CALIBRATION AND INTRALABORATORY QUALITY ASSESSMENT IN PULP AND PAPER & ALLIED INDUSTRIES

(CESS/IPMA PROJECTS)

SPONSORED BY

INDIAN PAPER MANUFACTURERS ASSOCIATION (IPMA)

CENTRAL PULP & PAPER RESEARCH INSTITUTE
SAHARANPUR 247 001 (UP) INDIA

DECEMBER 2004

CALIBRATION AND INTRALABORATORY QUALITY ASSESSMENT IN PULP AND PAPER & ALLIED INDUSTRIES

(CESS/IPMA PROJECT)

Based on the work of

Dr. Y. V. Sood, P. C. Pande,
Nisha, Renu Tyagi, R. Neethikumar

Under technical guidance of

Dr. A. G. Kulkarni
Director

Sponsored By

INDIAN PAPER MANUFACTURERS ASSOCIATION (IPMA)

CENTRAL PULP & PAPER RESEARCH INSTITUTE
SAHARANPUR 247 001 (UP) INDIA

DECEMBER 2004

ACKNOWLEDGEMENT

The management of Central Pulp and Paper Research Institute is thankful to M/S The West Coast Paper Mills Ltd., Dandeli (Karnataka), M/s Hindustan Paper Corporation Ltd., Kagajnagar (Assam) and M/s J/K.Paper Ltd., Raigad (Orissa), M/s Seshasayee Paper and Boards Ltd., Erode (TN) for supplying the desired paper reel samples used for this project.

EXECUTIVE SUMMARY

Quality of any end product has become one of the most important factor in global trading. This is turn has demanded proper calibration of the testing machines to be used for the evaluation of quality. Finish Pulp and Paper research Institute, Helsinki & PIRA, UK have been providing calibration services to the pulp & paper mills in their countries for quit a long time. No such facilities existed in India. Under this project, CPPRI started the **Comparative Calibration Services** on the similar pattern to help the mills to ensure correct quality evaluation of Pulp & Paper.

Comparative test samples covering the paper characteristics tearing strength, tensile strength, bursting strength, double fold, brightness, smoothness, thickness and gloss were prepared as the method described and sent to 10 paper mills/ organization. The test results obtained for them were analyzed statistically. Based on the results, relevant information regarding the instruments' performance was sent. Feed back data sheet was sent to participating mills. Eight out of ten mills sent positive response to CPPRI comparative calibration approach. No reply was received from the remaining two mills.

The test results obtained from the mills indicated that there is a major variation in results for properties viz. Brightness, bursting strength, double fold, smoothness and thickness. The results for properties like tensile strength, tearing strength and gloss from mills were quite in the agreement range.

A calibration schedule, which should be followed by paper mills for proper functioning of the testing instruments, has also been formulated.

TABLE OF CONTENTS

	Contents	P. No.
1.	Introduction	1
2.	Technical Approach	2
3.	Preparation of Paper Samples	3
4.	Effect of Moisture on Paper Characteristics	7
5.	Calibration and Objective of Paper Testing	9
5.1	Accuracy of Different Tests	13
5.2	Uncertainty, Repeatability & Reproducibility	15
6.	Mills/Organizations Selected for Participation	
7.	Properties Covered in this Service	17
8.	Test Results Obtained & Observations	17
8.1	Brightness Measurement	22
8.2	Bursting Strength	23
8.3	Double Fold	23
8.4	Bendtsen Smoothness	23
8.5	Thickness	23
8.6	The Remaining Properties	24
9.	Feedback from Participating Mills	24
10.	Recommended Calibration Schedule for Paper Testing Instruments	25
11.	Conclusions	27
12.	References	28
13.	Annexure I	29
14.	Annexure II	30
15.	Annexure III	46

INFRASTRUCTURE CREATED

Workstation for Paper Testing Instruments

This Equipment is Capable of Storing and Statistically Analyzing the Testing Data for Ten Different Paper Characteristics.

Other Instruments — Programmable Tear Tester, Digital Micrometer, Multi-directional Gloss Tester, Auto type Gurley SPS Tester.

1. INTRODUCTION

Testing raw materials, end products and intermediates of manufacturing process is a common feature for all industrial processes. In one form or another, testing has been performed as long as products have been manufactured. Today, testing is a very important part of all industrial activities. As industrial processes become more sophisticated and a tolerance for property variations of products becomes tighter, efficient and relevant testing increases in importance. Testing tries to describe numerically certain properties or features of the product, its intermediate, or both. In industrial production, the reasons for testing may be very different. Testing may use intermediates or final products to control process conditions. The intent may also be quality control of the final product for consistency and correspondence with relevant quality specifications. Testing may also try to obtain property values for use in marketing a product. In all these cases, usage of properly **calibrated instruments** is utmost important.

Today, an increasing amount of testing occurs directly on-line during the production process. On-line instruments do certainly enhance the possibility for efficient process and product quality control. Therefore, industry wants to perform process and product control on-line as much as possible. A lack of proper sensors and gauges is in many cases a deterrent to further development of process control.

Despite increasing on-line testing, the need for traditional laboratory testing will always remain for the following reasons:

- All necessary tests are not possible on-line.
- On-line testing equipment require calibration with laboratory tests.
- On-line testing does not include conditioning of the samples to standardized conditions.
- A customer may require very specific tests on purchased products.

To ensure the correct testing and functioning of the instruments it is utmost important that these are calibrated according to standard methods. The instruments not properly calibrated are liable to affect the proper quality assessment of end product.

Quality of any end product has become one of the most important factors in global trading. Evaluation of quality is closely linked with proper calibration of the testing machines. Finish Pulp & Paper Research Institute, Helsinki & PIRA UK etc have been providing calibration service to the pulp & paper mills in their countries for quite a long time. This helps the mills to ensure correct quality evaluation of pulp, paper & chemicals etc. It generates a confidence among the users. In India many of the pulp & paper mills have very old and obsolete testing machines. Ensuring the accurate performance these machines need regular calibration and performance check. **The Comparative Calibration Services** are required to help the pulp & paper mills to check the performance of testing machines so that the desired quality parameters of the raw material and end products are ensured. In the comparative calibration service calibration is not done at the site however standard samples are supplied to the clients. This is the practice being followed by Finnish Pulp & Paper Research Institute, Finland and PIRA, U.K.

2. Technical Approach

The following steps were adopted for comparative calibration services.

- Sophisticated imported instruments like programmable micrometer, digital tear tester, gloss tester, Auto work station etc having facilities of evaluating the results statistically were procured, installed and a regular calibration schedule by CPPRI scientists and an outside agency M/s Elof Hanson. New Delhi was followed. The existing instruments in CPPRI paper testing laboratory were also calibrated as per relevant ISO standard. The different grades of paper having good formation in reels were procured from different mills and were subjected to seasoning (conditioning under controlled atmosphere) prior to be used as standard sample.

- The samples were evaluated for different characteristics using calibrated instruments.
- Standard comparative samples were prepared and sent to the mills for evaluation.
- The result received from mills were evaluated and mills was informed about the
    - ❖ Action Limit
    - ❖ Performance of the equipment

3. Preparation of Paper Samples

Paper is not homogenous material. In paper testing, the measurement is often repeated several times to determine an average result that describes the level of the property better than single measurement. A statistical distribution always relates to the test result. The size and type of distribution depend not only on the homogeneity of the material and the number of repetitions of the test but also on other factors such as equipment and operator. For the preparation of comparative paper samples, the paper samples selected were those which fell into **Cases A, B, & C** of **Fig. 1**.

Case A:

The result and its uncertainty are both within the limits.

Case B and C:

The result is within the limit but a small part of the uncertainty is outside the limit. The result indicates that compliance is more probable than non-compliance.

Case D and E:

The result is on the limit itself and half the uncertainty is within the limit and the other half outside the limit. The result indicates that compliance is as probable as non-compliance.

Case F and G:

The result is outside the limit but a small part of uncertainty is within the limit. The result indicates that non-compliance is more probable than compliance.

Case H and I:

Both the result and the uncertainty are outside the limit. The product therefore does not comply with the specification.

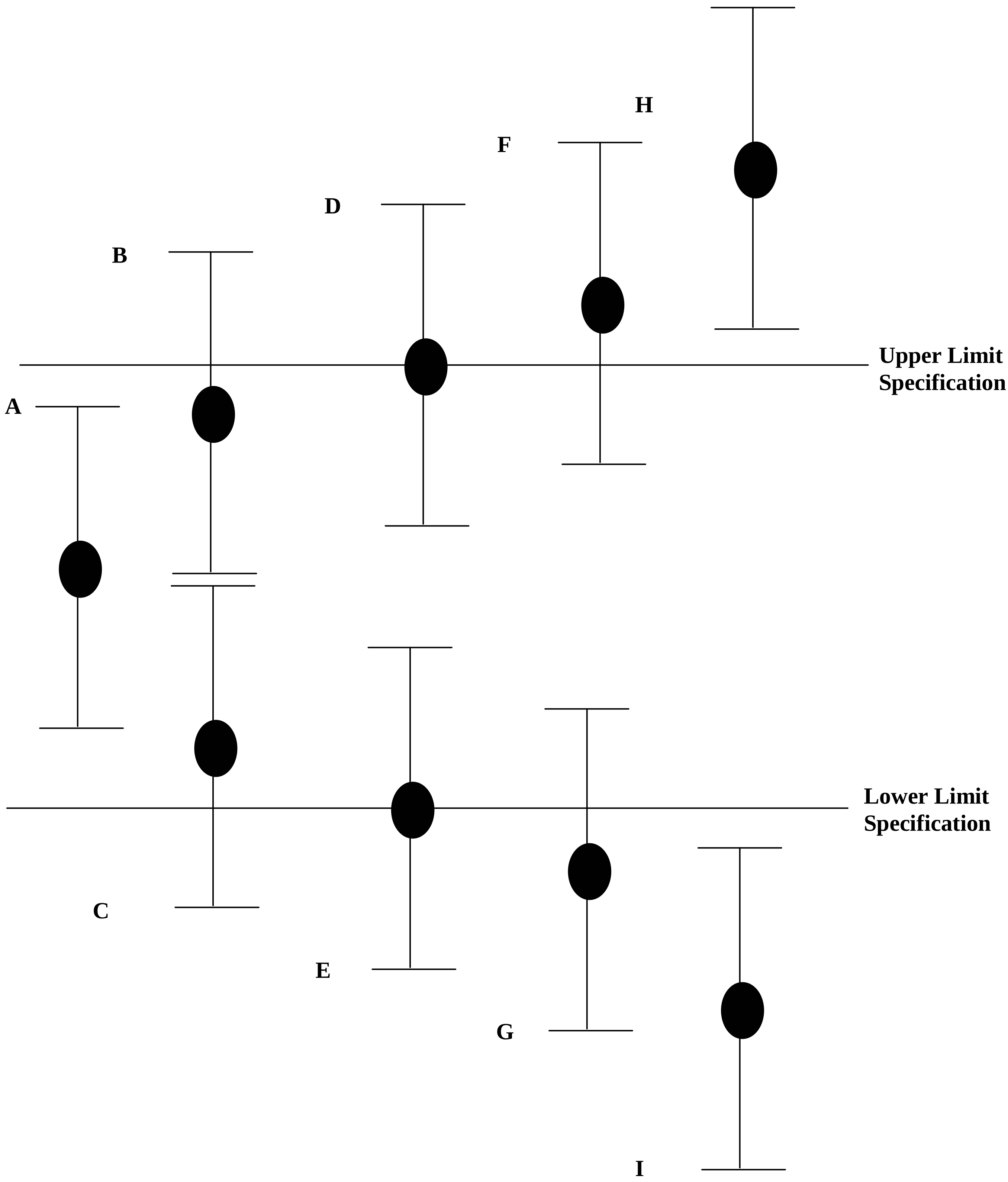


Fig.1: A result and its uncertainty compared with a given limit showing nine different cases

The care was taken to avoid the hystersis effect in paper samples. The strength properties of paper are dependent on ambient temperature and relative humidity. More precisely it is the actual moisture content in the paper, regardless of how it has obtained, which affects the strength. For the test material to attain a stable equilibrium moisture content in a standardized atmosphere, the test piece must be conditioned for a sufficiently long period of time. It is also important that the conditioning to standard atmosphere always take place by starting from lower humidity (about 30%) so called pre conditioning, in order to attain a reproducible equilibrium moisture content (***Fig. 3***). This is because of the so called moisture hystersis effect on the fibre material. Difference more than 2% can be obtained because of the moisture hystersis effect ***(Fig. 2***).

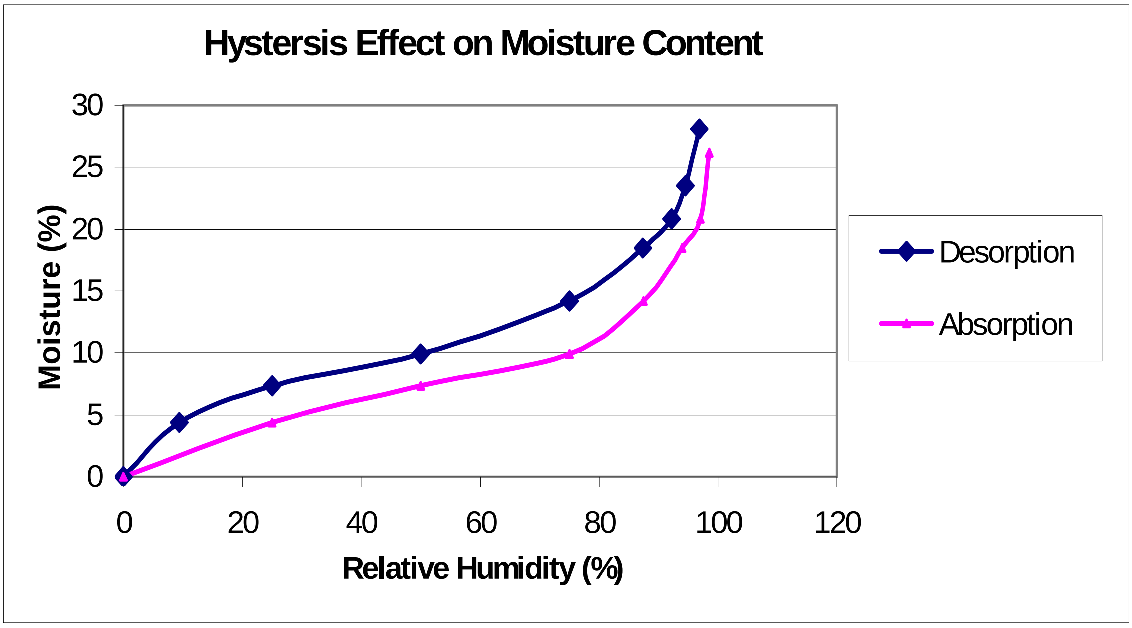


Fig. 2: Hystersis Effect on Moisture Content

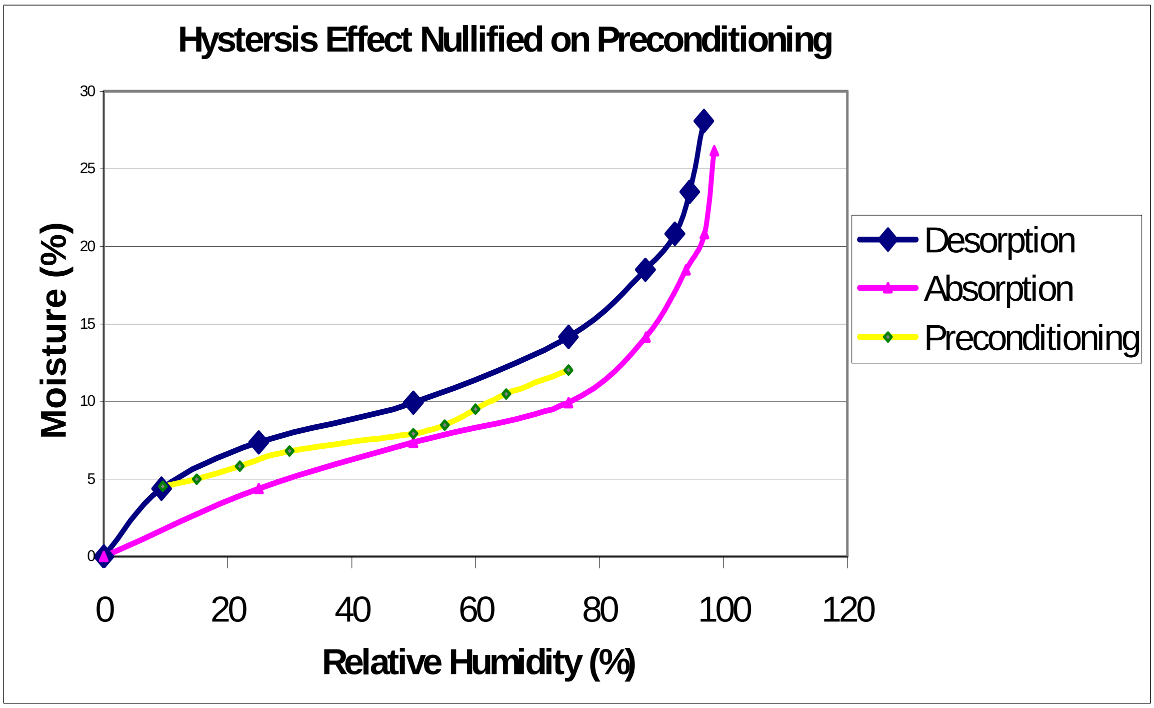


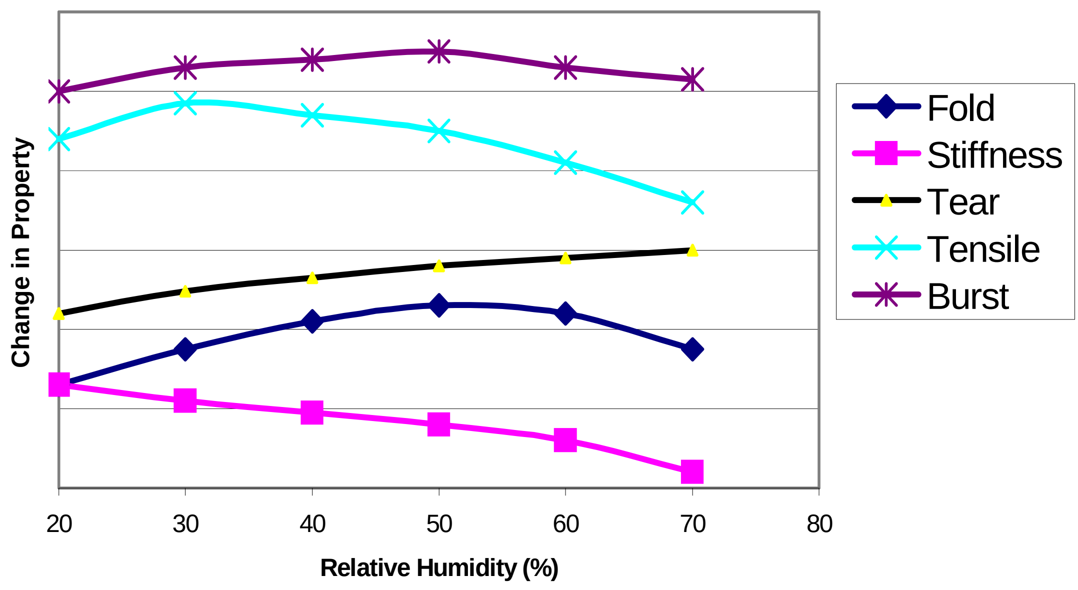
Fig. 3: Hystersis Effect nullified on Preconditioning

Internationally it has been recommended that the correct equilibrium moisture content is that which is obtained on absorption. ***(Fig. 3***).

4. Effect of Moisture on the Paper Characteristics

The effect of moisture on different paper characteristics is shown in ***Fig. 4***.

Fig. 4: General Trend of Changes in Paper Properties with Relative Humidity



The tensile strength increases slightly to a maximum at 30-35% relative humidity and then decreases quite rapidly at higher relative humidities. This decrease can be attributed to a weakening of fiber-to-fiber bonding.

Tearing resistance increases over the entire range of relative humidity. However, it is obvious that at some point above 80% the curve will fall off rapidly, due to the disruption of interfiber bonding. The paper becomes more stretchable and plastic with increasing moisture content. It is believed that this enables paper to distribute tearing stresses over a large area, thereby increasing the amount of stress absorbed before failure occurs. On the other hand, it is thought that the rigidity and low stretch characteristic of dry paper localizes tearing stresses, resulting in a low tearing strength.

Stiffness continuously decreases with increasing moisture content. This is primarily a result of increased fiber flexibility. Softness, which is inversely related to stiffness, increases substantially with increased moisture content. Consequently, in papers that require softness, additives are sometimes employed that encourage high moisture content.

The bursting strength curve shows a broad maximum between 30% and 60% relative humidity. This can be interpreted in the following way.

Bursting strength is thought to be primarily a function of tensile strength and stretch. From 20–35% relative humidity, both tensile and stretch increase, producing an increasing burst; from 35–50% relative humidity, stretch continues to increase and tensile falls off at an increasing rate, but stretch continues to dominate and burst continues to rise although at a decreasing rate. Finally, above 55% relative humidity, the decrease in tensile strength is greater than the increase in stretch, and bursting strength decreases continuously.

Folding endurance is strongly influenced by moisture content, also, increasing markedly up to 50–60% relative humidity and then falling off thereafter. Even though the curve in *Figure 4* shown above looks fairly straightforward, it cannot be analyzed in a complex function involving tension, compression, the stress-strain properties of the fibers, fiber flexibility, and probably other factors yet to be discovered.

5. Calibration and Objective of Testing

The main objectives of testing are as under:

1.	Quality Control	(i)	Establish and maintain quality
		(ii)	Control off-grade production
2.	Process control	(i)	Control of raw material
		(ii)	Control of process
		(iii)	Control of wastage
		(iv)	Improve process efficiency
3.	Process monitoring	(i)	Assess performance
		(ii)	Compare with other mills
		(iii)	Pinpoint problem areas
4.	Monetary control	(i)	Establish cost
		(ii)	Provide consideration for alternatives.

Before a test instrument is used, it must be calibrated so that it can produce results that are internally consistent, and which can be compared with results obtained on similar calibrated instruments by other when the same test method is used. Data generated by an uncalibrated or out of calibration instrument can cause untold damage in terms of wrong decisions and the resultant misdirection of effort and capital. An instrument calibration program is required if measurements are to be used to improve quality, product, and profitability. Apart from the calibration, precision and accuracy of the test method plays an important role. Precision is a statistical term used to describe the variability of introduced test values of some measured property about the average or mean value.

The data variability that results when a test method is used in a specific testing application has many sources. The sources are

- Sampling variability
- Equipment maintenance and calibration
- Difference among users

Sound decision making requires data of known precision. Decision made on imprecise data, particularly when the imprecision is unrecognized, can be costly.

The accuracy of test result is also important. The term accurate is used to describe the agreement of test results with some “absolute” correct value. Because of the hygroscopic viscoelastic nature of paper and the products made from it, there are few paper properties that can be treated as absolutes. Most properties must be considered in relationship to a specific test method and the accuracy defined on these terms. For example, because paper is hygroscopic, the value of basis weight as a function of relative humidity with which the paper is in equilibrium at the time of basis weight is determined. Unless a “standard relative humidity” is used for measurement, numerous “basis weight” will result. Similarly, because paper is viscoelastic, values determined vary. Mechanical properties such as tensile and bursting strength vary as a function of rate at which stress is applied to the paper tested, and the equilibrium relative humidity at which the testing is conducted.

Instrument calibration and maintenance are both key to providing reliable “accurate” test results.

For technical control of mill operations it is important that tests carried are sufficiently accurate. A poor test or an improperly made test is sometimes worse than no test at all. All testing procedures can be characterized by following:

- Their sensitivity (or instrument readability)
- Precision (a measure of the variation that can be expected when repeated tests are made on the same specimen)
- Accuracy (the difference between the test value and true value)

There is sometimes confusion regarding the distinction between precision and accuracy; precision is an assessment of test reproducibility, but says nothing about the relationship of the test value to the true value. For example, if the instrument is out of calibration and if a non-representative sample is being tested, the test result in either case may be precise, but probably not accurate. Factors affecting the precision or the accuracy of a test value are

1. Instrument readability
2. Instrument or test sensitivity
3. Sampling error
4. Procedural differences
5. Instrument calibration
6. Variation in correlation between measured property and desired property
7. External factors

The precision of any test result can be defined statistically in terms of standard deviation. It is frequently useful to convert the standard deviation into percentage of median test value i.e. co-efficient of variation. One way to improve test precision is to increase the number of test replications. However, greater replications mean higher cost for some technician testing. The number of replications specified for some common tests in different standards is listed in ***Table I***. Strict adherence to the number of replications is desired to get proper results.

Table I: Number of Replicates Specified in Different Standards for Different Properties.

Property	TAPPI	SCAN	APPITA	ISO	BIS
Bulking Thickness (piles)	10(5)	5(4)	10(8)	20(5)	5(5)
Grammage	-	20	20	20	10
Burst	10	8	10	10	nm*
Tensile &Stretch	10	8	10	10	10 or 20
Folding endurance	5	5	10	10	10
Cobb	-	-	-	5	nm*
Brightness	-	-	-	10	
Opacity	-	-	-	5	
Air resistance, Gurley	5	-	5	10	
Roughness, Bendtsen	-	-	-	10	
Stiffness	5	-	5	4	

nm* - Not mentioned.
In most of BIS standards, the number of replications to be carried out has not been mentioned.

5.1 Accuracy of Different Tests

The variation, which is expected in the determination of different paper properties, is given as under (***Table II***).

Table II: Reproducibility of different paper properties.

Property	**Repeatability***	**Comparability****	**Reproducibility*****	**Co-eff. of variation**
Tensile	4.0	-	15 (Ref. 1)	2.6 to 11 (Ref. 10, 11)
Bursting Strength	5.4	9.5	14.3 (Ref. 2)	4 to 10 (Ref. 12)
Thickness	1.25	-	5.5 (Ref. 3)	0.1 to 0.5 (Ref. 13)
Double fold	15	34	40 (Ref. 4)	-
Tear	1.5	2.5	4.5(Ref. 5)	2 to 9 (Ref. 14)
Stiffness	3 to 5	7 to 12	9-20 (Ref. 6)	2 to 5 (Ref. 5)
Cobb	-	-	10 (Ref. 7)	-
Air-resistance	11	-	2 (Ref. 8)	-
Opacity	0.64	-	0.77 (Ref. 9)	-

***Repeatability** – A limit within which agreement may be expected 95% time between two test results obtained under essentially the same conditions and from same homogenous sample of material.

**** Comparability** – A limit within which agreement may be expected 95% the time between two test results obtained under essentially the same conditions from samples of different materials being compared as to a particular property and having actually the same level of the measured property but differing perhaps markedly in other properties.

***** Reproducibility** – A limit within which agreement may be expected 95% of the time between two test results obtained in different standard laboratories for the same homogenous sample of material.

It clearly indicates that double fold is the most unreliable test. In our paper testing laboratory, we have observed that generally for most of the paper & board tests, co-efficient of variation lies between 5% and 10%. Exceptions are grammage and thickness, which give less; fold & stretch which give more.

In paper testing it is usual way to employ the mean value of a property as a guide to judge the suitability of the material. Where the standard deviation or co-efficient of variation result is calculated, this is normally done to determine the confidence limits of the mean result. Although for some properties such as substance, roughness and stiffness this data is normally adequate, for other properties the mean value is in itself of little utility. The test value that is required is the minimum value of the property that is likely to be encountered in practice. This is true for instance for tensile strength and pick resistance. Occasionally very low values of these properties could result in web breaks or the necessity for frequent wash down on printing presses although the average value of the relevant properties could be so high that trouble might not be anticipated if mean alone were considered.

For example, if we have two paper Samples A & B which have mean tensile strength of 5 kgf and standard deviation of 0.5 kgf and 0.1 kgf (***Table III***).

Table III: Paper Samples with Same Mean Value but Difference in Standard Deviation.

For A	For B
90% of paper will have tensile strength between 4.5 & 5.5 kgf	90% paper will have tensile strength between 3.9 & 4.1 kgf
95% strength between 4.0 and 6.0 kgf.	95% strength between 3.8 and 4.2 kgf.
99.8% strength between 3.5 and 6.5 kgf.	99.8 % strength between 3.7 and 4.3 kgf.

If minimum tensile load desired in converting operation is 3.8 kgf, B will give more web breaks than A. If minimum tensile load is 3.6 kgf, A will give more web breaks.

5.2 Uncertainty, Repeatability and Reproducibility

Uncertainty of a measurement is a parameter associated with the result of a measurement that characterized the dispersion of the values reasonably attributed to the measurand. The measurand is a particular quantity subject to measurement.

The uncertainty of a result is a comparison of many uncertainty components. It depends on material tested, sampling, principle of testing method, instructions for performance, experience and competence of the personnel, quality of the equipment and testing environment etc. Factors arising from systematic effects such as components associated with corrections and reference materials may also contribute to the dispersion.

A measurement result always consists of a value with information about measurement uncertainty. The quality of the measurement result depends on the error structure in the measurement process, while quality of the information about measurement uncertainty is determined by our knowledge about the error structure. A measurement that is not accompanied by some form of information about measurement uncertainty in therefore of no use as a measurement result. The paper industry has lacked guidance as to low measurement uncertainty should be estimated in physical testing. Measuring correctly is important, but for us in the paper industry, it is even more important to measure consistently. In other words, a measurement performed on one occasion should be comparable to measurement performed on other occasion in the same laboratory as well as in other laboratories. The standard published SCAN G.6.00 contains all the relevant information in this regard. A way of controlling measurement uncertainty is following a regular calibration schedule. The frequency of calibration is determined by the requirements for measurement quality.

Repeatability of result of measurement is the closeness of agreement between results of successive measurements using the same material under the same conditions. This mean the same operator repeats the measurements within a short period of time without any changes in measurement procedure, equipment or test conditions. Any variation noted this way describes the repeatability of the measurement.

Reproducibility of result of measurements is the closeness of the agreement between the results of measurements using different conditions of measurements when defining reproducibility, any conditions can change including the principle of the method. Statements about reproducibility therefore require a specification of the conditions.

6. Mills/Organization Selected for Participation

The following mills which have well equipped paper testing laboratories were chosen to try this CPPRI comparative testing calibration service methodology.

- M/s Ballarpur Industries Ltd. (3 Units)
- M/s Hindustan Paper Corporation Ltd.
- M/s Mysore Paper mills Ltd.
- M/s ITC Bhadrachalam Paper & Boards Ltd.
- M/s Century Pulp & Paper Ltd.
- M/s Seshasayee Paper & Board Ltd.
- M/s J.K. Paper Corporation Ltd.
- M/s The West Coast Paper mills Ltd.
- M/s Star Paper mills Ltd.
- Kumarappa National Handmade Paper Institute

These mills were sent the paper samples and the test results obtained from these mills were analyzed to check the performance of their instruments. The findings were conveyed to them for taking appropriate action at their end.

7. Properties Covered in this Service

The properties and the relevant standards followed covered under this service are given in ***Table IV***.

Table IV: Properties and Their Relevant Standard Test Methods.

Property	Standard Test method
Tearing Strength	ISO 1974:1990
Tensile Strength	ISO 1924
Bursting Strength	ISO 2758
Double Fold	ISO 5626
Brightness	ISO 2470
Smoothness	ISO 8791-2
Thickness	ISO R534
Gloss	TAPPI 480-om-99

8. Test Results obtained and Observations

The results obtained from the mills were analyzed.

The property was evaluated as per standard method. The action limit was evaluated using formulae

Action limit: Mean ± 2.0 S.D. The report was sent to the mills in the following format

Format in which the results were sent to the mills

Your Reference —

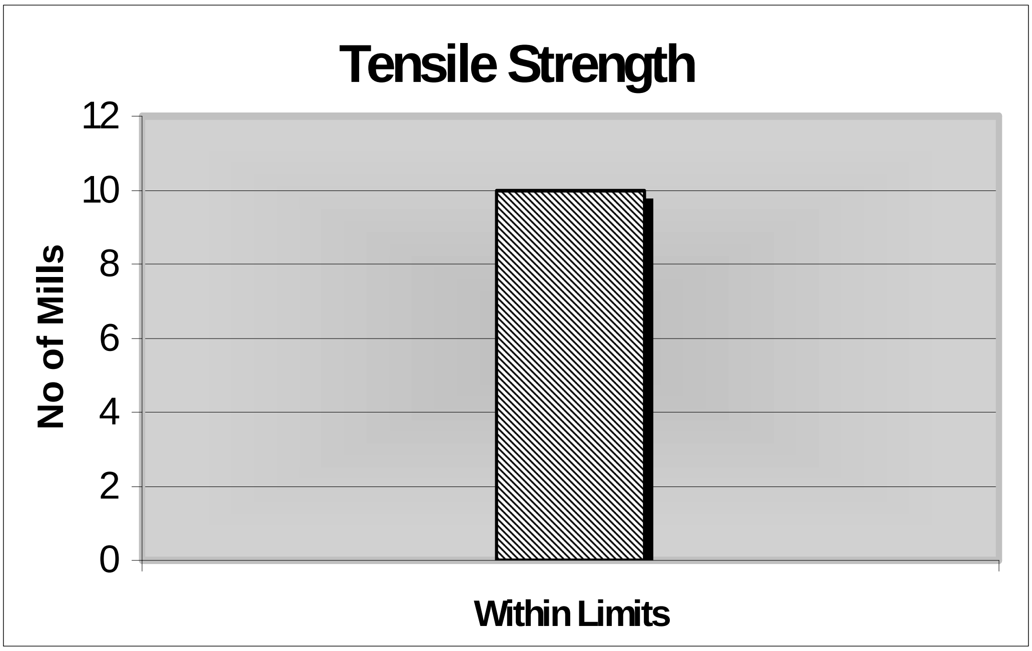
Our Reference —

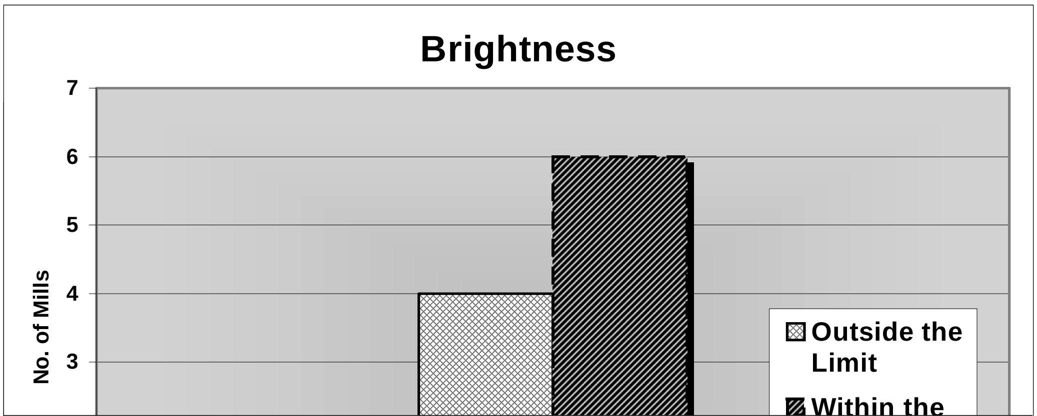
Property	Action Limit	Mills' Results	Comments
X	A to B	A+, B–	Results are in the limit
		A–, B+	Results are outside the limits and probable cause of variation

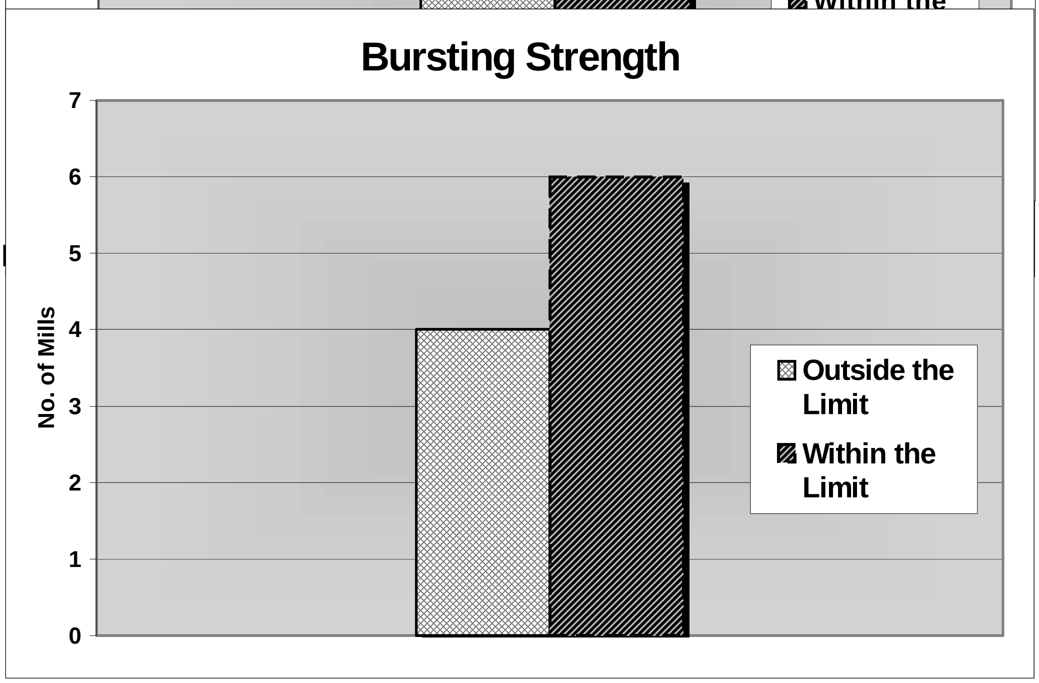
The mill took appropriate action to rectify the instrument (e.g. ***Annexure III***).

The analysis data obtained for different characteristics is depicted as bar diagram (***Figs. 5–12***).

Fig. 6: Thickness testing in laboratories of different mills







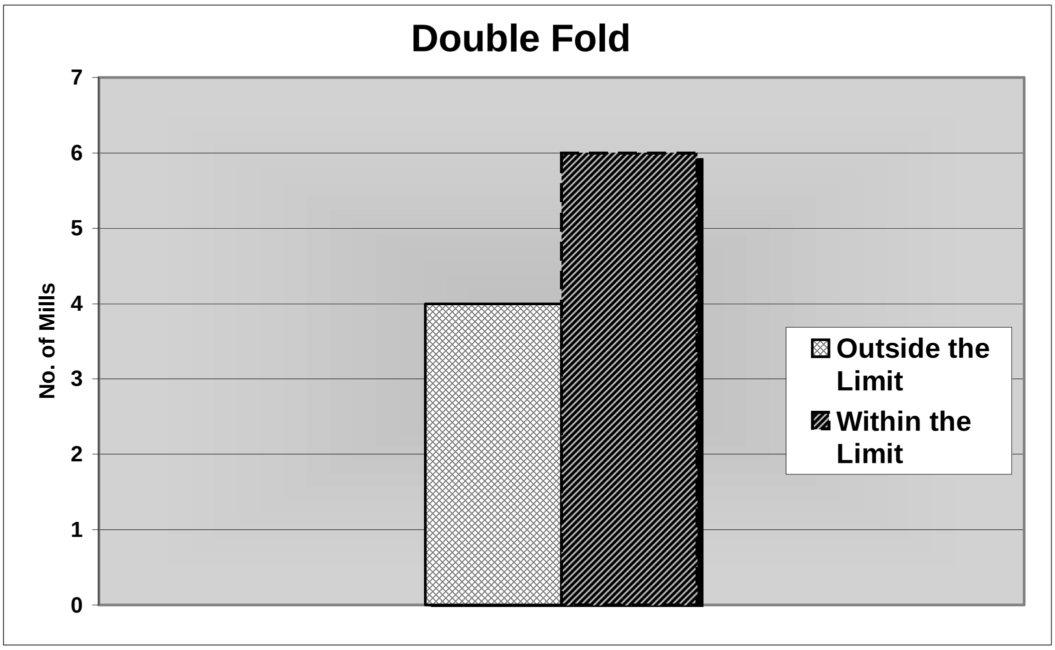


Fig. 9: Double Fold testing in laboratories of different mills

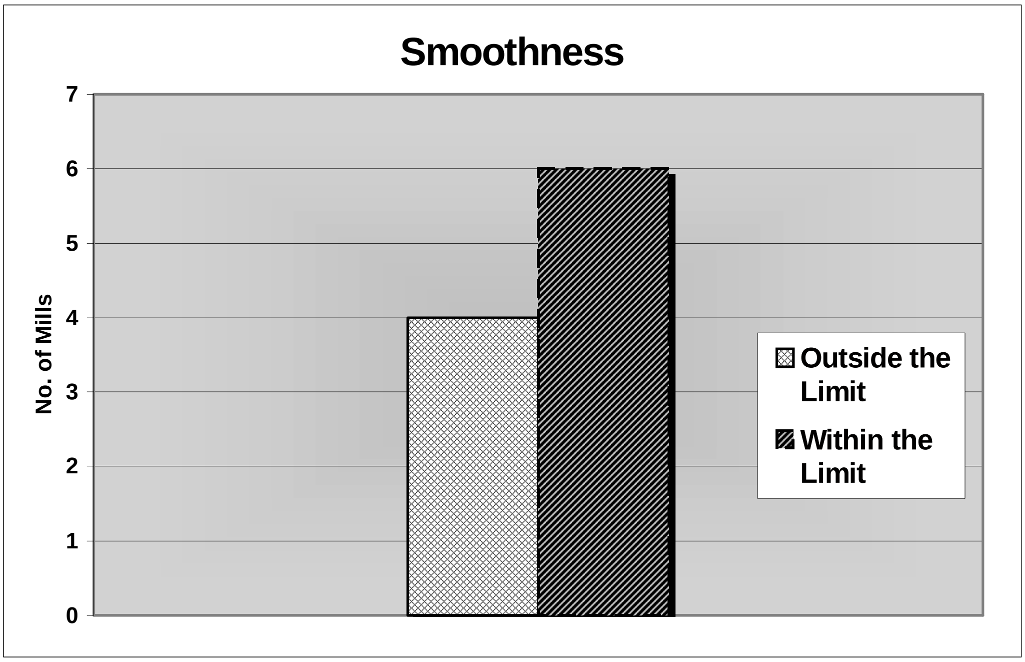


Fig. 10: Smoothness testing in laboratories of different mills

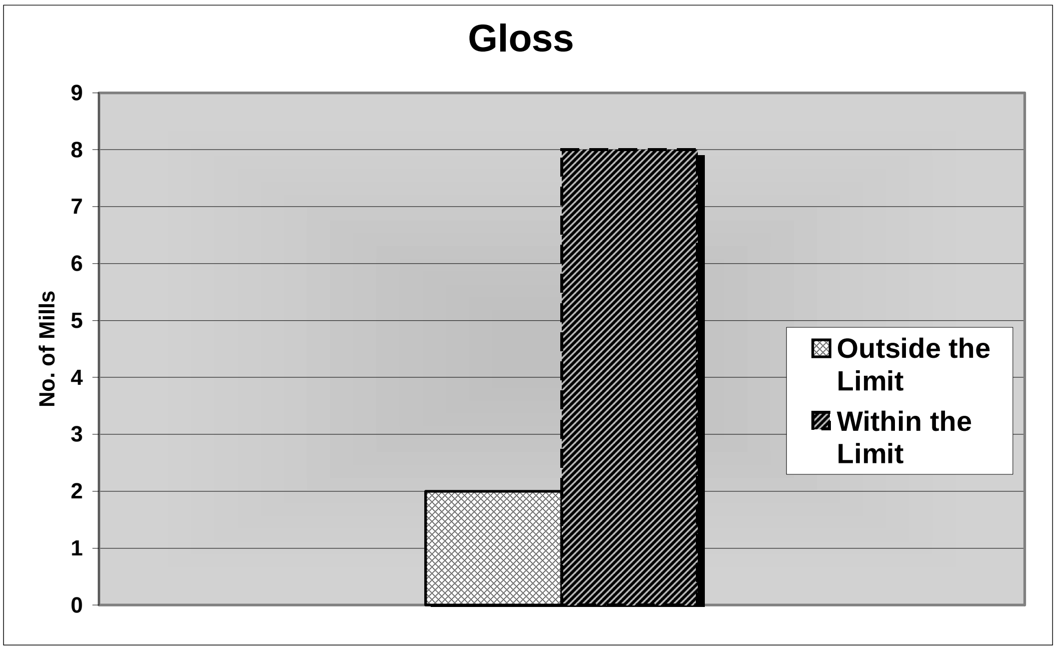


Fig. 11: Gloss testing in laboratories of different mills

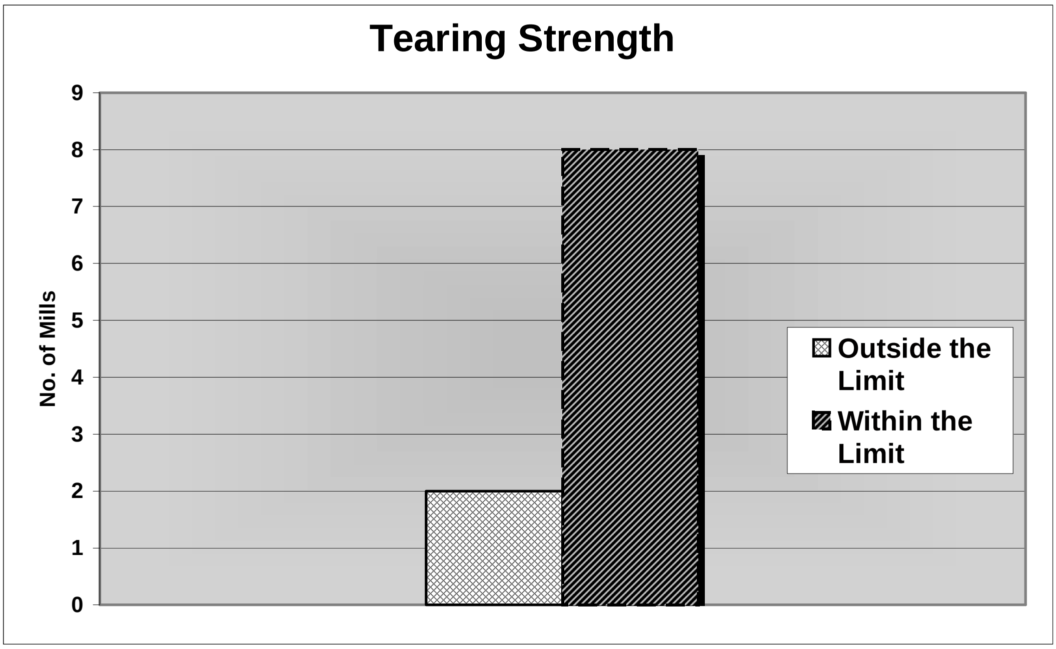


Fig. 12: Tearing Strength testing in laboratories of different mills

Results indicated that the major variation in results obtained is for the following properties

- Brightness
- Bursting Strength
- Double Fold
- Smoothness
- Thickness

The probable reasons for the variability may be as under:

8.1 Brightness Measurement

Some of the mills still have not adopted the amendment issued for ISO standard test method. In the latest amendment it has been recommended that a part of UV reflection should also be included in the brightness value. It is important to realize that fluorescence from a fluorescent whitening agent is a blue radiation that influence the brightness value if the measurement is not equipped with an UV filter that eliminates the fluorescence. For this reason, brightness often differs between instruments. There is a currently (1997) a proposal to adjust UV content is illumination according the to the CIE illumination C when measuring the brightness of fluorescent materials. The new generation spectrophotometers have provision for this adjustment of UV content. There are three brightness values for fluorescent materials.

- C brightness (ISO brightness)
- D_{65} brightness
- Brightness with fluorescent eliminated

In paper trade different brightness are referred.

The designations used are:

Directional Brightness Tappi T452 ($45^0/0^0$)	GE brightness, IPC brightness
Diffuse brightness ISO 2470 ($d/0^0$)	Elrepho brightness, ISO brightness CPPA brightness

No direct method of transforming values from the one to the other is possible. The difference is usually not greater than 2%.

8.2 Bursting Strength

Bursting strength is a complex paper property, which takes into consideration tensile strength, stretch as well as density of the paper. For this property the sheet clamping pressure is quite important and the bursting strength value is dependent on the clamping pressure. The mills are required to take appropriate action in this regard.

8.3 Double Fold

Double fold is very sensitive paper property. It depends on sheet structure, atmospheric condition, loading rate and the type of instruments. The mills are having different type of instrument viz. Kohler Molin, MIT, Schopper type. It is quite difficult to correlate all these instruments. The variation in this characteristic is always expected.

8.4 Bendtsen Smoothness

The variability obtained in this parameter is probably due to lack of auto clamping and damaged measuring head in the instruments. The manual handling of measuring head is more prone to operator’s skill. The operator personal skill in putting the measuring head on the paper surface and time taken to read the reading affects the results.

8.5 Thickness

Thickness is a critical measurement of the uniformity of paper or board today, when thickness is monitored by on-line equipment, it is vital to have an accurate thickness tester in the laboratory, in order to calibrate and verify the operation of the on-line equipment. In spite of this, the micrometer is one of the most overlooked instruments in many laboratories.

The micrometer should confirm to standard in:

- Lowering speed of the upper measuring face
- Contact pressure
- Good parallel alignment between the measuring faces

The conditions specified under different standard test methods are listed in ***Table V.***

Table V: The Conditions of Measuring Thickness as Specified Under different Standard Methods.

Standard Method	**Dead Weight Load, kg**	**Surface Size, cm^2**	**Lowering Speed, mm/s**
SCAN P7	2	2	1
ISO 534	2	2	2
Tappi T411	1	2	0.8

The variation in the results obtained is probably due to different testers available within the laboratories. The variation observed was more in case of bulking thickness values.

8.6 The Remaining Properties

Tensile strength, tearing strength and gloss — most of the mills have given satisfactory results.

9. Feed back from participating mills

A questionnaire (given in ***Annexure I***) was sent to these mills to get information about the usefulness of CPPRI calibration approach. In this response eight mills have responded (***Annexure II***). The positive remarks indicated by these mills have shown that the approach is useful to the mills.

10. Recommended Calibration Schedule for Paper Testing Instruments

For proper functioning of the instruments, the schedule to be followed is given below

Parameter	Schedule
Thickness Tester	
Parallelism of jaws	Quarterly
Accuracy of gauge using standard samples	Quarterly
Lowering speed	Two years
Bursting Strength	
Diaphragm Condition	Monthly
Glycerin level	Monthly
Accuracy of gauge using standard samples	Quarterly
Clamping pressure	Quarterly
Check value in case of electronic pressure gauges	Quarterly
Tensile strength	
Load cell accuracy	Quarterly
Functioning of stretch measuring device	Quarterly
Checking load with standard samples	Quarterly
Double fold	
Jaws condition	Weekly
Number of strokes per minute	Half yearly
Checking with standard samples	Quarterly
Tear tester	
Pointer friction	Monthly
Clamping section	Quarterly
Pendulum factor	Half yearly
Knife cut	Quarterly
Values using standard samples	Quarterly

(Continued)

Brightness tester	
Calibration with standard plates	Daily
Calibration using standard samples	Quarterly
Bendtsen smoothness tester and Porosity tester	
Level of instrument	Weekly
Accuracy using standard samples	Quarterly
Gloss tester	
Calibration with standard plates	Daily
Verification with standard samples	Quarterly

11. Conclusions

1. Comparative calibration service approach started by CPPRI has been given positive consent by participating mills/organization.
2. The Ten mills included in this study were having good quality imported instruments still the intra laboratory results were not consistent. The variation observed in the values received indicated that serious attention has not been given in some cases for the calibration. CPPRI Comparative Calibration Services has given them methodology of checking their instruments at regular interval and steps to rectify the abnormality. Some mills also got rechecked the performance after making necessary advised adjustments in their instruments.
3. The mills need serious attention to the evaluation of paper properties like brightness, bursting strength, double fold, smoothness and thickness, which have shown wide variation amongst mills.
4. The properties like tensile strength, tearing strength and gloss measured in different laboratories are well in agreement.
5. For proper functioning of paper testing instruments, the schedule recommended in the report should be followed by the mills. Further continuation of this service by CPPRI will be quite useful for Indian paper Industry. For this, CPPRI will formulate ‘Comparative Calibration Service’ on chargeable basis. This service will be extended to all the mills in future.

12. References

1. Tappi T 404-os-76
2. Tappi T 403-os-76
3. Tappi T 411-os-76
4. Tappi T 423-su-68
5. Tappi T 414-ts-65
6. Tappi T 489-os-76
7. Tappi T 441-os-69
8. Tappi T 460-os-75
9. Tappi T 425-os-75
10. BS 4415 : 1969
11. ISO Recommendation ISO/R 1924-1971
12. Appita P 403 rp - 73
13. Appita 427 Ts - 72
14. Appita P 400 m - 73
15. Appita P 431 rp – 73

13. Annexure I

Comments/Suggestion about the comparative calibration test samples services started by CPPRI

S. No.	Query	Comments/Suggestion
1.	Whether such service is helping your mill in updating the performance of your instruments.	
2.	Whether CPPRI should further continues this activity.	
3.	What should be the frequency of sending samples Quarterly/Half Year/Yearly.	
4.	What paper property should be covered under this service.	
5.	Any other remarks.	