PC-1005

Green Economy Initiatives Private Limited

Proficiency Testing Provider P-0015 **CIN:** U74900PB2013PTC038026

DISCIPLINE: CHEMICAL
GROUP: ATMOSPHERIC POLLUTION
SUBGROUP(S): STACK EMISSION - GASES

REPORT NO. & DATE: 23EM02P2, 30 DECEMBER 2023
REPORT STATUS: FINAL

NOTE: This scheme covers both sampling and testing together as sampling is an integral part of stack test methods. The laboratories performance in PT scheme, therefore, be judged collectively.

215 Silver City (Main), Zirakpur
District SAS Nagar (Mohali), 140603 Punjab, INDIA
www.greenalliance.in

PC-1005

CERTIFICATE OF INDIVIDUAL CAB PERFORMANCE

Participant:	**Centre of Excellence, Environmental Testing & Research Laboratory, Dr.Jivraj Mehta Institute of Technology, Anand, Gujarat, India**		
Type of Scheme:	Sampling (Qualitative) + Simultaneous (Quantitative)	**Scheme Duration:**	30.07.23-30.11.23
Discipline:	Chemical	**Group:**	Atmospheric pollution
Subgroup(s) | Material / Product(s):	Stack Emission- gases SO_2, NO_2, CO_2, O_2 in Stack Emissions- Sampling scheme SO_2, NO_2 Simultaneous (Quantitative)		

Measurand	SO_2 mg/Nm^3		NO_2 mg/Nm^3	
Participant Code	**Result**	**Z score**	**Result**	**Z score**
23EM02P2-09	32.04	-1.39	135.50	1.30

For the purpose of reporting only results submitted are taken as such as volume sampled per cubic meter at STP

Measurand	**SO_2**	**NOx**	**CO_2**	**O_2**
Participant Code	**Overall Performance Index (OPI) -Process of Sampling- Gases in Stack Emissions**			
23EM02P2-09	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**

Irrespective of OPI, wherever against a pre-determined criteria performance score is 0 or 1, as given on page-19 of report, root cause analysis and corrective action is recommended. For interpretations of score refer page-13 and 14 of report.

This certificate is only issued for ease of reference to performance of individual CAB. The detailed report is a part and be read along.

Report Authorized by

Digitally signed by Dr. Randeep Singh Saini
Date: 2024.01.10 15:17:47 +05'30'

PT Coordinator: Dr. Randeep Singh Saini
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Proficiency Testing Provider P-0015: Green Economy Initiatives Private Limited CIN: U74900PB2013PTC038026
215 Silver City (Main), Zirakpur, District SAS Nagar (Mohali), 140603 Punjab, INDIA

Symbols

d	Difference between a measurement value for a proficiency test item and an assigned value of a CRM
g	Number of proficiency test items tested in homogeneity checks
m	Number of repeat measurements made per proficiency test items
p	Number of participants taking part in round of proficiency test schemes
s_r	Estimate of repeatability standard deviation
s_R	Estimate of reproducibility standard deviation
s_s	Estimate of between sample standard deviation
s^*	Robust estimate of the participants standard deviation
s_w	Within-sample or within-CAB standard deviation
σ_{pt}	Standard deviation for proficiency assessment (SDPA)
σ_r	Repeatability standard deviation
σ_R	Reproducibility standard deviation
u_{hom}	Standard Uncertainty due to difference between proficiency test items
u_{stab}	Standard Uncertainty due to instability during the period of proficiency testing
u_{trans}	Standard Uncertainty due to instability during transport conditions
$u(x_i)$	Standard Uncertainty of a result from participant *i*
$u(x_{pt})$	Standard Uncertainty of the assigned value
$u(x_{ref})$	Standard Uncertainty of a reference value
x	Measurement Result (generic)
x_{char}	property value obtained from characterization (determination of assigned value)
x_i	Measurement result from participant *i*
x_{pt}	Assigned value
x_{ref}	Reference value for a stated purpose
x^*	Robust estimate of the participant mean
$\bar{x}$	Arithmetic average of a set of results
w_t	Between test portion range
z	Score used for proficiency assessment (absolute value ±)
z'	Modified z-score (commonly pronounced as z-prime) that account for $u(x_{pt})$ which is not negligible when compared to σ_{pt}. Performance evaluation given in terms of z'-score where participants are less than 12 is only indicative. PT Provider, however, follows appropriate procedure as applicable for small number of participants.
δ_{hom}	Errors due to difference between proficiency test items
δ_{stab}	Errors due to instability during the period of proficiency test items
δ_{trans}	Errors due to instability during under transport conditions
X	Homogeneity Average
Y	Stability Average
B	Blunder - Obvious odd values by visual review as well as subjecting the data to any one of the following methods individually or in combination (i) Results that deviate from the X by more than $\pm 5\sigma_{pt}$ or (ii) Outlier detection test such as Grubbs test (iii) presence of any obvious blunders or erroneous reporting by experience in case of qualitative schemes
RNS	Results not submitted–Participant may not submit results for a parameter(s) for various reasons- It is not in their scope or they have already covered that parameter(s) or participating only for outlier parameters or as per their plan will participate in parameter(s) in next scheme run or during testing is not confident of the results etc. PT provider in this case does not give score and mark the column as '--'.
RNC	Results not considered (Where participants - Report results as zero (except where results can be zero) or non-numerical results e.g. <0.1 or >1, Nil, BDL etc. or results are qualified by any symbol or given with any remarks etc.; these results are not considered for performance evaluation) – PT provider in this case do not give score and mark the column as '--'. This is also applicable, in case of sampling schemes if participant does not provide information as desired by PT Provider in line with requirements of case study.
$	In order to ensure σpt used for performance evaluations is fit for purpose in line with ISO 13528 clause 8.6.2, PT provider can use initial σpt from perception (literature review, expert advice and or from experience) or Horwitz equation for evaluating score for a parameter as mentioned in summary and performance statistics.

Abbreviations

ACV	Absolute compliant value
Amd.	Amendment
APAC	Asia Pacific Accreditation Cooperation
CAB	Conformity assessment body
CRM	Certified reference material
DP	Decimal point. This indicates the number of decimal places to which participants should report their measurement results.
e.g.	Stands for exempli gratia and means “for example”
etc.	Is a Latin expression that is used in English to mean "and other similar things"
E	Expert
GEIPL	Green Economy Initiatives Private Limited
HDPE	High-density polyethylene
IEC	International Electrotechnical Commission
ILAC	International Laboratory Accreditation Cooperation
ISO	International Organization for Standardization
MRA	Mutual recognition arrangement
MU	Measurement uncertainty
n	No. of key criteria indicators in sampling scheme
NABL	National Accreditation Board for Testing and Calibration Laboratories
NMI	National meteorological institute
OPI	Overall performance index
PDF	Portable document format, used to display documents in an electronic form independent of the software, hardware or operating system they are viewed on.
PS	Performance score
PT	Proficiency testing
PT coordinator	Proficiency testing coordinator
PT item	Proficiency testing item or Sample for analysis of determination of measurands or analytes or case study in case of sampling schemes
PT protocol	Proficiency testing protocol – general information on PT schemes by PT provider
PT program	Proficiency testing program or round
PT provider	Proficiency testing provider
PT scheme	Proficiency testing scheme
SI	International System of Units
w.r.t.	acronym for with respect to
Units	This indicates the units used for the assessment of data. These are the units in which participants should report their results. For some analytes in some schemes participants may have a choice of which units to report their results, however, the units stipulated in this scheme description are the default units to which any results reported using allowable alternative results will be converted to.

Any other symbol or abbreviation used is described at the first instance. For more details including terms and definitions refer to ISO/IEC 17043, ISO 13528, ISO/IEC 17025 and ISO/IEC 17011.

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- PT provider reserves the right to make any modifications or alterations in the report as may be required from time to time without any prior notice. All affected participants are informed when an issue is detected.

Confidentiality

- Identity of participants is kept confidential by unique coding. Participants may be given the same code number in different PT scheme by chance. GEIPL has a continuing obligation to identify and report any actual or potential conflicts of interest arising during the performance of this program. If an actual or potential organizational conflict of interest is identified, GEIPL will immediately make a full disclosure to the appropriate parties.
- The information provided by participants to PT providers is kept confidential:
  - When PT provider is required by law or authorized by contractual arrangements to release confidential information, the consent of participant is taken, unless prohibited by law.
  - As per NABL-181 the records of PT scheme participation shall be accessible to NABL. PT provider does the same so that NABL can use the results in line with NABL 163 for the benefit of participants. Results shall also be shared with regulators when asked by them. Results may also be shared with customer for which a PT scheme is provided through a contractual arrangement for its participants.
  - Participants can also be asked to waive of confidentiality within the PT scheme for the purpose of discussion and mutual assistance or as required due to very nature of PT scheme.
  - PT provider shall share data with organizations providing accreditation or recognition e.g. NABL as part of its audit or assessment requirements.
  - PT provider may also use data and experience from operation of PT schemes for the purpose of further developments including, but not be limited to, use for research publications or conferences, however, identity of participants shall be kept confidential.

CONTENTS

1.0 Design and implementation of PT scheme

The primary aim of the PT scheme is to enable participants to monitor their performance and, to help participants, to improve the CAB activities. PT scheme is designed to meet the requirements of ISO/IEC 17043, ISO 13528, customers, regulatory authorities and organizations providing recognitions. PT Plan and design document are available with PT provider and is available to organization providing accreditation or recognition for scrutiny. The PT provider uses an expert committee to advice on design as required. The designs are further improved on continuous basis as experience is gained including feedback from participants. Minimum number of participants allowed in a PT scheme are two or more, however, for commercial reasons and to meet requirements of standard schemes may be run when minimum 8 or 12 (preferable) participants are available. Both accredited and non-accredited participants meeting requirements of NABL-142 are eligible for participation except for additional details as provided in information brochure.

Key features of this PT scheme are as below:

Type of Scheme:	Sampling (Qualitative) + Simultaneous (Quantitative)	**Scheme Duration:**	30.07.23-20.11.23
Discipline:	Chemical	**Group:**	Atmospheric pollution
Subgroup(s) | Material / Product(s):	Stack Emission- gases SO_2, NO_2, CO_2, O_2 in Stack Emissions- Sampling scheme SO_2, NO_2 Simultaneous (Quantitative)		
Protocol	Relevant standards applicable for industries, operations or processes other as specified in Schedule of the Environment Protection Rules, 1989.		
Measurand(s) or characteristic(s) of interest in PT item	SO_2, NO_2, CO_2, O_2 in Stack Emissions- Sampling scheme SO_2, NO_2 Simultaneous (Quantitative)		
Total Participants:	48		

The information brochure on PT scheme includes (i) PT calendars (ii) Registration form (iii) Terms and conditions of participation (iv) PT protocol (v) Scope of accreditation and is made available on request, on website and also shared with prospective participants. A power point presentation titled “Frequently Asked Questions” is also made available to participants on routine nature of queries.

PT scheme timeline:

Date of closure of registration	30.07.2023
Sampling period	04.09.2023-20.09.2023
Date of sample dispatch by PT provider (Quantitative)	16.10.2023
Date by which results are accepted from participants (Sampling)	25.09.2023 (Extended)
Date by which results are accepted from participants (Quantitative)	20.11.2023
Date of issue of draft result sheet by PT provider	01.12.2023
Date of final report	30.12.2023

1.1 Subcontracted activities

PT provider uses a competent subcontractor, in line with ISO/IEC 17043 for testing homogeneity and stability of PT items as applicable for quantitative and qualitative programs. The sampling schemes does not involve subcontracting of any activities.

1.2 PT items, preparation details, homogeneity and stability assessment

PT items used may either be at natural levels, incurred or spiked at a particular formulation level and or manipulated as per PT design. Material used for preparation of PT items is procured in line with requirements of laws of the land. For this PT scheme:

Material used and preparation:
The sampling scheme involves a case study to assess correct application of a sampling method and plan. For quantitative scheme spiked samples or salts are used as PT item.

Case study	Method of Sampling
The customer has following requirements: • Wants to know SO_2, Oxides of Nitrogen in mg/Nm^3 and CO_2, O_2 in % for stack attached to any source of fuel burning as Boiler or Furnace or Incinerator or GENERATOR Set in any industry or operation or organization. **Note- this program is for stack emissions where fuel is burnt in the process** If GENERATOR set is chosen ensure relevant standards are looked into and GENERATOR set has proper stack in place for doing isokinetic sampling. GENERATOR sets > 1000 KVA are normally fit for this purpose. (Many laboratories in order to avoid going to a customer start monitoring there own GENERATOR sets which are small sizes <1000 KVA or 800 KW, do not have chimneys of adequate diameter and regulatory requirements are not fulfilled. Choosing wrong source may lead to Results Not Considered) Laboratory may choose any of its customer as a part of its ongoing contracts who is having requirements as stated in case study or Laboratory may fix monitoring especially for the purpose of PT case study if a routine assignment as stated in case study does not fall during the given sampling period.	Standards methods for emission monitoring where subsequent analysis for PM is based on Gravimetric Method • Relevant Part(s) of IS 11255 Series for SO_2, NOx • IS 13270 Orsat for CO_2, O_2 • Standard Methods based on same principle and methodology e.g. in USEPA / APHA (AIR) • Lab SOP based on Flue gas analyser method (PLEASE NOTE IF FLUE GAS ANALYSER IS USED FOR SO_2 OR NO_X IT USES RECOMMENDED TECHNIQUES BY CPCB) **If laboratory follows methods based on different principle or methodology it shall inform and consult PT provider before starting sampling** Protocols for compliance reporting will depend upon **boiler / furnace / Generator and or industry chosen for example -** • For routine boilers Compliance to Standards laid down in EPA notification GSR 176 (E) April 2, 1996 for boilers as amended • or For industry specific boiler standards e.g for boilers in Thermal Power Plant SO3305(E) & Dec 2015 • For GENERATOR sets GSR 489E 9.7.2002 and amendments made there of. **Real Time / Continuous Monitoring techniques are not accepted for this programme** Process/ Vent Emissions are not considered for this program

PT Item Supplied- Coding / Marking, Measurands	PT Item Supplied- Packing
23EM02P2 SO_2 (A) for SO_2	**@1gm PT item in zip lock pouch**
23EM02P2 SO_2 (B) for SO_2	**@1gm PT item in zip lock pouch**
23EM02P2 NO_2 for NO_2	**@ 8 ml PT item in HDPE bottle**

S.No.	Measurand (Analyte/Parameter)	Units	DP	Test Methods
1	SO_2 in Stack (volume of 0.01 N barium perchlorate titrant used for sample in ml)	ml	1	IS: 11255 Part-2
2	NO_2 in Stack (concentration of NO_2 in microgram in the 25 mL aliquot taken)	µg	1	IS: 11255 Part-7

For the purpose of reporting only results submitted are taken as such as volume sampled per cubic meter at STP

Following instructions are provided to participants (i) Advance information on PT scheme run (ii) Forwarding letter intimating dispatch of sample / case study (sampling schemes) and period during which sampling is to be done (iii) Reporting format, instructions for handling and analysis of PT items /case study including methods to be used and timeline to be followed (iv) PT item receipt acknowledgement form (v) PT protocol as applicable

Homogeneity and stability of PT items.

Quantitative and qualitative schemes-

For homogeneity ten replicates (g ≥10) at random are used for first PT scheme and or during trials. It is done prior to distribution of the PT items to the participants and after the PT items are packed and unique ID numbers are given. The PT items are ensured to be sufficiently stable for the duration of the program by doing stability checks every time over the duration of PT scheme by selecting a minimum of six replicates and testing two replicates at the conclusion of the PT testing scheme and compare these with one replicate tested prior to run. Where required during initial run of the scheme or during trials or otherwise stability checks may additionally involve establishing suitable transport and storage conditions that may involve combination of simulated conditions, expert advice and assessment of historic data as applicable and documented in PT design. Stability check may include comparing PT items retained at the PT provider's premises with PT items subjected to shipping and return. Studies based on exposure to reasonably foreseeable conditions of transport may also be used. However, for parameters where PT items used are sufficiently stable over the desired period, the stability testing may also not be carried out as laid down in design.

The homogeneity and stability are ensured by establishing $s_s \leq 0.3\ \sigma_{pt}$ for homogeneity and Homogeneity Average (X)- Stability Average (Y) $\leq 0.3\ \sigma_{pt}$ for stability. This can also be subsequently revalidated using σ_{pt} derived from participants algorithm. The PTP may additionally use Cochran's C Test Cmax< C critical (implying no evidence of analytical outliers).

In line with 4.4.3 of ISO/IEC 17043 there may be cases where it is not feasible for PT items to be subjected to homogeneity and stability testing e.g. sampling schemes or there are schemes where homogeneity testing cannot be carried out prior to distribution for practical, technical or logistical reasons. Such cases are documented in PT design and described in the report.

Further, in line with clause 6.1 of ISO 13528 as documented in PT design on case to case basis for subsequent schemes, the number of PT items included in homogeneity check may be reduced to g ≥4 based on experience under repeatable conditions or on the basis of experience with the behaviour of closely similar PT items in previous rounds of the PT scheme verified as necessary for the current round. Critical measurands in a program may be analysed only instead of all irrespective of replicates used.

The aim is to ensure that homogeneity and stability is fit for purpose and every participant receives comparable proficiency test items.

In case of non-compliance, heterogeneity and or instability of the PT items is considered for evaluating the performance of participants as per procedures. In these circumstances further explanation is given in the report and design is reviewed as applicable as certain PT items may be heterogenous by nature.

Sampling schemes-

The homogeneity and stability is not applicable for sampling schemes. The sampling scheme involves a case study to assess correct application of a sampling method and plan. The case study is chosen in line with Section-11 of ISO:13528 based upon requirements of regulators or customers through expert consensus.

1.3 Statistical analysis of data

Quantitative schemes-
The statistical analysis of data set is done starting with identification and removal of blunders by visual review as well as subjecting the data to any one of the following methods individually or in combination (i) Results that deviate from the X by more than $\pm 5\sigma_{pt}$ or (ii) Outlier detection test such as Grubbs test based on literature, experience and any other relevant factors as laid out in design. When any participant result is excluded then it is excluded only for the purpose of determination of x_{pt} and σ_{pt} or other evaluation criteria.

After removal of blunders, PT provider further uses robust estimators such as Algorithm-A in line with ISO 13528 for the determination of both assigned value as well as σ_{pt} from the consensus value of participants when $p \geq 12$ (after removal of outliers) as specified in Note 2 under D.1.2 of Annex D of ISO 13528. When $p < 12$ (after removal of outliers) PT provider uses other techniques as provided in ISO 13528 and laid down in its procedure as median of the participants' results or robust average from modified Algorithm-A.

When z-score or z-prime score is determined as specified above, PTP ensures that participants identified as blunders are getting z-score or z-primes score $\geq \pm 3$.

Qualitative schemes-
Where assigned value is reported on a categorical (or nominal) scale, the assigned value determined by any of the methods should match exactly with the results obtained from homogeneity assessment. Where assigned value is reported on an ordinal scale, the assigned value determined by any of the methods should not differ by more than the permissible limit (that is used for performance evaluation of participants) with the results obtained from homogeneity assessment.

Sampling schemes-
Sampling scheme uses expert consensus in line with Section-11 of ISO:13528 to decide a case study in line with regulatory or customer requirements and then uses predetermined criteria from sampling methods by expert consensus to determine correct application of a sampling method and plan by participants and their evaluation. Three experts are used for analysis of data.

1.4 Assigned value, metrological traceability and measurement uncertainty of assigned value

Quantitative schemes-
The assigned value x_{pt} is the value selected as being the best estimate of the 'true value' for the parameter under test. A consensus value of participants is taken by PTP as assigned value when PT scheme is planned and run with $p \geq 8$ as explained in design. The standard uncertainty of assigned value $u(x_{pt})$ is calculated using the following formula:

$$u(x_{pt}) = 1.25 \times \frac{s^*}{\sqrt{p}}$$

The $u(x_{pt})$ is compared with the following criteria to ensure compliance: $u(x_{pt}) \leq 0.3\ \sigma_{pt.}$ In case of non-compliance with the above criteria, performance evaluation is not done using z-score but using z'-score (z-prime) by taking into consideration the standard uncertainty of the assigned value also in the denominator.

The validity of the assigned value for measurands or characteristics of interest determined in PT items is done by determining the estimate of the reference value of the PT items determined independent of the participants results, x_{ref} (for example homogeneity average of the concerned measurand determined by an accredited CAB which is not a participant i.e. CAB that has done homogeneity or stability testing). The difference between homogeneity average and consensus average of participants is then calculated. The difference should be less than 2 times u_{diff} where $u_{diff} = \sqrt{[\ u(x_{pt})^2 + u(x_{ref})^2]}$

However, where PT scheme is planned and run with $p < 8$, assigned value and its uncertainty is determined (i) by formulation (also called as Known Value Scheme) or by using a CRM as PT item or by characterizing the PT item using a valid CRM in one CAB (also called as Value transfer from a CRM to a closely matched candidate RM); or (iv) by using consensus value from expert CAB (which are not participants in the PT Scheme)

The assigned value is traceable to SI units in line with requirements of ISO/IEC 17025 read along NABL-142 through traceable calibrations and reference materials.

Qualitative schemes-
When the test results reported on categorical (nominal) scale, mode (most common observation) reported by participants is used as the assigned value or when the test results reported on ordinal scale (i) either mode (most common observation) or (ii) median reported by participants is used as the assigned value.

Sampling schemes-
Predetermined criteria from sampling methods by expert consensus is considered as assigned value in line with Section-11 of ISO:13528

1.5 Standard deviation for proficiency assessment (σ_{pt})

Quantitative schemes-
Initially expected or target σ_{pt} can be chosen by perception (literature, expert opinion and or experience for previous programs) or predicted from model by Thompson based on Horwitz equation.

Subsequently, the robust standard deviation of the participants results is treated as σ_{pt} and it is determined by using Algorithm A as given in ISO 13528 where $p \geq 12$ of if $p < 12$ PT provider uses other techniques as provided in ISO 13528 and laid down in its procedure as median of the participants' results or robust average from modified Algorithm-A.

The proficiency testing provider ensures that the σ_{pt} used for performance evaluations from participants results is fit for purpose. The use of participants results can lead to criteria for performance evaluation that are not appropriate. Therefore, in line with ISO 13528 clause 8.6.2, PT provider can place a limit on the lowest value of σ_{pt} as well as a limit on the largest that will be used.

σ_{pt} is not applicable in case of **qualitative schemes** and **sampling schemes**.

1.6 Performance evaluation

Quantitative schemes-
Performance evaluation is conducted in terms of z-score which is calculated using the following formula:

$$\text{z-score} = \frac{(x_i - x_{pt})}{\sigma_{pt}}$$

It is possible for the z-scores published in this report to differ slightly from the z-score that can be calculated using the formula given above. These differences arise from the necessary rounding of the data prior to its publication in report.

When $u(x_{pt})$ is not meeting the criteria: $u(x_{pt}) \leq 0.3\ \sigma_{pt.}$ performance evaluation is done using z'-score (z-prime) by taking into consideration the standard uncertainty of the assigned value also in the denominator:

$$\text{z-score} = \frac{(x_i - x_{pt})}{\sqrt{[(\sigma_{pt})^2 + u(x_{pt})^2]}}$$

If p < 12 PT provider uses other techniques as provided in ISO 13528 and laid down in its procedure.

The following interpretation is given to results

Result	Interpretation	Coding
|z/z'-score| ≤ 2.0	Satisfactory result	Black
2.01 < |z/z'-score| <2.99	Questionable result (straggler)	**Bold Black**
|z/z'-score| ≥ 3.0	Unsatisfactory result	**Bold Red**
--	No score RNS or RNC as explained	Black
Blunder	Obvious odd values as explained	**B (Score) Bold Red**

Where |z| denotes the absolute value of the z-score. When an outlier is identified the sign of the z-score indicates whether the result is too high (positive z-score) or too low (negative z-score).

Qualitative schemes
The method used for performance evaluation is as under in line with section-11 of ISO 13528:

When the test results reported on **categorical (nominal) scale**, each participant CAB which has reported the result should be marked as **satisfactory** **(or scored as a success)** if it exactly matches the assigned value. Otherwise, the participant CAB should be marked as **unsatisfactory**, or given an **adverse performance score.**

When the test results reported on **ordinal scale**, each participant CAB which has reported the result should be marked as **satisfactory** **(or scored as a success)** if the difference between the result and assigned value do not deviate by more than half a grade. Otherwise, the participant CAB should be marked as **unsatisfactory**, or given an **adverse performance score.**

In both the cases specified above, the PT scheme report should clearly indicate the proportion or number of participants who have reported the assigned value correctly or with in permissible limits. In circumstances where number of participants whose results are not in agreement with assigned value are more than 75%, further explanation shall be given in the report.

No score is given for RNS or RNC as explained

Sampling schemes

The evaluation is done using "**Overall Performance Index** (OPI) Model" which makes uses of predetermined criteria agreed by expert consensus. The obvious strength of this approach is that it involves consideration of all key steps as identified in predetermined criteria in sampling method and plan to determine its correct application. Operational performance of individual steps is determined on the basis of assigned score by expert consensus w.r.t clause 11.4.3 of ISO 13528 as:

Assigned Performance Score (PS) by Expert Consensus	**Remarks**
3	Acceptable (Full compliant)
2	Followed to large extent
1	Followed to some extent
0	Unacceptable (Non-compliant)

The performance scores in individual steps are converted to Overall Performance Index (OPI) to reflect the overall performance of the CAB:

OPI = [Total PS obtained by participant ÷ (n x ACV)X Absolute Complaint Value for PS]

OPI Interpretation:

OPI ≤ 0.75	Unsatisfactory (outlier)	
0.76 < OPI ≤ 1.50	Questionable (straggler)	
1.51 < OPI ≤ 2.25	Satisfactory	
2.26 < OPI ≤ 3.00	Good	

OPI	**Level of action envisaged**	**Remarks**
Unsatisfactory (Outlier)	Shall review competence requirements and re-establish competence to do sampling including a review of training, supervision and authorization of personnel.	Irrespective of OPI, wherever against a pre-determined criteria performance score is 0 or 1 root cause analysis and corrective action is suggested, based on risk levels established by the laboratory.
Questionable (Straggler)	Shall do training of personnel on all aspects of sampling and review supervision	
Satisfactory	See remarks	
Good	See remarks	

No score is given for RNS or RNC as explained

Current Scheme:

In this PT Scheme for the quantitative evaluation assigned value is determined on the basis of consensus value of participants.

The σpt is determined by using Algorithm A as given in ISO 13528.

In order to ensure that the σpt used for performance evaluations is fit for purpose in line with ISO 13528 clause 8.6.2 PT provider may use initial σpt from perception (literature, expert opinion and or from experience) for a particular parameter for evaluation as detailed out in its procedures, PT plan and highlighted in summary and performance characteristics.

Sampling scheme uses expert consensus in line with Section-11 of ISO:13528 to decide a case study in line with regulatory or customer requirements and then uses predetermined criteria from sampling methods by expert consensus to determine correct application of a sampling method and plan by participants. Three experts are used for analysis of data.

1.7 Feedback, appeal and complaint

All due diligence is exercised in conducting the PT scheme yet if a participant has any concern about any aspect of PT scheme, they should contact undersigned within 15 days from the date of release of final report:

Quality Manager
Green Economy Initiatives Private Limited
greeneconomyipl@gmail.com
M: 8872061900

Participants are encouraged to provide feedback for improving any aspect of the PT scheme. Feedback form is sent along with the final report. Appeal, a request can be made by a participant for reconsideration of any adverse evaluation. If a complaint is received, an investigation is conducted in accordance with procedure laid down by GEIPL and the participant is conveyed of the outcome.

1.8 Participants results

Summary of participants performance is given below:

Quantitative Scheme

Parameter	SO_2 mg /nm^3	NO_2 mg /nm^3
Total Participating CABs	46	46
Results Not Submitted	4	4
Results Not Considered	0	0
Results Considered	44	44
Results Not Evaluated- Blunder	0	0
Results Evaluated	44	44
|z/z'-score| ≤ 2.0	40	42
2.01 < |z/z'-score| <2.99	3	2
|z/z'-score| ≥ 3.0	1	0

For the purpose of reporting only results submitted are taken as such as volume sampled per cubic meter at STP

Sampling scheme

	Process of Sampling			
Parameter	**SO_2**	**NO_2**	**CO_2**	**O_2**
Total Participating Cabs	48	48	48	48
Results Not Submitted	5	5	15	15
Results Not Considered	7	9	11	11
Results Considered & Evaluated	36	34	22	22
OPI ≤ 0.75 Unsatisfactory	0	0	0	0
0.76 < OPI ≤ 1.50 Questionable	0	0	0	0
1.51 < OPI ≤ 2.25 Satisfactory	36	34	22	22
2.26 < OPI ≤ 3.00 Good	0	0	0	0

Quantitative Scheme

Measurand	SO_2 mg/Nm^3		NO_2 mg/Nm^3	
Participant Code	**Result**	**Z score**	**Result**	**Z score**
DP	**2**		**2**	
23EM02P2-01	27.50	**-2.19**	112.03	-0.55
23EM02P2-02	42.30	0.43	118.40	-0.04
23EM02P2-03	38.10	-0.31	129.66	0.84
23EM02P2-04	RNS	--	120.55	0.13
23EM02P2-06	38.50	-0.24	112.50	-0.51
23EM02P2-08	42.30	0.43	140.90	1.73
23EM02P2-09	32.04	-1.39	135.50	1.30
23EM02P2-10	37.10	-0.49	116.41	-0.20
23EM02P2-12	40.95	0.19	121.84	0.23
23EM02P2-13	39.74	-0.02	111.08	-0.62
23EM02P2-15	RNS	--	RNS	--
23EM02P2-16	44.84	0.88	129.00	0.79
23EM02P2-17	34.00	-1.04	125.64	0.53
23EM02P2-18	40.77	0.16	111.53	-0.58
23EM02P2-20	RNS	--	RNS	--
23EM02P2-21	44.40	0.81	120.06	0.09
23EM02P2-22	36.20	-0.65	109.99	-0.71
23EM02P2-23	47.00	1.27	128.00	0.71
23EM02P2-24	21.00	**-3.35**	84.00	**-2.75**
23EM02P2-25	38.50	-0.24	120.60	0.13
23EM02P2-26	39.59	-0.05	RNS	--
23EM02P2-27	38.00	-0.33	128.03	0.71
23EM02P2-28	49.79	1.76	94.04	-1.96
23EM02P2-29	44.54	0.83	103.99	-1.18
23EM02P2-30	44.83	0.88	123.93	0.39
23EM02P2-32	50.00	1.80	135.20	1.28
23EM02P2-34	41.30	0.26	112.63	-0.50
23EM02P2-35	27.50	**-2.19**	117.11	-0.15
23EM02P2-36	47.04	1.27	124.57	0.44
23EM02P2-37	43.10	0.57	135.00	1.26
23EM02P2-38	44.65	0.85	115.55	-0.27
23EM02P2-39	35.30	-0.81	103.06	-1.25
23EM02P2-40	41.53	0.30	103.68	-1.20
23EM02P2-41	43.00	0.56	142.50	1.85
23EM02P2-42	44.75	0.87	134.90	1.26

For the purpose of reporting only results submitted are taken as such as volume sampled per cubic meter at STP

For interpretations of score refer page-13 and 14 of report.

Measurand	SO_2 mg/Nm^3		NO_2 mg/Nm^3	
Participant Code	**Result**	**Z score**	**Result**	**Z score**
DP	**2**		**2**	
23EM02P2-43	31.44	-1.50	84.58	**-2.71**
23EM02P2-44	RNS	--	RNS	--
23EM02P2-45	41.40	0.27	120.36	0.11
23EM02P2-46	39.78	-0.01	119.10	0.01
23EM02P2-47	44.70	0.86	118.60	-0.03
23EM02P2-48	25.62	**-2.53**	140.70	1.71
23EM02P2-49	37.80	-0.37	126.66	0.61
23EM02P2-51	28.60	-2.00	104.66	-1.13
23EM02P2-52	41.75	0.33	125.32	0.50
23EM02P2-53	36.40	-0.61	106.32	-0.99
23EM02P2-54	43.99	0.73	118.04	-0.07
23EM02P2-55	39.20	-0.12	109.11	-0.78
23EM02P2-56	39.42	-0.08	111.76	-0.57

Sampling schemes

Participant Code:	**23EM02P2-09**	Sampling Process for gaseous emissions in stack **P-1/1**				
			Performance Score (PS) by Expert Consensus			
Predetermined criteria for evaluation		Observations, Opportunities for improvement or gaps	E1/2/3 SO_2	E1/2/3 NOx	E1/2/3 CO_2	E1/2/3 O_2
Key equipment for sampling- Samplers	Compliance to methods as per method chosen- Sampling Train	SO_2: NOx: CO_2 / O_2 : FGA	3	3	3	3
Quality Assurance in sampling- Functional checks Intermediate Checks Handling	Quality Assurance at Lab	Leak Check SO_2: (Recommended Cl 8.1 IS 11255 P-2) ? NOx: (Recommended Cl 5.1.1 IS 11255 P-7) ? Master for intermediate check (Flow) : OK Record of Intermediate check: Acceptance criteria: (Recommended ±2%) Flue Gas Analyser: NP Gas Cylinders available: ---- Intermediate checks: (Recommended- on every use) Acceptance criteria: ---	2	2	1	1
Equipment handling and Installation at sampling site- Verification of Appropriateness of Sampling Site and related information	Compliance to sampling plan- **Record on sampling sheet:**	I Equipment / Shipment Bottles Identity; Source of Emission; Installed capacity; Fuel Used; Stack Height; Diameter: II APCD Provision; Sampling Port and compliance 8D / 2D; Sampling Platform Status; **Partial**	1	1	1	1
Equipment handling and operation	At site- Issues related to drawing of sample **Record on sampling sheet:**	III Operational Load; APCD status at time of sampling Port Hole Plugging **Partial** Maintenance of temperature around Impingers for SO_2 sampling **NP**	1	1	2	2
Additional relevant information on Sampling / Field data sheets and other records	Operational parameters Sampling data and calculations/ Logged data	Sampling flow rate; Record of difference in mercury levels in manometer at evacuate position (NOx) - Readings SO_2- (Recommended every 5 minute); Temperatures at DGM and at impinger outlet; Check for Condensation (NOx)- **Partial** Calculations/ Logged data- SO_2 NOx CO_2/O_2: Log Data not provided Sampling Data Transfer to Report: I II/III **Partial** Correcting SO_2/NOx for CO_2/O_2 as applicable- NP For Boiler its required G.S.R.96(E) on 29th January 2018 - for industrial boilers	1 Results in ppm	1 Result in ppm	1	1
		Total Performance Score (PS):	8	8	8	8
		Overall Performance Index (OPI):	**1.60**	**1.60**	**1.60**	**1.60**

NA- Not applicable | **NP**- Information not provided | **X**- Provided but does not meet the requirement **?**-Information provided but not clear or complete or only OK or Tick mark put in records.

CO_2/O_2 results not reported on Test report

Summary- Overall Performance Index

	SO_2	NOx	CO_2	O_2
Participant Code	Process of Sampling- Gases in Stack Emissions			
23EM02P2-01	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-02	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-03	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-04	RNS	RNS	RNS	RNS
23EM02P2-06	RNC	RNC	RNC	RNC
23EM02P2-08	**Satisfactory**	RNC	**Satisfactory**	**Satisfactory**
23EM02P2-09	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-10	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-12	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-13	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-15	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-16	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-17	RNC	RNC	RNS	RNS
23EM02P2-18	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-20	**Satisfactory**	RNC	**Satisfactory**	**Satisfactory**
23EM02P2-21	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-22	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-23	RNC	RNC	RNC	RNC
23EM02P2-24	RNC	RNC	**Satisfactory**	**Satisfactory**
23EM02P2-25	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-26	RNS	RNS	RNS	RNS
23EM02P2-27	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-28	RNC	RNC	RNS	RNS
23EM02P2-29	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-30	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-32	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-34	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-35	**Satisfactory**	**Satisfactory**	RNC	RNC
23EM02P2-36	RNC	RNC	RNC	RNC
23EM02P2-37	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-38	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-39	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-40	RNS	RNS	RNS	RNS
23EM02P2-41	RNC	RNC	RNC	RNC
23EM02P2-42	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**

For performance score against each pre-determined criterion refer page-19 of report.

	SO_2	NOx	CO_2	O_2
Participant Code	Process of Sampling- Gases in Stack Emissions			
23EM02P2-43	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-44	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-45	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-46	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-47	RNS	RNS	RNS	RNS
23EM02P2-48	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-49	RNS	RNS	RNS	RNS
23EM02P2-51	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-52	**Satisfactory**	**Satisfactory**	RNS	RNS
23EM02P2-53	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-54	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-55	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**
23EM02P2-56	**Satisfactory**	**Satisfactory**	**Satisfactory**	**Satisfactory**

1.9 Summary and performance statistics including graphical displays

Quantitative schemes

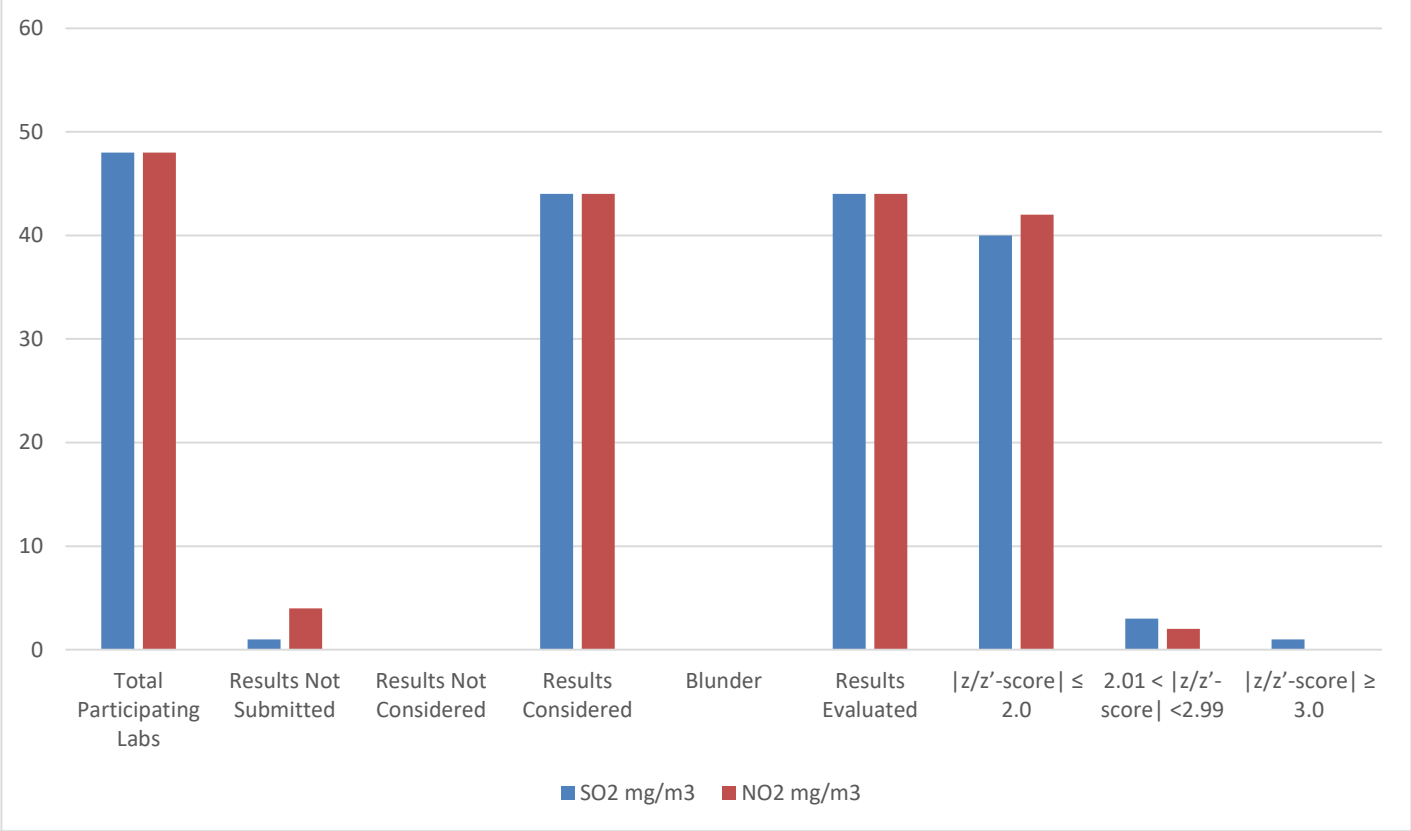
SO_2

Number of Excluded Results- Blunder (Blunders are not taken for Evaluation)	0
Number of Evaluated Results	44
Range- Result lowest	21.00
Range- Result highest	50.00
Participants assigned value	39.86
Uncertainty of assigned value	1.0616
SDPA (σpt)	5.6337
Total number of Scores	44
Number of scores z/z' ≤ ±2	40
% Satisfactory performance	90.91
Number of scores ±2.01 <z/z'<±2.99	3
% Questionable performance	6.82
Number of scores Z/Z' ≥±3	1
% Unsatisfactory performance	2.27

NO_2

Number of Excluded Results- Blunder (Blunders are not taken for Evaluation)	0
Number of Evaluated Results	44
Range- Result lowest	84.00
Range- Result highest	142.50
Participants assigned value	118.96
Uncertainty of assigned value	2.3936
SDPA (σpt)	12.7018
Total number of Scores	44
Number of scores z/z' ≤ ±2	42
% Satisfactory performance	95.45
Number of scores ±2.01 <z/z'<±2.99	2
% Questionable performance	4.55
Number of scores Z/Z' ≥±3	0
% Unsatisfactory performance	0.00

z-score/z'-score Histograms



2.0 Post programme support, comments on performance and recommendations:

The participant shall use data from PT report to control and, if applicable, improve the CAB's activities. It can help to prevent incorrect results from being reported. It can prevent, or reduce, risks from undesired impacts and potential failures in the CAB activities.

In this PT scheme report, four participant has unsatisfactory/ questionable performance in sulphur dioxide and two in oxides of nitrogen in quantitative part and seven results are not considered for SO_2, nine for NO_2 and eleven for CO_2 and O_2 in qualitative part

A list of possible reasons leading to an outlier as applicable, but not limited to, a parameter is summarized below:

- Data transfer errors or typographical errors.
- Errors in use of Certified Reference Material e.g. whether the dilutions and resultant concentrations calculations are correct.
- Errors in observation of end points and weighing to constant mass.
- Problem areas in measuring equipment's linked to selection of equipment's, calibration, intermediate checks, or maintenance and or use of expired consumables and issues like standardizations of normal solutions and applied normality.
- Improvements needed in competence of personnel in terms of understanding of the methods and adherence to details
- Incomplete sampling sheet formats and failure to record sampling data
- Lack of knowledge of regulatory requirements
- Compliance to instructions given by PT provider

In sampling scheme improvement required or gap is listed against each pre-determined criterion for further action on page-19.

- **General observations:**
- Records for leak check be maintained as per IS 11255
- Impingers/bladders/bottles, identity must be established in sampling sheet for audit trail.
- Intermediate checks is a mandatory requirement of ISO 17025 Clause 6.4.10 and cannot be NA. For gases lab should maintain a DGM (Flow calibrator) of better accuracy as Master. The calibration frequency of Master can be two year. Intermediate checks cannot be subcontracted.
- Flue gas analyzer must have data recording/ printing capabilities. The logged data print be maintained as part of sampling record. In addition even if flue gas analyzer is used sampling sheet must be maintained to record relevant information on stack, sampling platform, source of emission, pollution control devices, fuel used, installed and operational capacity, sampling port hole etc. and audit trail for logged/printed data. Sampling sheet should record type of fuel used and that FGA is set for appropriate fuel as per manufacturer's manual. FGA uses recommended techniques by CPCB for gases particularly for SO_2 and NO_2
- The sampling be done as per case study, understanding of regulatory requirement and difference between stack emissions, process/ vent emissions is very important. This program is not for real time monitoring.

In case of an outlier i.e. z/z' ≥±3 or blunder in quantitative scheme or unsatisfactory result in qualitative scheme or unsatisfactory overall performance index or performance score against a pre-determined criteria is 0 or 1 in sampling scheme, or in case of a straggler i.e. ±2.01 <z/z'<±2.99 in a quantitative scheme or questionable overall performance index in sampling scheme CAB shall determine the cause and implement any action needed as explained above appropriate to the effects from outlier/straggler. **As per NABL 163 for applicant CABs participation in PT program with results as outlier/straggler will also be acceptable, if the CAB has taken necessary corrective actions based on root cause analysis. It is therefore in interest of participants to do root cause analysis and take corrective action as soon as possible. NABL I63 lays down one month timeline for this.**

A sample root cause analysis format is provided along with the report with examples.

CAB should further review the effectiveness of corrective action taken in line with clause 8.7 of ISO IEC 17025. This can be done by participating in PT or inter CAB again for the parameter.

In both the cases, CAB should update risks and opportunities determined during planning and or make changes to the management system, if necessary.

PT provider encourages re-participation in parameters in which there is outlier or straggler by offering participation again at nominal or no cost. More details are available in forwarding letter with the report. PTP also organizes trainings, webinars or workshops to help improve the CAB activities from time to time.

Report authorized by: **Dr. Randeep Singh Saini,**
PT Coordinator

*** End of Report ***