INSTITUTO DE PESQUISAS TECNOLÓGICAS

PROFICIENCY TESTING SCHEME FOR PAPER

CYCLE 2026

PROTOCOL

SUMMARY

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1 INTRODUCTION

A laboratory can be considered the main environment for the practice of metrology and it is expected that it delivers results with assured quality. For that, it needs a quality system which ensures the emission of metrologically reliable results and an external evidence of its proficiency.

The participation in a Proficiency Testing Scheme (PT Scheme) is a manner an external evidence of proficiency of a laboratory, as mentioned in ISO/IEC 17025 These PT Schemes consist of measurement of one or more parameters performed independently by a group of laboratories in samples of a material. Their application requires a provider) and participating laboratories. Among the functions of the provider are: to prepare instructions, to send the samples (test items) to the participants and to statistically treat the results obtained from participating laboratories. The mean role of the participant is to follow the instructions given by the coordinator.

The mean steps of a PT Scheme are shown in **Figure 1**.

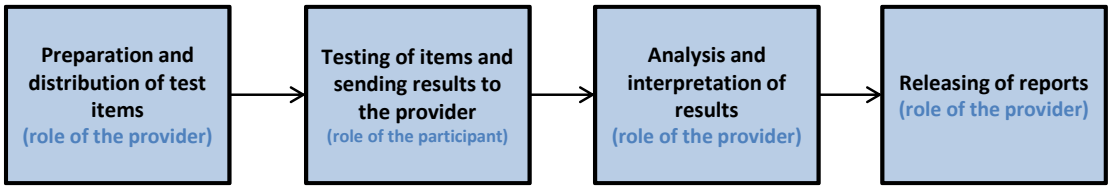

Figure 1 – Mean steps of a PT Scheme

IPT - Institute for Technological Research - has a large experience in coordinating PT Schemes, in which the first PT Scheme offered for tests in paper began in 1977.

The coordination of PT Scheme for Paper is the researcher Patrícia Kaji Yasumura, from *Laboratório de Celulose, Papel e Embalagem* (Pulp, Paper and

Packaging Laboratory), who, together with her team, offers a scheme that allows participating laboratories to observe their performance against a group of laboratories and to identify the nature of deviations of their results, as well as some problems such as calibration of equipment and technicians trainings.

The PT Scheme for Paper is offered yearly and consists of three rounds and includes printing paper (uncoated and coated paper), packaging paper and paperboard.

2 TARGET TYPE OF PARTICIPANT

Laboratories that perform tests in paper and paperboard, whether they are from industries, private companies, associations, research institutes or universities.

3 TESTS OFFERED

Test	Standard	Related Brazilian Standard
PRINTING PAPER		
UNCOATED PAPER		
○ Moisture content	TAPPI T 412 om-22	-
○ Grammage	ISO 536:2019 TAPPI/ANSI T 410 om-23	ABNT NBR NM ISO 536:2000 versão corrigida 2002
○ Thickness	ISO 534:2011 TAPPI T 411 om-21	ABNT NBR NM ISO 534:2006
○ Air permeance, *Gurley*	ISO 5636-5:2013 T 460 om-21	ABNT NBR NM ISO 5636-5:2006
○ Roughness, *Bendtsen*	ISO 8791-2:2013	ABNT NBR NM ISO 8791-2:2001
○ Surface strength (wax pick test)	TAPPI T 459 om-21	ABNT NBR NM 255:2001
○ ISO brightness	ISO 2470-1:2016	ABNT NBR NM ISO 2470:2001
○ Opacity	ISO 2471:2008	ABNT NBR NM ISO 2471:2001
○ Bursting strength (printing paper)	ISO 2758.2014 TAPPI T 403:2022	ABNT NBR NM ISO 2758:2007

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Test	Standard	Related Brazilian Standard
○ Tensile strength, elongation and tensile energy absorption - constant rate of elongation method (20 mm/min)	ISO 1924-2:2008	ABNT NBR NM ISO 1924-2:2012
○ Tearing resistance, *Elmendorf*	ISO 1974:2012 TAPPI T 414:2021	ABNT NBR NM ISO 1974:2001
○ Ash on ignition at 525 degrees C	ISO 1762:2019 TAPPI T 211:2022	ABNT NBR 13999:2017
PACKAGING PAPER		
○ Bursting strength (packaging paper)	ISO 2759:2014	ABNT NBR NM ISO 2759:2007
○ Compressive strength (RCT)	ISO 12192:2011 TAPPI/ANSI T 822 om-22	ABNT NBR ISO 12192:2012
○ Flat crush resistance after laboratory fluting (CMT)	ISO 7263-1:2018	ABNT NBR ISO 7263:2012
○ Water absorptiveness, *Cobb*	ISO 535:2023 TAPPI/ANSI T 441 om-20	ABNT NBR NM ISO 535:1999 versão corrigida 2011
○ Tensile strength, elongation and tensile energy absorption – constant rate of elongation (100 mm/min)	ISO 1924-3:2005	ABNT NBR ISO 1924-3:2006
○ Short-span compression strength	ISO 9895:2008 TAPPI T 826	ABNT NBR ISO 9895:2009

ABNT = *Associação Brasileira de Normas Técnicas* (Brazilian Association of Technical Standards).
ISO = International Organization for Standardization.
NBR = *Norma Brasileira* (Brazilian Standard).
NM = *Norma Mercosul* (Mercosul Standard).

4 APPLICATION

The laboratory interested in participating in this PT Scheme should fill in the Application Form included in the *Invitation Letter*. Also available on: (https://ipt.br/papel-e-celulose).

5 TEST ITEMS

5.1 Preparation

For the operation of PT Scheme for Paper, different lots of paper reels or cut sheets (depending on the sort of paper) are purchased from recognised manufacturers. A

printing office is contracted to cut sheets in specimens. The cutting process is monitored by provider assistants. From these lots, specimens are prepared to compose the samples to be tested by the participants.

The laboratory receives in each round for each test subscribed, one pair of samples (**Sample A** and **Sample B**). Each sample consists of a defined number of test items, in which all of them should be tested by the laboratory. The transport of the samples is carried out by a subcontracted company.

IPT ensures that every sample received by the participants has the same variability, because they are sent only after the verification of homogeneity. The parameters chosen for homogeneity check are shown below.

- Printing paper:
    - Uncoated: bursting strength and grammage;
- Packaging paper: grammage.

To verify the homogeneity of samples, according to the sort of paper (printing, packaging and paperboard), a defined number of specimens are extracted from both lots of samples A and B, and they are tested. The obtained values are treated using Analysis of Variance (ANOVA) single factor, whose result indicates whether or not the lot is homogeneous.

The stability test is performed through continuous monitoring of the homogeneity results of the sample used in each round, and it is determined based on ISO 13528:2022 – Statistical methods for use in proficiency testing by interlaboratory comparison – demonstrating that the samples remain stable during the period covering their shipment and the receipt of results (approximately thirty days).

5.2 Analysis and results sending

The participants perform tests in the samples received following the guidelines outlined in the Instruction Manual sent by IPT. In this manual is also indicated how participants should send their results to IPT.

The veracity of test results is a responsibility of the participant.

6 STATISTICAL ANALYSIS OF RESULTS

The statistical treatment applied to the participants' results aims to determine consensus values and evaluate laboratory performance, according to ISO 13528:2022 — *Statistical methods for use in proficiency testing by interlaboratory comparison*.

Calculations are performed using robust methods that reduce the influence of discrepant values, ensuring stable estimates representative of the dataset.

6.1 For tests with fewer than 6 participants

When there are fewer than six valid results, no robust statistical treatment is applied, as the reduced number of observations does not allow for reliable estimation of variability. In these cases, the results are presented in tables or graphs only, without performance statistics.

This procedure also applies to tests for which statistical treatment is not applicable (for example, surface strength – Dennison wax test).

6.2 For tests with six or more participants (robust Q/Hampel method)

For datasets with six or more valid results, the **robust Q/Hampel method** is applied, which combines two main estimators:

- **Robust standard deviation (s*)**: calculated using the **Qn estimator** (Croux & Rousseeuw, 1992), defined as the first quartile of all pairwise absolute differences multiplied by 2.2219. This estimator is resistant to up to 50 % of extreme values.
- **Consensus value (x*)**: calculated using the **Hampel M-estimator**, obtained iteratively from the median and weighted according to the robust dispersion s^*. This procedure down-weights distant results and converges to a stable consensus value.

For each result xi, the **robust z-score** is computed as:

$$zi = \frac{xi - x^*}{s^*}$$

Interpretation of performance follows the criteria of ISO 13528:2022:

$|z| \leq 2$ → Satisfactory performance;

$2 < |z| < 3$ → Questionable performance;

$|z| \geq 3$ → Unsatisfactory performance.

6.3 Construction of the Youden Plot

Laboratory performance for samples A and B is represented graphically through the **Youden plot**. Each point on the plot corresponds to a laboratory, with coordinates representing its results for samples A (X Axis) and B (Y Axis).

The plot center is given by the consensus (x_A^**,x_B^*), obtained by the robust Q/Hampel method.

The joint dispersion of results is represented by a **95 % confidence ellipse**, constructed from the covariance matrix between samples A and B. The ellipse boundary corresponds to:

$$(x-\mu)'\sum^{-1}(x-\mu) = \mathcal{X}^2_{2;0,95}$$

where $\mu = (x_A^*\,*, x_B^*)$, and Σ is the covariance matrix, and $\mathcal{X}^2_{2;0,95} = 5{,}991$ is the critical value of the chi-square distribution with 2 degrees of freedom.

In addition, the graph presents an elongated region in the direction of the largest eigenvector of Σ, representing the zone where systematic errors predominate.
Shifts approximately parallel to this direction indicate common trends between samples A and B (consistently high or low values).
Dispersions perpendicular to this direction characterize random error.

Rectangular zones centered at the consensus point, corresponding to ± 2σ and ± 3σ along each axis, are added to help interpret the magnitude of individual deviations, approximating the z-score.

The Youden Plot is generated individually for each test and allows immediate evaluation of:

- consistency between samples A and B
- presence of systematic trends
- random dispersion of results
- relative position of each participant compared to the consensus

7 CONFIDENTIALITY

Absolut secrecy is ensured to the participant, that is identified by a code known only by itself and IPT. The documents issued by IPT contain only the codes of the laboratories an there is no information that can identify these laboratories.

NOTE Participants can choose to waive confidentiality within the proficiency testing program for the purpose of discussion and mutual assistance, for example, to improve performance. Confidentiality may also be waived by participants for the purpose of regulation or recognition. In most cases, the results its the proficiency test can be provided by the participants themselves to a competent authority.

When an interested party requires the results of the proficiency test to be directly provided by the proficiency test provider, it will only be possible after approval by the participant.

8 PRESENTATION OF PT SCHEME RESULTS

By the end of each round, the participant receives one custom-made report where it can observe its position in relation to the group of participant laboratories. The report shows information and comments for comprehension of results obtained and advices in case of non-satisfactory performances.

By the end of last round, the participant receives a document that summarizes its performance in the PT Scheme.

9 COMPLAINT

To register a complaint, the participant must contact the IPT Ombudsman's Office via email ouvidoria@ipt.br.

The Ombudsman's Office will receive the complaint and register it in the system designed for this purpose. The participant will be notified of the receipt of their manifestation, the actions that will be taken and the deadline for responding.

The Ombudsman will evaluate the origin of the complaint with the area complained of and will monitor the service until the process is completed and the problem is corrected.

After completing the process, the Ombudsman will contact the participant to check on their satisfaction.

10 APPEAL

To appeal against the performance evaluation in the program, contact by email interlab@ipt.br. The deadline for appeal will be 15 calendar days after the submission of the report.

The appeal will be sent to the Quality Representative who will receive and record the request on the form intended for this purpose. The participant will be notified of the receipt of their manifestation, the actions that will be taken and the deadline for responding.

The Quality Representative will evaluate the origin of the complaint and will monitor the service until the process is completed and the problem is corrected.

Upon completion of the process, the Quality Representative will contact the participant to check on their satisfaction.

11 SCHEDULE

11.1 Of activities

FIRST ROUND

STEP	MARCH				APRIL				MAY			
International samples dispatch	06											
National samples dispatch		13										
Performing of tests by the participant and sending of results to IPT							20					
Composing of the report and sending to the participants											22	

SECOND ROUND

STEP	JUNE				JULY				AUGUST			
International samples dispatch		12										
National samples dispatch			19									
Performing of tests by the participant and sending of results to IPT								27				
Composing of the report and sending to the participants												28

THIRD ROUND

STEP	SEPTEMBER				OCTOBER				NOVEMBER			
International samples dispatch	04											
National samples dispatch		11										
Performing of tests by the participant and sending of results to IPT							19					
Composing of the report and sending to the participants											19	
Sending of performance summary and declaration of participation												11/12

11.2 Of payment

Charge	Months								
	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Single payment									

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