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Proficiency Testing Department
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PROFICIENCY TESTING PROGRAM

No CCB/PT-4.4/K.1

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Aggregates

PROFICIENCY TESTING ORGANIZER ACCREDITED BY PCA

No PT 014

Developed:	Approved:
Agata Dziubek *Statistician* **Brygida Augustyniok** *Technical Manager*	**Brygida Augustyniok** *Coordinator* 12.01.2026 Brygida Jadwiga Augustyniok Elektronicznie podpisany przez Brygida Jadwiga Augustyniok Data: 2026.01.12 06:54:19 +01'00' *date and signature*

Contents:

1. Proficiency Testing Organizer

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Proficiency Testing Department
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e-mail: badania.bieglosci@barg.pl
Tax Identification Number: 524-29-36-340

In the scope of these proficiency tests, the PT Organizer undertakes to maintain confidentiality of all information provided by Participants, including, among others, test results and the identities of individual Participants, and to ensure impartiality in evaluating their actions. The Organizer also commits to securing documentation related to the tests against unauthorized access.

This proficiency testing program is conducted in accordance with the requirements of the PN-EN ISO/IEC 17043:2011 (EN ISO/IEC 17043:2010)[W] standard. The PT Organizer is accredited by the Polish Accreditation Center for the objects and properties covered by this PT program in accordance with the scope presented in point 7 by this PT program – Accreditation Scope No. PT 014, available on the PT Organizer's website www.ccbarg.pl and on the PCA website www.pca.gov.pl.

2. Individuals involved in the design and operation of the proficiency testing program.

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3. Purpose of the program

The aim of the proficiency testing program is:

- evaluation of the Participant's performance in conducting specific tests / sampling
- providing evidence to confirm the validity of results and technical competence of the Participant
- enabling the Participant to identify areas for improvement through proficiency testing
- providing customers with additional information to enhance trust

[W] standard having withdrawn status

4. Object of proficiency testing

The proficiency testing objects will be aggregates obtained from the aggregate manufacturer/supplier. The proficiency testing program provides for two types of PT objects:

- **The object of the proficiency testing for sampling by Participants -** will be a batch of aggregate from which Participants will independently collect samples. The collected samples will be taken by Participants to their own locations, where they will be prepared for testing. The Participants will then submit the prepared samples to the PT Organizer for evaluation of the correctness of sampling by the Participants and the impact of this process on the laboratory test results.

- **The proficiency test object prepared by the PT Organizer** - will be a sample of aggregate collected, prepared, and packaged by the PT Organizer. The material prepared in this way will be sent to the Participants for laboratory testing.

5. Subcontracting

During the implementation of this proficiency testing program, the PT Organizer will use subcontracting in the following areas:

- sample collection for conducting tests to assess uniformity and stability, as well as preparing samples for Participants,
- preparation of proficiency testing objects,
- conducting tests to assess homogeneity and stability,
- conducting tests to evaluate the results of Participants' sampling activities.

The above activities will be carried out by the accredited laboratory BARG CENTRUM Sp. z o.o. based in Ożarów Mazowiecki, Accreditation Scope No. AB 1354. In addition, tests to assess homogeneity and stability will also be carried out by BARG M.B. Gdańsk Sp. z o.o. based in Gdynia, Accreditation Scope No. AB 1470, and FERROCARBO Sp. z o.o. based in Krakow, Accreditation Scope No. AB 687.

If it becomes necessary to subcontract in another area during the program, the PT Organizer will promptly inform Participants in writing about the additional services it intends to subcontract.

The proficiency testing organizer does not subcontract the planning of the proficiency testing program, assessment of performance results, or the development and authorization of the final report.

6. Criteria for Participation in Proficiency Testing

Participation in proficiency testing is possible after acceptance of the participation conditions specified in this program, which occurs upon submission of the dedicated Registration Form for a particular round, within the deadline indicated in the Schedule of the PT program, to the email address badania.bieglosci@barg.pl.

The proficiency testing format is open and is carried out cyclically. Participation is open to both accredited and non-accredited laboratories, as well as other interested parties involved in conformity assessment activities. The minimum number of Participants for each method is 5, while the maximum is 30. In case of too few submissions, the PT Organizer may extend the submission period (which may affect the deadlines indicated in the Schedule of the program for a given round) or cancel the proficiency testing for a specific property, and Participants will be promptly informed. In case of exceeding the number of Participants, the order of submissions will determine participation. In the event of an

overwhelming number of interested parties, the PT Organizer may announce additional rounds under this program. A Participant may take part in proficiency testing for selected properties. Tests should be conducted by the Participant using the testing methods specified by the PT Organizer.

In the proficiency test, for a given method, no more than:

- 2 Participants from one entity, where the total number of Participants is 10 and below,
- 3 Participants from one entity, where the total number of Participants is more than 10.

A Participant without accreditation for a specific test is also required to conduct the test using supervised equipment, ensuring measurement consistency, in accordance with DA-06 (ILAC-P10).

Details of the proficiency testing program implementation are described in the Instruction developed for each program round. Participants should follow the requirements of the Instruction.

Results from Participants should be provided with expanded measurement uncertainty, with the same accuracy and in the same unit as the test result, at a specified expansion factor k and expansion probability p, following ILAC-G17.

Results from Participants that do not meet program requirements and/or instructions for Participants, including results obtained using a different testing method, failure to meet requirements for measurement consistency, or reported without measurement uncertainty, will not be used to determine the values of x_{pt} and σ_{pt}.

Participation in proficiency testing is subject to a fee. Participation costs are presented in the Registration Form. They do not cover the costs of delivering proficiency testing objects (aggregate samples) to the PT Organizer by the Participant, or to the Participant by the PT Organizer. Samples prepared for the assessment of the Participant's performance in terms of sampling are delivered to the PT Organizer by the Participant (in person or via a shipping company) at the Participant's expense. Samples prepared by the PT Organizer for other tests covered by this program shall be delivered by the PT Organizer to the Participant (in person or via a shipping company and according to the shipping company's price list) at the Participant's expense. After registering for participation, the PT Organizer sends an invoice with a 14-day payment term to the Participant. The proficiency testing report can be provided to the Participant after settling the payment for participation. Failure to provide proficiency testing results by the Participant does not exempt them from the obligation to pay according to the scope of the reported participation.

A Participant has the right to withdraw from participation in proficiency testing free of charge, which requires submitting a written withdrawal to the email address badania.bieglosci@barg.pl within 14 days from the end of sending the applications.

7. Scope of Organized Proficiency Testing

Ord.	Measured quantity/property	Reference document
1.	Grain composition [A]	PN-EN 933-1:2012 (EN 933-1:2012)
	Fines content [A]	
2.	Flakiness index [A]	PN-EN 933-3:2012 (EN 933-3:2012)
3.	Crushed particles content [A]	PN-EN 933-5:2023-05 (EN 933-5:2022)
4.	Sand equivalent [A]	PN-EN 933-8+A1:2015-07 (EN 933-8+A1:2015)
5.	Resistance to wear Micro-Deval method [A]	PN-EN 1097-1:2024-05 (EN 1097-1:2023)
6.	Resistance to fragmentation Los Angeles method [A]	PN-EN 1097-2:2020-09 (EN 1097-2:2020)
7.	Bulk density [A]	PN-EN 1097-3:2000 (EN 1097-3:1998)
8.	Water content Weight method [A]	PN-EN 1097-5:2008 (EN 1097-5:2008)
9.	Particle density and water absorption Pyknometer method [A]	PN-EN 1097-6:2022-07 (EN 1097-6:2022)
10.	Resistance to freezing and thawing [A]	PN-EN 1367-1:2007 (EN 1367-1:2007)
11.	Resistance to freezing and thawing in the presence of salt (NaCl) [A]	PN-EN 1367-6:2008 (EN 1367-6:2008)
12.	Optimum water content Maximum dry density Proctor method [A]	PN-EN 13286-2:2010 (EN 13286-2:2010) PN-EN 13286-2:2010/AC:2014-07 (EN 13286-2:2010/AC:2012)
13.	Shape index [NA]	PN-EN 933-4:2008 (EN 933-4:2008)
14.	Flow coefficient of fine aggregates [NA]	PN-EN 933-6:2023-06 (EN 933-6:2022)
15.	Presence of humus [NA]	PN-EN 1744-1+A1:2013-05 p.15.1 (EN 1744-1:2009+A1:2012 p. 15.1)
16.	Lightweight contaminators content [NA]	PN-EN 1744-1+A1:2013-05 p.14.2 (EN 1744-1:2009+A1:2012 p. 14.2)
17.	California bearing ratio CBR [NA]	PN-EN 13286-47:2022-04 (EN 13286-47:2021)
18.	Alkaline reactivity, accelerated method [NA]	Test Procedure GDDKiA PB/1/18
19.	Sampling [NA] [assessed by means of grain composition testing performed by the Organizer PT in accordance with PN-EN 933-1:2012 (EN 933-1:2012) on samples taken by the Participant]	PN-EN 932-1:1999 (EN 932-1:1996)

[A] measured quantity/property covered by the scope of accreditation

[NA] measured quantity/property not covered by the scope of accreditation

The scope of measured quantities/properties is specified in the Registration Form and defined within successive rounds of the program in accordance with the Schedule of the PT program for a given calendar year. Detailed information on what needs to be identified, measured, or tested is provided in the Instruction and Test Result Sheets. Instructions and Test Result Sheets are made available to Participants no later than the day of transferring samples for proficiency testing. The range of expected values and/or properties for proficiency testing objects is indicated in the Registration Form and/or Instruction for a specific round.

8. Potential sources of errors

- Incorrect handling of test objects
- Occurrence of collusion among Participants
- Equipment that does not meet the requirements of the reference document
- Malfunctioning equipment during sampling / testing
- Influence of environmental conditions during sampling / testing
- Small number of Participants
- Use of a different method by the Participant than required in the proficiency testing program
- Non-compliance with the PT Organizer's guidelines
- Non-compliance with the guidelines included in the testing methods

9. Preventive Measures to Prevent Collusion Among Participants

Each Participant, by signing the registration form, commits to maintaining confidentiality of obtained test results in relation to other Participants and securing proficiency testing documentation from unauthorized access.

Participant is obligated to collect samples / perform tests and submit the results to the Proficiency Testing Department (DBB) of the PT Organizer, without consulting with other Participants, whose participation in each program is known to them from other sources. In the event of collusion detection, Participants will be disqualified from participating in the specific round and will bear the total costs of participation in the proficiency testing program. It should be noted, however, that avoiding collusion and falsifying results is the responsibility of each Participant.

10. Production, storage and distribution of research objects and instructions for Participants

Object of proficiency testing for sampling by Participants

The PT Organizer, after gathering the required number of Participants, organizes the sampling and provides all Participants with information related to the rules of sampling.

In order to ensure high homogeneity, the proficiency test object will be a pile of aggregate produced/obtained from a single location at a single point in time.

The samples collected by the Participants will be transported by the Participants to their own locations, where they will be prepared for testing. The Participants will then submit the prepared samples to the PT Organizer for evaluation of the correctness of sampling by the Participants and the impact of this process on the laboratory test results.

The Participant is responsible for transporting the samples to the place where the Participant will prepare the samples, as well as to the PT Organizer. The Participant is obliged to ensure that the method of securing the test objects, as well as the type and time of their transport, meets the requirements of this program and does not adversely affect their condition.

In the event of loss or damage to test objects to an extent that prevents the test from being performed in accordance with the test method, the Participant shall not take part in the assessment of sampling in a given round of the proficiency testing program. Failure to deliver samples or delivery of damaged samples to the PT Organizer does not release the Participant from the obligation to pay in accordance with the scope of the reported participation.

The proficiency test object prepared by the PT Organizer

Proficiency testing objects are manufactured in a way that ensures their high uniformity by sampling from a stockpile consisting of material obtained from one location at one point in time.

The storage of proficiency testing objects takes place under conditions consistent with the requirements of testing methods, preventing the influence of external factors on their properties, and ensuring the maintenance of their appropriate stability.

The method of packing proficiency testing objects, for the purpose of their transfer to Participants, is designed to ensure that the type and timing of transport do not negatively impact their condition and properties.

Proficiency testing objects are delivered to Participants through a shipping company. During the delivery of the shipment (in the presence of a courier), the Participant is obligated to check its condition. Any damages to the delivered sample should be immediately reported to the Proficiency Testing Coordinator. In the case of loss or damage to the proficiency testing objects, if possible, the Coordinator sends the Participant a reserve sample from the pool of archival samples.

All information related to the implementation of the proficiency testing program has been described in this program, the Schedule of the PT program, or is provided to the Participant in the form of Instructions for Participants.

The Instruction for Participants contains detailed information related to the execution of the tests, such as the type, size, and/or quantity of samples to be collected / tested, methods of preparing and storing objects, deadlines for completing individual stages of the test, properties of the object necessary for conducting the test, accuracy in reporting test results and measurement uncertainty, etc.

11. Checking the homogeneity and stability of proficiency testing objects

11.1. Homogeneity

Homogeneity is assessed according to the algorithm presented in Figure 1. Test samples will be randomly selected from the prepared proficiency testing objects for a given round of the program, in quantities specified in Table 1. Two portions (m) will be prepared from each series. The tests will be conducted under repeatability conditions as soon as possible after the samples are collected.

Proficiency testing facility for sampling

Sampling/series (g) will be spread evenly over the sampling period by the Participants. Two portions (m) will be prepared from each series. The tests will be performed under repeatability conditions.

Proficiency testing object intended for other tests

Two portions (m) will be prepared from each series. The tests will be conducted under repeatability conditions as soon as possible after the samples are collected.

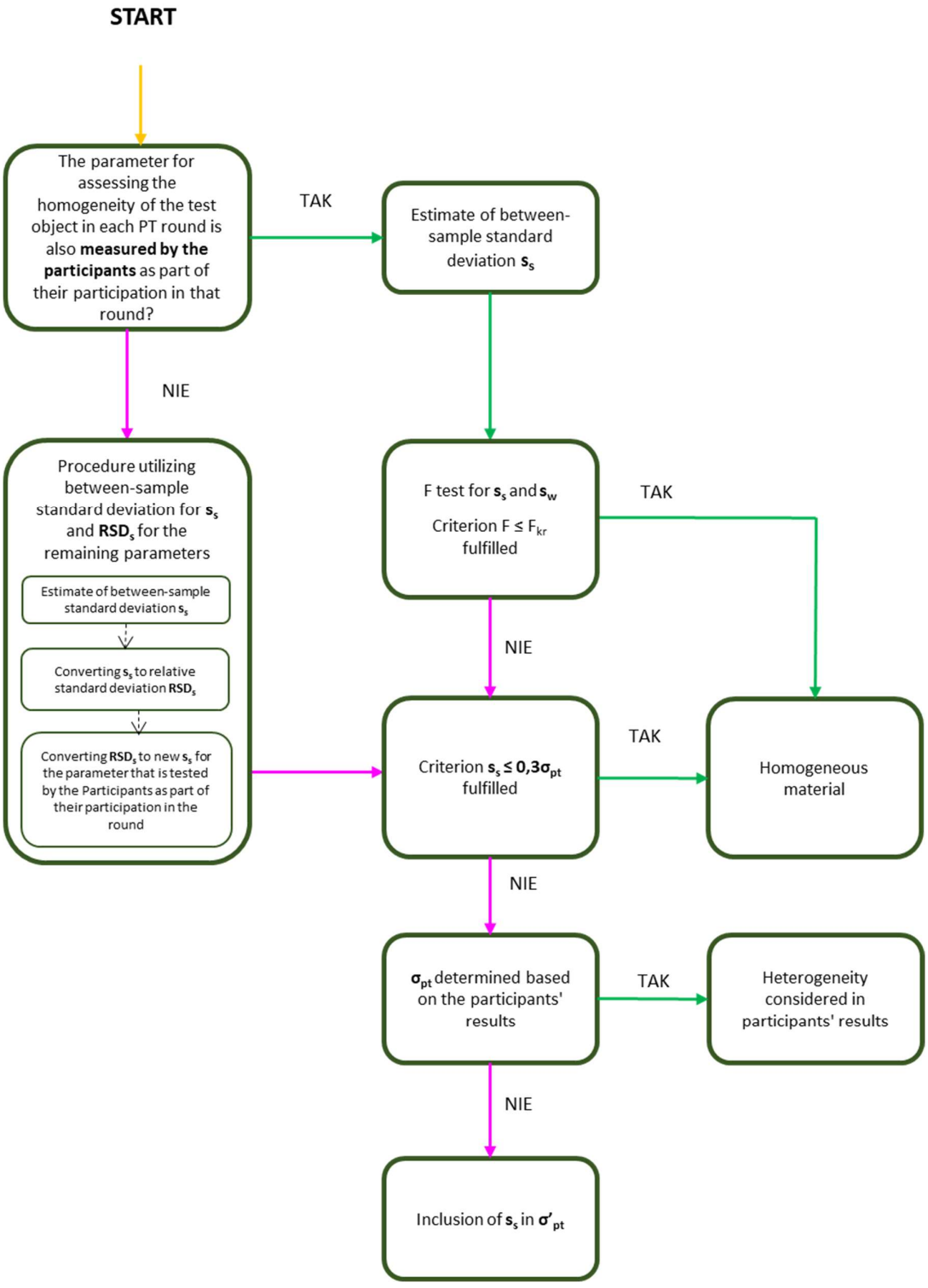


Fig. 1. Homogeneity assessment algorithm in proficiency testing

Table 1. List of values verifying homogeneity for individual values measured as part of proficiency tests.

Measured quantity/property	**Number of samples**	**A quantity verifying homogeneity**
Grain composition Fines content **PN-EN 933-1:2012 (EN 933-1:2012)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Flakiness index **PN-EN 933-3:2012 (EN 933-3:2012)**	6	Flakiness index [1)] **PN-EN 933-3:2012 (EN 933-3:2012)**
Crushed particles content **PN-EN 933-5:2023-05 (EN 933-5:2022)**	6	Crushed particles content [1)] **PN-EN 933-5:2023-05 (EN 933-5:2022)**
Sand equivalent **PN-EN 933-8+A1:2015-07** **(EN 933-8+A1:2015)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Resistance to wear Micro-Deval method **PN-EN 1097-1:2024-05 (EN 1097-1:2023)**	6	Resistance to fragmentation Los Angeles method **PN-EN 1097-2:2020-09 (EN 1097-2:2020)**
Resistance to fragmentation Los Angeles method **PN-EN 1097-2:2020-09** (**EN 1097-2:2020**)	6	Resistance to fragmentation Los Angeles method **PN-EN 1097-2:2020-09 (EN 1097-2:2020)**
Bulk Density **PN-EN 1097-3:2000 (EN 1097-3:1998)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Water content Weight method **PN-EN 1097-5:2008 (EN 1097-5:2008)**	6	Water content Weight method **PN-EN 1097-5:2008 (EN 1097-5:2008)**
Particle density and water absorption Pyknometer method **PN-EN 1097-6:2022-07** (**EN 1097-6:2022**)	6	Water absorption **PN-EN 1097-6:2022-07 (EN 1097-6:2022)**
Resistance to freezing and thawing **PN-EN 1367-1:2007 (EN 1367-1:2007)**	6	Water absorption **PN-EN 1097-6:2022-07 (EN 1097-6:2022)**
Resistance to freezing and thawing in the presence of salt (NaCl) **PN-EN 1367-6:2008 (EN 1367-6:2008)**	6	Water absorption **PN-EN 1097-6:2022-07 (EN 1097-6:2022)**
Optimal water content Maximum dry density Proctor method **PN-EN 13286-2:2010 (EN 13286-2:2010)** **PN-EN 13286-2:2010/AC:2014-07** **(EN 13286-2:2010/AC:2012)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Shape index **PN-EN 933-4:2008 (EN 933-4:2008)**	6	Shape index **PN-EN 933-4:2008 (EN 933-4:2008)**
Flow coefficient of fine aggregates **PN-EN 933-6:2023-06 (EN 933-6:2022)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Presence of humus **PN-EN 1744-1+A1:2013-05 p.15.1** **(EN 1744-1:2009+A1:2012 p. 15.1)**	6	Presence of humus **PN-EN 1744-1+A1:2013-05 p.15.1** **(EN 1744-1:2009+A1:2012 p. 15.1)**
Lightweight contaminators content **PN-EN 1744-1+A1:2013-05 p.14.2** **(EN 1744-1:2009+A1:2012 p. 14.2)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
California bearing ratio CBR **PN-EN 13286-47:2022-04** **(EN 13286-47:2021)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Alkaline reactivity, accelerated method **Test Procedure GDDKiA PB/1/18**	6	Determination of potential alkaline reactivity using a rapid method **PN-92/B-06714-46** [W]
Sampling **PN-EN 932-1:1999 (EN 932-1:1996)**	6	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**

[1)] Alternatively based on grain composition according to PN-EN 933-1:2012 (EN 933-1:2012)

[W] standard having withdrawn status

Estimate of between-sample standard deviation (according to ISO 13528:2022-08 Annex B.3), homogeneity is verified by calculating the standard deviation between samples:

If m=2

$$s_s = \sqrt{max(0,\ s_{\bar{x}}^2 - s_w^2 / 2)}$$

$$s_{\bar{x}} = \sqrt{\sum_{t=1}^{g} (\bar{x}_t - \bar{\bar{x}})^2/(g-1)}$$

$$s_w = \sqrt{\sum_{t=1}^{g} w_t^2/(2g)}$$

If m≠2

$$s_s^2 = s_{s,w}^2 - s_w^2 = \frac{1}{(g-1)}\sum_{t=1}^{g}(\bar{x}_t - \bar{\bar{x}})^2 - \frac{1}{m}\, s_w^2$$

$$s_x^2 = \frac{1}{(g-1)}\sum_{t=1}^{g}(\bar{x}_t - \bar{\bar{x}})^2$$

$$s_w^2 = \frac{1}{g}\sum_{t=1}^{g} s_t^2$$

$$s_{s,w}^2 = \frac{1}{(g-1)}\sum_{t=1}^{g}(\bar{x}_t - \bar{\bar{x}})^2 + \left(1 - \frac{1}{m}\right) s_w^2 = s_s^2 + s_w^2$$

where:
s_s – estimate of between-sample standard deviation
$s_{\bar{x}}$ – standard deviation of sample averages
s_w – ithin-sample or within-laboratory standard deviation
$s_{s,w}$ – combined variance value of s_s and s_w
$\bar{x}_t$ – mean for the t-th sample (t=1, …, g)
$\bar{\bar{x}}$ – overall mean
w_t – between-test-portion range
g – number of proficiency test items tested in a homogeneity check
m – number of replicate measurements to be made by each participant on a proficiency test item

Test samples will be deemed homogeneous if the condition is satisfied according to the algorithm presented in Figure 1:

$$F \leq F_{kr}$$

or

$$s_s \leq 0{,}3\ \sigma_{pt}$$

where:

$$F = \frac{s_{\bar{x}}^2}{s_w^2}$$

$F_{kr\ unilateral}$ (P = 95%; g-1; g·(m-1))

11.2. Stability

Stability will be assessed according to the algorithm presented in Figure 2. Test samples will be randomly selected from the prepared proficiency testing objects for a given round of the program, in quantities specified in Table 2. Two portions will be prepared from each series. The first group of samples will be tested before the planned distribution date, and the second group as soon as possible after the deadline for submitting results from Participants has passed. All samples are tested under repeatability conditions. The pre-distribution test may be skipped if there is an opportunity to use the test results obtained in the homogeneity assessment.

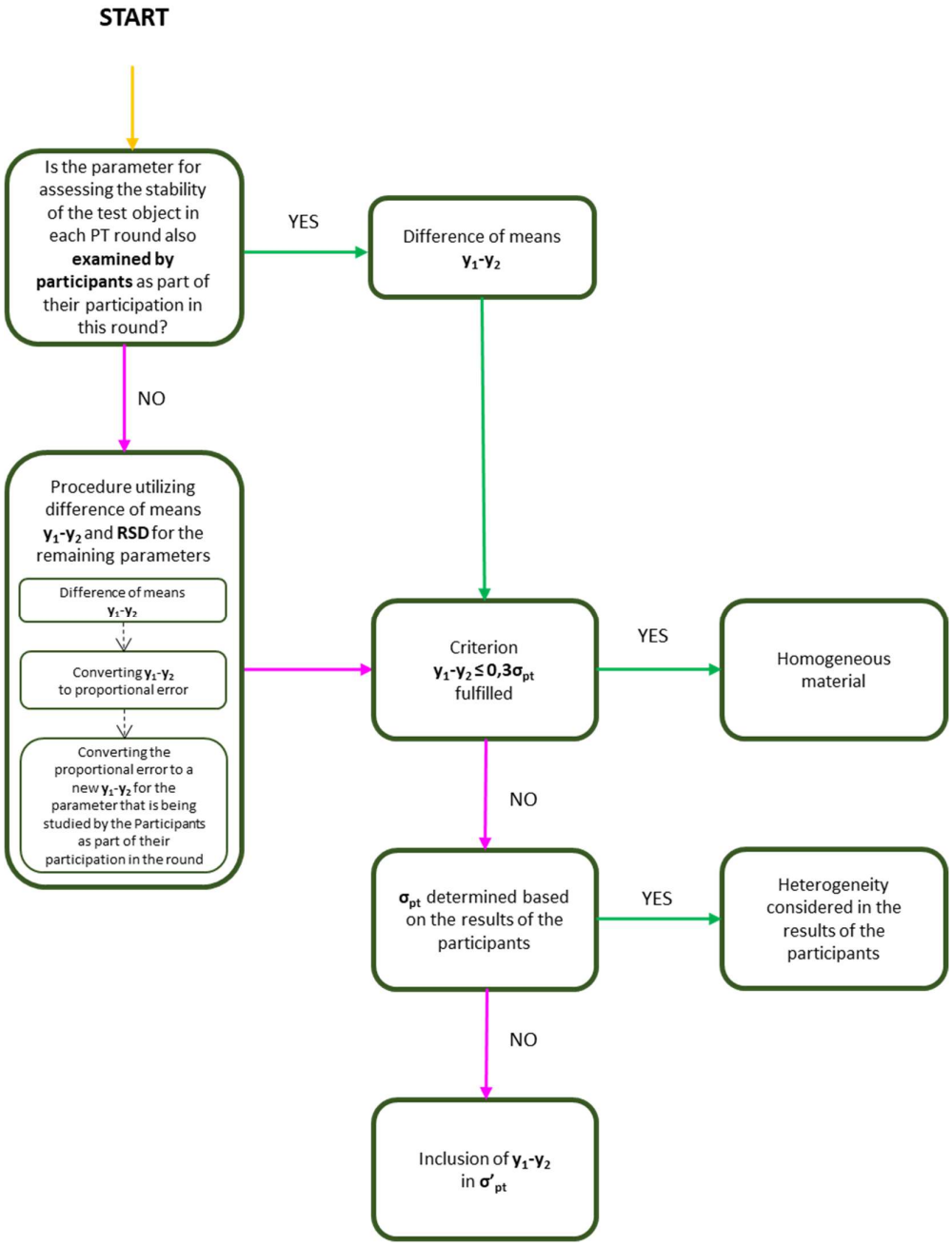


Fig. 2. Algorithm for assessing stability in proficiency testing

Table 2. List of values verifying stability for individual values measured as part of proficiency tests.

Measured quantity/property	Number of samples	A quantity verifying stability
Grain composition Fines content **PN-EN 933-1:2012 (EN 933-1:2012)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Flakiness index **PN-EN 933-3:2012 (EN 933-3:2012)**	2	Flakiness index [2)] **PN-EN 933-3:2012 (EN 933-3:2012)**
Crushed particles content **PN-EN 933-5:2023-05 (EN 933-5:2022)**	2	Crushed particles content [2)] **PN-EN 933-5:2023-05 (EN 933-5:2022)**
Sand equivalent **PN-EN 933-8+A1:2015-07** **(EN 933-8+A1:2015)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Resistance to wear Micro-Deval method **PN-EN 1097-1:2024-05 (EN 1097-1:2023**	2	Resistance to fragmentation Los Angeles method **PN-EN 1097-2:2020-09 (EN 1097-2:2020)**
Resistance to fragmentation Los Angeles method **PN-EN 1097-2:2020-09** (**EN 1097-2:2020**)	2	Resistance to fragmentation Los Angeles method **PN-EN 1097-2:2020-09 (EN 1097-2:2020)**
Bulk Density **PN-EN 1097-3:2000 (EN 1097-3:1998)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Water content Weight method **PN-EN 1097-5:2008 (EN 1097-5:2008)**	2	Water content Weight method **PN-EN 1097-5:2008 (EN 1097-5:2008)**
Particle density and water absorption Pyknometer method **PN-EN 1097-6:2022-07** (**EN 1097-6:2022**)	2	Water absorption **PN-EN 1097-6:2022-07 (EN 1097-6:2022)**
Resistance to freezing and thawing **PN-EN 1367-1:2007 (EN 1367-1:2007)**	2	Water absorption **PN-EN 1097-6:2022-07 (EN 1097-6:2022)**
Resistance to freezing and thawing in the presence of salt (NaCl) **PN-EN 1367-6:2008 (EN 1367-6:2008)**	2	Water absorption **PN-EN 1097-6:2022-07 (EN 1097-6:2022)**
Optimal water content Maximum dry density Proctor method **PN-EN 13286-2:2010 (EN 13286-2:2010)** **PN-EN 13286-2:2010/AC:2014-07** **(EN 13286-2:2010/AC:2012)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Shape index **PN-EN 933-4:2008 (EN 933-4:2008)**	2	Shape index **PN-EN 933-4:2008 (EN 933-4:2008)**
Flow coefficient of fine aggregates **PN-EN 933-6:2023-06 (EN 933-6:2022)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Presence of humus **PN-EN 1744-1+A1:2013-05 p.15.1** **(EN 1744-1:2009+A1:2012 p. 15.1)**	2	Presence of humus **PN-EN 1744-1+A1:2013-05 p.15.1** **(EN 1744-1:2009+A1:2012 p. 15.1)**
Lightweight contaminators content **PN-EN 1744-1+A1:2013-05 p.14.2** **(EN 1744-1:2009+A1:2012 p. 14.2)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
California bearing ratio CBR **PN-EN 13286-47:2022-04** **(EN 13286-47:2021)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**
Alkaline reactivity, accelerated method **Test Procedure GDDKiA PB/1/18**	2	Determination of potential alkaline reactivity using a rapid method **PN-92/B-06714-46** [W]
Sampling **PN-EN 932-1:1999 (EN 932-1:1996)**	2	Grain composition **PN-EN 933-1:2012 (EN 933-1:2012)**

[2)] Alternatively based on grain composition according to PN-EN 933-1:2012 (EN 933-1:2012)

[W] standard having withdrawn status

Stability is verified by comparing the overall means obtained at various stages of the control (according to ISO 13528:2022-08 Annex B.4):

$$|\bar{y}_1 - \bar{y}_2| \leq 0{,}3\ \sigma_{pt}$$

where:

$\bar{y}_1$ –overall mean of results obtained before the start of the round

$\bar{y}_2$ - overall mean of results obtained after the completion of the round

11.3. Procedure in case of inhomogeneity and instability (according to ISO 13528:2022-08 Annex B.2.5, B.5)

11.3.1. Inhomogeneity

If the criterion for sufficient homogeneity is not met, one of the following options is considered:

a. Option I

Rehomogenization and portioning of objects, followed by retesting for homogeneity.

b. Option II

Incorporating the deviation between samples s_s into data analysis by using:

- σ'_{pt} determined by the formula

$$\sigma'_{pt} = \sqrt{\sigma_{pt}^2 + s_s^2}$$

- or z' specified by the formula

$$z_i' = \frac{x_i - x_{pt}}{\sqrt{\sigma_{pt}^2 + s_s^2}}$$

c. Option III

Not assessing the results of participants' activities.

11.3.2. Instability

If the criterion for sufficient stability is not met, the first step involves checking the impact of measurement uncertainty on precision. For this purpose, the acceptance criterion is expanded according to the formula:

$$|\bar{y}_1 - \bar{y}_2| \leq 0{,}3\sigma_{pt} + 2\sqrt{u^2(\bar{y}_1) + u^2(\bar{y}_2)}$$

In the event that the expanded criterion is also not met, one of the following options is considered:

a. Option I

Incorporating the difference between overall means obtained at various stages of the control $\bar{y}_1 - \bar{y}_2$ into σ_{pt}

b. Option II

Not assessing the results of participants' activities.

12. Method and Evaluation Criteria

After receiving proficiency testing results from all participants, a preliminary data analysis will be conducted to verify whether the provided results meet the requirements set by the PT Organizer as specified in the program and instructions for participants. This data analysis may involve verification of measurement consistency, application of the appropriate research method, or presentation of the test result (correct unit, required precision, result with expanded measurement uncertainty), etc. Participants' results obtained in a given round of the program will be verified for distribution before statistical analysis of the data.

Results from participants that do not meet the program and/or instruction requirements, including results obtained using a different research method, failure to meet consistency requirements, or presented without measurement uncertainty, will not be used to determine the values x_{pt} and σ_{pt}.

In cases where analyses other than robust ones are applied to determine the values x_{pt} or σ_{pt}, a Grubbs' test will be conducted (according to PN-ISO 5725-2:2002 (ISO 5725-2:1994)) to detect outlier values.

The Grubbs' test will be used to check whether the dataset contains data affected by gross errors.

One observed outlier

For this purpose, the obtained values are ranked in ascending order, and then the parameters G_1 and G_p are determined according to the formulas:

$$G_1 = \frac{\bar{x} - x_1}{s}$$

$$G_p = \frac{x_p - \bar{x}}{s}$$

$$\bar{x} = \frac{1}{p}\sum_{i=1}^{P} x_i$$

$$s = \sqrt{\frac{1}{p-1}\sum_{i=1}^{P}(x_i - \bar{x})^2}$$

where:
$\bar{x}$ – mean value
x_1 – smallest value in the result set
x_p – largest value in the result set
s – standard deviation

The obtained values will be compared with the critical value at a confidence level of 95%. If G_1 or G_p exceeds the critical value, the corresponding result will be considered as an outlier and will be excluded from the dataset used for further calculations.

Two observed outliers

For this purpose, the obtained values are ranked in ascending order, and then the G parameters are determined according to the formulas:

For the two largest values

$$G = \frac{s_{p-1,p}^2}{s_0^2}$$

$$s_0^2 = \sum_{i=1}^{p} (x_i - \bar{x})^2$$

$$s_{p-1,p}^2 = \sum_{i=1}^{p-2} (x_i - \bar{x}_{p-1,p})^2$$

$$\bar{x}_{p-1,p} = \frac{1}{p-2} \sum_{i=1}^{p-2} x_i$$

For the two smallest values

$$G = \frac{s_{1,2}^2}{s_0^2}$$

$$s_{1,2}^2 = \sum_{i=3}^{p} (x_i - \bar{x}_{1,2})^2$$

$$\bar{x}_{1,2} = \frac{1}{p-2} \sum_{i=3}^{p} x_i$$

where:

$\bar{x}$ – mean value
x_1 – smallest value in the result set
x_p – largest value in the result set
s – standard deviation

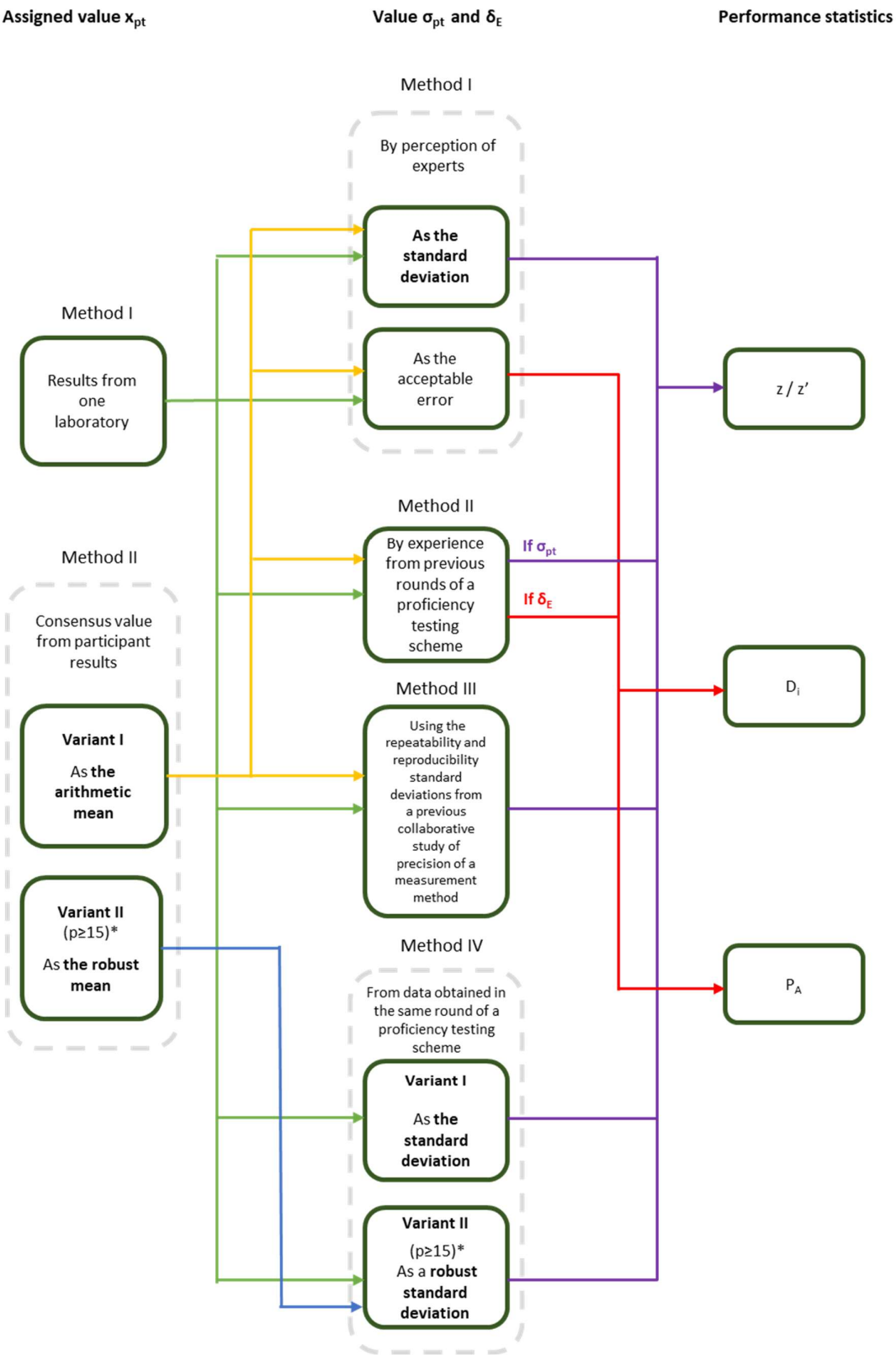
The values obtained will be compared with the critical value at a confidence level of 95%. If G is not within the range determined by the critical value, the corresponding result is considered an outlier and will be rejected from the data set used for further calculations.

For quantitative research, the general statistical model used in proficiency testing at Centrum Certyfikacji BARG Sp. z o.o. is presented in Figure No. 3 - Algorithm of the PT Statistical Model.

Methods for determining the assigned value, σ_{pt} value, δ_E value, and the indicators used for the purposes of this proficiency testing program are described in point 12.1.

With regard to qualitative results, the procedure for determining the assigned value and evaluating the results of the action is presented in section 12.2.

After receiving the result cards, the PT Organizer, due to the justification for applying a different approach, reserves the right to choose a different statistical path than presented in the following subpoints.



* in justified cases, it is allowed to use: p ≥ 12

Fig. 3. Statistical model algorithm in proficiency testing - quantitative research

12.1. Quantitative research

12.1.1. Determination of the assigned value

The assigned value x_{pt} will be determined according to Method II of the statistical model algorithm (Fig. 3) based on the results obtained in the current round using the arithmetic mean or Algorithm A described in Annex C of ISO 13528:2022-08, Variant I or II below.

12.1.1.1 Method II Consensus value from participant results (according to ISO 13528:2022-08, point 7.7)

Variant II

The assigned value x_{pt} as the arithmetic mean:

$$x_{pt} = \overline{x}$$

where:

$\overline{x}$ – arithmetic mean of results provided by participants in each round after excluding outliers

The uncertainty $u(x_{pt})$ is estimated using the formula:

$$u(x_{pt}) = \frac{s}{\sqrt{p}}$$

where:
s – standard deviation after excluding outliers
p – number of results after excluding outliers

Variant II

The assigned value x_{pt} as the robust mean when the number of Participants is 15 or more (p≥15):

$$x_{pt} = x*$$

where:

$x*$ - the robust mean calculated using algorithm A

The uncertainty $u(x_{pt})$ is estimated using the formula:

$$u(x_{pt}) = \frac{1{,}25}{\sqrt{p}} \cdot s^*$$

where:
s* - the robust standard deviation determined using algorithm A
p – the number of provided results

Limitation of the uncertainty of the assigned value.

If the condition is met:

$$u(x_{pt}) \leq 0{,}3\sigma_{pt}$$

where:

σ_{pt} – standard deviation for assessing proficiency testing

in that case, the uncertainty of the assigned value is considered insignificant and will not be taken into account in the interpretation of proficiency testing round results.

Otherwise, the uncertainty of the assigned value will be included in the calculations.

12.1.2. Determination of the σ_{pt} Value

The σ_{pt} value will be determined according to Method I, III, or IV of the statistical model algorithm (Fig. 3) as the standard deviation, respectively, required based on the precision of the measurement method or data obtained in the specific round.

12.1.2.1 Method I By perception of experts (according to ISO 13528:2022-08 point 8.2)

The standard deviation for assessing proficiency testing will be established by the expert panel based on experience derived from the application of the method.

12.1.2.2 Method III Using the repeatability and reproducibility standard deviations from a previous collaborative study of precision of a measurement method (according to ISO 13528:2022-08 point 8.5)

For measured quantities for which information on the repeatability (σ_r) and reproducibility (σ_R) of the method is available, the standard deviation for assessing proficiency testing (σ_{pt}) will be calculated based on this information as follows:

$$\sigma_{pt} = \sqrt{\sigma_R^2 - \sigma_r^2 \left(1 - \frac{1}{m}\right)}$$

where:

σ_R – reproducibility standard deviation

σ_r – repeatability standard deviation

m – number of repeated measurements made by each laboratory in a given PT round; if m = 1, then σ_{pt} = σ_R

12.1.2.3 Method IV From data obtained in the same round of a proficiency testing scheme (according to ISO 13528:2022 point 8.6)

Variant II (according to ISO 13528:2022 Annex C.3.1)

Standard deviation for assessing proficiency testing **as a robust deviation** when the number of Participants is 15 or more (p≥15):

$$\sigma_{pt} = s^*$$

where:

s^* – Robust estimate of the participant standard deviation using algorithm A (without rejecting outliers)

12.1.2.4 Determined for evaluation of sampling proficiency test

The standard deviation for evaluation of sampling proficiency testing is determined according to the formula:

$$\sigma_{pt,pob} = \sqrt{\sigma_{pt}^2 - \frac{\sigma_{powt}^2}{n}}$$

σ_{pt} –standard deviation for evaluation of proficiency testing

σ_{powt} – standard deviation of repeatability

n – number of repetitions of the measurement for the sample taken by the Participant

12.1.3 Criteria used for proficiency assessment

The z score or z' score will be used to assess the results of participants' performance.

The z score (according to ISO 13528:2022-08 point 9.4)

The z score is applicable when the condition is met $u(x_{pt}) \leq 0{,}3\sigma_{pt}$

$$z_i = \frac{(x_i - x_{pt})}{\sigma_{pt}}$$

where:

x_i – the result obtained by the Participant
x_{pt} – assigned value
σ_{pt} – standard deviation for proficiency testing evaluation

Criterion:

$\|z\| \leq 2{,}0$	acceptable result
$2{,}0 < \|z\| < 3{,}0$	warning signal result
$\|z\| \geq 3{,}0$	unacceptable result

The z' score (according to ISO 13528:2022-08 point 9.5)

The z' indicator is applicable when the condition is not met $(x_{pt}) \leq 0{,}3\sigma_{pt}$

$$z_i' = \frac{x_i - x_{pt}}{\sqrt{\sigma_{pt}^2 + u^2(x_{pt})}}$$

where:

x_i – the result obtained by the Participant
x_{pt} – assigned value
σ_{pt} – standard deviation for proficiency testing
$u(x_{pt})$ – uncertainty of the assigned value

Criterion:

$\|z'\| \leq 2,0$	acceptable result
$2,0 < \|z'\| < 3,0$	warning signal result
$\|z'\| \geq 3,0$	unacceptable result

12.2. Qualitative research

12.2.1 Determining the assigned value

12.2.1.1 Method A Based on the results of the Participants (according to ISO 13528:2022-08, point 11.3.5)

The assigned value will be determined based on the consensus of participants, understood as the percentage of consistent responses at a level of ≥ 80%.

12.2.1.2 Method B Based on knowledge of the origin of the material (according to ISO 13528:2022-08, point 11.3.4)

The assigned value will be determined based on information about the origin and/or composition of the test material known to the PT Organizer.

12.2.1.3 Method C Based on expert opinion (according to ISO 13528:2022-08, section 11.3.2)

The assigned value will be determined by a team of experts based on their experience with applying the method.

12.2.2 Evaluation of results

12.2.2.1 Method I Comparison with assigned value

Assessment of participants' performance based on a comparison of their results with the established

value assigned value.

Criterion:

Acceptable result - if it complies with the assigned value

Unacceptable result - if it does not comply with the assigned

12.2.2.2 Method II Based on expert opinion

The results will be evaluated by a team of experts based on their experience with the research method and their knowledge of its capabilities, limitations, and typical results.

The result will be considered acceptable if, in the opinion of the expert team, it is within the limits of deviations considered acceptable, resulting from the practice of using the method and the characteristics of the analyzed material.

13. Report

The PT organizer, upon receiving all results and conducting statistical analyses, will prepare a report that includes:

- Name and contact details of the Proficiency Testing (PT) study organizer
- Name and contact details of the PT study coordinator
- Name, position, and signature of the person authorizing the report
- Date of issuance and status of the report (e.g., preliminary, intermediate, or final)
- Report number and unambiguous identification of the proficiency testing program
- Indication of activities subcontracted by the PT study organizer
- Number of pages and clear identification of the end of the report
- Detailed description of the objects used in the proficiency testing, including necessary details regarding the preparation of proficiency testing objects and the assessment of homogeneity and stability
- Results of participants
- Statistical data and summary, including assigned values and the range of acceptable results, along with graphical presentation
- Procedures used to determine each assigned value
- Details regarding measurement consistency and uncertainty for each assigned value
- Procedures used to determine the standard deviation for proficiency assessment or other evaluation criteria
- Assigned values and statistical summaries for the testing methods/procedures used by each participant group (if different participant groups used different methods)
- Procedures used for statistical data analysis
- Comments from the PT study organizer regarding the participants' results
- Guidance on interpreting the statistical analysis, along with comments and recommendations resulting from the proficiency testing round's outcomes
- Statement regarding the confidentiality of proficiency testing results.

Information regarding the results obtained by specific Participants will be encoded and known only to the PT Organizer. Each Participant will receive information about the assigned code along with the Report.

All results, tabular summaries, participants' performance analyses presented in the proficiency testing report will be displayed according to the Participant's code.

Reports will be sent to Participants via email in PDF format within the specified schedule.

Participants are required to inform the PT Organizer of any comments on the report affecting the Participant's final assessment or any other errors found in the proficiency testing report within 14 days of receiving it. The PT Organizer is obligated to promptly correct any errors in the report and inform all

Participants about it. Comments on the PT report, if expressed dissatisfaction by a Participant, may be treated by the PT Organizer as a complaint and handled in accordance with point 14 of this program.

14. Complaints and Appeals

Participants have the right to submit complaints and/or appeals within 14 days of receiving the report to the email address: badania.bieglosci@barg.pl. The PT Organizer will review them within 30 days of receiving the complaint/appeal and provide feedback to the designated contact person. The DBB policy is to fairly address all complaints and appeals received from Participants, customers, or other parties. The procedure for conducting explanations and maintaining records regarding complaints and appeals is described in DSZ – section PT-5.8.

15. Contact with the Participant

DBB provides participants with all information regarding the implementation of the program, including each individual round. All documents and necessary forms are communicated to participants electronically, through courier services, or collected in person with confirmation of sample receipt.

The coordinator publishes the current schedule of the PT program with planned proficiency testing rounds and participation criteria on the website.

DBB provides participants in the proficiency testing program with:

• PT Program Schedule (4/PT-4.4)

• Registration Form (6/PT-4.4)

• Participant Instructions (5/PT-4.4) – provided before the start of each program round

• Test Result Cards (8/PT-4.4)

• Proficiency Testing Report – provided to participants after the completion of each program round

• Customer Evaluation Survey about the level of services provided by the PT Organizer (1/PT-5.10)

Participants in proficiency testing can contact the PT Organizer regarding any uncertainties, matters requiring clarification or justification, and any other issues contributing to the improvement of the proficiency testing organization.

16. Reference Documents

- PN-EN 932-1:1999 (EN 932-1:1996) Tests for general properties of aggregates - Part 1: Methods for sampling
- PN-EN 933-1:2012 (EN 933-1:2012) Tests for geometrical properties of aggregates - Part 1: Determination of particle size distribution - Sieving method
- PN-EN 933-3:2012 (EN 933-3:2012) Tests for geometrical properties of aggregates - Part 3: Determination of particle shape - Flakiness index
- PN-EN 933-4:2008 (EN 933-4:2008) Tests for geometrical properties of aggregates - Part 4: Determination of particle shape - Shape index
- PN-EN 933-5:2023-05 (EN 933-5:2022) Tests for geometrical properties of aggregates -- Part 5: Determination of percentage of crushed particles in coarse and all-in natural aggregates]

- PN-EN 933-6:2023-06 (EN 933-6:2022) Tests for geometrical properties of aggregates -- Part 6: Assessment of surface characteristics -- Flow coefficient of aggregates
- PN-EN 933-8+A1:2015-07 (EN 933-8+A1:2015) Tests for geometrical properties of aggregates - Part 8: Assessment of fines - Sand equivalent test
- PN-EN 1097-1:2024-05 (EN 1097-1:2023) Tests for mechanical and physical properties of aggregates - Part 1: Determination of the resistance to wear (micro-Deval),
- PN-EN 1097-2:2020-09 (EN 1097-2:2020) Tests for mechanical and physical properties of aggregates -- Part 2: Methods for the determination of resistance to fragmentation
- PN-EN 1097-3:2000 (EN 1097-3:1998) Tests for mechanical and physical properties of aggregates -- Part 3: Determination of loose bulk density and voids
- PN-EN 1097-5:2008 (EN 1097-5:2008) Tests for mechanical and physical properties of aggregates -- Part 5: Determination of the water content by drying in a ventilated oven
- PN-EN 1097-6:2022-07 (EN 1097-6:2022) Tests for mechanical and physical properties of aggregates -- Part 6: Determination of particle density and water absorption
- PN-EN 1367-1:2007 (EN 1367-1:2007) Tests for thermal and weathering properties of aggregates - Part 1: Determination of resistance to freezing and thawing
- PN-EN 1367-6:2008 (EN 1367-6:2008) Tests for thermal and weathering properties of aggregates - Part 6: Determination of resistance to freezing and thawing in the presence of salt (NaCl),
- PN-EN 1744-1+A1:2013-05 (EN 1744-1:2009+A1:2012) Tests for chemical properties of aggregates - Part 1: Chemical analysis
- PN-EN 13286-2:2010, PN-EN 13286-2:2010/AC:2014-07 (EN 13286-2:2010, EN 13286-2:2010/AC:2012) Unbound and hydraulically bound mixtures - Part 2: Test methods for laboratory dry density and water content - Proctor compaction
- PN-EN 13286-47:2022-04 (EN 13286-47:2021) Unbound and hydraulically bound mixtures -- Part 47: Test method for the determination of California bearing ratio, immediate bearing index and linear swelling
- Test Procedure GDDKiA PB/1/18 Instructions for testing the reactivity of aggregates using the accelerated method in a 1 M NaOH solution at 80^0C
- PN-88/B-04481 Building land - Soil sample testing [W]
- PN-EN ISO/IEC 17025:2018-02 (EN ISO/IEC 17025:2017) General requirements for the competence of testing and calibration laboratories
- PN-EN ISO/IEC 17043:2011 (EN ISO/IEC 17043:2010) Conformity assessment – General requirements for proficiency testing [W]
- PN-ISO 2854:1994 (ISO 2854:1976) Statistical interpretation of data — Techniques of estimation and tests relating to means and variances
- PN-ISO 5725-1:2002 (ISO 5725-1:1994) Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions

[W] standard having withdrawn status

- PN-ISO 5725-2:2002 (ISO 5725-2:1994) Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method
- ISO 13528:2022-08 Statistical methods for use in proficiency testing by interlaboratory comparisons
- DA-05 Policy on participation in proficiency testing or interlaboratory comparisons other than proficiency testing (ILAC-P9)
- DA-06 Measurement Consistency Policy (ILAC-P10)
- ILAC-G17 ILAC Guidelanes for Measurements Uncertainty in Testing