CVB |
|---|---|---|---|---|---|---|---|---|---|
| **Lab A** | sd | 0.4 | 1.0 | 0.7 | 0.4 | 0.6 | 0.5 | 1.1 | 0.8 |
| | range | 1.8 | 8.8 | 3.7 | 1.8 | 2.9 | 2.5 | 5.0 | 6.1 |
| **Lab B** | sd | 0.4 | 1.6 | 0.5 | 0.3 | 0.4 | 0.4 | 1.1 | 0.3 |
| | range | 1.7 | 8.8 | 2.4 | 1.3 | 1.5 | 1.3 | 5.0 | 1.6 |
| **Lab C** | sd | 0.4 | 0.3 | 0.4 | 4.1 | 0.6 | 0.7 | 0.8 | 0.3 |
| | range | 1.8 | 1.4 | 1.6 | 20.4 | 2.2 | 2.6 | 3.4 | 1.0 |

The values for these labs are somewhat lower than those experienced overall for the total Interwoollab results. They contain, between samples (A & B), sample draw (readings 1 & 2) and machine signal variation. Between top variation has been removed by normalizing the data to the individual top mean.

**Table 7. Differences Between Readings Within a Sample**

| | | Ha | K15 | L5 | Barbe | CVH | K25 | L1 | CVB |
|---|---|---|---|---|---|---|---|---|---|
| **Lab A** | sd | 0.6 | 1.4 | 1.1 | 0.6 | 0.9 | 0.8 | 1.8 | 1.2 |
| | range | 2.4 | 9.1 | 5.4 | 2.6 | 4.0 | 3.4 | 8.1 | 5.8 |
| **Lab B** | sd | 0.5 | 2.1 | 1.0 | 0.5 | 0.7 | 0.6 | 1.9 | 0.5 |
| | range | 1.5 | 8.8 | 3.7 | 1.7 | 2.3 | 1.7 | 7.8 | 1.8 |
| **Lab C** | sd | 0.3 | 0.1 | 0.3 | 2.2 | 0.4 | 0.3 | 0.9 | 0.3 |
| | range | 0.7 | 0.3 | 0.7 | 7.0 | 0.9 | 0.7 | 2.6 | 0.7 |

These values indicate the degree or range of differences experienced between readings of the same top sample with sequential Fibroliner draws i.e. the differences observed between test1 and test 2 for sample A or B. The data are normalized back to the mean value of the 4 tests undertaken on each top tested in the series to remove top length differences and therefore represent absolute not average differences. They contain both sample draw and machine signal variation.

**Table 8. Average Between Readings Within a Sample**

| | | Ha | K15 | L5 | Barbe | CVH | K25 | L1 | CVB |
|---|---|---|---|---|---|---|---|---|---|
| **Lab A** | sd | 0.2 | 0.4 | 0.6 | 0.4 | 0.2 | 0.2 | 0.4 | 0.5 |
| | range | 1.2 | 2.9 | 4.5 | 2.3 | 1.1 | 0.8 | 2.5 | 2.7 |
| **Lab B** | sd | 0.2 | 0.8 | 0.7 | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 |
| | range | 0.9 | 2.8 | 2.6 | 0.5 | 0.6 | 0.7 | 1.9 | 1.9 |
| **Lab C** | sd | 0.3 | 0.1 | 0.3 | 2.2 | 0.4 | 0.3 | 0.9 | 0.3 |
| | range | 0.7 | 0.3 | 0.7 | 7.0 | 0.9 | 0.7 | 2.6 | 0.7 |

These values represent the average differences between top samples i.e. A or B for the 2 readings taken on each sample. They contain both sample draw and machine signal variation.

Again the data has been normalized, as above, to allow across top amalgamation to increase the data set. Data was normalized on the basis of ($Y_1$ – Av Y) for each top within each lab and therefore removes the between top differences but retain the between lab (machine) differences.

The amalgamation process provided results from 20 whole tests i.e. 80 readings; there being 4 readings (scans) per test result reported in the Interwoollab summary statistics report.

The aim of this investigation was to investigate the machine effects rather than the sample and sampling variation as this is the prime issue in proving equivalence for minor changes to some of the electronic componentry of the Almeter instrumentation itself rather than a complete new technology looking at a complete measuring system, including measuring and sample preparation systems. Thus removal of as much non-machine related variation as possible, is a legitimate aim in this context.

**Variation in Commercial Context.**

These values should be kept in context with commercial topmaking results.

The data presented below in Table 9, represents results from 6 commercial tops. Almeter AL100 readings were taken every 2 tonnes of production and these data illustrate the variation in top parameters during the production of a combing batch.

Whilst the CV of the Hauteur readings of these commercial tops are within the 3% limit, for well managed mills, it is obvious that many of the other reported attributes of the top length distribution show considerable levels of variation.

Similarly, these values represent the total variation in the sampling, sample preparation and measurement plus within batch variation and thus represent perhaps the maximum values for well produced tops as opposed to the comparisons of the AL100 and *AL2ooo* presented both above for the Interwoollab round trails and below for the machine and signal differences. They do, however, put into context the variation being observed in instrument effects.

**Table 9. Variation in Top Parameters in Commercial Batches**.

| Top ID | | Ha | K15 | L5 | B | CVHa | K25 | L1 | CVB |
|---|---|---|---|---|---|---|---|---|---|
| A (n=15) | **Range** | 3.8 | 0.8 | 6.9 | 7.7 | 5.7 | 1.8 | 22.3 | 9.7 |
| | **CV%** | *1.7%* | *38.4%* | *1.4%* | *1.9%* | *3.0%* | *8.5%* | *3.4%* | *6.0%* |
| B (n=24) | **Range** | 8.3 | 2.8 | 11.1 | 9.3 | 5.7 | 3.5 | 15.2 | 3.5 |
| | **CV%** | *3.0%* | *74.0%* | *2.2%* | *2.6%* | *2.5%* | *12.0%* | *2.3%* | *2.2%* |
| C (n = 9) | **Range** | 3.6 | 0.6 | 8.9 | 4.9 | 2.1 | 1.6 | 18.6 | 2.9 |
| | **CV%** | *1.7%* | *61.1%* | *2.2%* | *1.8%* | *1.5%* | *8.7%* | *4.2%* | *2.4%* |
| D (n=49) | **Range** | 12.4 | 1.9 | 9.3 | 8.8 | 12.5 | 5.6 | 22.6 | 9.6 |
| | **CV%** | *3.2%* | *107.3%* | *1.7%* | *2.1%* | *6.6%* | *32.7%* | *2.7%* | *5.9%* |
| E (n=41) | **Range** | 9.0 | 1.5 | 8.3 | 6.7 | 9.4 | 4.4 | 29.7 | 9.7 |
| | **CV%** | *2.5%* | *93.5%* | *1.3%* | *1.7%* | *6.1%* | *40.8%* | *3.0%* | *6.5%* |
| F (n=47) | **Range** | 8.8 | 1.0 | 12.4 | 9.2 | 8.5 | 3.2 | 55.7 | 12.0 |
| | | *2.7%* | *167.3%* | *2.1%* | *2.4%* | *4.9%* | *42.7%* | *5.0%* | *5.9%* |

The CV% for the Interwoollab tops represents the variation associated with approx 160 top samples (2 samples x 80+ labs) with the Ha values representing the average of 4 (forward and reverse) scans of the Almeter measuring head. i.e. 320 Fibroliner draws.

Commercial top results usually are an average of a single reading from 2 draws at each test (every 2 tonnes or 2 hrs). A normal result is arrived at from around 50 samples (every 2 tonnes in a 100 tonne blend) i.e. 100 Fibroliner draws.

The Interwoollab results therefore have a higher degree of both averaging and sampling and this will affect the amount of variation reported, with the Interwoollab results being dampened down due to the greater averaging effects. The use of these values however is therefore relevant in so far as the selection of sample A & B for equivalence testing.

**IWTO Certification**

Certification of Mean Fibre Length in tops under the provisions of IWTO17 provides only for the reporting of the mean **Hauteur** result and the range of individual tests.

The IWTO Blue Book clause requires only that where the specified minimum mean fibre length specified in the contract is met then the top is acceptable. It does not provide any guide on the degree of variation in Hauteur within the delivery.

Commercial experience indicates, that in well managed mills, the CV of the Ha measurements within a top batch should be <3%. The Blue Book does however give some indication of acceptable within batch variability in section (2)49 when it provides CV values for Barbe, measured in the Almeter 100 as follows:-

- Tops of 61mm Barbe or more: 5%
- Tops of 55 and 61mm Barbe : 6%
- Tops less than those above: no limits.

IWTO Regulations 4.0 for Determination of Mean Fibre Length and Mean Fibre Diameter (… for tops) however does provide some indication of acceptable variation levels. The Regulations states in sect 4.1.3 Range Checks …the range of results should not exceed 7mm. In a text note it states… *The value of 3mm is calculated as the within lot maximum probable difference using the upper 95% value for within consignment standard deviation for testing 5 samples.*

This fails to recognize mean Ha values but for a mid range Hauteur top of 70mm this means a CV% of 10% considerably more than would be expected for production from a well managed combing plant.

IWTO 17 provides the Most Probable Difference (MPD) for Ha between labs (machines) for samples from the same top ball. Whilst the ball origin of the top sample material obtained for the samples used in these trials is unknown it is assumed that they are from the same ball. In such circumstances the Ha MPD is expected to be of the order of 4.09% and for Barbe the MPD is 3.5%. The MPD is calculated at a 95% confidence level of probability and will on average be exceeded only 5 times out of 100. IWTO 17 does not provide similar values for the distribution statistics. Under these circumstances the expected range for the tops tested in this study for within and between lab results are as follows:-

**Table 10. Assigned Values and IWTO 17 - 95% MPD Range for Trial Tops**

| | Assigned Value | | MPD Range | |
|---|---|---|---|---|
| **Top ID** | **Ha** | **B** | **Ha** | **B** |
| AD | 44 | 52.5 | 1.7 | 2.1 |
| ZZ | 64 | 81.4 | 2.5 | 3.2 |
| AP | 72 | 88.0 | 2.9 | 3.5 |
| AB | 74 | 88.3 | 2.9 | 3.5 |
| AZ | 82 | 93.5 | 3.2 | 3.7 |

** note: assigned values are those supplied by Interwoollabs.*

With these above values in mind, it can be seen that the results achieved by the *AL2ooo* (provided in the results section) are therefore well within those required to provide meaningful commercial results.

**QC Sensitivity Trapezium**

The *AL2ooo* has incorporated a QC procedure which checks the sensitivity of the signal strength and signal capture by the incorporation of a “Sensitivity Trapezium” with each test specimen being measured. This also provides a diagnostic reference point for quality management. The incorporation of this requires an additional procedure in the preparation of the sample to position the Sensitivity Trapezium with the test specimen and this is outlined in the recommendations to changes to IWTO17 in the Submission paper associated with this report.

A view of the fibre draw with the QC sensitivity trapezium in place is provided in Figure 3 below. It should be noted that the base of the fibres in this picture is not squared correctly. This is a function of having to remove the sample by hand onto an optical scanning bed in order to obtain an image, rather than a fault in sample preparation. It does however provide a visual image of the placement of the sensitivity slide alignment with the Fibroliner Draw sample.

The *AL2ooo* software reads the signal from the sensitivity trapezium as it scans the specimen. After interrogating the results and confirming that it is within the nominated acceptable range, it removes it along with the base-line signal, associated with the mylar film that sandwiches the test specimen. The user will not observe any effect from this unless there is a gross error and the instrument will reject the sample and seek a new sample. However, more importantly, diagnostic routines within the new software will allow service technicians to undertake a full set of off-site analysis from existing *AL2ooo* files that will provide cost-effective upgraded service to distant clients.

**Fig. 3. Sample with QC Sensitivity Trapezium in-situ.**

**Trial Design**

Earlier reports on equivalence testing of the Almeter *AL2ooo*, discussed the use of trapeziums to remove the effects of sample preparation and to remove the variation due to both sample and sample preparation.

It was and still is argued that equivalence testing of the *AL2ooo* against the AL100 should be restricted as far as possible to the measuring instrument machine effects i.e. the results generated by the measuring head and the conversion of the capacitance signals into Hauteur, Barbe and their associated distribution statistics.

Whilst this is possible for the perspex trapeziums and the two machines have shown to be equivalent for that medium, there was still a requirement to undertake equivalence testing on wool samples.

In a bid to reduce the sample and sample preparation effects, this study, concentrated as much as possible on measuring the variation resulting from the Almeter instrumentation per se rather that the sample/sampling effects. To achieve this each sample draw was measured 12 times in each instrument. Fibroliner samples for each instrument tested in each lab were sequential with no fibre being discarded between draws. Draw A was measured on the AL100 and draw B on the *AL2ooo*. For all intents and purposes the draws are therefore essentially from the same part of the top, thus variation of the top sample between machines within a lab should be kept to a minimum. The reported result from each instrument is the average of 4 tests thus providing 3 replicate results for each draw. This allows for precision of the measuring head to be determined.

To replicate other round trial design, as much as possible, the model chosen was close to that of the Interwoollab Top Length Round trials. These trials however report only 6 values:-

Ha CVHa %< 20mm %< 30mm %< 40mm and Barbe

These current trials have chosen to concentrate on the “short display” output values from the existing AL100 instrument.

Ha, CVHa L1% L5% K15mm K25 Barbe and CVB

This was done to report on the L1 & L5 values that used by spinners and provide the critical ranges that are reported in the full Almeter output. Whilst the report is restricted to these values the remainder of the statistics generated by the Almeter software, are available.

Three *AL2ooo* instruments were tested in total and four AL100 machines in four laboratories in a design as follows:-

*AL2ooo*’s

| Instrument | Laboratory | | |
|---|---|---|---|
| 1 | UK1 | UK2 | |
| 2 | UK1 | UK2 | |
| 3 | UK1 | OZ1 | OZ2 |

AL100’s

| Instrument | Laboratory | |
|---|---|---|
| 1 | UK1a | UK1b* |
| 2 | UK2 | |
| 3 | OZ1 | |
| 4 | OZ2 | |

- **note the AL100 from UK1 was tested on 2 separate occasions and therefore 5 separate sets of AL100 results are available:-*
  1. *for comparison with AL2ooo Instruments 1 & 2*
  2. *for comparison with AL2ooo Instrument 3.*

     *This instrument is therefore a common link between all instruments tested throughout the round trial series.*

Instrument 3 was shipped to Australia for trials in 2 separate laboratories as well as being tested in one of the UK labs.

Top Samples were obtained from residual Interwoollab trial material. The values assigned by Interwoollabs and descriptions are provided below in Table 11.

**Table 11. Assigned Values for Trial Tops**

| Sample ID | | Ha | CVHa | Barbe | K20 | K30 | K40 |
|---|---|---|---|---|---|---|---|
| **AD*** | mean (sd) | 44.2 (0.6) | 43.5 (1.3) | 52.5 (0.7) | 10.1 (1.3) | 27.7 (1.2) | 45.4 (1.3) |
| **ZZ** | mean (sd) | 64.7 (0.8) | 50.8 (1.2) | 81.4 (1.1) | 3.8 (0.8) | 13.2 (1.0) | 25.5 (1.1) |
| **AP** | mean (sd) | 72.0 (0.7) | 47.2 (1.3) | 88.0 (0.6) | 4.7 (0.7) | 13.4 (1.0) | 22.4 (1.0) |
| **AB** | mean (sd) | 73.8 (1.2) | 44.3 (1.4) | 88.3 (1.2) | 2.1 (0.9) | 8.7 (1.3) | 17.7 (1.7) |
| **AZ** | mean (sd) | 81.7 (0.8) | 38.0 (0.8) | 93.5 (0.6) | 0.9 (0.3) | 6.0 (0.7) | 12.2 (0.9) |

*Note: * To extend the range of Ha values lower in the range this short top was tested later in the UK Laboratories but not in the Australian Labs.*

**Results**

Summary Statistics of results from the 2 instrument types along with the Interwoollab assigned values for the tops used are provided in Table 12 below:-

It can be seen from the results in Table 12 that there is close agreement between the two instrument models. Values in general oscillate around the values assigned from previous Interwoollab round trial results for the tops used in this series of round trials.

The differences between instrument models are very small and are believed to be of little commercial relevance particularly when viewed in the context against of the range of differences observed in normal combing production when measured by the AL100. This comparison can be observed between the difference values provided in Table 12 against those provided in Table 9. A direct comparison is provided in Table 13 below.

**Table 12. Comparison of Grand Means and Distribution Statistics**

| Instrument Type | Top ID | Ha | CvH | K15 | K25 | L5 | L1 | B | CvB |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| AL100 | AD | mean | 43.6 | 44.6 | 4.6 | 20.0 | 77.6 | 91.8 | 52.3 | 37.2 |
| | | sd | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 |
| AL2ooo | AD | mean | 43.9 | 44.9 | 6.6 | 19.3 | 76.2 | 92.5 | 52.7 | 36.0 |
| | | sd | 0.8 | 1.5 | 0.6 | 1.6 | 4.7 | 2.0 | 0.7 | 1.5 |
| | | Diff. | -0.3 | -0.2 | -2.0 | 0.7 | 1.4 | -0.6 | -0.5 | 1.2 |
| Assigned Interwoollab Values | | mean | 44.2 | 43.5 | | | | | 52.5 | |
| | | sd | 0.6 | 1.3 | | | | | 0.7 | |
| AL100 | ZZ | mean | 65.6 | 49.9 | 0.9 | 7.4 | 127.5 | 148.2 | 78.7 | 41.7 |
| | | sd | 0.7 | 0.1 | 0.7 | 0.3 | 1.9 | 0.6 | 7.3 | 0.1 |
| AL2ooo | ZZ | mean | 66.1 | 50.4 | 2.7 | 8.3 | 128.1 | 149.9 | 82.3 | 41.3 |
| | | sd | 1.1 | 0.9 | 0.6 | 0.6 | 1.7 | 3.6 | 2.9 | 0.5 |
| | | Diff. | -0.5 | -0.5 | -1.8 | -0.9 | -0.6 | -1.7 | -3.6 | 0.3 |
| Assigned Interwoollab Values | | mean | 64.7 | 50.8 | | | | | 81.4 | |
| | | sd | 0.8 | 1.2 | | | | | 1.1 | |
| AL100 | AP | mean | 73.0 | 45.9 | 1.0 | 7.7 | 128.6 | 146.3 | 88.4 | 35.2 |
| | | sd | 0.9 | 0.7 | 0.3 | 0.5 | 0.9 | 0.3 | 0.7 | 0.4 |
| AL2ooo | | mean | 71.1 | 47.0 | 2.4 | 9.3 | 126.2 | 143.6 | 86.8 | 35.5 |
| | | sd | 0.8 | 1.3 | 0.9 | 1.3 | 0.9 | 3.1 | 0.5 | 0.6 |
| | | Diff. | 1.9 | -1.1 | -1.4 | -1.6 | 2.5 | 2.7 | 1.6 | -0.3 |
| Assigned Interwoollab Values | | mean | 72.0 | 47.2 | | | | | 88.0 | |
| | | sd | 0.7 | 1.3 | | | | | 0.6 | |
| AL100 | AB | mean | 74.2 | 44.3 | 0.3 | 4.7 | 129.9 | 151.4 | 88.8 | 35.9 |
| | | sd | 0.7 | 0.2 | 0.1 | 0.1 | 2.2 | 1.8 | 1.0 | 0.1 |
| AL2ooo | AB | mean | 74.1 | 44.2 | 1.2 | 5.5 | 128.4 | 149.7 | 87.3 | 35.4 |
| | | sd | 1.1 | 0.7 | 0.4 | 0.6 | 2.0 | 3.4 | 4.1 | 0.5 |
| | | Diff. | 0.1 | 0.1 | -0.9 | -0.8 | 1.4 | 1.7 | 1.4 | 0.5 |
| Assigned Interwoollab Values | | mean | 73.8 | 44.3 | | | | | 88.3 | |
| | | sd | 1.2 | 1.4 | | | | | 1.2 | |
| AL100 | AZ | mean | 81.2 | 38.8 | 0.6 | 3.7 | 130.4 | 149.0 | 93.3 | 31.0 |
| | | sd | 0.2 | 1.2 | 0.5 | 0.7 | 1.4 | 1.5 | 1.0 | 0.9 |
| AL2ooo | AZ | mean | 81.1 | 37.8 | 0.6 | 3.7 | 128.8 | 144.2 | 92.6 | 30.0 |
| | | sd | 0.8 | 1.2 | 0.6 | 0.7 | 3.0 | 6.9 | 1.3 | 1.2 |
| | | Diff. | 0.2 | 1.0 | 0.0 | 0.0 | 1.6 | 4.7 | 0.7 | 1.1 |
| Assigned Interwoollab Values | | mean | 81.7 | 38.0 | | | | | 93.5 | |
| | | sd | 0.8 | 0.8 | | | | | 0.6 | |

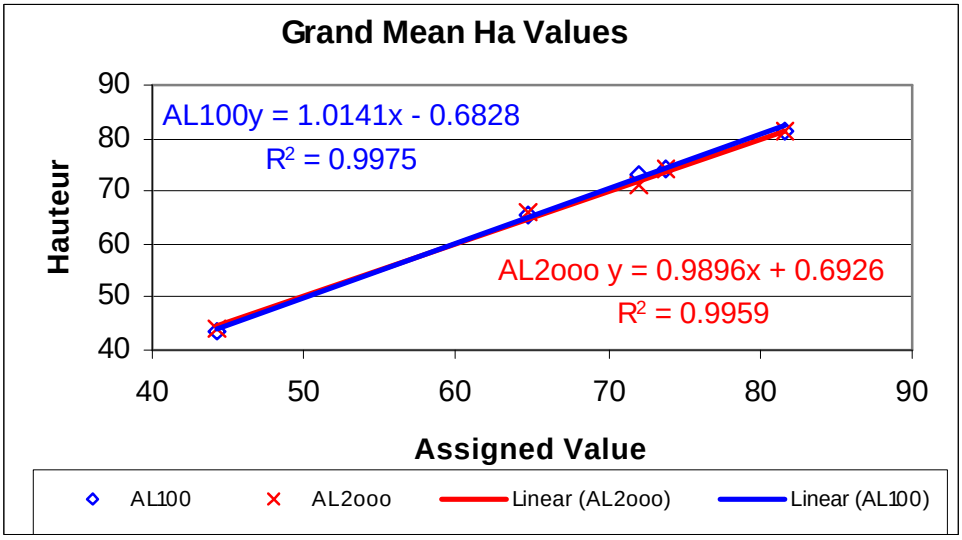
**Table 13. Comparison of Commercial Topmaking Parameter Range and Almeter Instrument Model Differences.**

**Range of Top Parameters in Commercial Topmaking Blends (ex Table 9)**

| Top ID | | Ha | K15 | L5 | B | CVHa | K25 | L1 | CVB |
|---|---|---|---|---|---|---|---|---|---|
| A (n=15) | Range | 3.8 | 0.8 | 6.9 | 7.7 | 5.7 | 1.8 | 22.3 | 9.7 |
| B (n=24) | Range | 8.3 | 2.8 | 11.1 | 9.3 | 5.7 | 3.5 | 15.2 | 3.5 |
| C (n= 9) | Range | 3.6 | 0.6 | 8.9 | 4.9 | 2.1 | 1.6 | 18.6 | 2.9 |
| D (n=49) | Range | 12.4 | 1.9 | 9.3 | 8.8 | 12.5 | 5.6 | 22.6 | 9.6 |
| E (n=41) | Range | 9 | 1.5 | 8.3 | 6.7 | 9.4 | 4.4 | 29.7 | 9.7 |
| F (n=47) | Range | 8.8 | 1.0 | 12.4 | 9.2 | 8.5 | 3.2 | 55.7 | 12.0 |
| **Differences Between Almeter Instrument Models AL100 v's *AL2ooo*** | | | | | | | | | |
| **AD** | Diff. | -0.3 | -0.2 | -2.0 | 0.7 | 1.4 | -0.6 | -0.5 | 1.2 |
| **ZZ** | Diff. | -0.5 | -0.5 | -1.8 | -0.9 | -0.6 | -1.7 | -3.6 | 0.3 |
| **AP** | Diff. | 1.9 | -1.1 | -1.4 | -1.6 | 2.5 | 2.7 | 1.6 | -0.3 |
| **AB** | Diff. | 0.1 | 0.1 | -0.9 | -0.8 | 1.4 | 1.7 | 1.4 | 0.5 |
| **AZ** | Diff. | 0.2 | 1.0 | 0.0 | 0.0 | 1.6 | 4.7 | 1.1 | 1.1 |

Figure 4 provides the Grand Mean plot for Hauteur for the 2 instruments against the Interwoollab assigned values for the tops used. These assigned values were the result of previous Interwoollab round trials entailing some 80 odd instruments.

**Fig.4. Grand Mean Hauteur Against Assigned Values**




When the individual values are plotted in the same manner it becomes apparent that there is slightly more variation in results for the *AL2ooo* instruments. These are presented below in Figures 5 & 6 for the AL100 and *AL2ooo* respectively.

**Fig. 5. AL100 Hauteur Against Assigned Values**

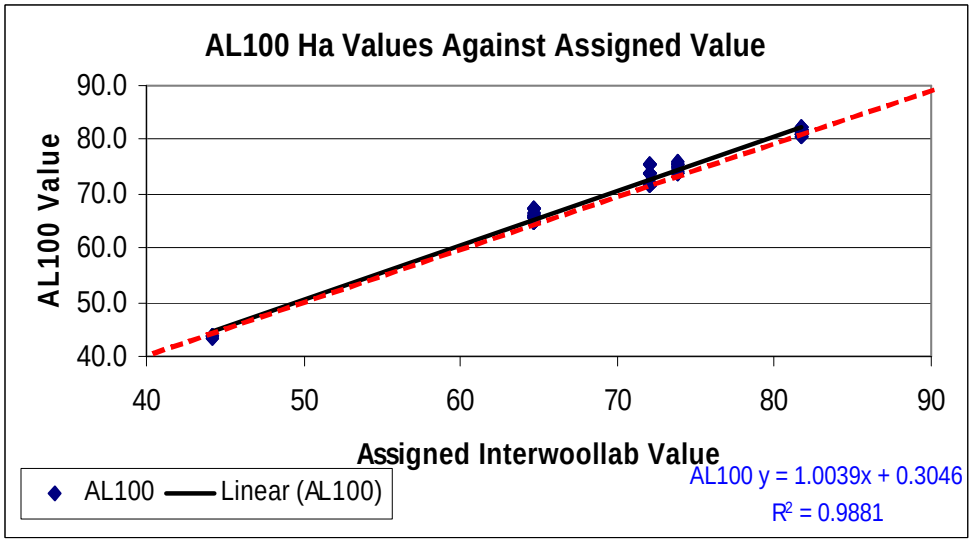
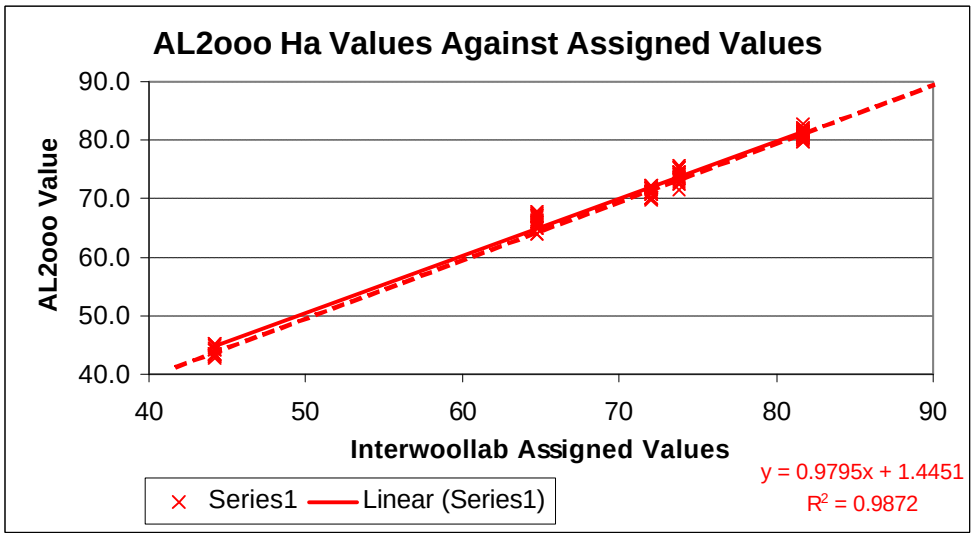
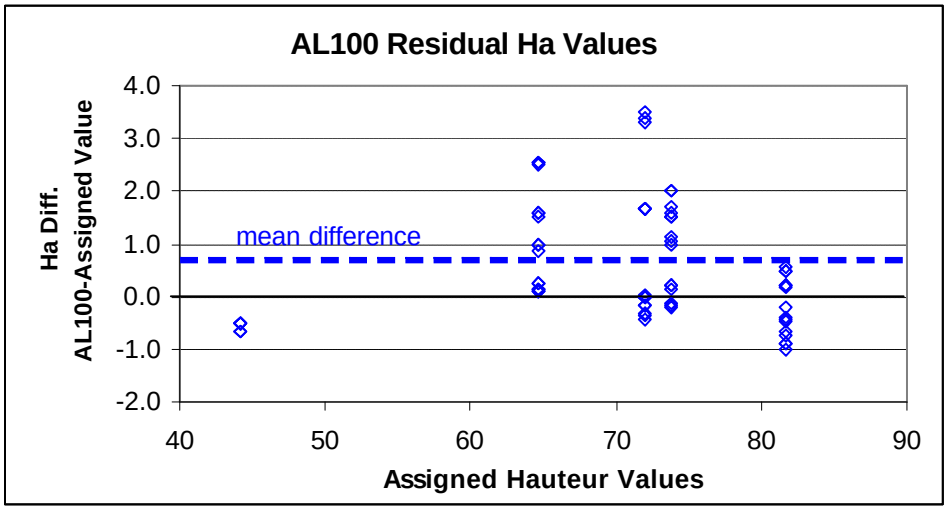



**Fig. 6. *AL2ooo* Hauteur Against Assigned Values**



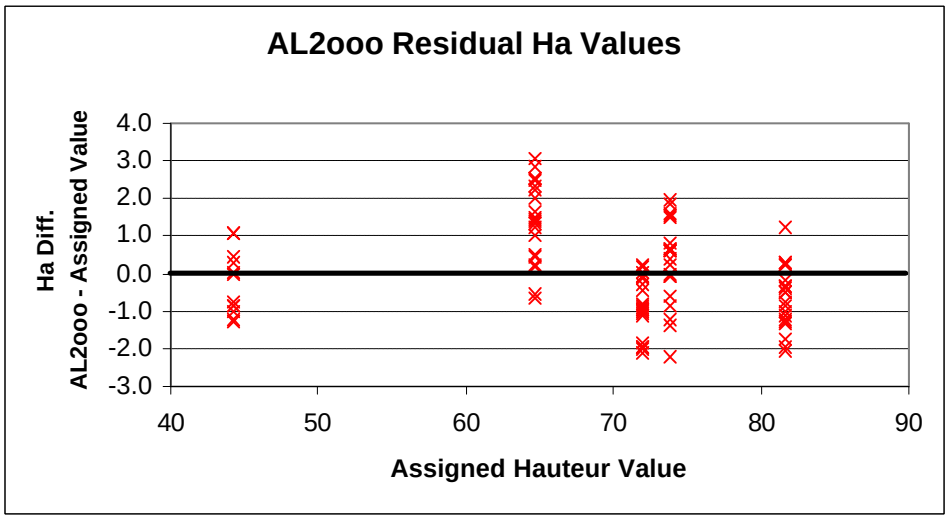

The residual values for each instrument are provided in Figures 7 and 8 for the AL100 and *AL2ooo* respectively.

**Fig. 7. Hauteur Residuals for the AL100.**




It can be observed that the AL100 values were slightly above the zero (0), assigned value, line for 3 of the 5 tops in the mid Ha range but these are not extreme.

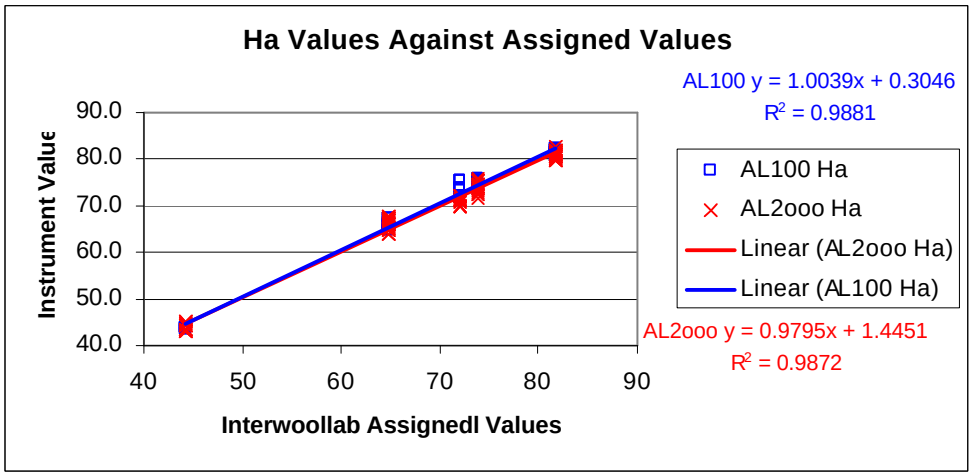
**Fig. 8. Ha Residuals for the *AL2ooo***




Whilst there is slightly more spread in the residual values from 4 of the 5 tops they are more evenly spread around the zero (0), assigned value, line.

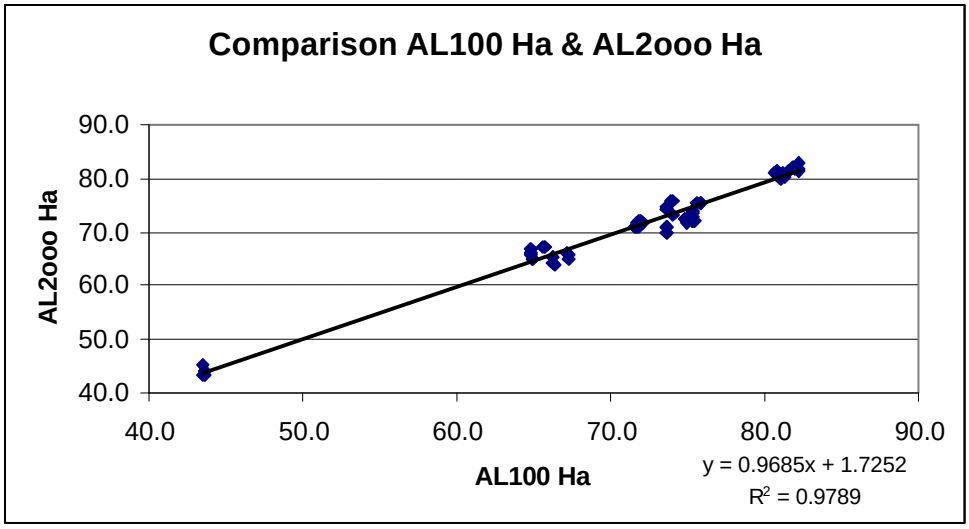
All the above data has used assigned Interwoollab values to compare different instrument type responses. The use of the Interwoollab assigned values represent readings from 80+ AL100's compared to just 4 AL100's in these trials.

**Fig. 9. Combined AL100 & AL2ooo Hauteur against Assigned Values**




The following plot compares the values obtained just from the instruments used in these trials. They illustrate the good level of agreement achieved between a direct comparison of Hauteur for the two instrument types.

**Fig.10 Direct Comparison of *AL2ooo* and AL100 Hauteur Results.**




Removal of the short (44.2 mm Ha top) reduced the $R^2$ value to 0.93, clearly indicating a higher degree of variation in the other tops. Of perhaps more interest is the minor change in the slope of the regression line following the removal of the short “influencing” top from 0.968 to 0.964 illustrating that it was causing very little leverage.

***AL2ooo* Machine Effects**.

To observe if there is any machine specific bias, the data for the differences between the assigned values and the top results from the 4 longer tops that were measured in all 4 laboratories, was normalised against the lab grand mean for each machine being tested to remove sample preparation (Fibroliner) differences but leaving between instrument variation and a small amount of sample variation. This has been minimized by using sequential Fibroliner draws in each machine type within the one lab. and using one sample for replicate results.

This was done to simplify the analysis in an unbalanced trial design. At the same time it embraces IWTO 0 Appendix B which encourages the removal of as much extraneous variation as possible in equivalence trials such as this.

IWTO 0 Appendix B states in paragraph 4, page 1 quote...

"*Data is collected by measuring samples by both methods. The samples may be:*

*(a) stable or completely homogenous substances (e.g. ceramic tiles used as colour standards);*
*(b) homoginised wool (e.g. blended wool top);*
*(c) specimens of raw wool (e.g. staples) when testing is non-destructiv so that the same specimens may be measured by both methods; or*
*(d) The means of raw wool specimen measurements from sale lots or processing batches, when testing is destructive*.*

* Authors Note: in this case whilst the test is non-destructive it is not possible to transfer the specimen between instruments so it can be interpreted as being a destructive test and thus this clause is relevant.

IWTO 0 clearly classifies the level of variation in the above sampling cases.

*"The sample categories as listed from (a) to (d) represent examples where the sampling variation is increasing from (a) to (d)" .*

In addition, this section of Appendix B goes on to state....

*" Where practicable, material with the least sampling variation should be used for testing method (or instrument) differences."*

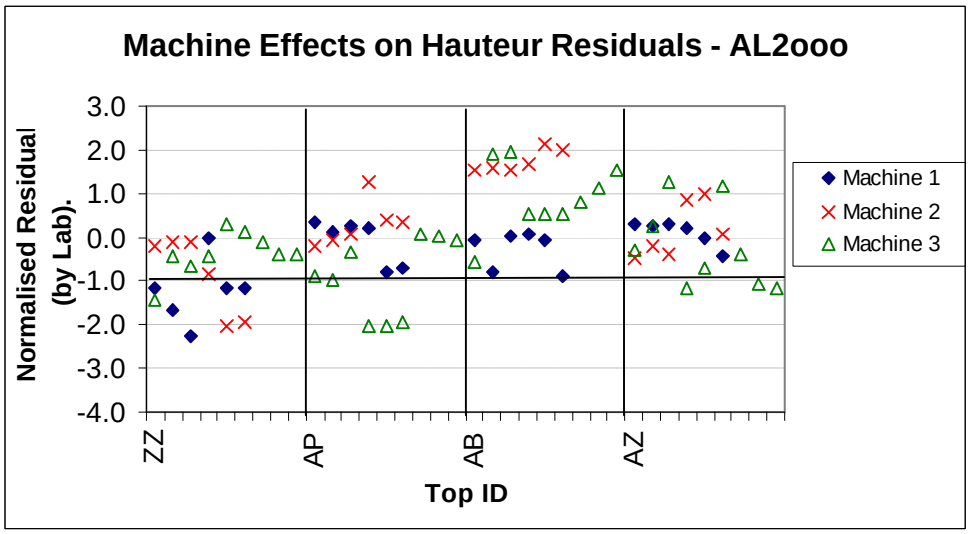
One method of achieving *clause (d)* above, is to normalize the data. The extent to which this technique has achieve this aim is such that there are only two remaining sources of variation, between top sample variation- very small as discussed above, and the between instrument variation – the very issue at stake in this equivalence testing. The test here is equivalence of the *AL2ooo* instrument to measure the same as the AL100 i.e. the equivalence of the measuring head of the updated Almeter to that of the current instrument.

There are a number of machines in different labs., thus allowing a direct comparison between machines - free of Fibroliner effects. These data are presented in Fig. 11 below:-

This normalisation allows for comparisons between instrument types (AL100 v's *AL2ooo*); or for investigation of machine differences **within** instrument type *AL2ooo* (or AL100) i.e. between machine within the same instrument type.

These trials used one sample in each instrument used (AL1000 or *AL2ooo*) to get the replications for each top. It was designed in this manner to remove as much extraneous variation as possible but it was still unable to remove the worst source of variation.... the Fibroliner preparation effects - as it is not possible to transfer the same sample between machines. By normalising the data on the basis of the laboratory grand mean this latter effect can be removed as well. After all, what we are trying to do in this study is to look at the effectiveness of the replacement electronic componentry in the same Almeter technology i.e. the equivalence of the machine signal capture and interpretation, not a different measuring SYSTEM per se. Such normalisation removes the individual Fibroliner effect but retains any machine or sample differences. An added benefit is that this technique highlights the degree of differences rather than presenting the data in absolute terms i.e. 44mm Ha or 72mm Ha type values. It allows the reader to focus in on the differences in those terms.

**Fig. 11. Machine Effects on Residuals – *AL2ooo***




The random nature of these points clearly illustrates that there is no top length bias in residual values between *AL2ooo* machines.

Whilst there is a small significant difference (P<0.04) between these three machines they are minor (range ± 0.35mm Ha). This should be considered against the range experienced in Interwoollab round trials and well within the 95% MPD values detailed in IWTO 17.

**Table 14 Anova Statistics for Normalised *AL2ooo* Machine Differences.**

| SUMMARY |
|---|

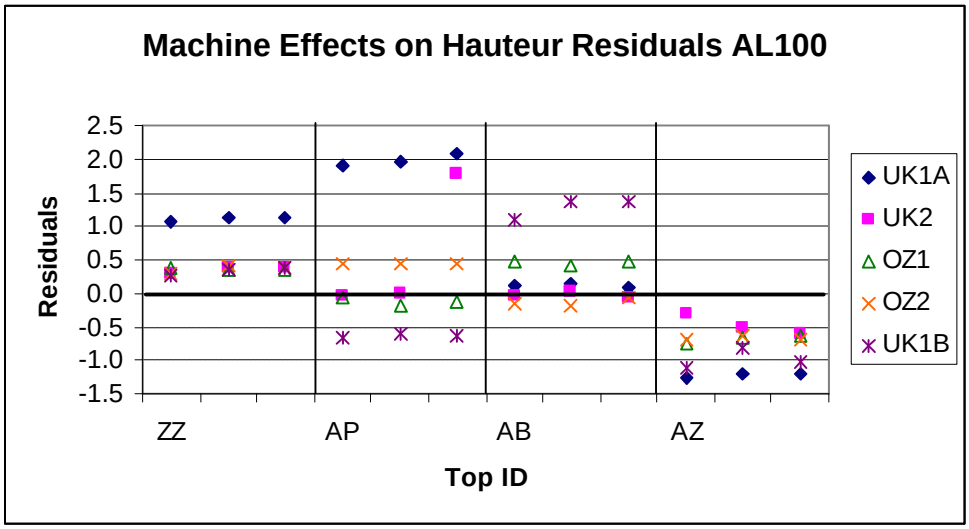
| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| **Machine 1** | 24 | -9.19 | **-0.4** | 0.51 |
| **Machine 2** | 24 | 7.77 | **0.3** | 1.25 |
| **Machine 3** | 36 | -5.50 | **-0.2** | 1.06 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 6.30 | 2 | 3.15 | 3.29 | **0.04** | 3.11 |
| Within Groups | 77.58 | 81 | 0.96 | | | |
| Total | 83.88 | 83 | | | | |

These can be compared against the AL100 (in Fig. 13 and Table 14, below) that showed no significant differences between instruments used. (P<0.49) with a range of ±0.25mm Ha.

**Fig. 13. Machine Effects on Residuals – AL100**




*Note *: Machine UK1 was tested on 2 different occasions (A & B) during the conduct of the round trials.*

Normalisation of the data in this way does however retain any sample differences due to variation in the top itself. To remove that would require normalisation by top mean value and this was considered not to be necessary in the current situation as the samples were sequential draws within each laboratory.

**Table 15. Anova Statistics for Normalised AL100 Machine Differences.**

| SUMMARY | | | | |
|---|---|---|---|---|
| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
| **UK1A** | 12 | 5.95 | **0.50** | 1.54 |
| **UK2** | 12 | 1.27 | **0.11** | 0.38 |
| **OZ1** | 12 | 0.00 | **0.00** | 0.22 |
| **OZ2** | 12 | 0.00 | **0.00** | 0.22 |
| **UK1B*** | 12 | 0.00 | **0.00** | 0.86 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 2.21 | 4 | 0.55 | 0.86 | **0.49** | 2.54 |
| Within Groups | 35.43 | 55 | 0.64 | | | |
| Total | 37.64 | 59 | | | | |

*Note *: This machine was tested on 2 different occasions during the conduct of the round trials.*

**Between Instrument Type Differences - Hauteur**

Table 14 and 15 shows the mean and variance estimates for the two instrument models used; the AL100 and *AL2ooo* respectively. Combining the details included in these respective tables allows for the determination of between instrument type differences. These are provided in Table 16 below.

**Table 16. Calculation of Instrument Type Differences**

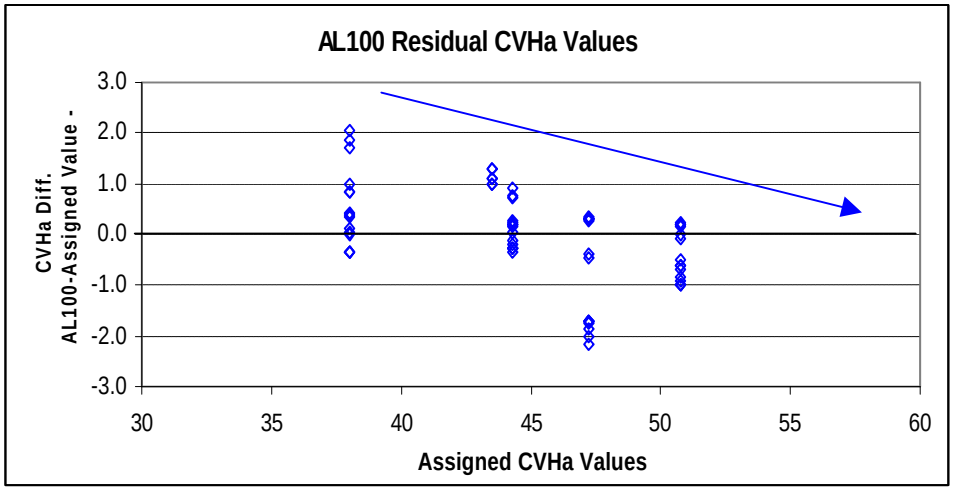
| | *AL2ooo* | AL100 | *F value* | *P-Value* |
|---|---|---|---|---|
| Average Variance | 0.9399 | 0.6442 | 1.4590 | 0.07 |

It can be seen from Table 16 that the P-Value of 0.07 clearly indicates that there is no significant difference in instrument type in respect to the repeatability of a single measurement result between the 2 instruments types tested and thus the *AL2ooo* is equivalent to the AL100 for the measurement of Hauteur, the only certifiable value for top length and length distribution under IWTO 17 or IWTO Blue Book provisions.

**CVHa Data**

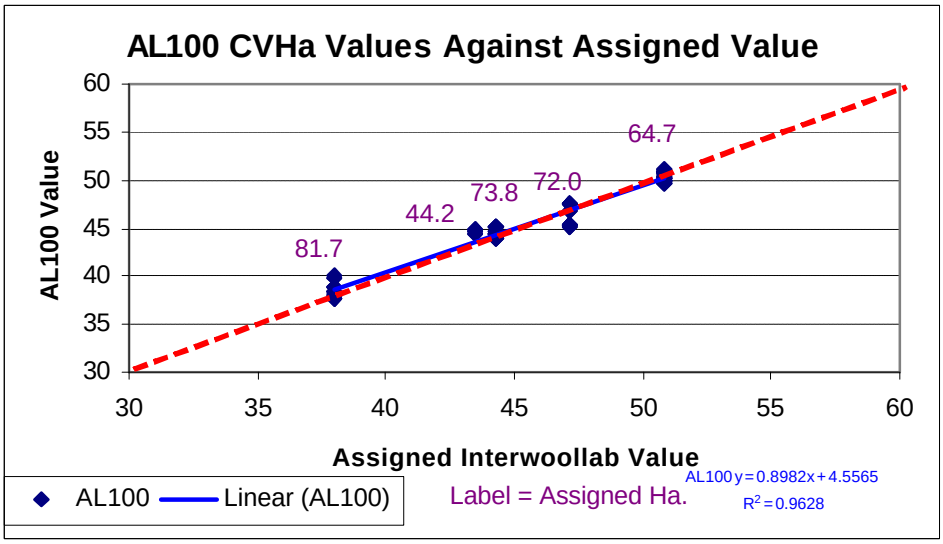
CVHa is an important value sought by users of the Almeter instrumentation. The following plots demonstrate the equivalence values for the two Almeter models.

**Fig. 13. AL100 CVHa Residuals against Assigned Values.**




There appears to be a bias associated with these AL100 data, in so far as, lower differences being experienced with the tops associated with higher CVHa assigned values. This may however only be as a consequence of the apparently higher variation observed in the results from tops with low assigned CVHa values. Overall, however, there is good agreement between the assigned values and those measured in these trials.

**Fig. 14. AL100 CVHa Values against Assigned Values**




These points are labelled with the assigned Hauteur value to illustrate that the bias is not associated with the top length.

**Fig. 15. *AL2ooo* Residual Values against Assigned Values.**

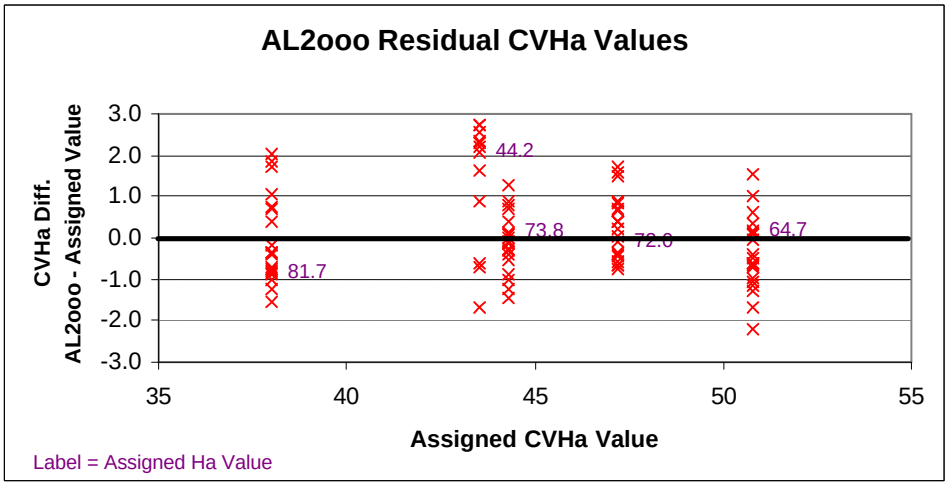
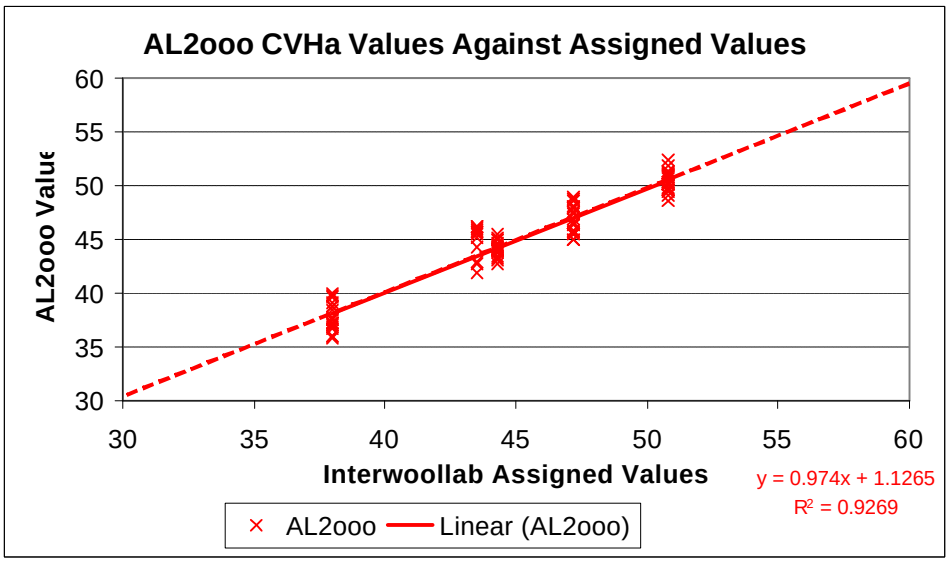



**Fig 16. *AL2ooo* CVHa Against Assigned Values.**




**Between Instrument Type Differences – CV of Hautuer**

Table 17 shows the mean and variance estimates for the two instrument models used; the AL100 and *AL2ooo* respectively. Combining the details included in these tables allows for the determination of between instrument type differences. These are provided in Table 17 below.

**Table 17. Calculation of Instrument Type Differences**

| CVHa | *AL2ooo* | AL100 | *F value* | *P-Value* |
|---|---|---|---|---|
| Average Variance | 1.0216 | 0.6817 | 1.4987 | 0.06 |

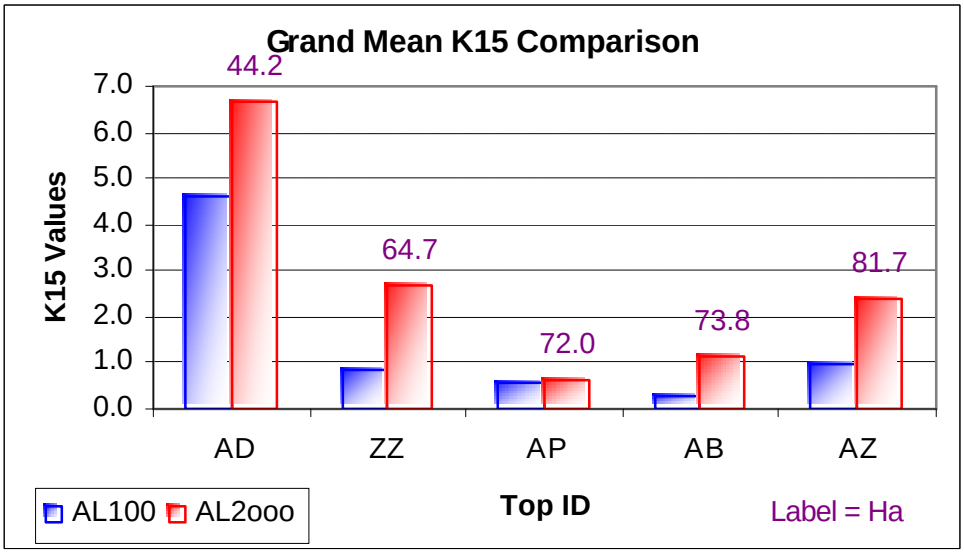
It can be seen from Table 17 that the P-Value of 0.06 clearly indicates that there is no significant difference in instrument type in respect to the repeatability of a single measurement result between the 2

instruments types tested and thus the *AL2ooo* is equivalent to the AL100 for the measurement of CV of Hauteur. There were no statistical differences for the three *AL2ooo* machines which showed the same between machine range of 0.6 %

**Short Fibre Content (K15 & K25) Values.**

The short fibre content values for the 2 instrument types are shown in Figure 17. Whilst there is an overall tendency for the *AL2ooo* to provide higher short fibre content in the K15 range (% fibres <15mm) the absolute differences are small and it has to be remembered that such values are known to be very variable and are not certifiable. The figures above the bars represent the assigned Hauteur values and from the randomness of the degree of difference it is clear that there is no top length bias.

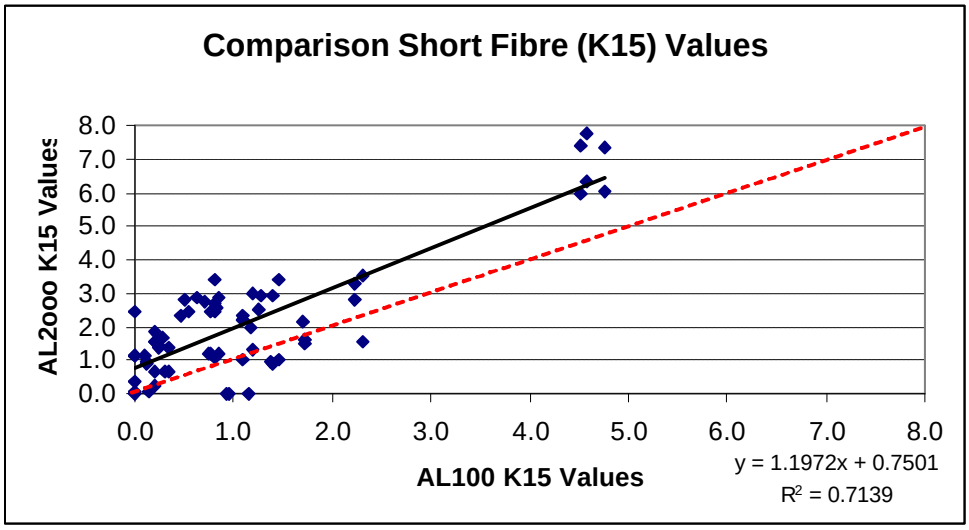
**Fig. 17. Short Fibre Content – K15 Values (%< 15mm).**




The above plot is based on grand means and it is perhaps of interest to look at the direct comparison of the two instrument types. These data are shown in Figure 18 below and not surprisingly show a degree of variability in both machine types. It has to be recognized that the low short fibre statistics are by their very nature highly variable as is demonstrated in the Interwoollab round trial data for the K20 (AL100) data.

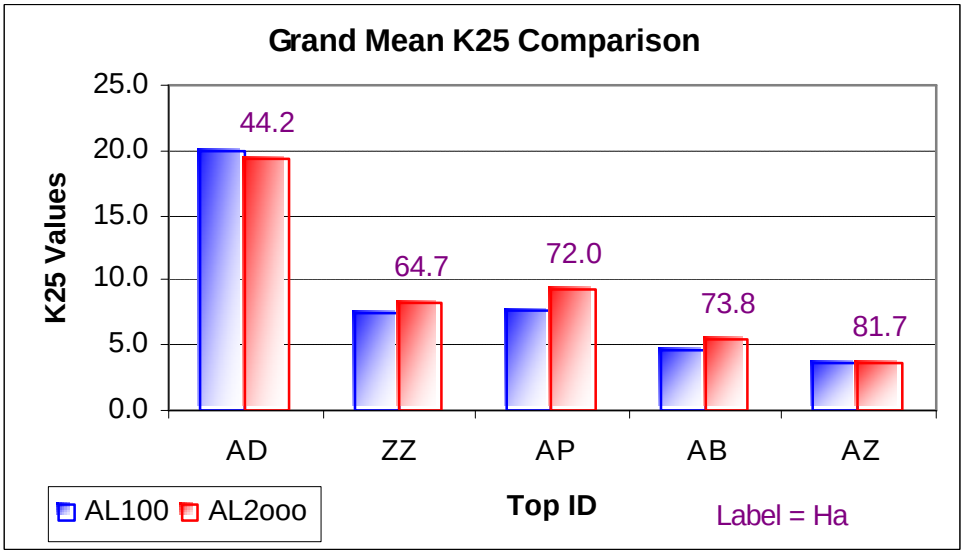
Similarly, K15 values for the AL100 shown earlier in Table 2 (within lab AL100 Interwoollab round trial data) and Table 9 (commercial blends data for the AL100) also show wide ranges for this parameter.

**Fig.18. Short Fibre (K15) Comparison Between Instrument Types**




Perhaps a value more important to spinners is the K25 value (% fibres<25mm). The comparison between instrument models is provided below in Figure 19.

**Fig. 19 Short Fibre Content – K25 Values (%< 25mm).**




Again there is a slight tendency for the *AL2ooo* to show small increases in K25 values but these are minor in degree. It is noticeable that the degree of difference between the 2 sets of results has reduced considerably from the K15 values to provide a much more stable situation. The assigned Ha values are provided as labels to illustrate that there is no top length bias.

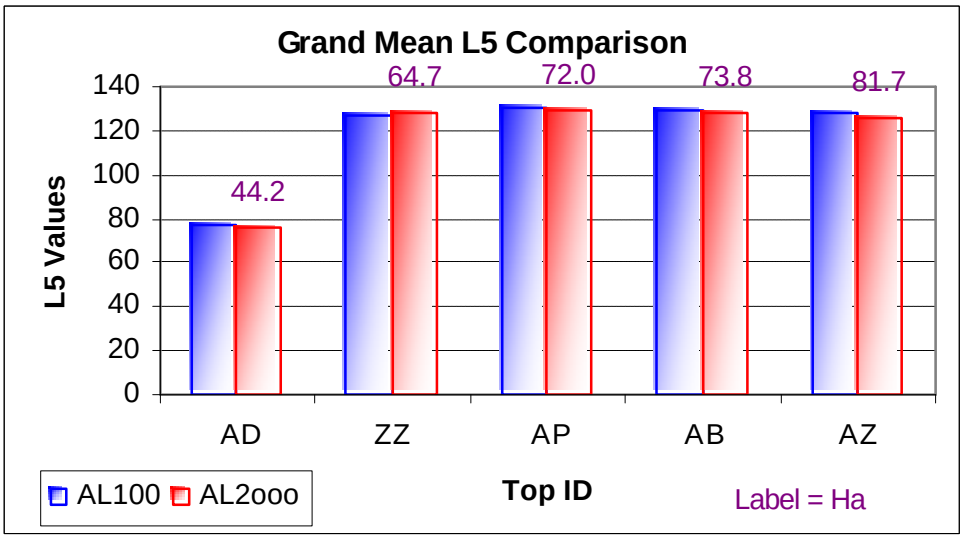
**Long Fibre Content (L5 & L1) Values.**

The L5 values (Length of 5% of Fibres) are presented in Figure 20 for the two instrument types. There is a slight tendency for the *AL2ooo* to provide slightly lower L5 and L1 values than the AL100.

This is interesting in so far as the *AL2ooo* methodology placed a QC Sensitivity Trapezium so as it just touched the longest fibre on the mylar film sample holder and thus the position of the longest fibre was

known for that instrument. The AL100 determines that position from the strength of the scanning signal alone. It is unknown if this phenomenon is responsible for the slight differences observed.

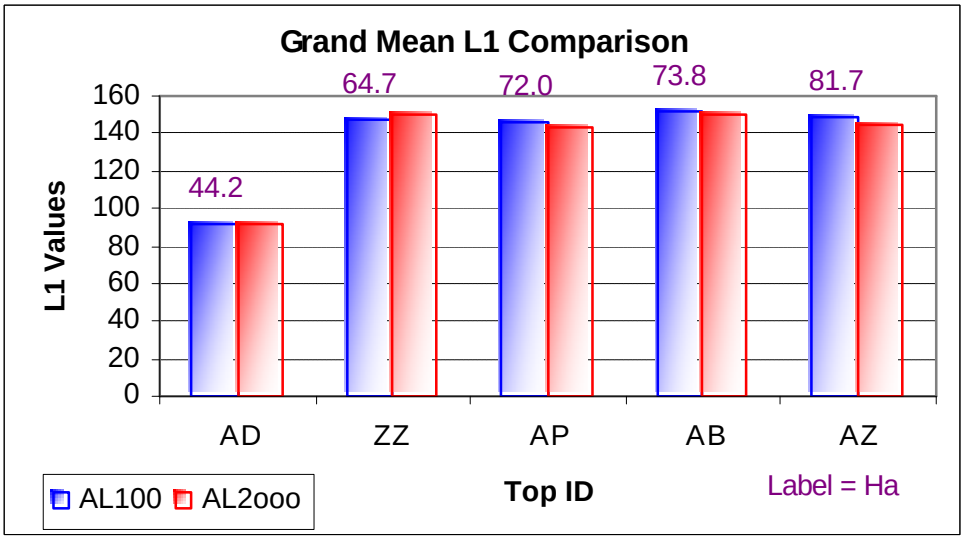
**Fig.20. L5 Value (Length at 5% of the Fibres) Comparison.**




These data show good agreement between instrument types.

Not surprisingly there is more variation in the results for the L1 values. The comparisons are provided in Figure 21 below. There is however good agreement between the two instrument types.

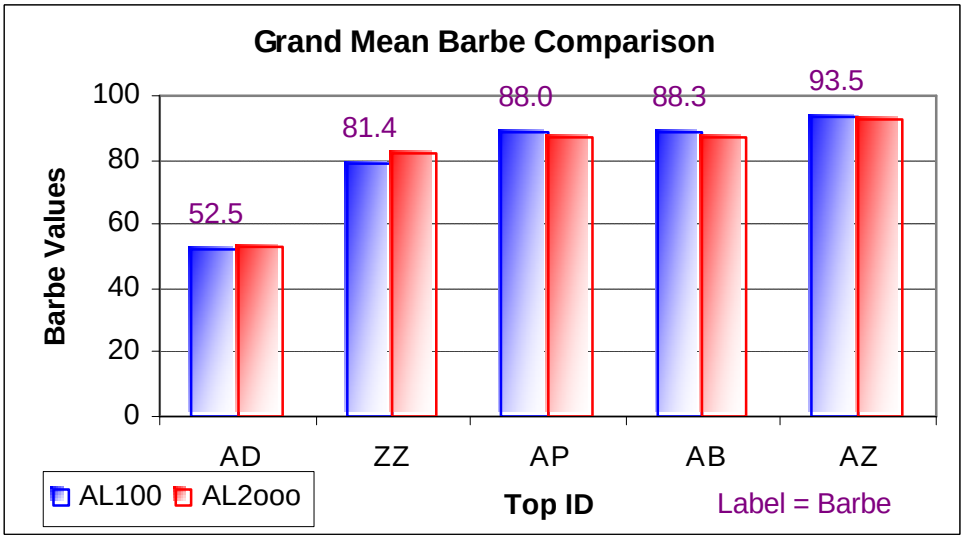
**Fig.21. L1 Value (Length at 1% of the Fibres) Comparison**.




**BARBE and CVB**

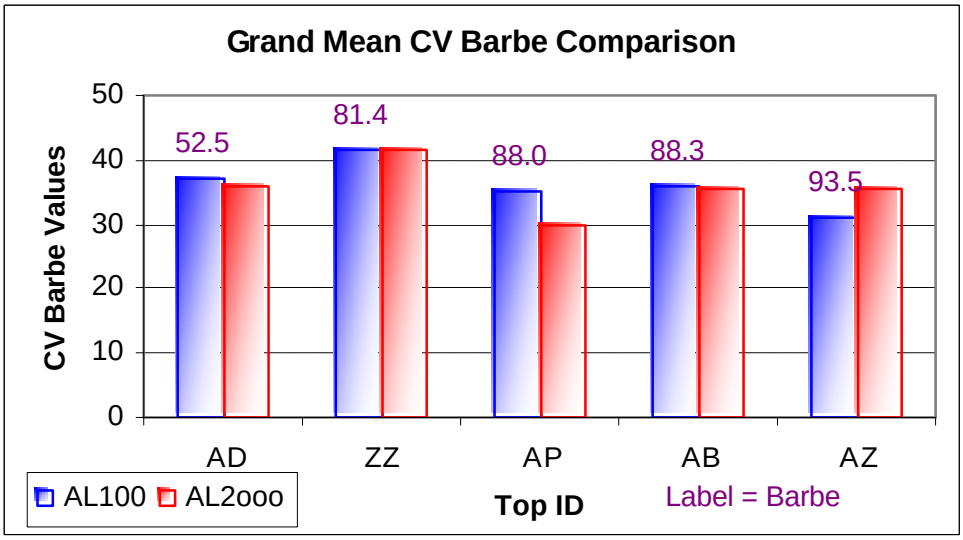
Whilst Barbe is a measurement generally restricted to comb sorters and carding wools, particularly for the shorter length tops for LAC measurements, it is never the less important for that portion of the wool trade. The following plots (Figs. 22 & 23) illustrate the equivalence obtained with both Barbe and CV Barbe.

**Fig 22. Barbe Comparison**




It can be seen that the Barbe comparison, particularly at the lower end which is the area corresponding to carding types being tested for LAC, that there is a high degree of agreement between the two instrument models. There is overall good agreement across the range of tops tested.

**Fig. 23. CV Barbe Comparison**




Similarly the CV Barbe comparison between instrument models particularly at the shorter top end shows a high degree of agreement. Differences in tops AP and AZ are commercially insignificant.

**Precision Estimates.**

It must be clearly understood that precision estimates provided here are not those associated with an Almeter test for the reporting of commercial results but the between instrument measurement precision of the Almeter (AL100 or *AL2ooo*) measuring head. Because it is impossible to eliminate entirely the sample variation occurring between any one sample from a top there is a very small component of top variation included in these precision estimates. Until it is possible to transfer a single fibre draw sample between machines this small component of variation will always be present. The trial design and data analysis technique used were such that this was constrained to the minimum possible.

Table 18. Individual Result Precision

| | Hauteur | | CV Hauteur | |
|---|---|---|---|---|
| | *AL2ooo* (81 d.f.) | AL100 (55 d.f.) | *AL2ooo* | AL100 |
| Average Variance | 0.9399 | 0.6441 | 1.4987 | 1.0216 |
| 95% CL | 1.90 mm | 1.57mm | 1.98% | 1.62% |

These should not be confused with the MPD values provided in IWTO 17, which equate to v 2 * 95% CL.

The IWTO Regulations, in a text note relating to acceptable limits states… *The value of 3mm is calculated as the within lot maximum probable difference using the upper 95% value for within consignment standard deviation for testing 5 samples.* The above values therefore fall within these requirements for the only certifiable result mentioned; Hauteur.

### Conclusions

These findings clearly demonstrate the equivalence of the AL2ooo with the AL100 and lead to the recommendation to include the AL2ooo as a suitable instrument to undertake IWTO testing and certification of top length and distribution attributes under IWTO 17.

To accommodate this requires a simple change in the text of IWTO 17 to substitute the text “Almeter AL100” with the text “AL100/AL2ooo”. With the addition of the QC sensitivity trapezium to the sample on the scanning bed a change in wording for Sections A5.2.1 & A5.10.5 of IWTO 17 are also required. Details of the additional text are included in Submission SG01 of this meeting.

## REFERENCES

Couchman R. C.& Holmes P.J. (2002) Investigations into the Repeatability and Precision of the Re-configured Almeter - AL 2ooo. IWTO T&S Committee, Nice, Report Number SG-02.

Couchman R. C.& Holmes P.J. (2003) Effect of Application of a Raw Signal Filter on the Precision and Accuracy of the Almeter AL2ooo. IWTO T&S Committee, Buenos Aries, Report Number SG-02.

IWTO-0-98: Introduction to IWTO Specification – Procedures for the Development, Review, Progression or Regulation of the IWTO Test Methods and Draft Test Methods.

IWTO-17-85: Determination of Fibre Length Distribution Parameters by Means of the Almeter

### Acknowledgements

The authors wish to acknowledge the assistance provided by M.Laurent Houillon, (Institut Francais Textile - Habillement), in the provision of background data and material on Interwoollab round trials and assistance in trial conduct received from the following:-

Mr Dale Carrol, & Ms Margot Carr (CSIRO), Mrs Judy Turk, (Michell Aust.P/L), Testex Laboratory and staff (Woolmark UK) and Bulmer & Lumb, laboratory and staff, UK.

Without their assistance these trials would not have been possible.

**Supplementary Paper to SG - 03.**
**Report on the Equivalence Round Trials for the Almeter AL2ooo**

R C Couchman & P J Holmes.

## Background.

Since SG-03 was posted on the IWTO internet site, additional information has been sought on data for an IWTO 0 analysis of additional non-certifiable values covered by IWTO 17, to assist technicians interpret data presented for equivalence of the *AL2ooo* under that test method. In addition, some errors and omissions have also been observed in a small number of cases. This supplementary paper provides additional information and corrections to the original text of SG-03.

Whilst there are statistical differences within and between instrument types for different attributes analysed, all such significant differences are showing only minor absolute differences that amount to non-commercial differences. This can be gauged by comparing the absolute differences with the degree of differences being shown in tables 2 and 6 for the AL100 Interwoollab trial data. Similarly, when compared to the results from commercial tops in table 9 the differences observed in these trials are minimal.

It is emphasized that only Hauteur is certifiable under IWTO 17 and Barbe in AS/NZS 4844 the Interim Australian & New Zealand standard for Length after Carding test.

## MPD values for Hauteur & Barbe

MPD values from two of the most recent Interwoollab trials suggest that the MPD values, using the formula to v 2 * 95% CL to calculate MPD's, provides the following values for the Interwoollab tops used in these round trials.

**Table A1**. Assigned Values and IWTO 17 - 95% MPD Range for Trial Tops

| | Assigned Value | | MPD Range | |
|---|---|---|---|---|
| Top ID | Ha | B | Ha | B |
| AD | 44 | 52.5 | 1.7 | 2.1 |
| ZZ | 64 | 81.4 | 2.5 | 3.2 |
| AP | 72 | 88.0 | 2.9 | 3.5 |
| AB | 74 | 88.3 | 2.9 | 3.5 |
| AZ | 82 | 93.5 | 3.2 | 3.7 |

*Note: "assigned" values are those supplied for Interwoollab tops used in these trials.*

## Barbe IWTO 0 Analysis

Barbe is a measurement used in LAC testing and is used in Part 1 of the Australian and New Zealand Interim Standard AS/NZS 4844 to indicate length after carding values. It is therefore of some interest to users of this interim standard.

The values analysed represent differences from the Interwoollab “assigned” values rather than the grand mean of the results obtained in the conduct of the trials.

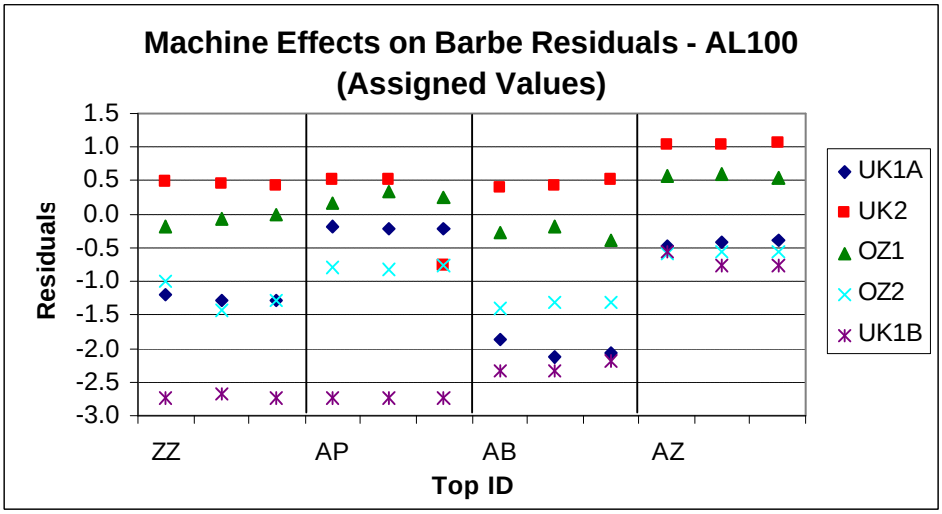
**Table A3**

| SUMMARY | **AL100** | **Barbe** | | | |
|---|---|---|---|---|---|
| *Groups* | | *Count* | *Sum* | *Average* | *Variance* |
| **UK1A** | 12 | -11.725 | -0.98 | 0.57 | 0.5739 |
| **UK2** | 12 | 6.1 | 0.51 | 0.23 | 0.2327 |
| **OZ1** | 12 | 1.4 | 0.12 | 0.12 | 0.1192 |
| **OZ2** | 12 | -11.85 | -0.99 | 0.12 | 0.1193 |
| **UK1B** | 12 | -25.25 | -2.10 | 0.76 | 0.7634 |
| mean | | | | -0.7 | 0.3617 |
| 95% CL | | | | 1.71 | |

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 51.08996 | 4 | 12.77249 | 35.31314 | 1E-14 | 2.5397 |
| Within Groups | 19.89307 | 55 | 0.3616922 | | | |
| Total | 70.98303 | 59 | | | | |

The analysis of variance shows high statistical significant differences between AL100 instruments but this is primarily due to the low level of variation in these overall results.

**Fig.A1**




The residual plot data above appear to show a laboratory effect which is probably a function of the sample preparation effect on Barbe.

**Fig.A2.**

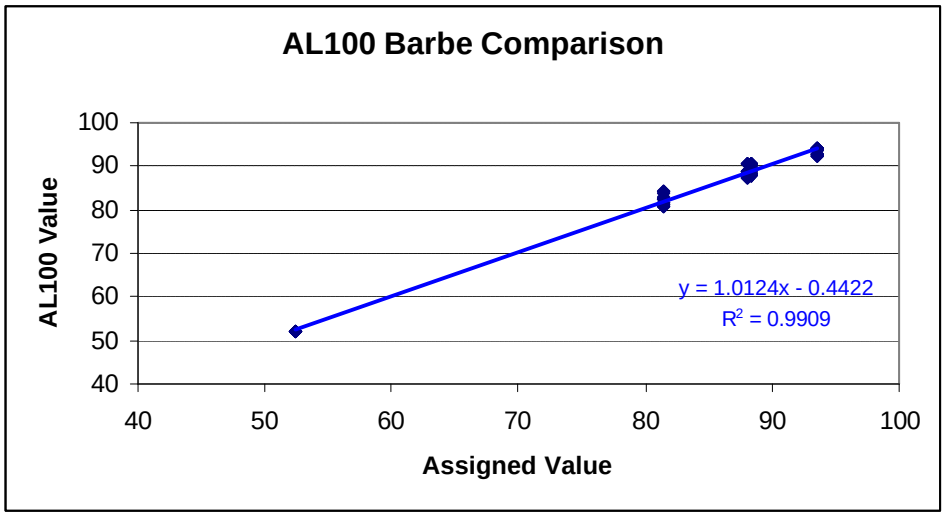
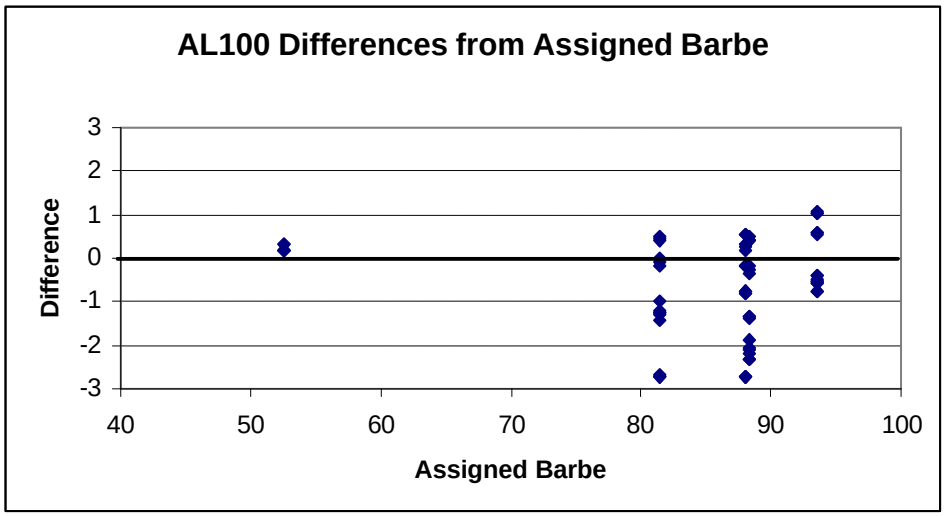



**Fig.A3.**




The *AL2ooo* instruments however show no significant difference between the three instruments in the 4 labs in which tests were performed. It should be noted that the Fibroliner effects have been removed from these data to allow combination of individual instrument data and thus across instrument differences to be observed. The data here therefore represent, as much as practical, as stated in the body of the report, the scanning signal differences.

**Table A4.**

| SUMMARY | *AL2ooo* | **Barbe** | | | | |
|---|---|---|---|---|---|---|
| *Groups* | *Count* | *Sum* | *Average* | *Variance* | | |
| Machine 1 | 24 | 12.96185 | 0.540077 | 0.876389 | | |
| Machine 2 | 24 | -5.77981 | -0.240826 | 1.771154 | | |
| Machine 3 | 36 | 0.809838 | 0.022495 | 2.900111 | | |
| mean | | | 0.1 | 1.999346 | | |
| 95%CL | | | 2.77 | mm | | |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 7.650187 | 2 | 3.825094 | 1.907867 | 0.155006 | 3.109307 |
| Within Groups | 162.3974 | 81 | 2.004906 | | | |
| Total | 170.0476 | 83 | | | | |

| **Between Instrument Type Analysis** | | | | F = | f Critical |
|---|---|---|---|---|---|
| | | | | 2.62 | 1.1E-04 |
| Instrument Mean | | | P Value | | |
| AL100 | -0.69 | | 1E-14 | | |
| AL2ooo | 0.10 | | 0.16 | | |
| Difference | 0.8 | mm | | | |

There are however significant differences between the machine types, however that difference is inconsequential commercially being <1mm Barbe (0.8mm). A difference such as this, when taken in context, is minimal and represents only 0.9% of the actual Barbe value.

The LAC test is used as an indicative test for carding wools and will, in processing practice, be subject to significantly higher within and between mill processing effects. In addition, when compared with the Interwoollab round trial details presented in table 2 it is clear that this difference is insignificant.

**Fig.A4.**

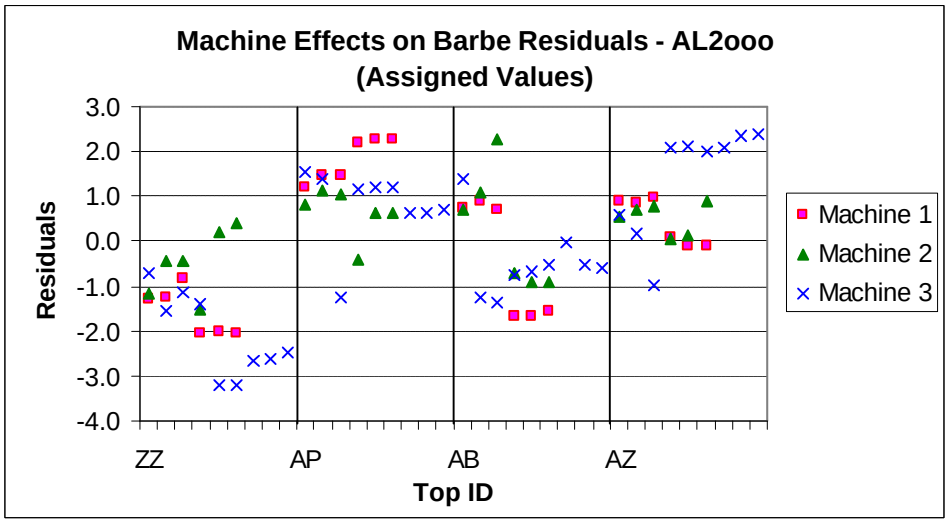


**Fig.A5.**

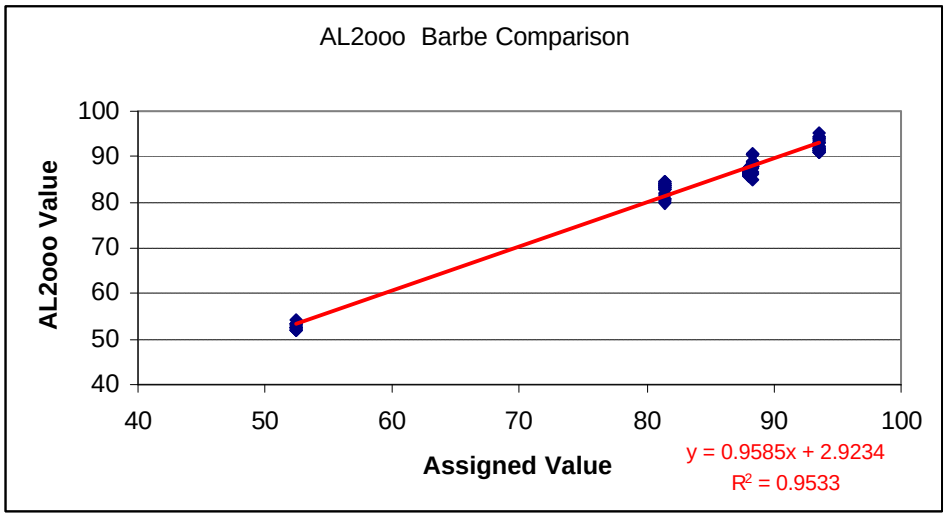
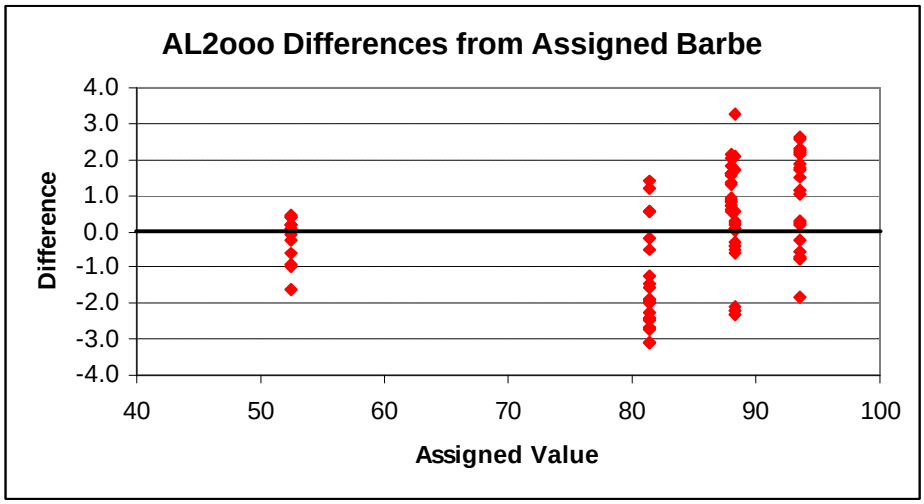



**Fig.A6.**




**Error Corrections**

Page 6….. Table 2. The 1st series range for Ha should read 6.5 not 1.5. as follows:-

| | | | Mean deviation | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Series** | **n** | | **Ha** | **CVHa** | **Barbe** | **K20** | **K30** | **K40** |
| 227-230 | 344 | Range | 6.5 | 12 | 11.1 | 5.6 | 13.4 | 21.9 |
| | | sd | *0.8* | *0.9* | *0.9* | *0.6* | *1.3* | *1. 2* |

Page 11, para 3.. The following sentence ~~This fails to recognize mean Ha values but for a mid range Hauteur top of 70mm this means a CV% of 10% considerably more than would be expected for production from a well managed combing plant.~~

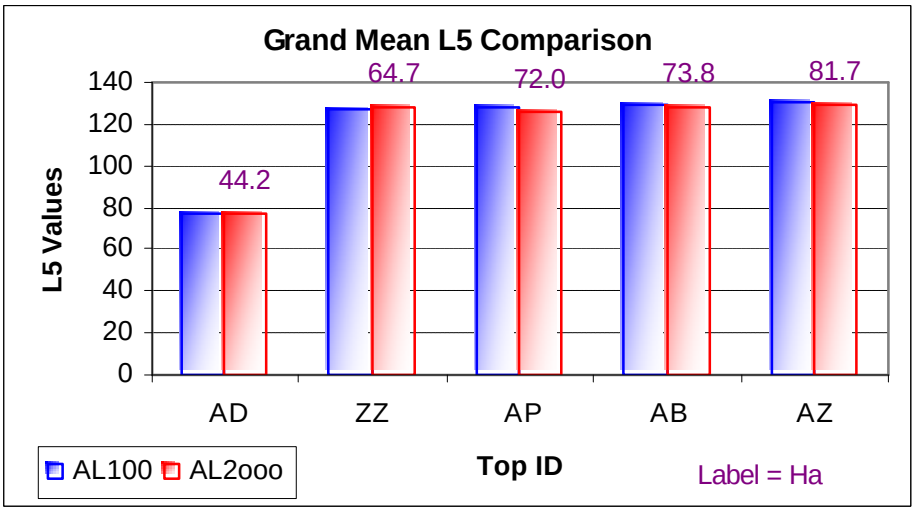
should be replaced with

This 7mm value fails to relate this to an Ha value but as an example, for a mid range Hauteur top of 70mm, this means a difference of 10% or an approximate CV of 1.7%, if it is assumed that the range represents 3sd's; a value that would be expected for production from a well managed combing plant.

Page 14. It is understood that Interwoollabs does not "assign" values to tops. This term does have a specific connotation in respect to an official or endorsed value but is used in the paper to signify a "reference value" that was provided by Interwoollabs. The "assigned" or reference value used here represents the mean result obtained for these tops during regular Interwoollab round trials.

There was a data transposition error in Fig.20, the correct figure is provided below.

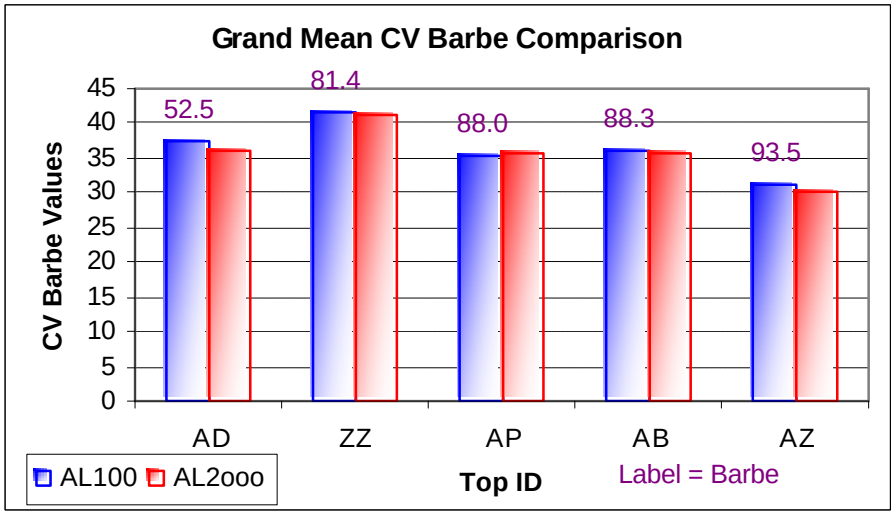
**Fig.20**. (replacement)




**CV Barbe Analysis**

CV Barbe is a value rarely used. But the gross values are provided in the report. A check of the data revealed 4 data transposition errors in the plot information provided in SG-03. This has been corrected and an updated figure 23 is provided below. The main differences are observed in the AL2ooo values for Top AP and for the AL100 values for Top AZ. The net effect is to show a closer relationship overall for this parameter than was previously shown in the original figure 23.

**Figure 23.** (Replacement)




In undertaking the additional analysis a check of the data, 1 data point transposition error was related to L5 information provided in Table 12 of SG-03. The corrected values for both CVB and L5 are highlighted below.

**Table 12.**

**Comparison of Grand Means**

| | | | Ha | CvH | K15 | K25 | L5 | L1 | B | CvB |
|---|---|---|---|---|---|---|---|---|---|---|
| AL2ooo | AD | mean | 43.9 | 44.9 | 6.6 | 19.3 | **77.6** | 92.5 | 52.7 | 36.0 |
| | | sd | 0.8 | 1.5 | 0.6 | 1.6 | **0.7** | 2.0 | 0.7 | 1.5 |
| AL2ooo | AB | mean | 74.1 | 44.2 | 1.2 | 5.5 | 128.4 | 149.7 | 87.3 | **35.4** |
| | | sd | 1.1 | 0.7 | 0.4 | 0.6 | 2.0 | 3.4 | 4.1 | **0.5** |

Comment was received seeking a summary table illustrating the overall differences observed between instrument types. This is provided below in Table 12a.

**Table 12a.**

**Comparison of Grand Mean Differences.***

| Top ID | Ha | CvH | K15 | K25 | L5 | L1 | B | CvB |
|---|---|---|---|---|---|---|---|---|
| **AD** | -0.3 | -0.2 | -2.0 | 0.7 | 0.0 | -0.6 | -0.5 | 1.2 |
| **ZZ** | -0.5 | -0.5 | -1.8 | -0.9 | -0.6 | -1.7 | -3.6 | 0.3 |
| **AP** | 1.9 | -1.1 | -1.4 | -1.6 | 2.5 | 2.7 | 1.6 | -0.3 |
| **AB** | 0.1 | 0.1 | -0.9 | -0.8 | 1.4 | 1.7 | 1.4 | 0.5 |
| **AZ** | 0.2 | 1.0 | 0.0 | 0.0 | 1.6 | 4.7 | 0.7 | 1.1 |

** note. A positive value signifies that the AL100 is providing a higher value that the AL2ooo*

Table 13 has transposition errors in part 2 of the table. This table has been re-formatted to correct this transposition and to place values in a logical attribute order for easier reading. The correct placement of values is provided below:-

**Table 13.**

**Range of Top Parameters in Commercial Topmaking Blends (ex Table 9)**

| | | Ha | CVHa | K15 | K25 | L5 | L1 | B | CVB |
|---|---|---|---|---|---|---|---|---|---|
| A (n=15) | Range | 3.8 | 5.7 | 0.8 | 1.8 | 6.9 | 22.3 | 7.7 | 9.7 |
| B (n=24) | Range | 8.3 | 5.7 | 2.8 | 3.5 | 11.1 | 15.2 | 9.3 | 3.5 |
| C (n= 9) | Range | 3.6 | 2.1 | 0.6 | 1.6 | 8.9 | 18.6 | 4.9 | 2.9 |
| D (n=49) | Range | 12.4 | 12.5 | 1.9 | 5.6 | 9.3 | 22.6 | 8.8 | 9.6 |
| E (n=41) | Range | 9.0 | 9.4 | 1.5 | 4.4 | 8.3 | 29.7 | 6.7 | 9.7 |
| F (n=47) | Range | 8.8 | 8.5 | 1.0 | 3.2 | 12.4 | 55.7 | 9.2 | 12 |
| **Differences Between Almeter Instrument Models AL100 v's AL2ooo** | | | | | | | | | |
| AD | Diff. | -0.3 | -0.2 | -2.0 | 0.7 | 0.0 | -0.6 | -0.5 | 1.2 |
| ZZ | Diff. | -0.5 | -0.5 | -1.8 | -0.9 | -0.6 | -1.7 | -3.6 | 0.3 |
| AP | Diff. | 1.9 | -1.1 | -1.4 | -1.6 | 2.5 | 2.7 | 1.6 | -0.3 |
| AB | Diff. | 0.1 | 0.1 | -0.9 | -0.8 | 1.4 | 1.7 | 1.4 | 0.5 |
| AZ | Diff. | 0.2 | 1.0 | 0.0 | 0.0 | 1.6 | 4.7 | 1.1 | 1.1 |

The Precision Estimates for CVHa in Table 18 are incorrect and should read as follows:-

**Table 18. Individual Result Precision**

| | Hauteur | | CV Hauteur | |
|---|---|---|---|---|
| | *AL2ooo* (81 d.f.) | AL100 (55 d.f.) | *AL2ooo* | AL100 |
| Average Variance | 0.9399 | 0.6441 | 1.4987 | 1.0216 |
| 95% CL | 1.90 mm | 1.57mm | 2.40% | 1.98% |

**Submission SG-01**

The following references are to be included in Submission SG-01 as recommended changes to IWTO 17.

Couchman R. C. & Holmes P.J. ( 2002) Investigations into the Repeatability and Precision of the Re-configured Almeter - AL 2ooo. IWTO T&S Committee, Nice, Report Number SG-02.

Couchman R. C. & Holmes P.J. ( 2003) Effect of Application of a Raw Signal Filter on the Precision and Accuracy of the Almeter AL2ooo. IWTO T&S Committee, Buenos Aries, Report Number SG-02.

Couchman R.C. & Holmes P.J. (2003) Report on Equivalence Round Trials for the Almeter AL2ooo IWTO T&S Committee, Istanbul, Report Number SG-03.