



TENDER DOCUMENT

NEW MANGALORE PORT AUTHORITY

CIVIL ENGINEERING DEPARTMENT

NIT No. CIVIL/CE(C)/EE(C)/55/2022-23

E-Tender Event No. 2022_NMPT_714993_1

Tender for

“SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
RETENDER”

THROUGH E-TENDERING MODE

Tender Amount	:	Rs. 1,76,49,332/-
E.M.D.	:	Rs. 4,16,600/-
Tender Fee	:	Rs. 1,120/-(Including GST @ 12%)



TENDER DOCUMENT
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CIVIL ENGINEERING DEPARTMENT

Tender for
"SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
RETENDER"

Volume - 1

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NEW MANGALORE PORT AUTHORITY

PANAMBUR, MANGALORE -575010

NIT No: CIVIL/CE(C)/EE(C)/55/2022-23 Date: 08-11-2022

TENDER ID: 2022_NMPT_714993_1

i) NOTICE INVITING TENDER

(Through E-Procurement only)

E-Tenders are invited by New Mangalore Port Authority, Panambur, Mangalore-575010 through <https://www.eprocure.gov.in/eprocure/app> of CPP portal from the reputed Contractor fulfilling the Minimum Eligibility Criteria stipulated in this notice in two cover bidding procedure for the work of "Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender".

Minimum Eligibility Criteria:

- a) The tenderers must have experience of having successfully completed *similar works during last 7 (seven) years ending last day of month previous to the one in which applications are invited shall be either of the following
At least Three similar completed works costing not less than the amount equal to Rs.70.60lakhs each

or

At least Two similar completed works costing not less than the amount equal to Rs.88.25lakhs each

or

At least One similar completed works costing not less than the amount equal to Rs. 141.20lakhs

Note1: "**Similar work(s) means:** Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System.

Note2: Documentary evidence for successful completion of the work shall be furnished along with work order and work completion certificate.

- b) Average Financial turnover of the tenderer over the last three financial years 2018-19, 2019-20 and 2020-21 shall be at least Rs.52.95lakhs.

The financial capacity of bidders would be evaluated considering the works in hand at NMPA. The port would award the work not exceeding the remaining financial capacity of the bidder. The financial capacity to be 3.33 times of the average financial turnover of last three years of the bidder minus works in hand at NMPA. The bidder must fill the annexure-6.

c) The bidder shall provide/upload as a declaration the details of the following along with the bid Document Certifications form,

i. US-EPA; The official web-site of the US-EPA one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a "list of the Designated Reference and Equivalent Methods" where the Method/Model No, Designation Number and Method code Number allotted by the Approving Agencies i.e for PM₁₀, PM_{2.5}, SO₂, O₃ and CO, NO₂ is mentioned. This can be Accessed via internet as shown below,

<https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>,
List of Designated Reference and Equivalent Methods in a Pdf Format (designated_ reference_ and_ equivalent)

The bidder has to declare the make/model number, designation number and method code of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation, after Technical bid and before Price Bid.

TUV QAL-1; the official web-site of the TUV one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a list of "Certified measuring and Evaluating-Systems according to EN 15267" Where the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) allotted by the Approving Agencies i.e NO, NO₂, NO_x, SO₂, CO, PM₁₀, PM_{2.5}, O₃ & Benzene, is mentioned in the Ambient Air Section. This can be Accessed via internet as shown below,

ii. <https://qal1.de/>

a) On the Extreme Right hand top side Select Language "English".

b) Select Manufacturer.

c) Manufacturer's Overview screen Opens Now select the Manufacturer of the equipment and list of "certified measuring and Evaluating-Systems according to EN 15267 " here the details of the Equipment's shall be verified.

The bidder has to declare the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation after Technical Bid and before Price Bid.

Pertinent information is given in the following table:

i)	Estimated Amount put to Tender	Rs.1,76,49,332/-
ii)	Earnest Money Deposit (EMD)	<p>Rs.4,16,600/- (Rupees Four Lakh Sixteen Thousand Six Hundred Only)</p> <p>The EMD shall be in the form of Insurance Surety Bonds, Account Payee Demand draft, Fixed Deposit Receipt, Bankers Cheque, Bank Guarantee as per Annexure 9 or shall be paid by RTGS in favour of F.A. & C.A.O., NMPA. Scanned copy should be uploaded along with bid.</p> <p>The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udh yog Aadhar Memorandum or Udyam Registration Certificate or any other body specified by Ministry of MSME.</p>
iii)	Cost of Tender (Tender fee)	<p>Rs.1,120/- (Rupees One Thousand One Hundred Twenty Only) Payment of Tender fee by NEFT in favour of F.A. & C.A.O., NMPA. Scanned copy should be uploaded along with bid. Scanned copy should be uploaded along with bid. The benefit of Exemption of Tender Fees to all Micro and small enterprises (MSE) registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries</p>

		Corporation (NSIC) or Directorate of handicrafts and handlooms or Udyog Aadhar Memorandum or any other body specified by Ministry of MSME, will be considered.
iv)	Document download start date and time	08-11-2022 at 15.00 HRS
v)	Seek clarification start date and time	14-11-2022 at 10.00 HRS
vi)	Seek clarification end date and time	15-11-2022 at 15.00 HRS
vii)	Bid submission start date and time	22-11-2022 at 10.00 HRS
vii)	Bid submission closing date and time	29-11-2022 at 15.00 HRS
ix)	Date & time of opening of Cover - I : Technical Part - II : Financial	30-11-2022 at 15.30 HRS Shall be communicated separately.
x)	Completion period	Installation period 05 Months and Maintenance for 5 years after commissioning of CAAQMS (including monsoon)
xi)	Validity of Tender	120 days from the date of closing of online submission of e-tender.

Tenderer shall have to pay the prescribed cost of tender i.e., Rs.1120/- (Rupees One Thousand One Hundred Twenty Only) by NEFT in favour of F.A. & C.A.O., NMPA.

NMPA Bank Details:-

1. Name of the Bank: State Bank of India, Panambur, Mangalore - 575 010.

2. Bank A/C No. 10205649448

3. IFSC Code: SBIN0002249

4. MICR Code: 575002011

Contact Nos. 0824-2887306 and 0824-2407149

Email id: yogindra.s@nmpt.gov.in and chiefengineer@nmpt.gov.in Amendments / further information etc. pertaining to the tender, if any shall be uploaded only on websites <https://www.eprocure.gov.in/eprocure/app> of CPP portal, may have to be referred by the prospective Tenderer from time to time.

-sd-

Executive Engineer (Civil)

NEW MANGALORE PORT AUTHORITY

PANAMBUR, MANGALORE -575010

NIT No: CIVIL/CE(C)/EE(C)/55/2022-23

E-Tender event No. 2022_NMPT_714993_1

ii) INSTRUCTIONS TO TENDERERS

A. Instructions for E-Tendering

INSTRUCTION TO E-TENDERING

1. SPECIAL INSTRUCTIONS TO THE BIDDERS FOR THE E-SUBMISSION OF THE BIDS ONLINE THROUGH THIS E-PROCUREMENT PORTAL.

This is an e-procurement event of NMPA. The e-procurement service provider is <https://www.eprocure.gov.in/eprocure/app> of CPP portal. You are requested to read the terms & conditions of this tender before submitting your online tender. Tenderers who do not comply with the conditions with documentary proof (wherever required) will not qualify in the Tender.

1. Bidder should do Online Enrolment in the Portal using the option Click Here to Enroll available in the Home Page. Then the Digital Signature enrollment has to be done with the e-token, after logging into the portal.
2. Bidder then logs into the portal giving user id / password chosen during enrollment.
3. The e-token that is registered should be used by the bidder and should not be misused by others.
4. DSC once mapped to an account cannot be remapped to any other account. It can only be inactivated.
5. The Bidders can update well in advance, the documents such as certificates, purchase order details etc., under My Documents option and these can be selected as per tender requirements and then attached along with bid documents during bid submission. This will ensure lesser upload of bid documents.
6. After downloading / getting the tender schedules, the Bidder should go through them carefully and then submit the documents as per the tender document; otherwise, the bid will be rejected.
7. The BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for that tender. Bidders are allowed to enter the Bidder Name and Values only.

8. If there are any clarifications, this may be obtained online through the e-Procurement Portal, or through the contact details given in the tender document. Bidder should take into account of the corrigendum published before submitting the bids online on the portal or on www.newmangaloreport.gov.in Bidder, in advance, should prepare the bid documents to be submitted as indicated in the tender schedule and they should be in PDF formats.
9. Bidder should arrange for the EMD and tender fee as specified in the tender. The benefit of Exemption of EMD and Tender Fees to all Micro and small enterprises (MSE) registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udyog Aadhar Memorandum or any other body specified by Ministry of MSME, will be considered. Necessary document for having registered with similar category should be submitted along with Technical Bid.
10. The bidder should read the terms and conditions and accepts the same to proceed further to submit the bids.
11. The bidder has to submit the tender document(s) online well in advance before the prescribed time to avoid any delay or problem during the bid submission process.
12. There is no limit on the size of the file uploaded at the server end. However, the upload is decided on the Memory available at the Client System as well as the Network bandwidth available at the client side at that point of time. In order to reduce the file size, bidders are suggested to scan the documents in 75-100 DPI so that the clarity is maintained and the size of file gets reduced. This will help in quick uploading even at very low bandwidth speeds.
13. It is important to note that, the bidder has to click on the Freeze Bid Button, to ensure that, he/she completes the Bid Submission Process. Bids, which are not frozen, are considered as Incomplete/Invalid bids and are not considered for evaluation purposes.
14. The Tender Inviting Authority (TIA) will not be held responsible for any sort of delay or the difficulties faced during the submission of bids online by the bidders due to local issues.
15. The bidder may submit the bid documents online mode only, through this portal. Offline documents will not be handled through this system.

16. At the time of freezing the bid, the e-Procurement system will give a successful bid updating message after uploading all the bid documents submitted and then a bid summary will be shown with the bid no., date & time of submission of the bid with all other relevant details. The documents submitted by the bidders will be digitally signed using the e-token of the bidder and then submitted.
17. After the bid submission, the bid summary has to be printed and kept as an acknowledgement as a token of the submission of the bid. The bid summary will act as a proof of bid submission for a tender floated and will also act as an entry point to participate in the bid opening event.
18. Successful bid submission from the system means, the bids as uploaded by the bidder is received and stored in the system. System does not certify for its correctness.
19. The bidder should see that the bid documents submitted should be free from virus and if the documents could not be opened, due to virus, during tender opening, the bid is liable to be rejected.
20. The time that is displayed from the server clock at the top of the tender Portal, will be valid for all actions of requesting bid submission, bid opening etc., in the e-Procurement portal. The Time followed in this portal is as per Indian Standard Time (IST) which is GMT+5:30. The bidders should adhere to this time during bid submission.
21. The bidders are requested to submit the bids through online e-Procurement system to the Tender Inviting Authority (TIA) well before the bid submission end date and time (as per Server System Clock).
22. Tender form Fee and EMD shall be submitted with the Part I- Technical BID. BID submitted without fees, as mentioned above will not be considered for evaluation and shall be rejected summarily. The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will be considered. The bidders shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udhog Aadhar Memorandum or any other body specified by Ministry of MSME. The bidder/tenderer/contractor shall file the applicable returns with Tax departments in time and submit the same as documentary proof.
23. The bidder/tenderer/contractor shall file the applicable returns with Tax departments in time and submit the same as documentary proof.

24. The GST applicable shall be shown as a separate line items in the Tax invoices to avail in put credit to Port.

2. Cover – I Details (Technical)

The following documents shall be uploaded online only.

1. Scanned copy of NEFT Payment details for cost of tender or exemption certificate.
2. Scanned copy of RTGS/NEFT Payment details for EMD (bid security) / documentary evidence for exemption of EMD. The original document to be submitted by post or by hand immediately after the closing date for submission of online e-tender)
3. Scanned copy of documents as per Annexure 1 to 13 of section I(iii) of volume-I (Original power of attorney i.e. Annexure 2 to be submitted by post or by hand immediately after the closing date for submission of online e-tender).
4. The tenderer shall attach Scanned copy of Pre-contract, Integrity Pact agreement executed as per Appendix II The Original copy to be submitted by post or by hand so as to reach the Executive Engineer (Civil) immediately after closing date for submission of online tender
5. Scanned copy of valid Pan Card, EPF, ESI and GST Registration certificate.
6. List of Ongoing works in hand at NMPA should be indicated in the prescribed form.
7. Scanned copy of Form of Tender as per Section VI(iii) of volume -III
8. Technical bid document – Cover I (Volume I to Volume III) along with amendments and clarifications.

3. Cover – II Detail (Finance)

PRICE BID (Bill of Quantities)

Price should be quoted in the BOQ template available in the portal. The BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevant columns, else the bidder is liable to be rejected for that tender. The Bidder shall fill in the percentage of Excess or Less in the Bill of Quantities through CPP e-portal Bidders are allowed to enter the Bidder Name and Values only.

Any indication of 'Quoted price' in the online technical bid documents shall lead to rejection of the bid outright.

The price bid submitted through e-portal mode only will be taken up for the purpose for evaluation.

4. Opening of bids

- A. Part I Techno-Commercial bid will be opened electronically on specified date and time as given in the NIT. Bidder(s) can witness electronic opening of bid.
- B. Part II Price bid will be opened electronically of only those bidder(s) whose Part I Techno-Commercial Bid is found to be Techno-Commercially acceptable by NMPA. Such bidder(s) will be intimated, the date of opening of Part II Price bid, through valid email confirmed by them

Note: The tenderers are advised to offer their best possible rates. There would generally be no negotiations hence most competitive prices may be quoted while submitting the price bid. However in case the lowest rate appears to be reasonable taking into account the prevailing market conditions, the work may be awarded to the lowest bidder and if the rate is still considered high, action as per prevailing instructions / guidelines shall be taken. All entries in the tender should be entered in online Technical & Commercial Formats without any ambiguity.

5. Evaluation process:

A proposal shall be considered responsive if –

- a. It is received by the proposed Due Date and Time.
- b. It is Digitally Signed.
- c. It contains the information and documents as required in the Tender Document.
- d. It contains information in formats specified in the Tender Document.
- e. It mentions the validity period as set out in the document.
- f. It provides the information in reasonable detail. The Port Authority reserves the right to determine whether the information has been provided in reasonable detail.
- g. There are no significant inconsistencies between the proposal and the supporting documents.
- h. The Technical qualification conforms to as specified in the qualification criteria.
- i. A Tender that is substantially responsive is one that conforms to the preceding requirements without material deviation or reservation. A material deviation or reservation is one (1) which affects in any substantial way, the scope, quality, or performance of the Tenderer or (2) which limits in any substantial way, inconsistent with the Tender document, or (3) whose rectification would affect unfairly the competitive position of other Qualified Applicant presenting substantially responsive bids.
- j. The Port Authority reserves the right to reject any tender which in its

opinion is non-responsive and no request for alteration, modification, substitution or withdrawal shall be entertained by the Port Authority in respect of such Tenders.

- k. The Port Authority would have the right to review the Technical Qualification and seek clarifications wherever necessary.
- l. Since the tender involves selection based on pre-qualification criteria and technical specification, the Chief Engineer will examine and seek clarification if any and list out the firms, which are found technically suitable and Cover-II Price Bid of such tenderers only will be opened and EMD will be returned to the unsuccessful tenderers
- m. The date and time will be intimated to tenderers whose offers are found suitable and Cover – II of such tenderers will be opened on the specified date and time
- n. The cost of stamping Agreement must be borne by the successful Tenderer
- o. The Fax/E-Mail offers will be treated as defective, invalid and rejected. Only detailed complete offers received through online prior to closing time and date of the tenders will be taken as valid.

B. Instructions To Tenderers (General)

1. Introduction:

This work essentially comprises of "Supply, Errection,Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender"

2. Applicants:

Contractors who wish to bid for the tender for the contract work should apply for the tender document. The successful bidder will be expected to complete the works by the intended completion date specified in the Contract document.

3. Invitation for Bids:

The online Invitation for Bids is open to all eligible bidders meeting the eligibility criteria. The bidders may submit bids for the works detailed in the NIT through e-tender mode only.

4. Purchase of Tender Documents:

Tender document can be downloaded from NMPA website www.newmangaloreport.gov.in, www.tender.gov.in & <https://www.eprocure.gov.in/eprocure/app> of CPP portal

5. One Bid per Bidder:

Each bidder shall submit only one bid for one package. Bidder who submits or participates in more than one Bid will cause all the proposals with the Bidder's participation to be disqualified.

6. Cost of Bidding:

The bidder shall bear all costs associated with the preparation and submission of his Bid, and the Employer will in no case be responsible and liable for those costs.

7. Site visit:

The Bidder, at the Bidder's own responsibility and risk is encouraged to visit and examine the work site and its surroundings and obtain all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The costs of visiting the site shall be at the Bidders' own expense.

8. Content of Bidding Documents:

Tender Document will consist of:

Volume I	Section I	Notice Inviting Tenders Instructions to Tenderers Annexure (1 to 12)
	Section II	Form of Agreement
	Section III	Conditions of Contract: Part A - E: General Conditions Conditions of Contract : Part F: Special Conditions Contract Data Form of Securities (A & B) Appendix - I and Appendix - II
Volume II	Section IV	Technical Specifications
	Section V	Drawings
Volume III	Section VI	Preamble Bill of Quantities For of tender
	Section VII	Schedules (A & B)

Any indication of "Quoted price" in the technical bid, shall lead to rejection of the bid outright. For evaluation purpose the uploaded offer documents will

be treated as authentic and final. No hard copy shall be submitted, upload the entire document on the CPP portal only.

9. Clarification of the Bidding Documents:

The Tenderers are advised to examine the Tender Document carefully and if there be or appear to be any ambiguity or discrepancy in the documents, or any clarifications needed on the Tender Documents; these shall be referred to the Chief Engineer (Civil) in writing, so as to reach at least three days before start date of submission of bid. It is to be noted that queries asked after closing date of pre bid meeting will not be answered. Employer's clarifications shall be furnished in the CPP e-portal or shall be issued a corrigendum in the web site after closing date of online pre-bid meeting without identifying the source.

A provision is made in the CPP e-portal for online pre-bid meeting during the date mentioned in the NIT. The bidders can ask queries if any during the period of pre-bid meeting through online. The queries of the bidders shall be answered online or a separate consolidated list of queries and clarifications shall be uploaded in web sites after closing date of online pre-bid meeting.

10. Amendment of Bidding Documents:

Any modification of the tender documents as a result of any ambiguity shall be shall be made exclusively through the issue of an Addendum. Any addendum thus issued shall be part of the tender documents and will be uploaded in CPP e-portal and Port website to all the bidders. Prospective bidders shall acknowledge receipt of each addendum to the Employer. Such addenda will be numbered and it shall be submitted by the Tenderers as part of Part I of their bid. The Addendum can also be downloaded from NMPA official website from 'Ongoing Project link'. The responsibility of downloading such addendum / amendment from NMPA website and CPP e-portal fully lies with the bidder

11. Preparation of bids:

All documents relating to the bid shall be in the English language.

12. Minimum Eligibility Criteria:

- a) The tenderers must have experience of having successfully completed similar works during last 7 (seven) years ending last day of month previous to the one in which applications are invited shall be either of the

following

At least Three similar completed works costing not less than the amount equal to Rs. 70.60 lakhs each

or

At least Two similar completed works costing not less than the amount equal to Rs. 88.25lakhs each

or

At least One similar completed works costing not less than the amount equal to Rs. 141.20 lakhs

Note1: **Similar work(s) means** “Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System”.

Note2: Documentary evidence for successful completion of the work shall be furnished along with work order and work completion certificate.

b) Average Financial turnover of the tenderer over the last three financial years 2018-19, 2019-20 and 2020-21 shall be at least Rs.52.95lakhs. The financial capacity of bidders would be evaluated considering the works in hand at NMPA. The port would award the work not exceeding the remaining financial capacity of the bidder. The financial capacity to be 3.33times of the average financial turnover of last three years of the bidder minus works in hand at NMPA. The bidder must fill the Annexure-6.

In case the average turnover is Rs.3.00crores, the financial capacity of the contractor will considered as (3x3.333) Rs.10.00crores.

Illustration:-Average turnover for 3 years is the Financial capacity or construction will be 3.00cr(3x3.33) i.e 10.0crores.

c) The bidder shall provide/upload as a declaration the details of the following along with the bid Document Certifications form,

- i. US-EPA; The official web-site of the US-EPA one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a "list of the Designated Reference and Equivalent Methods" where the Method/Model No, Designation Number and Method code Number allotted by the Approving Agencies i.e for PM₁₀, PM_{2.5}, SO₂, O₃ and CO, NO₂ is mentioned. This can be Accessed via internet as shown below,
<https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>,
List of Designated Reference and Equivalent Methods in a Pdf Format (designated_ reference_ and_ equivalent)**

The bidder has to declare the make/model number, designation number and method code of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation, after Technical bid and before Price Bid.

TUV QAL-1; the official web-site of the TUV one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a list of "Certified measuring and Evaluating-Systems according to EN 15267" Where the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) allotted by the Approving Agencies i.e NO, NO₂,NOX, SO₂,CO,PM₁₀, PM_{2.5}, O₃ & Benzene, is mentioned in the Ambient Air Section. This can be Accessed via internet as shown below,

ii. <https://qal1.de/>

- d) On the Extreme Right hand top side Select Language "English".
- e) Select Manufacturer.
- f) Manufacturer's Overview screen Opens Now select the Manufacturer of the equipment and list of "certified measuring and Evaluating-Systems according to EN 15267 " here the details of the Equipment's shall be verified.

The bidder has to declare the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation after Technical Bid and before Price Bid.

The turnover means sales/ contract receipts excluding taxes other income shall not be considered for calculation of turnover. Copy of the work order, Client's satisfactory work completion Certificate, along with any other documentary proof certifying the year of completion, brief description of the project and project completion cost shall be submitted in support of the assignments performed and claimed by the tenderer to fulfill the eligibility criteria for qualification. Work completion certificate issued by a private organization shall be considered, only if Tax Deducted at Source Certificate with respect to referred work, issued by Competent Authority is enclosed along with the tender. In case work executed on subcontract, only approved or authorized subcontract shall be considered for eligible assignment.

A statement duly certified by the Chartered accountant showing the average annual Financial Turnover over the last 3 financial years shall be submitted.

Even though the bidders meet the above qualifying criteria, they are subject to be disqualified if they have:

- i) made misleading or false representations in the forms, statements and attachments submitted in proof of the qualification requirements; and/or
- ii) record of poor performance such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history, or financial failures etc.,

13. Bid Prices:

The contract shall be for the whole works as described in based on the priced Bill of Quantities submitted through CPP e-portal by the Bidder .The Bidder shall fill in the percentage of Excess or Less in the Bill of Quantities through CPP e-portal. Items for which no rate or price is entered will not be paid for by the Employer when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities.

14. Currencies of Bid and Payment:

The Unit rates and the prices shall be quoted by the bidder entirely in Indian Rupees

15. Bid Validity:

Bids shall remain valid for a period not less than one hundred twenty days (120 days) after the last date for online bid submission. A bid valid for a shorter period shall be rejected by the Employer as non-responsive.

In exceptional circumstances, prior to expiry of the original bid validity period, the Employer may request that the bidders may extend the period of validity for a specified additional period. The request and the bidders' responses shall be made in writing or by cable. A bidder agreeing to the request will not be permitted to modify his bid and also shall submit an extension for EMD, if it is in the form of Bank Guarantee

16. Bid Security / EMD:

- i. The EMD shall be in the form of Insurance Surety Bonds, Account Payee Demand draft, Fixed Deposit Receipt, Bankers Cheque or Bank Guarantee as per Annexure 9 or shall be paid by RTGS/NEFT in favour of Financial Adviser & Chief Accounts Officer, New Mangalore Port Authority, Mangalore
NMPA Bank Details.

1. Name of the Bank: State Bank of India, Panambur, Mangalore - 10.

2. Bank A/C No. 10205649448
3. IFSC Code: SBIN0002249
4. MICR Code: 575002011.

The Techno Commercial Bid shall be accompanied by the Bank Guarantee or RTGS/NEFT deposit details towards Earnest Money Deposit of Rs.416600/- (Rupees Four Lakh Sixteen Thousand Six Hundred Only) as stipulated in the tender. The tender without EMD shall be treated invalid. The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udhayog Aadhar Memorandum or Udyam Registration Certificate or any other body specified by Ministry of MSME.

- ii. In the event of Bidder withdrawing his Bid before the expiry of tender validity period of 120 days from the last date for online bid submission, the tender shall be cancelled and EMD shall be forfeited.
- iii. The Earnest Money Deposit of unsuccessful bidder shall be returned without interest on conclusion of contract. The Earnest Money Deposit of the successful bidder shall be refunded (without interest) after he has signed the agreement and furnished required performance security.
- iv. The Bid Security of a successful bidder will be forfeited in the following cases:
 - a) If the bidder withdraws his Tender during the period of bid validity.
 - b) In case of a successful tenderer fails
 - i) to commence the work, apart forfeiture of other claims
 - ii) within the specified time limit to sign the Agreement or furnish the required Performance Security. In the event of forfeiting the EMD / SD / LD and while imposing penalty GST as applicable will be collected.

17. No Alternative Proposals by Bidders:

Bidders shall submit offers that comply with the requirements of the bidding documents, including the basic technical design as indicated in the drawing and specifications. Alternatives will not be considered.

18. Format and Signing of Bid:

The Bid shall be in online mode. The Bid shall contain no alterations or additions, except those comply with instructions issued by the Employer

19. Bid Submission:

Tender document including quoted bid price have to be submitted online only through CPP Portal before deadline for online submission of bid.

For evaluation purpose the uploaded offer documents will be treated as authentic and final.

The Tender shall be submitted in Two Bids.

I. Technical Bid: Shall contain the following.

- i) Techno Commercial Bid: Shall contain all the documents. Techno Commercial Bid should not contain Price Bid. "Disclosure/indication of Price in the Techno Commercial Bid shall render the tender disqualified and rejected.
- ii) The details of payment of EARNEST MONEY DEPOSIT for Rs. 416600/- (Rupees Four Lakh Sixteen Thousand Six Hundred Only) by RTGS/NEFT to NMPA Bank Account, failing which the Techno commercial Bid shall not be considered).
- iii) Transaction details of payment towards the COST OF TENDER Fee: Rs. 1120/-(Rupees One Thousand One Hundred Twenty Only) (To be paid by RTGS/NEFT to NMPA Bank Account).
- iv) List of Ongoing works in hand at NMPA should be indicated in the prescribed form.

II. FINANCIAL BID: shall contain only the Price. The Bidder shall fill in the percentage of Excess or Less in the Bill of Quantities

III. LAST DATE FOR SUBMISSION OF ONLINE TENDER: is as per the date mentioned in the NIT NMPA may at its sole discretion reserves the right to extend the date for receipt of Bid. Bid after the aforesaid time and date or the extended time and date, if any, shall not be accepted by the portal.

The following details pertaining to Techno Commercial Bid shall be uploaded online.

- a) Letter of Submission- Covering letter (vide Annexure – 1)
- b) Power of Attorney in favour of signatory/s to the Tender,.(vide Annexure-2) (Original power of attorney ie. Annexure 2 to be submitted by post or by hand so as to reach the Executive Engineer (Civil) immediately after the closing date for submission of online e-tender).
- c) Organization Details (vide Annexure-3)
- d) Details of "Minimum eligibility criteria" as per Clause 12 of instruction to Tenderers and certificates (Client Certificates / work completion certificates or any other documentary evidences with respect to the

eligibility work) (vide Annexure-4) of condition of contract. The following specific instruction may be noted ;

- i) Bidders are expected to provide information in respect of Eligible Assignments in this Section. The assignments cited must comply with the criteria specified in Clause No. 12 (a) for "Minimum eligibility".
 - ii) A separate sheet should be filled for each of the eligible assignments.
 - iii) the details are to be supplemented by documentary proof from the respective client for having carried out such assignment duly certified by client's completion certificates and work orders etc.
- e) A statement duly certified by Chartered Accountant showing Average Financial turnover of the tenderer over the last three financial years (vide Annexure-5) with balance sheet.
- f) List of Ongoing works in hand at NMPA should be indicated in the prescribed form (Annexure 6).
- g) A list of Plant and equipment proposed to be engaged for work. (vide Annexure-7) The equipment indicated in the Annexure -7 will form part of contract agreement and as such the bidders are requested to indicate the availability of the equipment at site at what stage of the construction period the equipment would made available.
- h) A declaration to the effect that (vide Annexure -8):-
- a. All details regarding construction plant and machinery, temporary work and personnel for site organization considered necessary and sufficient for the work have been furnished in the Annexure to Conditions of Contract in Volume I and that such plant, temporary works and personnel for site organization will be available at appropriate time of relevant works for which the equipment have been proposed at site till the completion of the respective work.
 - b. No conditions are incorporated in the financial bid. In case any conditions are specified in the financial bid, the tender will be rejected summarily without making any further reference to the bidder.
 - c. We have not made any payment or illegal gratification to any persons/ authority connected with the bid process so as to influence the bid process and have not committed any offence under PC Act in connection with the bid.
 - d. We disclose with that we have made / not made payments or propose to be made to any intermediaries (agents) etc in

connection with the bid.

- i) NEFT Payment details towards cost of tender.
- j) RTGS/NEFT Payment details towards EMD / documentary evidence of exemption of EMD.
- k) The tenderer shall attach Scanned copy of Pre-contract, Integrity Pact agreement executed as per Appendix II The Original copy to be submitted by post or by hand so as to reach the Executive Engineer (Civil) immediately after closing date for submission of online tender.
- l) Tenderer should submit copy of Permanent Account Number. (PAN), ESI, PF and GST Registration (GSTIN) Number along with certificates issued by the authority as applicable

20. Deadline for Submission of the Bids:

- i) The completed bid shall be submitted in the electronic form by the date and time mentioned in NIT only through CPP e-portal.
- ii) The Employer may extend the deadline for submission of bids by issuing an amendment in accordance with Clause 10, in which case all rights and obligations of the Employer and the bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.
- iii) Price should be quoted in CPP e-portal. Any indication of 'Quoted price' in the online technical bid documents shall lead to rejection of the bid outright. For evaluation purpose the uploaded offer documents will be treated as authentic and final. No hard copy shall be submitted for reference purpose. The bid submitted through e-tendering mode only will be taken up for the purpose for evaluation.
- iv) The uploaded Port Tender Document will be treated as authentic tender and if any discrepancy is noticed at any stage between the Port's tender document and the one submitted/uploaded by the tenderer, the conditions mentioned in the Port's uploaded document shall prevail. Besides, the tenderer shall be liable for legal action for the lapses.

21. Late Bids:

The tenderer should ensure that their tender is received online at NMPA before the deadline prescribed in Clause 20

The time that is displayed from the server clock at the top of the CPP e-portal, will be valid for all actions of requesting bid submission, bid opening etc., The bidders should adhere to this time during bid submission.

22. Modification and Withdrawal of Bids:

- i) Bidders may modify the offers by deleting their already frozen bids in online only through CPP e-portal (after submission of bid) and resubmit/upload the revised offer before the deadline prescribed in Clause 20.
- ii) No bid shall be withdrawn and resubmitted through CPP e-portal by the bidder after the deadline for submission of bids.
- iii) Withdrawal of a Bid between the deadline for submission of bids and the expiration of the original period of bid validity specified in Clause 15 may result in the forfeiture of the Bid Security pursuant to Clause 16.
- iv) Bidders may only modify the prices and other required details of their Bids by Resubmitting Bid only in accordance with this clause through CPP e-portal.

23. Bid Opening - Technical Bid:

- a. On the due date and time as specified in Clause 20, the Employer will On the due date and time as specified in Clause 20, the Employer will first open Techno Commercial bids of all bids received online in presence of the Bidders or their representatives who choose to attend. In the event of specified date for bid opening is declared as holiday by the Employer, the bid will be opened at the appointed time and location on the next working day.
- b. In the first instance the Techno Commercial Bid containing the RTGS/NEFT payment details of EMD & Cost of tender document will be verified. If EMD and Tender Fee is in line with the Tender Condition there after the Techno Commercial Bid will be considered for evaluation. The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or UdhogAadhar Memorandum or Udyam Registration Certificate or any other body specified by Ministry of MSME
- c. If all Bidders have submitted unconditional Bids together with requisite Bid security, then all Bidders will be so informed then and there. If any Bid contains any deviation from the Bids documents and / or if the same does not contains Bid security in the manner prescribed in the Bid documents, then that Bid will be rejected and the Bidder informed accordingly.

24. Bid Opening – Financial Bid:

The date and time of opening of price bid (cover-II) shall be intimated to the qualified bidders based on the evaluation of the technical bid. The price bid (cover-II) of such eligible bidders shall be opened on the specified date and time.

If bidder withdraws his tender after opening of price bid the bidder will be disqualified for participating in NMPA tender for a period of two years.

25. Clarification of Bids:

To assist in the examination and comparison of Bids, the Employer may, at his discretion, ask any Bidder for clarification of his Bid, including breakdown of unit rates. The request for clarification and the response shall be in writing, but no change in the price or substance of the Bid shall be sought, offered, or permitted.

No Bidder shall contact the Employer on any matter relating to his bid from the time of the bid opening to the time the contract is awarded. If the Bidder wishes to bring additional information to the notice of the Employer, he should do so in writing.

Any effort by the Bidder to influence the Employer's bid evaluation, bid comparison or contract award decisions, may result in the rejection of his bid.

26. Examination of Bids and Determination of Responsiveness:

Prior to detailed evaluation of Bids, NMPA will determine whether each Bid

- a) meets the eligibility criteria as defined in Clause 12.
- b) has been properly signed by an authorised signatory (accredited representative) holding Power of Attorney in his favour. The Power of Attorney shall inter alia include a provision to bind the Bidder to settlement of disputes clause;
- c) is accompanied by the requisite Bid security and;
- d) is responsive to the requirements of the Bidding documents.

A responsive Bid is one which conforms to all the terms, conditions and specification of the Bidding documents, without material deviation or reservation. A material deviation or reservation is one

- i. which affects in any substantial way the scope, quality or performance of the Works;
- ii. which limits in any substantial way, the Employer's rights or the Bidder's obligations under the Contract; or
- iii. whose rectification would affect unfairly the competitive position of other Bidders presenting responsive Bids.

The tenderer shall submit a certificate in the tender schedule in the Technical Bid that he has not incorporated any conditions in the Financial Bid and in case any conditions are specified in the financial bid his tender will be rejected without making any further reference to him.

If a Bid is not substantially responsive, it shall be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

27. Correction of Errors: (Not Applicable)

28. Evaluation and Comparison of Bids:

The Employer will evaluate and compare only the Bids determined to be responsive in accordance with Clause 26. In evaluating the Bids, the Employer will determine for each Bid the evaluated Bid Price by adjusting the Bid Price as follows:

- a) making appropriate adjustments to reflect discounts or other price modifications offered in accordance with Clause 22.

29. Alteration of tender documents:

No alteration shall be made in any of the tender documents or in the Bill of Quantities and the tender shall comply strictly with the terms and conditions of the tender document. The Employer may however ask any tenderer for clarifications of his tender if required. Nevertheless, no tenderer will be permitted to alter his tender price after opening of the tender.

30. Alternative conditions and Proposal:

The Tenderer shall note that alternative or qualifying tender conditions, or alternative design proposal for whole or part of the work will not be acceptable. Tenders containing any qualifying conditions or even Bidder's clarifications in any form will be treated as non-responsive and will run the risk of rejection. Part II: Price Bid of such Bidder's will not be opened.

31. Award of Contract:

The Employer will award the Contract to the bidder whose bid has been determined to be responsive to the bidding documents and who has offered the lowest evaluated bid price, provided that such bidder has been determined to be

- a) Eligible in accordance with the provisions of Clause 12, and
- b) Qualified in accordance with the provisions of Clause 12.

32. Notification of Award:

- i) The Bidder whose Bid has been accepted will be notified about the award by the Employer prior to expiration of the Bid validity period by, fax or e-mail and confirmed by registered letter. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") will state the sum that the Employer will pay the Contractor in consideration of the execution, completion and maintenance of the works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").
- ii) The notification of award will constitute the formation of the Contract subject only to the furnishing of a performance security in accordance with the provisions of Clause 33.
- iii) The Agreement will also incorporate all correspondence exchanged between the employer and the successful bidder. Within 21 days of receipt of Letter of Acceptance, the successful bidder will furnish the performance security and sign the Agreement with the Employer. The contractor shall make 20 copies of the Agreement and submit to the employer within 7 days following the date of signing of Agreement.

33. Release of Bid Security / EMD:

The Earnest Money Deposit of unsuccessful bidder shall be returned (in case of BG) or refunded without interest by RTGS/NEFT on conclusion of Contract. The Earnest Money Deposit of the successful bidder shall be refunded (without interest) after he has signed the agreement and furnished required performance security.

34. Performance Security:

- i) Within 21 days of receipt of the Letter of Acceptance, the successful Bidder shall deliver to the Employer a Performance Security in the form in the form of Insurance Surety Bonds, Account Payee Demand draft, Fixed Deposit Receipt from a commercial bank, remittance by RTGS or Bank Guarantee (BG) or for an amount equivalent to 3% of the Contract price including GST, as applicable rounded off to the nearest 1000.
- ii) If the performance security is provided by the successful Bidder in the form of a Bank Guarantee, it shall be issued by a Nationalized /Scheduled Indian bank having its branch at Mangalore acceptable by NMPA and cashable at Mangalore. The BG shall be issued in favor of FA&CAO, New Mangalore Port Authority in the Format enclosed in Volume I as Annexure-A.

35. Fraud and Corrupt Practices:

The bidder and their respective officers, employees, agents and advisers shall observe the highest standard of ethics during the Selection Process. Notwithstanding anything to the contrary contained in this document, the Port shall reject the tender without being liable in any manner whatsoever to the bidder, if it determines that the bidder has, directly or indirectly or through an agent, engaged in corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice (collectively the "Prohibited Practices") in the Selection Process. In such an event, the Port shall, without prejudice to its any other rights or remedies, forfeit and appropriate the Bid Security or Performance Security, as the case may be, as mutually agreed genuine pre-estimated compensation and damages payable to the Port for, inter alia, time, cost and effort of the Authority, in regard to the Tender, including consideration and evaluation of such Bidder's Proposal. Such Bidder shall not be eligible to participate in any tender or RFP issued by the Authority during a period of 2 (two) years from the date such Bidder is found by the Authority to have directly or through an agent, engaged or indulged in any corrupt practice, fraudulent practice, coercive practice, undesirable practice or restrictive practice, as the case may be.

For the purposes of this Clause, the following terms shall have the meaning hereinafter respectively assigned to them:

(a) "corrupt practice" means

- i) the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the action of any person connected with the Selection Process (for avoidance of doubt, offering of employment to or employing or engaging in any manner whatsoever, directly or indirectly, any official of the Authority who is or has been associated in any manner, directly or indirectly with the Selection Process or the LOA or has dealt with matters concerning the Agreement or arising there from, before or after the execution thereof, at any time prior to the expiry of one year from the date such official resigns or retires from or otherwise ceases to be in the service of the Authority, shall be deemed to constitute influencing the actions of a person connected with the Selection Process; or
- ii) engaging in any manner whatsoever, whether during the Selection Process or after the issue of the LOA or after the execution of the Agreement, as the case may be, any person in respect of any matter relating to the Project or the LOA or the Agreement, who at any time

has been or is a legal, financial or technical consultant/ adviser of the Authority in relation to any matter concerning the Project;

- (b) "fraudulent practice" means a misrepresentation or omission of facts or disclosure of incomplete facts, in order to influence the Selection Process;
- (c) "coercive practice" means impairing or harming or threatening to impair or harm, directly or indirectly, any persons or property to influence any person's participation or action in the Selection Process;
- (d) "undesirable practice" means
 - i) establishing contact with any person connected with or employed or engaged by the Authority with the objective of canvassing, lobbying or in any manner influencing or attempting to influence the Selection Process; or
 - ii) having a Conflict of Interest; and
- (e) "restrictive practice" means forming a cartel or arriving at any understanding or arrangement among Applicants with the objective of restricting or manipulating a full and fair competition in the Selection Process.

36. Rejection of Tender:

Any Tender not conforming to the foregoing instructions will not be considered. The Employer does not bind himself to accept the lowest or any tender and has the right to reject any tender without assigning any reason thereof. No representation whatsoever will be entertained on this account.

37. Additional Information:

The "Instructions to Tenderers" shall not form part of the Contract. They are intended only to aid the Tenderers in the preparation of their tender.

38. Compliance of Local Content as per Make in India Policy:

Bidder shall comply with DPIIT Order No. P-45021/2/2017-PP(B-II) dtd. 16-09-2020 in respect of Local Content and furnish an undertaking in the prescribed format as per Annexure 13, to that effect, failing which, the bid may be liable for cancellation.

39. The declaration should be uploaded

The bidder shall provide/upload as a declaration the details of the following along with the bid Document Certifications form,

- i. US-EPA; The official web-site of the US-EPA one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a "list of the Designated Reference and Equivalent Methods" where the Method/Model No, Designation Number and Method code Number allotted by the Approving Agencies i.e for PM₁₀, PM_{2.5}, SO₂, O₃ and CO, NO₂ is mentioned. This can be Accessed via**

internet as shown below,

<https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>,
List of Designated Reference and Equivalent Methods in a Pdf Format
(designated_reference_and_equivalent)

The bidder has to declare the make/model number, designation number and method code of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation, after Technical bid and before Price Bid.

TUV QAL-1; the official web-site of the TUV one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a list of "Certified measuring and Evaluating-Systems according to EN 15267" Where the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) allotted by the Approving Agencies i.e NO, NO₂,NOX, SO₂,CO,PM₁₀, PM_{2.5}, O₃ & Benzene, is mentioned in the Ambient Air Section. This can be Accessed via internet as shown below,

ii. <https://qal1.de/>

- g) On the Extreme Right hand top side Select Language "English".
- h) Select Manufacturer.
- i) Manufacturer's Overview screen Opens Now select the Manufacturer of the equipment and list of "certified measuring and Evaluating-Systems according to EN 15267 " here the details of the Equipment's shall be verified.

The bidder has to declare the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation after Technical Bid and before Price Bid.

Annexure – 1

**LETTER OF SUBMISSION - COVERING LETTER
(ON THE LETTER HEAD OF THE BIDDER)**

Date:

To,

The Executive Engineer (Civil),
New Mangalore Port Authority,
Administration Building,
Panambur, Mangalore – 575 010

Sir,

Sub: The work of "Supply, Errection,Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender"
Being duly authorized to represent and act on behalf of

(Hereinafter referred to as "the Bidder") and having reviewed and fully understood all of the requirements of the bid document and information provided, the undersigned hereby apply for the project referred above.

We are submitting our Bid enclosing the following, with the details as per the requirements of the Bid Document, for your evaluation.

- i. Tender Document along with Addendum No -----
- ii. Power of Attorney - (Annexure - 2)
- iii. Organization Details - (Annexure - 3)
- iv. Details to fulfill the "Minimum Eligibility Criteria" and certificates - (Annexure 4)
- v. Average Financial turnover over the last three financial year - (Annexure 5)
- vi. List of Ongoing works at NMPA-(Annexure-6)
- vii. List of plant and equipment – (Annexure - 7)
- viii. Declaration – (Annexure – 8)
- ix. Bid Security / EMD Paid by RTGS/NEFT vide UTR No.....dtd. of (name and address of the branch).
- x. Banker's Details – Annexure 10 & 11
- xi. Tender fee paid by NEFT vide vide UTR No.....dtd. of (name and address of the branch).
- xii. Pre-Integrity pact agreement executed as per Appendix II
- xiii. Copy of valid ESI, PF & GST Registration certificate.

Signature
(Authorised Signatory)

Annexure – 2

ON STAMP PAPER of Rs 100/-
 “SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
 CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
 RETENDER”

FORMAT OF POWER OF ATTORNEY (in original)

In favour of signatory/s to the Tender, duly authenticated by Notary Public.

POWER OF ATTORNEY IN FAVOUR OF -----
 (Name, Designation, Company name)

TO ALL TO WHOM THESE PRESENTS shall come, I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors) do hereby sub-delegate/delegate, in terms of the powers delegated to me by the Board of Directors, ----- (name of the Co.) to Shri ----- (name, designation & address of the Attorney) the following:

NOW KNOW YE AND THOSE PRESENTS that I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors), do hereby authorize and empower Shri ----- (name, designation & address of the Attorney) to do severally amongst others, for the purpose of carrying on our business, the following:

- a) To represent lawfully the (name of the Co.) for obtaining bid/tender documents, prepare, sign, execute and submit tenders for execution of (Name of work)or any other works incidental to such construction works.
- b) To discuss the technical and financial matters, negotiate and accept prices and take decisions regarding terms and conditions and sign agreements and contracts and also to bind the (name of the Co.) to the arbitration clause included in the contract.
- c) For all or any of the purposes here of to sign and deliver or otherwise execute such deed or deeds, transfer or transfers, endorsement or endorsements and to perform such other acts, matters, things as the Attorney shall consider requisite or advisable as full and effectively as the Company could do, if present and acting there.

I, (Name & address of the authorized person to sub-delegate/delegate powers,

delegated on him by the Board of Directors) in terms of the powers delegated to me by the Board of Directors of (name of the Co.), do hereby agree that all acts, deeds and things done by the said Attorney by virtue of this power of attorney, shall be construed as acts, deeds and things done by the Company.

I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors), further undertake to ratify and confirm whatever our said attorney shall do or cause to be done for the Company, the said Company, in the premises, by virtue of the powers hereby given.

WHEREAS, this sub-delegation is signed and delivered to Shri ----- (name & designation of the Attorney), on this _____ day of _____, 20____ (Two thousand _____).

WHEREAS, even though this sub-delegation is signed on this _____ day of _____ 20____ (Two thousand _____), will have effect from the date he signs and receives this delegation.

IN WITNESS WHEREOF, I, (Name & address of the authorized person to sub-delegate/delegate powers, delegated on him by the Board of Directors) has, this _____ day of _____ 20____ (Two thousand _____) set my hands and subscribed my signature unto this instrument.

SIGNED AND DELIVERED ON
_____ BY

(Name of authorized person to delegate powers)

WITNESS:

SIGNED AND RECEIVED ON
_____ BY
(Name & designation of Attorney)

Annexure - 3

"SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
RETENDER"

--

ORGANIZATION DETAILS

CONTACT No.:

NAME OF APPLICANT:

1. Name of the Owner:
2. Address:
Telephone No. :
Fax No.
3. Description of Applicant
(for e.g. General, Civil Engineering
Contract or Joint Venture/Consortium etc.)
4. Registration and Classification of Contractors:
5. Name and address of bankers:
6. Number of years of experience as a general contractor:-
In own Country:
Internationally:
7. Number of years of experience as a sub-contractor:
Name and Address of partners or associated companies to be involved in the
project and whether Parent/Subsidiary/other:
8. Name and address of any associates knowledgeable in the procedures of
customs, immigration and local experience in various aspect of the project
etc.
9. Name and address of the companies / Sub-contractors who will be involved
in the execution of works, namely:

Signature
(Authorised Signatory)

Annexure - 4

NEW MANGALORE PORT AUTHORITY

"SUPPLY, ERRECTION, INSTALLATION, TESTING AND COMMISSIONING OF
CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
RETENDER"

Tenderer shall furnish Details of "eligibility works experience" as per Clause 12(a) of Minimum Eligible Criteria (MEC) of Instruction to Tenderer and certificates in the following format (Client Certificates/work completion certificates or any other documentary evidences with respect to the eligibility work)

ELIGIBLE ASSIGNMENT DETAILS FOR MEC

Assignment Number:

Description	Bidder to fill up the details here
Name and Address of the Client	
Title of the Eligible Assignment	
Date of completion of the Eligible Assignment	
Project Cost	
Reference No of the enclosed work order	
Reference No of the enclosed Client work Completion Certificate	
Reference No of any other documentary evidence; if enclosed.	
Name, telephone no, telefax no and email address of the client's representative	
Description and Scope of Work	

Instructions:

- i. Bidders are expected to provide information in respect of Eligible Assignments in this Section. The assignments cited must comply with the criteria specified Clause No. 12.0(a) Minimum eligibility of the "Instructions to Tenderers".
- ii. A separate sheet should be filled for each of the eligible assignments.
- iii. The details are to be supplemented by documentary proof (Work order and work completion certificate) from the respective client for having carried out such assignment duly certified by clients.

Signature

(Authorised Signatory)

Annexure - 5

NEW MANGALORE PORT AUTHORITY
 "SUPPLY, ERRECTION, INSTALLATION, TESTING AND COMMISSIONING OF
 CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
 RETENDER"
 FINANCIAL CAPABILITY

(A) Net worth & Average Annual Turnover of the Bidder

Net Worth	Turnover			
	Year 1	Year 2	Year 3	Average

Instructions:

Net Worth = (Subscribed and Paid-up Equity + Reserves) - (Revaluation reserves + Miscellaneous expenditure not written off + depreciation not provided for). Year 1 will be the Financial Year 2020-21. Year 2 shall be the year immediately preceding Year 1 and Year 3 shall be the year immediately preceding Year 2. The Bidder shall provide audited Annual Reports as required under this Bid Document.

Net worth & Annual turnover of the bidder shall be submitted duly verified by Chartered Accountant or Competent Authority.

(B) (Here specify proposed sources of credit line to meet the Cash flow demand for the work)

Source of Credit line	Amount

There should be a letter from the Bank mentioning that line of credit offered is specifically for this work/contract.

NOTE: If the Tenderer intends to meet the "Cash Flow Demand" for the project through their internal resources without availing the loan of credit, a specific mention to be made to this effect and proof for such resources shall be enclosed.

Certified by C.A Signature
(Authorised Signatory)

Annexure - 6

NEW MANGALORE PORT AUTHORITY
 "SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
 CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
 RETENDER".

LIST OF ONGOING WORKS IN HAND AT NMPA

The Tenderer shall furnish in the format given below details of works being carried out by him at the time of bidding in NMPA

SI.No.	Name of work	Work order No. and Date	Value of Work Order in Rs.	Average annual financial turnover as per MEC for the work

Contractor

Annexure – 6A(Not applicable)

NEW MANGALORE PORT AUTHORITY

“SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
RETENDER”

DETAILS OF PROPOSED APPROACH & METHODOLOGY

Bidder shall furnish a detailed method statement (Technical Note) for carrying out of the works, along with a construction programme showing sequence of operation and the time frame for various segments of temporary and permanent works.

Signature
(Authorised Signatory)

Annexure – 8

NEW MANGALORE PORT AUTHORITY
“SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
RETENDER”

DECLARATION

We M/s. (Name & address of the bidder) hereby declare that:-

- i. I have read the tender document Vol. I (Section I to III) Vol.II (Section IV and V) and Vol.III (Section V and VII) and agreed to the terms and conditions mentioned therein.
- ii. All details regarding construction plant, temporary work and personnel for site organisation considered necessary and sufficient for the work have been furnished in the Annexures to Conditions of Contract in Volume I and that such plant, temporary works and personnel for site organisation will be available at the site till the completion of the respective work.
- iii. No conditions are incorporated in the financial bid. In case any conditions are specified in the financial bid, the tender will be rejected summarily without making any further reference to the bidder.
- iv. We have not made any payment or illegal gratification to any persons/ authority connected with the bid process so as to influence the bid process and have not committed any offence under PC Act in connection with the bid.
- v. We shall undertake that, the Employer i.e. NMPA is **indemnified** against all damages or compensation payable at Law in respect of or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or Sub-Contractor against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto and the Employer shall be at liberty to deduct or adjust from the Contactor's bills an amount that Employer may be called upon to pay towards claims, demands, proceedings, costs, charges and expenses Whatsoever in respect of or in relation to any accident or injury referred to above without any reference to the Contractor.
- vi. We shall comply with all the Central State and Municipal Laws and Rules and

we shall be solely responsible for complying with the provisions of the Contract Labour (Regulations & Abolition) Act, 1970 & the contract labour (Regulation & Abolition) Karnataka Rules 1974 and rules there under and the enactments that may be applicable including ESI Act, the payment of wages act, Provident Fund Act, the Minimum Wages Act, the Factory's Act. The Workmen Compensation Act or any other applicable legislation and the Municipal by-laws or other statutory Rules and Regulations whatsoever in force if these are applicable. Any obligations finding or otherwise missed under any statutory enactments, rules & regulations there under shall be the responsibility of the Contractor and the NMPA will take no responsibility for the same. The Contractor should take Workmen's Compensation Policy for his Workers, who are not covered under ESI and submit the same to the EIC immediately after commencement of the work.

- vii. We undertake that, we are liable to pay all Statutory Compensation to the Labourers/persons engaged by him for the satisfactory execution of the works. If any claim is made against New Mangalore Port Authority on this work, the Port Authority shall have the right to deduct the same from the bill amount payable to the contractor after verification of the validity and if admissible as per rules
- viii. *We disclose with that we have made / not made payments or propose to be made to any intermediaries (agents) etc in connection with the bid.

* Note: Delete whichever is not applicable.

Signature
(Authorised Signatory)

Annexure-9**BID SECURITY (BANK GUARANTEE) (Not applicable to this Contract)**

WHEREAS, _____ [Name of Bidder] (hereinafter called "the Bidder") has submitted his bid dated _____ [date] for the Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender (hereinafter called "the Bid").

KNOW ALL PEOPLE by these presents that We _____ [name of bank] of _____ (name of country) having our registered office at _____ (hereinafter called "the Bank") are bound unto _____ [name of Employer] (hereinafter called "the Employer") in the sum of _____ i* for which payment well and truly to be made to the said Employer the Bank binds itself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this _____ day of _____ 20 _____

THE CONDITIONS of these obligations are:

(1) If after Bid opening the Bidder withdraws his Bid during the period of bid validity specified in the Form of Bid;

or

(2) If the Bidder having been notified of the acceptance of his Bid by the Employer during the period of bid validity:

(a) fails or refuses to execute the Form of Agreement in accordance with the Instructions to Bidders, if required; or

(b) fails or refuses to furnish the Performance Security, in accordance with the Instructions to Bidders, or

(c) does not accept the correction of the Bid Price pursuant to Clause 27;

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him owing to the occurrence of one or any of the three conditions, specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date _____ ii* days after the deadline for submission of Bids as such deadline is stated in the Instructions to Bidders or as it may be extended by the Employer, notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

Notwithstanding anything mentioned above,
Our liability against this guarantee is restricted to Rs (Rupees only) and unless a claim in writing is lodged with us within 3 months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharges.

IN WITNESS WHEREOF this guarantee has been duly executed on this day of 20

DATE_____ SIGNATURE OF THE BANK_____

WITNESS_____SEAL_____

[Signature, name and address]

i*The Bidder should insert the amount of the guarantee in words and figures denominated in Indian Rupees. This figure should be the same as shown in Clause 16 of the Instructions to Bidders.

ii*30 days after the end of the validity period of the Bid. Date should be inserted by the Employer before the Bidding documents are issued.

Annexure-10

DETAILS OF THE PARTY OPTING FOR REFUND OF EMD THROUGH E-PAYMENT SYSTEM FROM NEW MANGALORE PORT Authority

Name of the Party :

Bank A/c No :

Account type : (Savings / Current / Overdraft)

Bank Name :

Branch :

IFSC Code Number : (11 digit code)

Centre (Location) :

FAX No. :

E-Mail ID : (For forwarding information of remittance)

Mobile No :

Signature of the Party

Annexure-11

FORMAT FOR FURNISHING BANK INFORMATION FOR e-PAYMENT

1	Name and full address of the beneficiary	
2	Credit Account No. (Should be full 14 digit)	
3	Account Type (SB or CA or OD)	
4	Name of the Bank	
5	Branch (Full address with telephone No.)	
6	IFSC Code Number (11 digit)	
7	MICR code (Should be 9 digit)	
8	Telephone/Mobile/Fax No. of the beneficiary	Telephone:
		Mobile :
		Fax :
9	Photostat copy of a Cheque	

Signature of the party with seal

Verified the details furnished by the party and it is ascertained that the information furnished are in full shape as required. Xerox copy of a Cheque is also enclosed.

Signature of the HOD/HOO with seal

Annexure-12**Indemnity Bond**

(To be furnished in Stamp paper not less than Rs.100 e-Stamp paper)

This deed of indemnity is executed by herein after referred to as 'Indemnifier' which expression shall unless repugnant to the context or meaning thereof, include its successors, Administrator, representatives and assignees in favour of New Mangalore Port Authority, Panambur, Mangalore 575010, herein after referred to as 'Indemnified' which expression shall unless repugnant to the context or meaning thereof include its representatives and assignees witnesses as to.

Whereas the indemnified herein as awarded to the indemnifier herein a Tender/Contract or for on terms and conditions set out interalia in the work order No..... valued at Rs.....

AND Whereas, the clauses No..... of the above mentioned work order provides for indemnifying the indemnified by the indemnifier for any accident, damage or compensation payable to any workmen or other person in the employment of the contractor or any sub contractor during the period of tender/contract.

AND Whereas, the Indemnifier hereby irrevocably agrees to indemnify the indemnified against all damages or compensation payable at law in respect of or in consequence of any accident or injury to any workmen or other person in the employment of the contractor or sub-contractor against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto and the indemnified shall be at liberty to deduct or adjust from the bills payable to the indemnifier by the indemnified for an amount that the indemnified may be called upon to pay towards claims, demands, proceedings, costs, charges and expenses whatsoever in respect of or in relation to any accident or injury referred to above without any reference to the indemnifier.

The Indemnifier shall comply with all the Central State and Muncipal Laws and Rules and shall be solely responsible for complying with the provisions of the Contract Labour (Regulations & Abolition) Act, 1970 & the contract labour (Regulation & Abolition) Karnataka Rules 1974 and rules there under and the enactments that may be applicable including ESI Act, the payment

of wages act, Provident Fund Act, the Minimum Wages Act, the Factory's Act, the Workmen Compensation Act or any other applicable legislation and the Muncipal by-laws or other statutory Rules and Regulations whatsoever in force if these are applicable. Any obligations finding or otherwise missed under any statutory enactments rules & regulations there under shall be the responsibility of the Indemnifier and the Indemnified will have no responsibility for the same. The Indemnifier shall obtain Workmen's Compensation Policy for his workers, who are not covered under ESI and submit the same to the ESIC immediately after commencement of the work.

The Indemnifier is liable to pay all Statutory Compensation to the Labourers / persons engaged by him for the satisfactory execution of the works. If any claim is made against Indemnified arising out of this work, the Port shall have the right to deduct the same from the bill amount payable to the Indemnifier after verification of the validity and if admissible as per rules.

The Indemnifier shall ensure the use of PPE such as helmets, safety shoes, nose masks, hand gloves, safety harness or any other equipment as required depending on nature of work by his staff at site.

In addition to complying of the above, the Indemnifier hereby undertakes to indemnify the indemnified against any unforeseen incidents / accidents, which may lead to fatality including death, permanent/ partial disablement, injury, financial loss, legal issues or any other etc of the labourers / workmen's/ staffs of the contractor / sub-contractor for which the indemnified and its officers / representation are in no way responsible.

For.....

INDEMINIFIER

(Signature with Name and Designation)

Company Seal

Station:

Date:

Format for Self Certification under Preference to "MAKE
IN INDIA" Policy

(Refer Clause No. 38 of ITT)

CERTIFICATE

In line with Government Public Procurement Order No. P-45021/2/2017-PP(B-II) dtd. 16-09-2020, as amended from time to time and as applicable on the date of submission of tender, we hereby certify that we M/s_____ (name of the Bidder) are local supplier meeting the requirement of minimum Local content (50%) as defined in above orders for the material against Tender NIT No_____ for the work of _____

—
Details of location at which local value addition will be made is as follows:

We also understand, false declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rule for which for which a bidder or its successors can be debarred for up two years as per Rule 151 (iii) of the General Financial Rules along with such other actions as may be permissible under law. Seal and Signature of Authorized Signatory

Signature of the Bidder

Date :

Place :

Annexure - 14

NEW MANGALORE PORT AUTHORITY
 "SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING OF
 CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-
 RETENDER"

EQUIPMENT DECLARATION

Format for Declaration of Analyzer Model Nos Intended to be Installed in the CAAQMS Station for respective parameters to be analyzed

SI No	Parameter to be analyzed	Manufacturer's Equipment Model No which is mentioned in the website of the USEPA and TUV-qa1 authorized approving agencies	Remarks

Signature
(Authorised Signatory)

SECTION - II

iii) FORM OF AGREEMENT

THIS AGREEMENT made the _____ day of _____ 20__ BETWEEN New Mangalore Port Authority (hereinafter called "the Employer") of the one part and _____

(hereinafter called "the Contractor") of the other part WHEREAS the Employer is desirous that certain works should be executed by the Contractor, Viz----- and has accepted a Tender by the Contractor for the execution and Completion of such works and the remedying of any defects therein at a contract price of Rs

NOW THIS AGREEMENT WITNESSETH as follows:

- 1 In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the General Conditions hereinafter referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.-
 - a) The Letter of Acceptance;
 - b) The Said Tender (Technical Bid);
 - c) The Conditions of Contract (Parts I and II)
 - d) The Specifications;
 - e) The Drawings;
 - f) The Bill of Quantities and
 - g) The Addenda
 - h) Letters exchanged between the Employer and the Tenderer up to the issue of Letter of Acceptance as separately listed and annexed here to.
3. In consideration of the payments to be made by the Employer to the contractor as hereinafter mentioned the Contractor hereby covenants with the Employer to execute and complete the works and remedy any defects therein in conformity in all respect with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the works and the remedying of defects therein

the Contract Price or and such other sum as may become payable under the Provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed the day and year first above written in accordance with their respective laws.

This document contains pages in all. This agreement is assigned No. CEA /20XX-XX.

The Common Seal of

was hereunto affixed in the presence of :

SECTION - III

iv) CONDITIONS OF CONTRACT

A. General**1. Definitions**

Terms which are defined in the Contract Data are not also defined in the Conditions of Contract but keep their defined meanings. Capital initials are used to identify defined terms.

Bill of Quantities means the priced and completed Bill of Quantities forming part of the Bid.

Compensation Events are those defined in Clause 44.

The Completion Date is the date of completion of the Works as certified by the Engineer or his nominee in accordance with Sub Clause 54

The Contract is the contract between the Employer and the Contractor to execute, complete and maintain the Works. It consists of the documents listed in Clause 2.3 below.

The Contract Data defines the documents and other information which comprise the Contract.

The Contractor is a person or corporate body whose Bid to carry out the Works has been accepted by the Employer.

The Contractor's Bid is the completed Bidding documents submitted by the Contractor to the Employer.

The Contract Price is the price stated in the letter of acceptance and thereafter as adjusted in accordance with the provisions of the Contract.

Days are calendar days, months are calendar months.

A Defect is any part of the Works not completed in accordance with the Contract.

The Defects Liability Period is the period named in the Contract Data and

calculated from the Completion Date.

The Employer is the party who will employ the Contractor to carry out the Works.

Equipment is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works.

The Initial Contract Price is the Contract Price listed in the Employer's Letter of Acceptance.

The Intended Completion Date is the date on which it is intended that the Contractor shall complete the works. The Intended Completion Date is specified in the Contract Data. The Intended Completion Date may be revised only by the Engineer or his nominee by issuing an extension of time.

Materials are all supplies, including consumables, used by the contractor for incorporation in the Works.

The Engineer or his nominee is the person named in the Contract Data (or any other competent person appointed and notified to the contractor to act in replacement of the Engineer or his nominee) who is responsible for supervising the Contractor, administering the Contract, certifying payments due to the Contractor, issuing and valuing Variations to the Contract, awarding extensions of time and valuing the Compensation Events.

Plant is any integral part of the Works which is to have mechanical, electrical, electronic or chemical or biological function.

The Site is the area defined as such in the Contract Data.

Site Investigation Reports are those which are included in the Bidding documents and are factual interpretative reports about the surface and sub-surface conditions at the site.

Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Engineer or his nominee.

The Start Date is given in the Contract Data. It is the date when the Contractor shall commence execution of the works. It does not necessarily

coincide with any of the Site Possession Date.

A Subcontractor is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract which includes work on the Site.

Temporary Works are works designed, constructed, installed and removed by the Contractor which are needed for construction or installation of the Works.

A Variation is an instruction given by the Engineer or his nominee which varies the Works.

The Works are what the Contract requires the Contractor to construct, install and turn over to the Employer as defined in the Contract Data.

The Trained Work Person are those employed / proposed to be employed by the Contractor at the Project Site, who have participated and are in possession of a valid Competency Certificate through a programme run under the auspices of a University, State Technical Board, Ministry of Government of India.

2. Interpretation

- 2.1 In interpreting these Conditions of Contract, singular also means plural, male also means female or neuter and the other way around. Headings have no significance. Words have their normal meaning under the language of the Contract unless specifically defined. The Engineer or his nominee will provide instructions clarifying queries about the Conditions of Contract.
- 2.2 If sectional completion is specified in the Contract Data, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion date for the whole of the Works).
- 2.3 The documents forming the Contract shall be interpreted in the following order of priority:

- (1) Agreement
- (2) Letter of Acceptance and notice to proceed with works
- (3) Contractor's Bid
- (4) Contract Data
- (5) Conditions of Contract including Special Conditions of Contract
- (6) Specifications
- (7) Drawings
- (8) Bill of quantities and
- (9) any other documents listed in the Contract Data as forming part of the Contract.

3. Language and Law

- 3.1 The language of the Contract and the law governing the Contract are stated in the Contract Data.

4. Engineer or his nominee's Decisions

- 4.1 Except where otherwise specifically stated, the Engineer or his nominee will decide contractual matters between the Employer and the Contractor in the role representing the Employer.

5. Delegation

- 5.1 The Engineer or his nominee may delegate any of the duties and responsibilities to other people after notifying the Contractor and may cancel any delegation after notifying the Contractor.

6. Communications

Communications between parties which are referred to in the conditions are effective only when in writing. A notice shall be effective only when it is delivered (in terms of Indian Contract Act 1872).

7. Contract Agreement

A suitable form is annexed as "FORM OF AGREEMENT" to the Contract Document. Upon signing the Contract Agreement, the Contractor shall make 20 copies of Contract Documents in hardbound cover which shall cover documents used in Contract/Agreement and provide the same to the Employer at no extra cost.

Data made available by the Employer in accordance with provisions of the Condition of Contract shall be deemed to include data listed elsewhere in the Contract and open for inspection at the office of the Deputy Chief Engineer (Civil) of the New Mangalore Port Authority (by prior appointment with the

Engineer).

8. Subcontracting

8.1 The Contractor may subcontract with the approval of the Engineer or his nominee but may not assign the Contract without the approval of the Employer in writing. Subcontracting does not alter the Contractor's obligations.

Other Contractors

8.2 The Contractor shall co-operate and share the site with other contractors, public authorities, utilities, and the Employer between the dates given in the Schedule of other contractors. The Contractor shall as referred to in the Contract Data, also provide facilities and services for them as described in the Schedule. The employer may modify the schedule of other contractors and shall notify the contractor of any such modification.

9. Personnel

9.1 The Contractor shall employ the key personnel named in the Schedule of Key Personnel as referred to in the Contract Data to carry out the functions stated in the Schedule or other personnel approved by the Engineer or his nominee. The Engineer or his nominee will approve any proposed replacement of key personnel only if their qualifications, abilities, and relevant experience are substantially equal to or better than those of the personnel listed in the schedule.

9.2 If the Engineer or his nominee asks the contractor to remove a person who is a member of the contractor's staff of his work force stating the reasons, the contractor shall ensure that the person leaves the site within seven days and has no further connections with the work in the contract.

10. Employer's and Contractor's Risks

10.1 The Employer carries the risks which this Contract states are Employer's risks and the contractor carries the risks which this Contract states are contractor's risks.

11. Employer's Risks

11.1 The Employers risks are

- a) in so far as they directly affect the execution of the Works in the country where the Permanent Works are to be executed:
 - i) war and hostilities (whether war be declared or not), invasion, act of

- foreign enemies;
 - ii) rebellion, revolution, insurrection, or military or usurped power, or civil war;
 - iii) ionizing radiations, or contamination by radioactivity from any nuclear fuel, or from any nuclear waste, from the combustion of nuclear fuel, radioactive toxic explosive or other hazardous properties of any explosive nuclear assembly or nuclear component thereof;
 - iv) pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds; and
 - v) riot, commotion or disorder, unless solely restricted to the employees of the Contractor or of his Subcontractors and arising from the conduct of the Works;
 - vi) Unforeseen Rains (Rains if any; during the period other than the Monsoon period as stated in the Tender), floods, tornadoes, earthquakes and landslides.
- b) loss or damage due to the use or occupation by the Employer of any Section or part of the Permanent Works, except as may be provided for in the Contract;
 - c) loss or damage to the extent that it is due to the design of the Works, other than any part of the design provided by the Contractor or for which the Contractor is responsible; and
 - d) any operation of the forces of nature (in so far as it occurs on the Site) which an experienced contractor:
 - i) could not have reasonably foreseen, or
 - ii) could reasonably have foreseen, but against which he could not reasonably have taken at least one of the following measures:
 - A) prevent loss or damage to physical property from occurring by taking appropriate measures, or
 - B) insure against.

12. Contractor's Risks

- 12.1 All risks of loss of or damage to physical property and of personal injury and death which arise during and in consequence of the performance of the Contract other than the excepted risks are the responsibility of the Contractor.

13. Insurance

- 13.1 The Contractor shall provide in the joint names of the Employer and the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the

Contract Data for the following events which are due to the Contractors risks.

- a) loss of or damage to the Works, Plant and Materials
 - b) loss of or damage to Equipment;
 - c) loss of or damage of property (except the Works, Plant, Materials and Equipment) in connection with the Contract; and
 - d) personal injury or death.
- 13.2 Policies and certificates for insurance shall be delivered by the contractor to the Engineer or his nominee for the Engineer or his nominee's approval before the start date. All such insurances shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.
- 13.3 If the contractor does not provide any of the policies and certificates required, the Employer may affect the insurance which the contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the contractor or, if no payment is due, the payment of the premiums shall be a debt due.
- 13.4 Alterations to the terms of insurance shall not be made without the approval of the Engineer or his nominee.
- 13.5 Both parties shall comply with all conditions of the insurance policies.

14. Site Investigation Reports

The Contractor, in preparing the Bid, shall rely on the Site Investigation Report referred to in the Contract Data, supplemented by any information available to the Bidder.

15. Queries about the Contract Data

The Engineer or his nominee will clarify queries on the Contract Data.

16. Contractor to Construct the Works

The Contractor shall construct and install the works in accordance with the Specification and Drawings.

17. The Works to Be Completed by the Intended Completion Date

The Contractor may commence execution of the works on the Start Date and shall carry out the works in accordance with the program submitted by the contractor as updated with the approval of the Engineer or his nominee, and complete them by the Intended Completion Date.

18. Approval by the Engineer or his nominee

- 18.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Engineer or his nominee, who is to approve them if they comply with the specifications and Drawings.
- 18.2 The Contractor shall be responsible for design of Temporary Works.
- 18.3 The Engineer or his nominee's Approval shall not alter the contractor's responsibility for design of the Temporary Works.
- 18.4 All Drawings prepared by the contractor for the execution of the temporary or permanent Works, are subject to prior approval by the Engineer or his nominee before their use.

19. Safety

The contractor shall be responsible for the safety of all activities on the Site.

20. Discoveries

Anything of historical or other interest or of significant value unexpectedly discovered on the Site is the property of the Employer. The Contractor is to notify the Engineer or his nominee of such discoveries and carry out the Engineer or his nominee's instructions for dealing with them.

21. Possession of the Site

The Employer shall give possession of all parts of the Site to the Contractor, free from encumbrances. If possession of a part is not given by the start date stated in the Contract Data the Employer is deemed to have delayed the start of the relevant activities and this will be a Compensation Event.

22. Access to the Site

The Contractor shall allow the Engineer or his nominee and any person authorized by the Engineer or his nominee access to the Site to any place where work in connection with the Contract is being carried out or is intended to be carried out and to any place where materials or plant are being manufactured, fabricated and/or assembled for the works.

23. Instructions

The Contractor shall carry out all instructions of the Engineer or his nominee which comply with the applicable laws where the Site is located.

24. Disputes

If the Contractor believes that a decision taken by the Engineer or his nominee was either outside the authority given to the Engineer or his

nominee by the Contract or that the decision was wrongly taken, the decision shall be referred to the Dispute Review Board (DRB) within 28 days of the notification of the Engineer or his nominee's decision.

25. Settlement of Disputes

- 25.1 If a dispute of any kind whatsoever arises between the Employer and the Contractor in connection with, or arising out of the Contract or the execution of the Works, whether during the execution of the Works or after their completion and whether before or after repudiation or after termination of the Contract, including any disagreement by either party with any action, inaction, opinion, instruction, determination, certificate or valuation of the Engineer or his nominee, the matter in dispute shall, in the first place be referred to the Disputes Review Board [DRB] established pursuant to Appendix 1 hereto.

Unless the Contract has already been repudiated or terminated or frustrated the Contractor shall in every case, continue to proceed with the Works with all due diligence and the Contractor and the Employer shall give effect forthwith to every decision of the Engineer or his nominee unless and until the same shall be revised, as hereinafter provided, in a Dispute Review Board Recommendation / Arbitral Award.

25.2 Arbitration

Any dispute in respect of in respect of contracts where party is dissatisfied by the Dispute Review Board's (DRB) decision shall be decided by arbitration as set forth below:

- i) A dispute with contractor shall be finally settled by arbitration in accordance with the Indian Arbitration and Conciliation Act, 1996, or any statutory amendment thereof. The arbitral tribunal shall consist of 3 arbitrators, one each to be appointed by the Employer and the contractor, and the third to be appointed by the mutual consent of both the arbitrators, failing which by making a reference to CIDC-SIAC Arbitration Center from their panel.
- ii) Neither party shall be limited in the proceedings before such arbitrators to the evidence or arguments already put before the Engineer or his nominee or the Board, as the case may be, for the purpose of obtaining said recommendations/decision. No such recommendations/decision shall disqualify the Engineer or his nominee or any of the members of the Board, as the case may be, from being called as a witness and giving evidence before the arbitrators or any matter whatsoever relevant to the dispute.
- iii) The reference to arbitration shall proceed notwithstanding that the works shall not then be or be alleged to be complete, provided always that the obligations of the Employer, the Engineer or his nominee and the Contractor shall not be

altered by reason of the arbitration being conducted during the progress of the works. Neither party shall be entitled to suspend the works to which the dispute relates, and payment to the Contractor shall be continued to be made as provided by the contract.

- iv) If one of the parties fails to appoint its arbitrators in pursuance of sub-clause [i], within 14 days after receipt of the notice of the appointment of its arbitrator by the other party, then President/Chairman of the nominated Institution shall appoint arbitrator within 14 days of the receipt of the request by the nominated institution. A certified copy of the President's/ Chairman's order, making such an appointment shall be furnished to both the parties.
- v) Arbitration proceedings shall be held at Mangalore, and the language of the arbitration proceedings and that of all documents and communications between the parties shall be 'English
- vi) The Arbitration shall be conducted by the experts from the panel of CIDCSIAC Arbitration Center.
- vii) The decision of the majority of arbitrators shall be final and binding upon both parties. The expenses of the arbitrators as determined by the arbitrators shall be shared equally by the Employer and the Contractor. However, the expenses incurred by each party in connection with the preparation, presentation, etc. of its case prior to, during and after the arbitration proceedings shall be borne by each party itself.
- viii) All arbitration awards shall be in writing and shall state the reasons for the award.
- ix) Performance under the contract shall continue during the arbitration proceedings and payments due to the contractor by the Employer shall not be withheld, unless they are subject matter of the arbitration proceedings.

26. Replacement of Conciliator (Deleted)

B. TIME CONTROL

27. Program

27.1 Within the time stated in the Contract Data the Contractor shall submit to the Engineer or his nominee for approval a Program showing the general methods, arrangements, order, and timing for all the activities in the works along with monthly cash flow forecast.

27.2 An update of the Program shall be a program showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work including any changes to the sequence of the activities.

27.3 The Contractor shall submit to the Engineer on the first day of each week or such longer period as the Engineer may from time to time direct, a progress report in an approved form showing up-to-date total progress, progress achieved against planned progress, during the previous week and progress forecast for the following week for all important items in each section or portion of the Works, in relation with the approved Program.

27.4 The Contractor shall submit to the Engineer or his nominee, for approval an updated Program at intervals no longer than the period stated in the Contract Data. If the Contractor does not submit an updated Program within this period, the Engineer or his nominee may withhold the amount stated in the Contract Data from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Program has been submitted.

28. Revised Program

The Engineer or his nominee's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Engineer or his nominee again at any time. A revised Program is to show the effect of Variations and Compensation Events.

29. Extension of the Intended Completion Date

29.1 The Engineer or his nominee shall extend the Intended Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date without the Contractor taking steps to accelerate the remaining work and which would cause the Contractor to incur additional cost.

- 29.2 The Engineer or his nominee shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Engineer or his nominee for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

30. Delays Ordered by the Engineer or his nominee

The Engineer or his nominee may instruct the Contractor to delay the start or progress of any activity within the Works.

31. Management Meetings

- 31.1 Either the Engineer or his nominee or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.
- 31.2 The Engineer or his nominee shall record the business of management meetings and is to provide copies of his record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken is to be decided by the Engineer or his nominee either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

32. Early Warning

- 32.1 The Contractor is to warn the Engineer or his nominee at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price or delay the execution of works. The Engineer or his nominee may require the Contractor to provide an estimate of the expected effect of the event or circumstance on the Contract Price and Completion Date. The estimate is to be provided by the Contractor as soon as reasonably possible.
- 32.2 The Contractor shall cooperate with the Engineer or his nominee in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer or his nominee.

C. QUALITY CONTROL

33. Identify Defects

The Engineer or his nominee shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Engineer or his nominee may instruct the Contractor to search for a Defect and to uncover and test any work that the Engineer or his nominee considers may have a Defect.

34. Tests

If the Engineer or his nominee instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does the Contractor shall pay for the test and any samples. If there is no Defect the test shall be a Compensation Event.

35. Defect Liability

35.1 The Engineer or his nominee shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion and is defined in the Contract Data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

35.2 Every time notice of a Defect is given, the Contractor shall correct the notified defect within the length of time specified by the Engineer or his nominee's notice. To the intent that the works shall, at or as soon as practicable after the expiration of the Defects Liability Period, be delivered to the Employer in the condition required by the Contract, fair wear and tear excepted, to the satisfaction of the Engineer, the Contractor shall :

- (a) Complete the work, if any, outstanding on the date stated in the Taking-Over Certificate within the date to be intimated by the engineer and
- (b) execute all such work of amendment, reconstruction, and remedying defects, shrinkages or other faults as the Engineer may, during the Defects Liability Period or within 14 days after its expiration, as a result of an inspection made by or on behalf of the Engineer prior to its expiration, instruct the Contractor to execute.

35.3 Cost of Remedying Defects

All work referred to in Sub-Clause 35.2 shall be executed by the contractor at his own cost if the necessity thereof is, in the opinion of the Engineer, due to:

- a) The use of materials, Plant or workmanship not in accordance with the Contract, or
- b) Where the Contractor is responsible for the design of part of the

Permanent Works, any fault in such design, or the neglect or failure on the part of the Contractor to comply with any obligation, expressed or implied, on the Contractor's part under the Contract.

35.4 Defects Liability Certificate

The Contract shall not be considered as completed until a Defects Liability Certificate shall have been signed by the Engineer and delivered to the Employer, with a copy to the Contractor, stating the date on which the Contractor shall have completed his obligations to execute and complete the Works and remedy any defects therein to the Engineer's satisfaction. The Defects Liability Certificate shall be given by the Engineer within 28 days after the expiration of the Defects Liability Period, or, if different defects liability periods shall become applicable to different Sections or parts of the Permanent Works, the expiration of the latest such period, or as soon thereafter as any works instructed, pursuant to Clauses 35, have been completed to the satisfaction of the Engineer.

35.5 Unfulfilled Obligations

Notwithstanding the issue of the Defects Liability Certificate the Contractor and the Employer shall remain liable for the fulfillment of any obligation incurred under the provisions of the Contract prior to the issue of the Defects Liability Certificate which remains unperformed at the time such Defects Liability Certificate is issued and, for the purposes of determining the nature and extent of any such obligation, the Contract shall be deemed to remain in force between the parties to the Contract.

36. Uncorrected Defects.

If the Contractor has not corrected a Defect within the time specified in the Engineer or his nominee's notice the Engineer or his nominee will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

D. COST CONTROL

37. Bill of Quantities

- 37.1 The Bill of Quantities shall contain items for the construction, supply, installation, testing and commissioning work to be done by the Contractor.
- 37.2 The Bill of Quantities is used to calculate the Contract Price. The Contractor is paid for the quantity of the work done at the rate in the Bill of Quantities for each item.

38. Changes in the Quantities

- 38.1 If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than +25 % provided the change exceeds +10% of initial Contract Price, the Engineer or his nominee shall adjust the rate(s), to allow for the change.
- 38.2 The Engineer or his nominee shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 percent except with the Prior approval of the Employer.
- 38.3 If requested by the Engineer or his nominee where the quoted rate(s) of any item(s) is abnormally high, the Contractor shall provide the Engineer or his nominee with a detailed cost breakdown of such rate in the Bill of Quantities.

39. Variations

- 39.1 The Engineer shall make any variation of the form, quality or quantity of the Works or any part thereof that may, in his opinion, be necessary and for that purpose, or if for any other reason it shall, in his opinion, be appropriate, he shall have the authority to instruct the Contractor to do and the Contractor shall do any of the following:
 - e) increase or decrease the quantity of any work included in the Contract,
 - f) omit any such work,
 - g) change the character or quality or kind of any such work,
 - h) change the levels, lines, position and dimension of any part of the Works,
 - i) execute additional work of any kind necessary for the completion of the Works,
 - j) change any specified sequence or timing of construction of any part of the Works.

No such variation shall in any way vitiate or invalidate the Contract, by the effect, if any, of all such variations shall be valued in accordance with Clause 40. Provided that where the issue of an instruction to vary the works is necessitated by some default of or breach of contract by the contractor or for which he is responsible, any additional cost attributable to such default shall

be borne by the contractor. All Variations shall be included in updated Programs produced by the contractor.

39.2 Instructions for Variations

The Contractor shall not make any such variation without an instruction of the Engineer. Provided that no instruction shall be required for increase or decrease in the quantity of any work where such increase or decrease is not the result of an instruction given under this clause, but is the result of the quantities exceeding or being less than those stated in the Bill of Quantities.

40. Payments for Variations

- 40.1 Variation permitted shall not exceed +25% in quantity of each individual item, and +10% of the total contract price. Within 14 days of the date of instruction for executing varied work, extra work or substitution, and before the commencement of such work, notice shall be given either (a) by the contractor to the Employer of his intention to claim extra payment or a varied rate or price, or (b) by the Employer to the contractor of his intention to vary rate or price.
- 40.2 For items not existing in the Bill of Quantities or substitution to items in the Bill of Quantities, rate payable should be determined by methods given below and in the order given below:
- i) Rates and prices in Contract, if applicable plus escalation as per contract.
 - ii) Rates and prices in the Schedule of Rates applicable to the Contract plus ruling percentage.
 - iii) Market rates of materials and labor, hire charges of plant and machinery used, plus 10% for overheads and profits of contractor.
- 40.3 For items in the Bill of Quantities but where quantities have increased beyond the variation limits, the rate payable for quantity in excess of the quantity in the Bill of Quantity plus the permissible variation should be:
- i) Rates and prices in contract, if reasonable plus escalation, failing which (ii) and (iii) below will apply
 - ii) Rates and prices in the schedule of Rates applicable to the contract plus ruling percentage.
 - iii) Market rates of material and labor, hire charges of plant and machinery used plus 10% for overheads and profits of contractor.
- 40.4 If there is delay in the Employer and the Contractor coming to an agreement on the rate of an extra item, rates as proposed by the Employer shall be payable provisionally till such time as the rates are finally determined or till

date mutually agreed.

- 40.5 If the Engineer or his nominee decides that the urgency of varying the work prevent a quotation being given and considers not delaying the work, no quotation shall be given and the Variation shall be treated as a Compensation Event.

41. Cash flow forecasts

- 41.1 When the Program is updated, the contractor is to provide the Engineer or his nominee with an updated cash flow forecast.

42. Payment Certificates

- 42.1 The Contractor shall submit to the Engineer or his nominee monthly statements of the estimated value of the work completed less the cumulative amount certified previously.
- 42.2 The Engineer or his nominee shall check the Contractors' monthly statement within 14 days and certify the amount to be paid to the Contractor after taking into account any credit or debit for the month in question in respect of materials for the works in the relevant amounts and under conditions set forth in sub-clause 51.6 of the Contract Data (Secured Advance).
- 42.3 The value of work executed shall be determined by the Engineer or his nominee.
- 42.4 The value of work executed shall comprise the value of the quantities of the items in the Bill of quantities completed.
- 42.5 The value of work executed shall include the valuation of variations and Compensation Events.
- 42.6 The Engineer or his nominee may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

43. Payments

- 43.1 Bills /Tax invoice shall be prepared and submitted by the Contractor. Joint measurements shall be taken continuously and need not be connected with billing stage. System of 4 copies of measurements, one each for Contractor, Employer and Engineer or his nominee, and signed by both Contractor and Employer shall be followed.
- 43.2 75% of bill amount shall be paid within 14 days of submission of the bill. Balance amount of the verified bill shall be paid within 28 days of the submission of the bill.
- 43.3 Contractor shall submit final Bill within 60 days of issue of defects liability certificate. Client's Engineer or his nominee shall check the bill within 60 days after its receipt and return the bill to Contractor for corrections, if any. 50% of undisputed amount shall be paid to the Contractor at the stage of returning the bill.
- 43.4 The contractor should re-submit the bill, with corrections within 30 days of its return by the Engineer or his nominee. The re-submitted bill shall be checked and paid within 60 days of its receipt.
- 43.5 If an amount certified is increased in a later certificate as a result of an award by the DRB or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.
- 43.6 Items of the Works for which no rate or price has been entered in will not be paid for by the Employer and shall be deemed covered by other rates and prices in the Contract.

44. Compensation Events

- 44.1 The following mutually agreed Compensation Events unless they are caused by the Contractor would be applicable:
 - (a) The Employer does not give access to a part of the Site by the Site Possession Date stated in the Contract Data.
 - (b) The Employer modifies the schedule of other contractors in a way which affects the work of the contractor under the contract.
 - (c) The Engineer or his nominee orders a delay or does not issue drawings, specifications or instructions required for execution of works on time.
 - (d) The Engineer or his nominee instructs the Contractor to uncover or to carry out additional tests upon work which is then found to have no

Defects.

- (e) The Engineer or his nominee unreasonably does not approve for a subcontract to be let.
- (f) Ground conditions are substantially more adverse than could reasonably have been assumed before issuance of Letter of Acceptance from the information issued to Bidders (including the Site Investigation Reports), from information available publicly and from a visual inspection of the site.
- (g) The Engineer or his nominee gives an instruction for dealing with an unforeseen condition, caused by the Employer, or additional work required for safety or other reasons.
- (h) Other contractors, public authorities, utilities or the Employer does not work within the dates and other constraints stated in the Contract that cause delay or extra cost to the Contractor.
- (i) The effect on the Contractor of any of the Employer's Risks.
- (j) Other Compensation Events listed in the Contract Data or mentioned in the contract.

Whenever any compensation event occurs, the contractor will notify the employer, within 14 days and provide a forecast cost of the compensation event.

44.2 If a Compensation Event would cause additional cost or would prevent the work being completed before the Intended Completion Date, the Contract Price shall be increased and/or the Intended Completion Date shall be extended. The Engineer or his nominee shall decide whether and by how much the Contract Price shall be increased and whether and by how much the Intended Completion Date shall be extended.

44.3 As soon as information demonstrating the effect of each Compensation Event upon the Contractor's forecast has been provided by the Contractor, it is to be assessed by the Engineer or his nominee and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable the Engineer or his nominee shall adjust the Contract Price based on Engineer or his nominee's own forecast. The Engineer or his nominee will assume that the Contractor will react competently and promptly to the event.

45. Tax

45.1 The rates quoted by the Contractor to be inclusive of Taxes if any excluding GST that the Contractor will have to pay for the performance of this Contract. The Employer will perform such duties in regard to the deduction of such taxes at sources as per applicable law. Any new Taxes, levies, duties imposed after signing the Contract shall be reimbursed by the employer on

production of documentary evidence.

The GST shall be quoted separately in tax invoice.

The Contractor shall file the applicable returns with tax department in time and submit the same as documentary evidence.

46. Currencies

46.1 All payments shall be made in Indian Rupees unless specifically mentioned.

47. Price Adjustment. (Not Applicable)

47.1 Contract price shall be adjusted for increase or decrease in rates and prices of labour, materials, fuels and lubricants in accordance with the following principles and procedures and as per formula given below:

- (k) The price adjustment shall apply for the work done from the start date given in the contract data up to end of the initial intended completion date or extensions granted by the Engineer or his nominee and shall not apply to the work carried beyond the stipulated time for reason attributable to the contractor.
- (l) The price adjustment shall be determined during each quarter from the mutually agreed formula given in the contract data based on the following premises.

I (A) Formula for Labour Component

V1	=	0.85	x	(R-C)	x	K1	x	I - I0
						100		I0

Where V1 = Amount of variation payable for a value R of work done.

R = Value of work done during the period under consideration.

C = Cost of Cement & steel calculated on star rates for quantity as per design, incorporated in to the work during the period under consideration to be taken from II A and II B.

K1 = Percentage of Labour Component to be taken as 25%.

I0 = Basic Consumer Price Index for Bangalore Centre (Base 2001 = 100) for industrial workers declared as per the Labour Bureau, Ministry of Labour & Employment, Government of India as prevailing on the Base Date (28 days prior to

the latest date for submission of the Bid).

I = Average Consumer Price Index for Bangalore Centre (Base 2001 = 100) for industrial workers declared by the Labour Bureau, Ministry of Labour & Employment, Government of India for the period in which the value R of work is done. If the period covered by a bill does not coincide with a calendar month, then weighted time average for the period will be taken for I.

I (B) Formula for Balance Material Component (excluding cement, steel).

V2	=	0.85	x	(R-C)	x	K2		M – M0
						100	x	M0

Where V2 = Amount of variation payable for a value R of work done on account of material.

R = Value of work done during the period under consideration.

C = Cost of Cement and steel at Star rate calculated on star rates for quantity as per design, incorporated in to the work during the period under consideration to be taken from II A and II B.

K2 = Percentage of Material Component to be taken as 70%.

M0= Wholesale price index for all commodities prepared by the office of Economic Advisor, Ministry of Industry, Government of India as prevailing on the Base Date (28 days prior to the latest date for submission of the Bid).

M = Average wholesale price index for all commodities prepared by the office of Economic Advisor, Ministry of Industry, Government of India, during the period under consideration. If the period covered by a bill does not coincide with a calendar month, then weighted time average for the period will be taken for M.

I (C) Formula for Petrol, Oil and Lubricant (POL) Component

V3	=	0.85	x	(R-C)	x	K3		P – P0
						100	x	P0

Where V_3 = Amount of variation payable for a value R of work done on account of POL component.

R = Value of work done during the period under consideration.

C = Cost of Cement & steel calculated on star rates for quantity as per design/specification, incorporated in to the work during the period under consideration to be taken from II A and II B .

K_3 = Percentage of POL Component to be taken as 5%.

P_0 = The price (average of the prices declared by IOC/HPCL/BPCL) of HSD for Mangalore on the Base Date (28 days prior to the latest date for submission of the Bid).

P = Average Price (average of the prices declared by IOC/HPCL/BPCL) of HSD-RSP (Rs/litre) for Mangalore during the period under consideration.

After removal of actual cost of cement & steel for B above, price adjustment for the cost of cement and steel will be made as follows:

Price Adjustment

(II) (A) For Cement

P_c	=	R_c	x	Q_{cc}	x	$I_c - I_0c$
						I_0c

Where P_c = Price adjustment for cement

R_c = Rate per MT of cement prevailing on the Base Date (28 days prior to the latest date for submission of the Bid) i.e. Star Rate.

I_c = Average Index for cement published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under "Index numbers of Wholesale Prices by Group and Sub-Groups (Monthly data) under Group (1) – Non Metallic Mineral Products Sub-Group (C) – Cement and Lime, " or Monthly whole sale price index published by the office of economic advisor, government of India under cement & Lime forming the base forming the base of

calculation for index of wholesale prices during the period under consideration.

loc = Index for cement published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under Index numbers of Wholesale Prices by Group and Sub-Group (Monthly data) under Group (1) – Non Metallic Mineral Products Sub-Group (C) – Cement & Lime or Monthly whole sale price index published by the office of economic advisor, government of India under cement & Lime forming the base of calculation for index of wholesale prices on the date 28 days preceding the latest date prescribed for the receipt of the Bid.

Qcc= Quantity in MT of cement as per design incorporated in to the work during the period under consideration.

II (B) For Steel

Ps	=	Rs	x	Qsc	x	Is – I0s
						I0s

Where Ps = Price adjustment for steel

Rs= Rate per MT of steel prevailing on the Base Date (28 days prior to the latest date for submission of the Bid). i.e. Star rate.

Is = Average Index for iron and steel published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under “Index numbers of Wholesale Prices by Group and Sub-Groups (Monthly data) under Group (J) – Basic Metals, Alloys & Metal Products, Sub-Group (a) Ferrous metals – (a1) Iron & Semis” or Monthly whole sale price index published by the office of economic advisor, government of India under Iron & Semis forming the base of calculation for index of wholesale prices during the period under consideration.

a. Ios = Average Index for Iron and Steel published by the Reserve Bank of India (source: office of the economic advisor, Ministry of commerce & Industry Government of India) under “Index numbers of Wholesale Prices by Group and Sub-Groups (Monthly data) under Group (J) – Basic Metals, Alloys & Metal Products, Sub-Group (a) Ferrous metals – (a1) Iron & Semis” or Monthly whole sale price index published by the office of economic advisor, government of India under Iron & Semis forming the base forming the base of calculation for index of prices on the date 28 days preceding the latest date prescribed for the receipt of the Bid.

Qsc = Quantity in MT of steel as per design incorporated in to the work during the period under consideration.

Notes:

- (i) The quantities of cement and steel considered for working out price variation shall be certified by the Engineer based on approved designs and as consumed in the work excluding wastage.
 - (ii) The time for completion of the contract shall mean the period commencing from the date of the commencement of the contract and ending on the date when the time allowed for the work specified expires, taking into consideration the extension of time, if any, for completion of the work granted by the Engineer under the relevant clause or the conditions of contract in cases other than those where such extension is necessitated on account of default of the contractor. The decision of the Engineer as regards the time of completion of the contract shall be final, conclusive and binding on the contractor, where compensation for delay is levied on the contractor on account of delay in completion or inadequate progress under the relevant contract provision the escalation amount for the balance work from the date of levy of such compensation shall be worked out as follows:
Indices I, M, P, Ic, & Is will be pegged to the levels corresponding to the date from which such compensation for delay is levied.
- b. Pegged indices as well as actual indices prevailing at the time of calculation of escalation for the period under consideration will be compared and lower of the two will be taken for calculating actual escalation amount.
- (iii) Price variation shall be calculated in accordance with the formulae mentioned at (I)(A)(B) above, separately for labour, material and POL components, as well as for price adjustment for cement and steel in accordance with formulae mentioned at (II) (A) and(B) above. The relevant websites for ascertaining the various indices are as follows:
<http://www.iocl.com/Products/HighSpeedDiesel.aspx>
http://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/38T_BUL110610.pdf
<http://labourbureau.gov.in/indtab.pdf>
<http://indiabudget.nic.in/es2006-07/chapt2007/tab53.pdf>
<http://www.eaindustry.nic.in/default.html>
<http://labourbureau.nic.in/indnum.htm>
 - (iv) The price variation under clause 47.1 shall not be payable for the extra items required to be executed during the progress of the work and where the rates payable for the extra items have been fixed as per the current market rates provided under Clause of General Conditions of Contract or mutually agreed.
 - (v) The clause No.47.1 is operative both ways, i.e. if the price variation in the said Wholesale Price Index for all commodities, Consumer Price Index (New Series) or price of HSD of Bangalore or cost of cement or steel or bitumen is on the plus side, payment on account of the price variation

shall be allowed to the Contractor and if it is on the negative side, the NMPA shall be entitled to recover the same from the contractor and the amount shall be deductible from the Contractor's bill for the respective period in which there are fluctuation.

- (vi) In order to facilitate computation of price variation to be made under clause 47.1 the contractor shall keep such books of accounts and other documents as are necessary. The contractor shall allow inspection of the same by an Engineer or his nominee and shall at the request of the Engineer may require true copies of any document so kept and such other information as the Engineer may require for verification.
 - (vii) Calculation of Price Variation and Price Adjustment amount at the time of preparation of interim and final bill will be based on confirm indices and the prices of the POL products and bitumen products declared by IOC/BPCL/HPCL.
 - (viii) Save and except for what is provided in the foregoing clause, nothing herein shall be construed to entitle the contractor to reimbursement of any increase in the price of materials or in the wages of labour occurring at any time and for any reason whatsoever, including the imposition of any tax, duty or fee or an increase in the price of any petroleum product, coal, electricity or water effected by or under the order of the Central Government of a State Government.
 - (ix) The basic price (star rate) will be fixed as per the prevailing rate at the time of invitation of the tender before 28 days from date of submission of the tenders.
 - (x) The mobilization and de-mobilization shall not be considered for calculation of Price Variations and the price variation for the items quoted on Lump sum basis shall not be payable .
- 47.2 To the extent that full compensation for any rise or fall in costs to the contractor is not covered by the provisions of this or other clauses in the contract, the unit rates and prices included in the contract shall be deemed to include amount to cover the contingency of such other rise or fall in costs.

47.3 Subsequent Legislation

If, after the date 28 (Twenty eight) days prior to the date for submission of tenders for the contract there occur changes to any National or Statute Stature, Ordinance or Decree or other Law or any regulation or bye law of any local or other duly constituted authority or introduction of any such state statute, Ordinance, Decree, Law, regulation or bye law which causes additional or reduced cost to the contractor in execution of the contract, such additional or reduced cost shall, after due consultation with the Employer and the contractor be determined by the Engineer or his nominee and shall be

added to or deducted from the contract price and the Engineer or his nominee shall notify the contractor accordingly with a copy to the Employer.

48. Retention

- 48.1 The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the Works.
- 48.2 Retention Money shall be deducted at the rate of 10% from first Running Bill onwards subject to a max. of 5% of the contract price including GST. Retention money shall be refunded after completion of defect liability period along with performance security.

49. Liquidated Damages

- 49A In case of delay in completion of the contract, liquidated damages (L.D) may be levied at the rate of half per cent ($\frac{1}{2}\%$) of the contract price per week of delay, or part thereof subject to a maximum of 10 per cent of the contract price.
- 49A(i) The Employer, if satisfied, that the works can be completed by the contractor within a reasonable time after the specified time for completion, may allow further extension of time at its discretion with or without the levy of L.D. In the event of extension granted being with L.D, the Employer will be entitled without prejudice to any other right or remedy available in that behalf, to recover from the contractor as agreed damages equivalent to half per cent ($\frac{1}{2}\%$) of the contract value of the works for each week or part of the week subject to the ceiling defined in sub-Clause 49 A. In the event of forfeiting the LD/EMD/SD performance guaranty and while imposing penalty GST at applicable rate is applicable.
- 49A(ii) The Employer, if not satisfied that the works can be completed by the contractor, and in the event of failure on the part of the contractor to complete work within further extension of time allowed as aforesaid, shall be entitled, without prejudice to any other right, or remedy available in that behalf, to rescind the contract.
- 49A(iii) The Employer, if not satisfied with the progress of the contract and in the event of failure of the contractor to recoup the delays in the mutually agreed time frame, shall be entitled to terminate the contract.
- 49A(iv) In the event of such termination of the contract as described in clauses 49A(ii) or 49A(iii) or both the Employer shall be entitled to recover L.D. up to ten per

cent (10%) of the contract value and forfeit the security deposit made by the contractor besides getting the work completed by other means at the risk and cost of the contractor.

49A(v) In case Part / portions of the work can be commissioned and the Port operates the portion for commercial purposes, the rate of LD will be restricted to the uncompleted value of work, the maximum LD being on the entire contract value.

50. Nominated Subcontractors

All specialists, merchants, tradesmen and others executing any work or supplying any good, materials, Plant or services for which provisional Sums are included in the Contract, who may have been or be nominated or selected or approved by the Employer or the Engineer, and all persons to whom by virtue of the provisions of the Contract, the Contractor is required to subcontract shall, in the execution of such work or the supply of such goods, materials, Plant or services, be deemed to be subcontractors to the Contractor and are referred to in this Contract as "Nominated Subcontractors".

51. Advance payment (not applicable)

The Employer shall make the following advance payments:

- 51.1 Mobilization Advance shall be paid up to 10% of Contract price, payable in two equal installments. The first installment shall be paid after mobilization has started and next installment shall be paid after satisfactory utilisation of earlier advance.
- 51.2 Construction / installation equipment Advance shall be paid up to 5% of Contract price, limited to 90% of assessed cost of machinery.
- 51.3 Mobilization Advance and Construction Equipment Advance shall be paid at SBI PLR + 2% p.a. (as on date of payment) interest rate at the discretion of the employer and against Bank Guarantee for Mobilization Advance and against hypothecation of Construction Equipment to the Employer.
- 51.4 Equipment advance will be paid in two or more installments. First installment shall be paid after Construction Equipment has arrived at the site and next installment shall be paid after satisfactory utilization of earlier advance (s).
- 51.5 Recovery of Mobilization and Construction Equipment advance will start when 15% of the work is executed and recovery of total advance should be completed by the time 80% of the original Contract work is executed.
- 51.6 Secured Advance: The Engineer or his nominee shall make advance payment in respect of materials and plant brought to site but not yet

incorporated and installed in the Works in accordance with conditions stipulated in the Contract Data.

75% of cost of materials and plant brought to site for incorporation into the works only shall be paid as Secured Advance. Materials which are of perishable nature should be adequately insured.

52. Securities

- 52.1 Security deposit shall consist of two parts
- k) Performance security to be submitted at award of the work
 - l) Retention Money to be recovered from Running Bills.
- 52.2 The Security Deposit at 8% of the Contract amount including GST of which 3% of contract price should be submitted as Bank Guarantee within 21 days of receipt of letter of acceptance and balance 5% recovered as retention money from running bills. Recovery of 5% of retention money shall commence from the first RA bill onwards @ 10% for each bill. The retention money shall be refunded after completion of defect liability period. The performance Bank Guarantee will be released after completion of defect liability period.

53. Removal of Craft or Plant which has sunk

The Contractor shall forthwith and with dispatch at his own cost raise and remove any craft or plant (floating or otherwise) belonging to him or to any sub-contractor employed by him (including also any plant which is held by the Contractor or any sub-contractor under agreement for hire or hire-purchase) which may be sunk in the course of the construction completion or maintenance of the Works or otherwise deal with the same as the Engineer may direct or until the same shall be raised and removed, the contractor shall set al such buoys and display at night such lights and do all such things for the safety of navigation as may be required by the Engineer or by Employer. In the event of the Contractor not carrying out his obligation imposed upon him by this clause the Employer may provide buoy and light such sunken craft or plant and raise and remove the same (without prejudice to the right of the Employer to hold the Contractor liable under General Conditions) and the Contractor shall refund to the Employer all costs incurred in connection therewith.

Contractor's Temporary Moorings

Should the Contractor need, in connection with implementing the Works, to provide temporary moorings for his craft he may be allowed to do so in location and manner approved by the Engineer subject to all necessary permissions being first obtained by the Contractor from the authorities

concerned. The Contractor shall not lay his temporary moorings such as to interfere with the port traffic and such moorings shall be removed if and when required by the Employer.

54. Cost of Repairs

- 53.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of the Defects Correction period shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.

E. FINISHING THE CONTRACT

55. Completion

After completion of the work, the contractor will serve a written notice to the Engineer or his nominee/Employer to this effect. The Engineer or his nominee/Employer upon receipt of this notice shall conduct a complete joint survey of the work within 7 days and prepare a defects list jointly. The defects pointed out by the Engineer or his nominee/Employer would be rectified by the contractor within 14 days and thereafter acceptance report be signed jointly by the contractor and the Employer. This joint acceptance report shall be treated as 'Completion Certificate'.

56. Taking Over

The Employer shall take over the Site and the Works within seven days of the Engineer or his nominee issuing a certificate of Completion.

57. Final Account

The Contractor shall supply to the Engineer or his nominee a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Engineer or his nominee shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 60 days of receiving the Contractor's account if it is correct and complete. If it is not, the Engineer or his nominee shall issue within 15 days a schedule that states the scope of the corrections or additions that are necessary for the correction and certify payment of 50% of the undisputed amount to the contractor. If the Final Account is still unsatisfactory after it has been resubmitted the Engineer or his nominee shall decide on the amount payable to the Contractor and issue a payment certificate, within 60 days of receiving the Contractor's revised account.

58. Submission of 'As built Drawings'

"As built" Drawings are required to be submitted by the Contractor and shall be supplied by them by the dates stated in the Contract Data. If the Contractor does not supply the Drawings and/or manuals by the dates stated in the Contract Data, or they do not receive the Engineer or his nominee's approval, the Engineer or his nominee shall withhold the amount stated in the Contract Data from payments due to the Contractor.

59. Termination

59.1 The Employer or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.

59.2 Fundamental breaches of Contract include, but shall not be limited to the following:

- (a) The Contractor stops work for 28 days when no stoppage of work is shown on the current Program and the stoppage has not been authorized by the Engineer or his nominee.
- (b) The Engineer or his nominee instructs the Contractor to delay the progress of the Works and the instruction is not withdrawn within 28 days.
- (c) The Employer or the Contractor becomes bankrupt or goes into liquidation other than for a reconstruction restructure or amalgamation.
- (d) a payment certified by the Engineer or his nominee is not paid by the Employer to the Contractor within 50 days of the date of the Engineer or his nominee's certificate:
- (e) The Engineer or his nominee gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer or his nominee.
- (f) The Contractor does not maintain a security which is required.
- (g) the Contractor has delayed the completion of works by the number days for which the maximum amount of liquidated damages can be paid as defined in the Contract data and
- (h) If the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices in competing for or in the executing the Contract.

For the purpose of this paragraph: "corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution. "Fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Employer, and includes collusive practice. Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Employer of the benefits of free and open competition."

59.3 When either party to the Contract gives notice of a breach of contract to the Engineer or his nominee for a cause other than those listed under Sub Clause 59.2 above, the Engineer or his nominee shall decide whether the breach is fundamental or not.

59.4 Notwithstanding the above, the Employer may terminate the Contract for convenience subject to payment of compensation to the contractor including

loss of profit on uncompleted works. Loss of profit shall be calculated on the same basis as adopted for calculation of extra/additional items.

- 59.5 If the Contract is terminated the Contractor shall stop work immediately, make the Site safe and secure and leave the Site as soon as reasonably possible.

60. Payment upon Termination

- 60.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer or his nominee shall issue a certificate for the value of the work done less advance payments received up to the date of the issue of the certificate, less other recoveries due in terms of the contract, less taxes due to be deducted at source as per applicable law and less the percentage to apply to the work not completed as indicated in the Contract Data. Additional Liquidated Damages shall not apply. If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable to the Employer.
- 60.2 If the Contract is terminated at the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Engineer or his nominee shall issue a certificate for the value of the work done, the reasonable cost of removal of Equipment repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works and loss of profit on uncompleted works less advance payments received up to the date of the certificate, less other recoveries due in terms of the contract and less taxes due to be deducted at source as per applicable law.

61. Property

All materials on the Site, Plant, Equipment, Temporary Works and Works for which payment has been made to the contractor by the Employer, are deemed to be the property of the Employer, if the Contract is terminated because of a Contractor's default.

62. Release from Performance

If the Contract is frustrated by the outbreak of war or by other event entirely outside the control of either the Employer or the Contractor, the Engineer or his nominee shall certify that the Contract has been frustrated. The Contractor shall leave the Site and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which commitment was made.

F. SPECIAL CONDITIONS OF CONTRACT

The conditions of contract shall be the general conditions of contract in Section-III (v) as modified or added by the following condition of special conditions as provided in Section – III(vi) herein, which shall be read and construed with the general condition in Section – 3 A to E as if they were incorporated therein. In so far as any of the condition of the special conditions may conflict or be in consisting with any of general conditions of in Section -3F- Special condition of the contract shall prevail.

63. Labour

The Contractor shall, unless otherwise provided in the Contract, make his own arrangements for the engagement of all staff and labour, local or other, and for their payment, housing, feeding and transport.

The Contractor shall, if required by the Engineer or his nominee, deliver to the Engineer or his nominee a return in detail, in such form and at such intervals as the Engineer or his nominee may prescribe, showing the staff and the numbers of the several classes of labour from time to time employed by the Contractor on the Site and such other information as the Engineer or his nominee may require.

64. Compliance with labour regulations

During continuance of the contract, the Contractor and his sub-contractors shall abide at all times by all existing labour enactment and rules made there under, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules) regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or Central Government or the local authority. Salient features of some of the major labour laws that are applicable to construction industry are given below. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the competent authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments. If the Employer is caused to pay or reimburse such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules/regulations including amendments, if any, on the part of the Contractor the Engineer or his nominee/Employer shall have the right to deduct any money due to the Contractor including his amount of performance security. The Employer / Engineer or his nominee shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer.

The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Employer at any point of time.

65. Safety, Security and Protection of the Environment.

Subject and without prejudice to any other provision of the Contract, the Contractor shall take all reasonable precautions:

- (a) In connection with underground water resources (including percolating water) to prevent
 - (i) Any interference with the supply to or abstraction from such sources
 - (ii) Pollution of the water so as to affect adversely the quality thereof.
- (b) All works shall be carried out without unreasonable noise and disturbance. The Contractor shall indemnify the Employer from and against any liability for damages on account of noise or other disturbance created while or in carrying out the work and from and against all claims, demands, proceedings, damages, costs, charges and expenses whatsoever in regard or in relation to such liability.
- (c) The Contractor at his own cost shall make such provisions for lighting of Works, Temporary Works, Materials and Plant and shall provide all such marks and lights as may be required by the Employer or the Engineer or any other authority having jurisdiction over the Site together with all labour stores and services required for their efficient working and use at any time, day or night.

The Contractor shall also provide at his own cost every description of watching and maintenance required in connection with the foregoing, and all other services for protecting and securing all places dangerous whether to Contractor's workmen or to other persons until the Works are handed over to the Employer, or till such time when the Engineer decides that such services are no longer required.

All lights provided by the Contractor shall be placed or screened such as not to interfere with any navigation lights or with any traffic or signal lights of any local or other authority.

66. Insurance of Works and Contractor's Equipment

The Insurance shall be issued by Nationalized Insurance Company from its Mangalore Branch which has been determined by the Contractor to be acceptable to the Employer.

The contractor shall at his own costs and expenses obtain and shall cause any subcontractor to obtain such insurance as may be necessary to cover the liability of the contractor or as the case may be of such subcontractor in respect of personal injuries and death arising out of or in the course of or caused during the execution of the works for a minimum amount of Rs. 25 lakhs and shall produce or cause any such subcontractor to produce for inspection the relevant policy or policies together with receipt for the premium paid under such policy/policies as and when required by the

Employer.

- i. The Employer (NMPA) shall not be liable for any accident, damage or compensation payable to any workman or other person in the employment of the Contractor or any Subcontractor.
- ii. Employer Liability Insurance: The Contractor shall indemnify and keep indemnified the Employer i.e. NMPA against all damages or compensation payable at Law in respect of or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or Sub-Contractor against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto and the Employer shall be at liberty to deduct or adjust from the Contractor's bills an amount that Employer may be called upon to pay towards claims, demands, proceedings, costs, charges and expenses Whatsoever in respect of or in relation to any accident or injury referred to above without any reference to the Contractor.
- iii. The Contractor shall comply with all the Central State and Municipal Laws and Rules and shall be solely responsible for complying with the provisions of the Contract Labour (Regulations & Abolition) Act, 1970 & the contract labour (Regulation & Abolition) Karnataka Rules 1974 and rules there under and the enactments that may be applicable including ESI Act, the payment of wages act, Provident Fund Act, the Minimum Wages Act, the Factory's Act. The Workmen Compensation Act or any other applicable legislation and the Municipal by-laws or other statutory Rules and Regulations whatsoever in force if these are applicable. Any obligations finding or otherwise missed under any statutory enactments, rules & regulations there under shall be the responsibility of the Contractor and the NMPA will take no responsibility for the same. The Contractor should take Workmen's Compensation Policy for his Workers, who are not covered under ESI and submit the same to the EIC immediately after commencement of the work.
- iv. The Contractor is liable to pay all Statutory Compensation to the Labourers/persons engaged by him for the satisfactory execution of the works. If any claim is made against New Mangalore Port Authority on this work, the Port Authority shall have the right to deduct the same from the bill amount payable to the contractor after verification of the validity and if admissible as per rules.
- v. PERSONAL PROTECTIVE EQUIPMENTS The Contractor shall ensure the use of PPE such as helmets, safety shoes, nose masks, hand gloves, Safety Harness or any other equipment as required depending on nature of work by his staff at site.

67. War Risks Insurance

If the Contractor receives instructions from the Employer to insure against war risks, such insurance if normally available shall be effected, at the cost of the Employer, with the Insurance Company acceptable to the Employer and shall be in the joint

names of the Employer and the Contractor.

68. Royalty

Except where otherwise stated, the contractor shall pay to the authority all tonnage and other royalties, rent and other payments or compensation if any, for getting stone, sand, gravel, clay or other materials by him and his subordinates and his subcontractors and required for the works, at the rates and such conditions as notified by the State Government. The applicable rates for royalty is enclosed as Schedule-A in Volume –III. The contractor should submit the Mineral Dispatch Permit (MDP) in original for the quantity executed by the contractor for the requisite quantity of material incorporated in works for which MDP is issued by the authorized supplier. If contractor fails to submit the MDP in original the amount equal to 5 times the royalty charges shall be deducted from the contractor's bills as per prevailing orders issued by the Authority.

69. Transport of Contractor's Equipment or Temporary Works

If it is found necessary for the Contractor to move one or more loads of heavy constructional plant or equipment materials or pre-constructed units or parts of units of work over roads, highways or bridges on which such oversized and over weight items are not normally allowed to be moved, the Contractor shall obtain prior permission from the concerned authorities. Payments for complying with the requirements, if any, for protection of or strengthening of the roads, highways or bridges shall be deemed to be included in his contract price.

70. Transport of Materials or Plant

The contractor shall save harmless and indemnify the Employer in respect of all claims, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any claim made by the concerned authorities in respect of damage or injury to roads, highways or bridges. In case of failure of the Contractor to settle such claims and in case the Employer is held responsible for payment to the authorities, then the Employer shall settle the claim and the Employer's expenses in this regard, as certified by the Engineer, may be deducted by the Employer from any money due or to become due to the Contractor and the Engineer shall notify the Contractor accordingly with a copy to the Employer.

71. Labor Laws & Regulations

The Contractor shall at all times during the continuance of the Contract comply fully with all existing Acts, regulations and bye-laws including all statutory amendments and re-enactment of State or Central Govt. and other local authorities and any other enactments and act that may be passed in future either by the State or the Central

Govt. or local authority, including Indian Workmen's Compensation Act, Contract Labour (Regulation And Abolition) Act 1970 and Equal Remuneration Act 1976, Employees' State Insurance Act, 1948, Factories Act, Minimum Wages Act, Provident Fund Regulations. Employees' Provident Fund Act and schemes made under the same Act, Health and Sanitary Arrangements for Workmen, Insurance and other benefits and shall keep the Employer indemnified in case any action is commenced for contravention by the Contractor. If the Employer is caused to pay or reimburse any amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated here-forth on the part of the Contractor, the Engineer shall have the right to recover from the Contractor any sum required estimated to be required for making good the loss or damage suffered by the Employer. The Tenderers must have valid ESI and PF registration and shall maintain the records prescribed under ESI Regulations and PF Act & make the contribution towards ESI and PF in respect of persons employed by the Contractor. These contributions on the part of Employer paid by the contractor shall be reimbursed by the Engineer –in –charge to the contractor on actual basis. The contractor shall make available such records for inspection by ESI and PF authorities during inspection and furnish the copies of such records to the employer regularly. The EPF and ESI contribution on the part of the employer in respect of this contract shall be paid by the contractor. These contributions on the part of Employer paid by the contractor shall be reimbursed by the Engineer –in –charge to the contractor on actual basis. The minimum wages applicable for Mangalore City is enclosed as Schedule – B in Volume – III.

71.1. Accident Prevention/Safety Officer

The Contractor shall have on his staff on site an officer dealing with all matters regarding safety and protection against, accidents of all staff and labour. This officer shall be qualified for this work and shall have the authority to issue instructions and shall take protective measures to prevent accidents.

71.2 Disorderly Conduct

The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst his staff and labour and for the preservation of peace and protection of Persons and property in the neighborhood of the Works from the same.

71.3 Health and Safety

Due precautions shall be taken by the Contractor, and at his own cost, to ensure the safety of his staff and labour and, in collaboration with and to the requirements of the local health authorities, to ensure that medical staff, first aid equipment and stores, sick bay and suitable ambulance services are available at the camps, housing and on the site at all times throughout the period of the Contract and that suitable arrangements are made for the

prevention of epidemics and for all necessary welfare and hygiene requirements.

71.4 Supply of Water

The Contractor shall, so far as is reasonably practicable, having regard to local conditions provide on the Site, to the satisfaction of the Engineer's Representative, an adequate supply of drinking and other water for the use of the Contractor's staff and work people.

71.5 Alcoholic Liquor or Drugs

The Contractor shall not, otherwise than in accordance with the Statutes, Ordinances and Government Regulations or Orders for the time being in force, import, sell, give, barter or otherwise dispose of any alcoholic liquor, or drugs or permit or suffer any such importation, sale, and gift, barter disposal by his sub-contractions agents or employees.

71.6 Arms and Ammunition

The Contractor shall not give, barter or otherwise dispose of to any persons or person, any arms or ammunition of any kind or permit or suffer the same as aforesaid.

71.7 Festivals and Religious Customs

The Contractor shall in all dealings with labour in his employment have due regard to all recognized festivals, days of rest and religious or other customs.

71.8 Epidemics

In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Govt., or the local medical or sanitary authorities for the purpose of dealing with and overcoming the same.

71.9 Employment of Person in the Service of Others

The Contractor shall not recruit or attempt to recruit his staff and labour from amongst persons in the service of the Employer or other agencies engaged for any works of the Employer.

71.10 Housing for Labour

Save in so far as the Contract otherwise provides, the Contractor shall provide and maintain such accommodation and amenities as he may consider necessary for all his staff and labour employed for the purposes of or in connection with the Contract, including all fencing water supply (both for drinking and other purposes), electricity supply, sanitation, cook houses fire prevention and fire-fighting equipment, **crèche for children** of his staff and labour employed for the purposes, furniture other requirements in connection

with such accommodation or amenities. On completion of the Contract, unless otherwise agreed with the Employer, the temporary camps/housing provided by the Contractor shall be removed and the site reinstated to its original condition, all to the approval of the Engineer. The land for construction of labour camps shall be allotted outside the security area to the extent available and such area allotted for labour camps will be charged a ground rent at TAMP approved rates depending upon the location. The ground rent is liable for change as per the prevailing TAMP rates from time to time during the currency of the contract.

71.11 Fair Wages, Records, Inspection

The Contractor shall pay the labourers engaged by him on the work not less than a fair wage which expression shall mean whether for time or piecework the respective rates of wages as fixed by the Public Works Department as fair wages for Dakshina Kannada District payable to the different categories of labourers of those notified under the Minimum Wages Act.

The Contractor shall maintain records of Wages and other remuneration paid to his employee in such form as may be convenient and to the requirements of the Employer/Engineer and the Labour Enforcement Officer (Central), Ministry of Labour, Govt. of India, or such other authorized person appointed by the Central Govt. The Contractor shall allow inspection of the aforesaid Wage Records and Wage Slips to the Engineer and to any of his workers or to his agent at a convenient time and place after due notice is received, or to any other person authorized by him on his behalf.

71.12 Reporting of Accidents

The Contractor shall report to the Engineer details of any accident as soon as possible after its occurrence. In the case of any fatality or serious accident, the Contractor shall, in addition, notify the local police authorities immediately by the available means.

71.13 Observance by Sub-Contractors

The Contractor shall be responsible for observance by his sub-contractors of the foregoing provisions.

71.14 Port Entry Permission

The Contractor shall submit prior application for Port entry passes to the concerned Port authority for his Materials, labours and the staffs engaged in the works. The Contractor has to get the vehicle and labour RIFD based passes for the entry inside the wharf area based on prevailing rates.

71.15 Site - Protected Area

The Site of Work is a protected area. Entry to the Port premises is regulated by entry passes. These passes will be issued by the Central Industrial Security Force or any other authority authorized by the Employer. The

Contractor should furnish a list of person for whom the passes are to be issued to the Engineer and arrange to obtain the passes from the appropriate authority, based on the recommendation of the Engineer and abide by the Rules of the New Mangalore Port Authority with regard to entry etc. For the entry of trucks and other vehicles also, the Contractor should obtain necessary permits.

The Contractor shall retain the original passes obtained by them in respect of their labour and staffs engaged in the Works and produce the same to the Engineer as and when called for. It should not be either destroyed or allowed to be taken by the labour/staff after its use.

The entry and exit of construction equipment, Plants, construction materials etc., into the Port premises is also regulated by Gate passes. These gate passes will be issued by the Engineer and the Contractor shall produce the same at the security Gate during the entry and exit of the materials. The duplicate copy of the inward pass shall be retained by the Contractor and shall be produced at the Gate during the exit of the materials along with the outward gate pass.

72. Life Saving Appliances and First Aid

The Contractor shall provide and maintain upon the Works sufficient proper and efficient lifesaving appliances and first aid equipment to the approval of the Engineer. The appliances and equipment shall be available for use at all times.

73. Diving Operations

- a) Any diving work shall be carried out in accordance with the Diving Operations Regulations of the Government of India.
- b) Before any diving work is undertaken the Contractor shall supply the Engineer or his representative with two copies of the Code of signals to be employed and is to have a copy of such Code Prominently displayed on the craft or structure from which the operations take place

74. Bribes

If the Contractor, or any of his Subcontractors, agents or servants gives or offers to give to any person any bribe, gift, gratuity or commission as an inducement or reward for doing or forbearing to do any action in relation to the Contract or any other contract with the Employer, or for showing or forbearing to show favour or disfavor to any person in relation to the Contract or to any other contract with the Employer, then the Employer may enter upon the Site and the works and terminate the employment of the Contractor and the provisions of Clause 63 hereof shall apply as if such entry

and termination had been made pursuant to that Clause.

The bidders shall give an undertaking that they have not made any payment or illegal gratification to any person/authority connected with the bid process so as to influence the bid process and have not committed any offence under the PC Act in connection with the bid.

The bidders shall disclose any payments made or proposed to be made to any intermediaries (agents etc) in connection with the bid.

The bidder shall execute Integrity Pact Agreement with NMPA as per the Integrity Pact Agreement Appendix II. The following Independent External Monitor (IEM) is nominated.

Shri Prem Chand Pankaj, Ex CMD, NEEPCO,
M 402, Pioneer Park, Sector 61, Golf Course,
Extn., Road, Gurgaon
Mob No. 9717433886
E-mail ID : prempankaj@gmail.com

Details to be Confidential

The Contractor shall treat the details of the contract as private and confidential, save insofar as may be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof in any trade or technical paper or elsewhere without the previous consent in writing of the employer. If any dispute arises as to the necessity of any publication or disclosure for the purpose of the Contract the same shall be referred to the decision of the Employer whose award shall be final.

75. Contractor's Temporary works, office, etc.

76.1 The Contractor shall submit to the Engineer for his approval not less than 15 days before commencement of erection of any part of Temporary Works, drawings and detailed proposals for the method of construction of Temporary works such as office, store, false work and temporary platforms etc. which he intends to construct for the execution of the contract and no such work shall be constructed before obtaining the written approval of Chief Engineer. These temporary works, office, store etc. shall be erected at or near the work area subject to approval of the Employer and the land space for the same will be allotted free of ground rent to the extent available. The Contractor shall obtain permission for any Temporary Works and would ensure that during execution of works the statutory requirements of the concerned authorities such as New Mangalore Port Authority, Police, Customs, etc. would be complied with.

76.2 Submission of Reports, Returns, etc.

All reports, statements, returns, drawings, diagrams etc. which the Contractor is required to submit to the Engineer during the progress of the Works, shall be furnished in triplicate without any additional cost.

76. Water Supply

Water to the extent available will be supplied to the Contractor at a fixed point on the main water supply line within the Port area. The plumbing connection and extension of necessary supply pipeline to the working area shall be arranged by the Contractor at his own cost. The Contractor shall also provide a water meter at his cost for metering the quantity of water used. Charges for the consumption of the water will be paid by the Contractor to the Employer at the prevailing rate notified time to time during the currency of the Contract. For non-supply of water at any stage port will not be responsible and the Contractor shall not have any claim whatever for loss or damage.

77. Power Supply

The Electricity connection for lighting, welding and other mechanical works to the extent available will be made available by the Employer within the Port area. Drawing of power lines etc. from the available point of supply of power to the actual work site either by overhead lines or underground cables shall be arranged by the contractor at his cost. The temporary lines and connections by the Contractor shall be approved by the Engineer's representative before availing power. The Contractor shall provide Trivector Meter to read consumption in units, power demand and power factor.

The Contractor shall indicate his requirement of power to the Engineer within 15 days from the date of the letter of acceptance of the tender. If the power requirement is more than 50 KW, the Contractor has to avail the power supply at 11 KV and install his own transformer of suitable capacity and work carried out as per IE Rules & Regulations as approved by the CEA. The Contractor shall pay to the Employer, the power charges as per the prevailing Tariff schedule of MESCOM in force during the work of the Contractor with applicable demand charges and security deposit along with departmental charges @ 23.75% of the bill amount. The Contractor shall also pay the connection and disconnection charges as applicable.

The Contractor shall ensure that the power factor of the system does not fall below 0.90 at any time and shall provide at his cost required capacity capacitors bank to maintain the Power Factor of all power loads. If the capacity of the capacitor found less than stipulated as per regulation during inspection, surcharge at Rs. 0.03 per unit will be levied. The contractor shall pay refundable Security Deposit before availing the power supply.

The Contractor shall submit a complete drawing of the power points, wiring, diagram

indicating all electrical loads, earthing etc. in complete shape along with the completion report. The Trivector Meter provided is calibrated either by M/s. MESCOM or NITK, Surathkal, and such a Certificate to be produced. For non supply of power at any stage port will not be responsible and the Contractor shall not have any claim whatever for loss or damage.

78. Taxes and Duties

79.1 The Contractor shall pay tax if any, and other levies as applicable from time to time. GST at applicable rate shall be shown separate line items in the tax invoice.

79.2 Sales / Turnover Tax on Works Contract **(DELETED)**

79.3 Income Tax

The Contractor and his staff shall be responsible for payment of all personal income taxes to the concerned authorities as per the law in force from time to time. Deduction of Income Tax shall be made by the Employer from each certificate of payment to the contractor at the rate of 2% plus surcharge or such other rates as may be specified by the Central Government from time to time, on the gross amount of the Contractor's bill for payment.

79.4 Goods and Service Tax

The contractor shall not include GST component in rate. The GST shall be paid to the contractor separately as applicable. The contractor shall submit running account bills indicating GST separately as applicable. The Contractor shall be responsible for the payment of GST applicable, to the GST authority.

79. Price Adjustment (not applicable to this contract)

The following clause shall be read in continuation to clause no. 47 of GCC. The sanction towards the compensation for escalation or deduction on account of de-escalation and the amount thus sanctioned will be included in the next running account bill or final bill as the case may be. The cost of work for which escalation/de-escalation is applicable / deductible shall be worked out as per cl. 32.8.6.1., CPWD works manual, 2003.

The cost of work for which escalation/de-escalation is applicable / deductible shall be worked out as below:

- (a) Gross value of work done up to this quarter (A)
- (b) Gross value of work done up to the last quarter (B)
- (c) Gross value of work done since previous quarter (a) – (b) (C)
- (d) Full assessed value of SA fresh paid in this quarter (D)
- (e) Full assessed value of SA recovered in this quarter (E)
- (f) Full assessed value of SA for which escalation is payable in this quarter
(d) – (e) (F)

- (g) Advance payment made during the quarter (G)
- (h) Advance payment recovered during the quarter (H)
- (i) Advance payment for which escalation is payable in this quarter (g)– (h) (I)
- (j) EI paid based on prevailing M/R during the quarter (J)

$$X = C \pm F \pm I - J$$

$$Y = 0.85 X$$

- (k) Less cost of materials supplied by the department & recovered during the quarter (K)
- (l) Less cost of services tendered at fixed charges & recovered during the quarter (L)
- (m) Cost of work for which escalation/de-escalation is applicable $W = Y - (K + L)$

80. Noise and Disturbance

All works shall be carried out without unreasonable noise and disturbance. The Contractor shall indemnify the Employer from and against any liability for damages on account of noise or other disturbance created while or in carrying out the work and from and against all claims demands proceedings damages costs charges and expenses whatsoever in regard or in relation to such liability.

81. Safety Code

Necessary Indian Safety regulations for the safety purpose shall be adhered to by the contractor and he will be held responsible for any violations of the same. The set of such conditions (regulation) is available with NMPA and the contractor is required to go through it before tendering.

Besides the above, the Contractor shall also scrupulously adhere to and observe the following safety codes:

The Contractor has to provide sufficient barricades to site of work so that traffic plying nearby should not damage the recently concreted work. In case of any damage on account of above, the entire responsibility will remain with contractor and nothing extra will be paid on this account.

Suitable and strong scaffolds should be provided for the workmen for all work that cannot be safely done from ground. No portable single ladder shall be over 8 meters in length.

Hoisting machines and tackles used in the works including their attachments, and supports shall be in perfect condition as per stipulations of the relevant Rules. The ropes used for hoisting or lowering materials or as means or suspension shall be of durable quality and adequate strength and free from defects.

The excavated material shall not be placed within 1.5 meters of the edge of the trench or half of the depth of the trench, whichever is more. All trenches and excavation shall be provided with necessary fencing to lighting. Every opening in the floor of a building or in a working platform shall be provided with suitable fence to prevent the fall of persons or materials. No floor, roof or other parts of the structure shall be so overloaded with debris or materials as to render it unsafe.

Workers employed on mixing and handling materials such as cement, cement mortar, concrete, lime mortar and asphalt shall be provided with protective footwear and rubber hand gloves and thin cloth for covering face and head.

Those engaged in welding work shall be provided with welder protective eye shield and glove.

All safety rules shall be strictly followed while working on live electrical systems or installations as stipulated in the relevant Rules.

82. Port Authority Rules

The Contractor shall observe the Conservancy Rules relating to the harbour and shall always take such necessary additional steps to keep the harbour waters free of noxious or unhygienic matters coming from his works as are required by the Employer. Under no circumstances shall inflammable materials be allowed to spill into the harbour waters.

The Contractor shall always observe and comply with the working rules and regulations of the Port Authority in force or as issued from time to time.

83. Execution of work

The contractor shall be required to execute the work in such a way so as not to cause any damage, hindrance or interference with port activities going on in the area or nearby. He should not also deposit the materials at such places which may cause inconvenience to the public and the work going on in the nearby area. The Contractor shall have to make good all damages done by him to the structures nearby while executing the work and no extra payment shall be made to him on that account.

All the materials required to be used in the work shall have to be got approved from the Engineer-in-Charge before stacking at the site of work.

Barricading, including proper lighting arrangement in the night at the required places shall have to be provided by the contractor at his own cost, including necessary arrangements for proper movement of traffic by carefully maintained approaches and

road diversions with suitable sign boards for indications of road signs etc. as directed by the Engineer-in-Charge.

84. Customs Duty

Being Port Development Project, Customs Duty shall be applicable as per project import chapter 9801.00 read with Notification 17-2001, serial No. 38 (vi) and Notification 42-96 amended by 21-2000 of customs tariff, Government of India.

Customs Duty leviable shall be paid directly by the Contractor to the Customs Authorities, Government of India. The Employer shall reimburse this amount upon submission of documentary evidence in original for the proof of payment of such Customs Duty. The reimbursement of such amount towards Customs Duty shall be limited to the Ceiling amount quoted by the Contractor in the Bill of Quantities as above. If the Contractor incurs Customs Duty Levy less than the said Ceiling Amount, the reimbursement by the Employer shall be limited to the documented cost of Customs Duty levies actually paid to the Customs Authorities, Government of India. If the Actual Customs Duty levies paid by the Contractor exceeds the said Ceiling Amount, then the reimbursement by the Employer shall be limited to the Ceiling Amount. The reimbursement of the Customs Duty will be limited only to the Imported Materials listed in "Preamble and Bill of Quantities", BOQ No.__. During the execution of the Works, if it necessitates for expeditious completion of the Works, Contractor may resort to import of any of the materials not listed aforesaid, with the approval of the Employer. However, the aggregate amount of Customs Duty to be reimbursed shall not exceed the lump sum amount offered in the Priced Bill of Quantities.

It shall be the responsibility of the Contractor to provide the requisite particulars and documents to the customs and other Government authorities and get the Imported Materials cleared and transported in time. The Contractor shall be fully responsible for port and Customs clearance including stevedoring, handling, unloading, loading, storage, inland transportation, if any of materials, equipments and plant to storage godowns, yards, sites etc. The contractor shall be fully responsible for any delays, penalties charges and losses if any in this regard.

The Employer shall upon request from the Contractor along with necessary details, provide recommendatory letter(s) for Imported Materials at concession rate or Customs Duty as applicable. However, the responsibility for obtaining such concession rate of customs duty shall be that of the Contractor.

It shall be the responsibility of the Contractor to check the latest position on Customs duty levies applicable and the Employer does not accept any liability on the account. For bill of Lading, the "Consignee" for permanent materials to be incorporated into the Works will be the New Mangalore Port Authority. The Contractor will be "Notify Party". Notwithstanding the above, obtaining "Essentiality Certificate" (if any), payment of deposit (if any) towards Customs Duty, etc. shall be the responsibility of the Contractor.

The Contractor shall give an undertaking follows:

- a) Being the ultimate Employer of the materials to be imported and incorporated into the works covered under the Tender _____ we request New Mangalore Port Authority to be consignee in the matter of permanent materials to be imported by us at our cost (covering payments of materials by letter of credit) including freight, insurances, taxes and any other charges whatsoever payable in connection with the import and its incorporation into the work.
- b) We hereby confirm, in the event of New Mangalore Port Authority becoming consignee, it will not absolve us from any of the obligations, and will not alter the payment terms under the Contract No. SCB II/ 2009 dated between (*the Contractor*) and New Mangalore Port Authority.
- c) New Mangalore Port Authority becoming a consignee is a matter of convenience and we undertake to abide by all the obligations, responsibilities etc. as if we are our self a consignee.
- d) In respect of nay consequences arising out of New Mangalore Port Authority becoming the consignee we hereby unequivocally and irrevocably agree to indemnify New Mangalore Port Authority for such consequences.
- e) We also undertake and confirm to obtained all permits and licenses etc. at our own cost. New Mangalore Port Authority's responsibilities in this regard will be the same as under the said contract and limited to issuing required recommendatory letters for obtaining such permits and licenses.
- f) *This undertaking does not in anyway vitiate our contractual liabilities and obligations cast upon us by Contract No. SCB II/ 2009 dated*

..... between(*the Contractor*) and New Mangalore Port Authority.

85. Drawings & Designs

(a) General details of the works are shown on the drawings accompanying this tender document. The Engineer will supply to the Contractor from time to time during the progress of the works such further working drawings as will be necessary in his opinion for the proper and adequate execution and maintenance of the Works in accordance with the Engineer's designs and/or any modification thereof as decided by the Engineer and the Contractor shall carry out the work in accordance with the said working drawings. Two sets of such working drawings will be issued. If the Contractor requires more sets he will have to make his own arrangement at his cost. Residual Design, Detailing & Engineering: - The Engineer to the project has done the detailed design and engineering for the subject tender. During execution of the work the residual design, detailing and engineering, if needed, is to be carried out by the contractor at no extra cost to the Employer. For equipment/ Installations detailed drawings need to be produced by the contractor at no extra cost to the Employer. The contractor shall also get approved such design, detailing & engineering from the Engineer.

(b) In the event of the Contractor proposing any alteration/modification to the Engineer's design, detail, method of construction, he shall at his own expenses prepare and submit for approval of the Engineer copies in duplicate (in the first instance) of detailed working drawings which may be required for such alteration/modification and at the same time call the attention of the Engineer to any alternative detail or modification of the contract drawings which the Contractor may wish to make at least 30 days prior to the commencement of the work or part of the work to which such drawings relate. The contractor shall at the same time, if so required by the Engineer, furnish calculation sheets in duplicate relating to the strength and anticipated deflections in respect of such altered/modified works. The Engineer will, after any such alteration which he may approve, record on the copies as amended his approval and will return one copy of the drawings and calculation sheets to the contractor, who shall carry out the work in accordance therewith. The contractor shall forward to the Engineer three additional copies of the working drawings and calculation sheets as approved in addition to these working drawings and calculation sheets as approved. In addition to these working drawings are also to be submitted (the same procedure as in the case of the contractor) in respect of any work proposed to be executed by sub-contractors. The approval of the Engineer of all or any of the calculation sheets, drawings shall not relieve the contractor of

responsibility in connection with the execution of the altered/modified or subcontractor's work.

(c) Submission of 'As built Drawings'

"As built" Drawings are required to be submitted by the Contractor and shall be supplied by them by the dates stated in the Contract Data. If the Contractor does not supply the Drawings and/or manuals by the dates stated in the Contract Data, or they do not receive the Engineer or his nominee's approval, the Engineer or his nominee shall withhold the amount stated in the Contract Data from payments due to the Contractor.

86. Monsoon Period

Monsoon period will be reckoned from 1st June to 30th September.

87. Progress Report

The following reports shall be submitted for review; as an input to the Management meeting to be held as per Clause No 31 of Conditions of Contract.

88.1 Daily reports

The contractor shall submit daily report indicating daily activities, weather condition, actual manpower, equipment and the prominent materials available and arriving to site. The contractor shall submit the daily report format to the Department for prior approval.

88.2 Monthly Reports

Monthly progress reports shall be prepared by the Contractor and submitted to the Engineer in triplicate. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7days after the last day of the period to which it relates. Reporting shall continue until the Contractor has completed all work, which is known to be outstanding at the completion date, stated in the Taking-Over Certificate for the Works.

Each report shall include:

Charts and detailed descriptions of progress, including each stage of design (if any), Contractor's Documents, procurement, manufacture, delivery to Site, construction,

erection and testing; and including these stages for work by each Sub-Contractor, Photographs in hardcopy & digital copy and videography in two sets showing the various stages of progress on the Site monthly;

For the supply of manufactured items, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:

Commencement of manufacture,

Contractor's/Engineer's inspections,

Tests,

Shipment and arrival at the Site;

Copies of quality assurance documents, test results and certificates of Materials;

Safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and

Comparisons of actual and planned progress, with details of any events or circumstances which may jeopardize the completion In accordance with the Contract, and the measures being (or to be) adopted to overcome delays.

88. Completion Documents

To treat that the work has been completed and issue a final payment certificate, the following documents will be deemed to form the completion documents:

The Technical documents according to which the work was carried out. Certificates of final levels and dimensions as set out for various works. Certificates of tests performed for various works.

89. Facilities / Services to be provided at the site (Not Applicable)

After the issue of Engineer's notice to commence, the Contractor shall as soon as possible, make available of the following facilities for the staff of the Engineer at the Site of Work, all to the approval of the Engineer or his Representative and the Contract Price shall be deemed to be inclusive of the provision for these facilities:

Provide and maintain, throughout the period of Contract, one no of Office accommodation at site office / Porta cabin measuring not less than 4m x 5m. each, with electricity and water supply and adequate ventilation for the sole use of Engineer's Representative, his staff.

Provide and maintain suitable furniture for the office, including: Tables with two lockable drawers and chairs, Almirah with shelves and necessary electrical fittings.

Provide and maintain, throughout the period of Contract, a Toilet along with washroom facilities with electricity and water supply and adequate ventilation for the

sole use of Engineer's Representative, his staff.

Desk top Computers of latest configuration with printers and all other necessary accessories, internet and loaded with the latest version of software like M.S. Office, AutoCAD etc. with windows operating system.

One photocopying machine capable of Black & White copying / Scanning A4 & A3 size of paper, with auto feed of papers (Source to be copied) along with sorting facilities.

The contractor shall make available during the currency of contract all the Survey instruments and various measuring devices necessary for the execution of the project.

A lock and four (4) keys for the office room. There shall be no spare keys in the possession of any person other than Engineer's Representative.

90. Payments

The Clause No. 43 payments shall be replaced as follows

- i. The Contractor has to submit the bill within 7 days of joint measurement taken along with the concerned Engineer. The Engineer has to ensure that joint measurement to be completed within 7 days of completing of part work / running work. The concerned Engineer i/c shall check and make entries into bill/M.B within 10 days of submission of the interim bill and submit to Executive Engineer/ Superintending Engineer (Civil). The Executive Engineer/ Superintending Engineer (Civil) shall check the bills and after certification of the quantities as per manual shall forward to the Finance Department within 3 working days. The Contractor and Assistant Engineer both jointly complete the measurements, if Contractor due to any reason does not attend/avoid joint survey/measurements the Executive Engineer shall give notice to the contractor to be present at the site for joint measurement within 7 days' notice. If the contractor fails to attend the joint measurement second notice shall be issued to the contractor to attend the joint measurement within 3 days failure to attend the site for joint measurement the Assistant Engineer and AEE or EE would record the reason and complete the measurements in a transparent manner departmentally and submit the bill. Bills shall be prepared and submitted by the Contractor. Joint measurements shall be taken continuously and need not be connected with billing stage. System of 4 copies of measurements, one each for Contractor, Employer and Engineer or

- his nominee, and signed by both Contractor and Employer shall be followed.
- ii. Interim of bill amount will be paid within 14 days of submission of the bill.
 - iii. Contractor shall submit final Bill within 60 days from the date of completion of work and the same will be paid by the Port within 30 days from the date of submission
 - iv. The payment will be made to the contractor after deducting any dues payable to the Port statutory authorities etc
 - v. If an amount certified is increased in a later certificate as a result of an award by the DRB or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.
 - vi. Items of the Works for which no rate or price has been entered in will not be paid for by the Employer and shall be deemed covered by other rates and prices in the Contract.

91. Retention

The Clause No. 48 Retention shall be replaced as follows

The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the Works.

Retention Money shall be deducted at 10% from Running Bills subject to a max. of 5% of the contract price plus Goods Service tax applicable. Retention money shall be refunded after issue of No defects certificate.

92. Submission of statutory documents

The successful bidder, with in 7days from the date of work order, shall submit self-attested copy of statutory documents such PAN card, GST registration certificate, ESI registration certificate, EPF registration certificate, Labour Identification Number (LIN) and any other documents required for successful completion of work.

93. Special conditions of contract

The Contractor shall be responsible for the Up-keeping of the Equipment's, housekeeping of the premises. The necessary log Books, Registers, Reports, Stock Book of the Consumables shall be submitted to the Division Office as and when required. The same shall be witnessed by the concerned Engineer at least once in a week.

The contractor has to maintain a stock of consumables and chemicals at – least for one month stock.

- The contractor or his representative/supervisor should be available at the site premises all the working time to receive instructions from the Department Staff.
- The contractor has to pay wages which are not less than the minimum wages fixed to the labours as prescribed to the Competent Authority from time to time. If minimum wages increase and contractor claims the difference in wages including PF/ESI, will be reimbursed by department on actual basis.
- Contractor has to make Payment to the labours through bank only.
- The contractor has to submit the monthly bill along with documentary proofs for payments made to the operators/workers through the bank along with details of PF & ESI payment details.

G. SALIENT FEATURES OF SOME MAJOR LAWS APPLICABLE TO ESTABLISHMENTS ENGAGED IN CONSTRUCTION WORK

- (a) Workmen Compensation Act 1923:- The Act provides for compensation in case of injury by accident arising out of and during the course of employment.
- b) Payment of Gratuity Act 1972: Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years service or more on death at the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.
- (c) Employees P.F and Miscellaneous Provision Act 1952: The Act Provides for monthly contributions by the employer and workers @ 13.61% and 12% respectively. The benefits payable under the Act are:
 - (i) Pension to family pension on retirement or death, as the case may be.
 - (ii) Deposit linked insurance on the death in harness of the worker.
 - (iii) Payment of P.F accumulation on retirement/death etc.
- d) Maternity Benefit Act 1951:-The Act provides for leave and some other benefits to workmen/ employees in case of confinement or miscarriage etc.
- e) Contract Labour (Regulation & Abolition) Act 1970:-The Act provides for certain welfare measures to be provided by the Contractor to contract labour and in case the Contractor fails to provide, the same are required to be provided, by the Principal Employer by Law. The Principal Employer is required to- take Certificate of Registration and the Contractor is required to take license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ 20 or more contract labor.
- f) Minimum Wages Act 1948: The Employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act if the employment is a scheduled employment Construction of Buildings, Roads, Runways are scheduled employment.
- (g) Payment of Wages Act 1936:-It lays down as to by what date the wages are to be paid when it will be paid and what deductions can be made from the wages of the workers.
- (h) Equal Remuneration Act 1979:-The Act provides for payment of equal wages for work of equal nature to Male and Female workers and for not making

discrimination against Female employees in the matters of transfers, training and promotions etc.

- i) Payment of Bonus Act 1965: The Act is applicable to all establishments employing 20 or more employees. The Act provides for payments of annual bonus subject to a minimum of 8.33% of wages and maximum of 20% of wages to employees drawing Rs. 3500/- per month or less. The bonus to be paid to employees getting Rs. 2500/- per month or above up to Rs. 3500/- per month shall be worked out by taking wages as Rs. 2500/- per month only. The Act does not apply to certain establishments. The newly set-up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of this Act.
- j) Inter-State Migrant workmen's (Regulation of Employment & Conditions of Service) Act 1979: The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The Inter-State migrant workmen, in establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, travelling expenses from home upon the establishment and back,
- k) The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and the Cess Act of 1996:-All the establishments who carry on any building or other construction work and employs 10 or more workers are covered under this Act. All such establishments are required to pay cess at the rate not exceeding 2% of the cost of construction as may be modified by the Government. The Employer of the establishment is required to provide safety measures at the Building or Construction work and other welfare measures, such as Canteens, First-Aid facilities. Ambulance, Housing accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.

v) CONTRACT DATA

Items marked "N/A" do not apply in this Contract.

Sl. No.	Description	Reference Cl. No.
1	The following documents are also part of the Contract	
	The Schedule of other contractors	(8)
	The Schedule of Key personnel	(9)
2	The above insertions should correspond to the information provided in the Invitation of Bids.	
3	The Employer is	(1)
	New Mangalore Port Authority, Panambur, Mangalore – 575010	
	Name of Authorized Representative:	
	Name : Chairman, New Mangalore Port Authority, Panambur, Mangalore – 575010	
4	The Engineer is	
	Name : Chief Engineer (C), New Mangalore Port Authority, Panambur, Mangalore- 57501010	
	Name of Nominee is	
	Name : Superintending Engineer C-II Civil Engineering Department, NMPA, Panambur, Mangalore- 575010	
5	The name and identification number of the Contract is	
	Name of Contract :- "Supply, Errection,Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender" Tender no: CIVIL/CE(C)/EE(C)/55/2022-23	(1)
6	The works consist of "Supply, Errection,Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender.	(1)

Sl. No.	Description	Reference Cl. No.		
7	The start date shall be 15 days from the date of Issue of Letter of Acceptance	Conditions of contract A-General 1.Definitions		
8	The Contract price is the price stated in the letter of acceptance. However payment will be made as per actual work done accordance with the contract provisions.	1.Definitions		
9	The Intended Date completion for the Supply, Errection, Installation, Testing and Commissioning of the CAAQMS System is 5 months from the date of written order to commencement of work (Including Monsoon). Further the Operation and maintenance of the CAAQMS System shall Begin from date succeeding the date of commissioning of the system. The Operation and Maintenance of the CAAQMS System shall be carried out for a period of 5 years from the date of Commissioning of the same.	(17,28)		
10	<p>Milestone dates:</p> <table border="1"> <tr> <td>i).Supply, Errection, Installation, Testing and Commissioning of the CAAQMS System.</td> <td>ii). The Operation and Maintenance of the CAAQMS System shall be carried out for a period of 5 years from the date of Commissioning of the same.</td> </tr> </table> <p>Milestones dates shall be provided to the Contractor by the Executive Engineer executing the work ,for completion of the work as per the scheduled date.</p>	i).Supply, Errection, Installation, Testing and Commissioning of the CAAQMS System.	ii). The Operation and Maintenance of the CAAQMS System shall be carried out for a period of 5 years from the date of Commissioning of the same.	
i).Supply, Errection, Installation, Testing and Commissioning of the CAAQMS System.	ii). The Operation and Maintenance of the CAAQMS System shall be carried out for a period of 5 years from the date of Commissioning of the same.			
11	<p>The following shall form part of the Contract Document:</p> <ol style="list-style-type: none"> (1) Form of Agreement (2) Letter of Acceptance (3) Contractor's Bid (4) Contract Data (5) Conditions of Contract including Special Conditions of Contract (6) Specifications (7) Drawings 	(2.3)		

Sl. No.	Description	Reference Cl. No.
	(8) Bill of quantities and (9) Any other documents listed in the Contract Data as forming part of the Contract. (10) Correspondence exchanged after the opening of the Bid and before the issue of Letter of Acceptance by which the Condition of Contract are amended, varied or modified in any way by mutual consent (to be enumerated).	
12	The Contractor shall submit a Program for the Works within 14 days of delivery of the letter of Acceptance.	(27)
13	The site possession date The site will be handed over immediately after issue of Letter of acceptance and the site is free from encumbrances.	(21)
14	The site is located at Panambur in NMP area and is defined in drawing No. 3/14/CAAQM/CE(C)/2021-22/TS-LP1	
15	The Defects Liability Period is 05 (Five) year.	(35)
16	The minimum insurance cover for physical property, injury and death is Rs. 5,00,000/- (Rupees five Lakhs) per occurrence with the number of occurrences limited to four. After each occurrence, contractor will pay additional premium necessary to make insurance valid for four occurrences always.	(13)
17	The following events shall also be Compensation Events: The Employer terminates the contract for his convenience.	(44)
18	The period between Programme updates shall be 30 days.	(27)
19	The amount to be withheld for late submission of an updated Programme shall be Rs. 25,000/-.	(27)
20	The Penalty for the delay in submission of the Performance guarantee shall be at the rate of 0.25% of the amount of performance guarantee for each week or part of the week for the number of weeks delayed beyond the stipulated date of submission.	(52.2) 34.1
21	The language of the Contract documents is English.	(3)
22	The law, which applies to the Contract, is the law of Union of India.	(3)

Sl. No.	Description	Reference Cl. No.
23	The currency of the Contract is Indian Rupees.	(46)
24	Fees and types of reimbursable expenses to be paid to the Dispute Review Board as per actual and equally shared by both the parties.	(25)
25	The Dispute Review Board shall be constituted after signing of the agreement on mutually agreed terms.(Appendix 1). (Not applicable to this contract)	(25)
26	Price Adjustment (deleted)	(47) (80)
27	The proportion of payments retained (retention money) shall be 10% of total tax invoice value from each running bill subject to a maximum of 5% of the contract price including GST as applicable.	(48)
28	The maximum amount of liquidated damages for the whole of the works is 10 % of the contract price plus taxes and duties. The half per cent (½%) per week L.D is applicable for delay period of $\frac{1}{3}$ of contract period and thereafter 10% L.D is applicable.	[49]
29	Clause No. 49A (v) deleted.	
30	Advance payment is not applicable to this contract	[51]
31	Repayment of secured advance: deleted	(51.6)
32	The Securities shall be for the following minimum amounts equivalent as a percentage of the Contract Price.	(52)
33	Performance Security in the form of Bank guarantee for 3% of contract price including GST.	(52.2)
34	The standard form of Performance Security acceptable to the Employer shall be an unconditional Bank Guarantee of the type as presented in Section III (iv) of the Bidding Documents.	Annexure-A

vi) FORM OF SECURITIES

Acceptable forms of securities are annexed. Bidders should not complete the Performance Security form at this time. Only the successful Bidder will be required to provide Performance and Advance Payment Securities in accordance with one of the forms, or in a similar form acceptable to the Employer.

Annexure A: Performance Bank Guarantee

Annexure B: Bank Guarantee for Advance Payment

Annexure A**PERFORMANCE BANK GUARANTEE**

To: _____ [name of Employer]
 _____ [address of Employer]

WHEREAS _____ [name and address of Contractor] (hereinafter called "the Contractor") has undertaken, in pursuance of Contract _____ No. _____ dated _____ to execute _____ [name of Contract and brief description of Works] (hereinafter called "the Contract").

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with his obligations in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee;

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of _____ [amount of guarantee]¹ _____ [In words], such sum being payable in the types and proportions of currencies in which the Contract Price is payable, and we undertake to pay you, upon your first written demand, and without cavil or argument, any sum or sums within the limits of _____ [amount of guarantee]¹ as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change or addition to or other modification of the terms of the Contract or of the Works to be performed there under or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

This guarantee shall be valid until 28 days from the date of expiry of the Defects Liability Period.

Notwithstanding anything mentioned above,

Our liability against this guarantee is restricted to Rs. (Rupees only) and unless a claim in writing is lodged with us within 3

months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharges.

IN WITNESS WHEREOF this guarantee has been duly executed on this day of

Signature and seal of the guarantor _____

Name of Bank _____

Address _____ Date__

1 An amount shall be inserted by the Guarantor, representing the percentage of the Contract Price specified in the Contract and denominated in Indian Rupees.

Annexure B

BANK GUARANTEE FOR ADVANCE PAYMENT

To: _____ [name of Employer]
_____ [address of Employer]
_____ [name of Contract]

Gentlemen:

In accordance with the provisions of the Conditions of Contract, Sub-clause 51.1 ("Advance Payment") of the above mentioned Contract, _____ [name and address of Contractor] (hereinafter called "the Contractor") shall deposit with _____ [name of Employer] a bank guarantee to guarantee his proper and faithful performance under the said Clause of the Contract in an amount of

1 _____ [amount of guarantee] _____ [in words].

We, the _____ [bank or financial institution], as instructed by the Contractor, agree unconditionally and irrevocably to guarantee as primary obligator and not as Surety merely, the payment to _____ [name of Employer] on his first demand without whatsoever right of objection on our part and without his first claim to the Contractor, in the amount not exceeding _____ [amount of guarantee]1 _____ [in words].

We further agree that no change or addition to or other modification of the terms of the Contract or of Works to be performed there under or of any of the Contract documents which may be made between _____ [name of Employer] and the Contractor, shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification. The guarantee shall remain valid and in full effect from the date of the advance payment under the Contract until _____ [name of Employer] receives full repayment of the same amount from the Contractor.

Notwithstanding anything mentioned above,

Our liability against this guarantee is restricted to Rs.....(Rupeesonly) and unless a claim in writing is lodged with us within 3 months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharges.

IN WITNESS WHEREOF this guarantee has been duly executed on thisday of

Yours truly,

Signature and seal: _____

Name of Bank/Financial Institution: _____

Address: _____

Date: _____ 1. An amount shall be inserted by the bank or financial institution representing the amount of the Advance Payment, and denominated in Indian Rupees.

APPENDIX – I (Not applicable to this contract)
TO GENERAL CONDITIONS OF CONTRACT

DISPUTES REVIEW BOARD AGREEMENT

THIS AGREEMENT, made and entered into this Day of
..... 20..... Between (“the Employer”)
and.....
..... (“the Contractor”), and the Disputes Review Board
 (“the Board”) consisting of One / three Board Members, (1)
..... (2)
..... (3)
.....

[Note: Delete whatever is not applicable]

WITNESSETH, that
WHEREAS, the Employer and the Contractor have contracted for the construction of
the
.....
..... (Project name)
..... (the “Contract”) and

WHEREAS, the contract provides for the establishment and operation of the Board
NOW THEREFORE, the parties hereto agree as follows:

The parties agree to the establishment and operation of the Board in accordance with
this Board Agreement.

Except for providing the services required hereunder, the Board Members should not
give any advice to either party or to the Engineer or his nominee concerning conduct
of the Works.

The Board Members:

- (a) shall have no financial interest in any party to the contract or the Engineer or
his nominee, or a financial interest in the contract, except for payment for
services on the Board.

- (b) shall have had no previous employment by, or financial ties to, any party to
the contract, or the Engineer or his nominee, except for fee based consulting
services on other projects, all of which must be disclosed prior to appointment

to the Board.

- (c) shall have disclosed in writing to the parties prior to signature of this Agreement any and all recent or close professional or personal or personal relationships with any director, officer, or employee of any party to the contract, or the Engineer or his nominee, and any and all prior involvement in the project to which the contract relates;
- (d) shall not, while a Board Member, be employed whether as a consultant or otherwise by either party to the contract, or the Engineer or his nominee, except as a Board Member.
- (e) shall not, while a Board Member, engage in discussion or make any agreement with any party to the contract, or with the Engineer or his nominee, regarding employment whether as a consultant or otherwise either after the contract is completed or after services as a Board Member is completed;
- (f) shall be and remain impartial and independent of the parties and shall disclose in writing to the Employer, the Contractor, the Engineer or his nominee, and one another any fact or circumstances which might be such to cause either the Employer or the Contractor to question the continued existence of the impartiality and independence required of Board Members.

Except for its participation in the Board's activities as provided in the contract and in this Agreement none of the Employer, the Contractor, the Engineer or his nominee, and one another any fact or circumstances which might be such to cause either the Employer or the Contractor to question the continued existence of the impartiality and independence required of Board Members.

The Contractor shall :

- a) furnish to each Board Members one copy of all documents which the Board may request including contract documents, progress reports, variation orders, and other documents, pertinent to the performance of the Contract.
 - b) in co-operation with the Employer, co-ordinate the Site visits of the Board, including conference facilities, and secretarial and copying services.
- The Board shall serve throughout the operation of the contract. It shall begin operation following execution of this Agreement, and shall terminate its activities after issuance of the taking over Certificate and the Board's issuance of its Recommendations on all disputes referred to it.

Board Member shall not assign or subcontract any of their work under this Agreement.

The Board Members are independent and not employees or agents of either the Employer or the Contractor.

The Board Members are absolved of any personal or professional liability arising from the activities and the Recommendations of the Board.

Fees and expenses of the Board Member[s] shall be agreed to and shared equally by the Employer and the Contractor. If the Board requires special services, such as accounting, data research, and the like, both parties must agree and the costs shall be shared by them as mutually agreed.

Board Site visits :

- a) The Board shall visit the Site and meet with representatives of the Employer and the Contractor and the Engineer or his nominee at regular intervals, at times of critical construction events, and at the written request of either party. The timing of Site failing agreement shall be fixed by the Board.
 - b) Site meetings shall consist of an informal discussion of the status of the construction of the works followed by an inspection of the works, both attended by personnel from the Employer, the Contractor and the Engineer or his nominee.
 - c) If requested by either party or the Board, the Employer will prepare minutes of the meetings and circulate them for comments of the parties and the Engineer or his nominee.
11. Procedure for disputes referred to the Board:
- a) If either party objects to any action or inaction of the other party or the Engineer or his nominee, the objecting party may file a written Notice of Dispute to the other party with a copy to the Engineer or his nominee stating that it is given pursuant to Clause 65 and stating clearly and in detail the basis of the dispute.
 - b) The party receiving the Notice of Dispute will consider it and respond in writing within 7 days after receipt.
 - c) This response shall be final and conclusive on the subject, unless a written appeal to the response is filed with the responding party

within 7 days of receiving the response. Both parties are encouraged to pursue the matter further to attempt to settle the dispute. When it appears that the dispute cannot be resolved without the assistance of the Board either party may refer the dispute to the Board by written Request for Recommendation to the Board, the other party and the Engineer or his nominee stating that it is made pursuant to Clause 65.

- d) The Request for recommendation shall state clearly and in full detail the specific issues of the dispute to be considered by the Board.
 - e) When a dispute is referred to the Board, and the Board is satisfied that the dispute requires the Board's assistance, the Board shall decide when to conduct a hearing on the dispute. The Board may request that written documentation and arguments from both parties be submitted to each Board Member before the hearing begins. The parties shall submit insofar as possible agreed statements of the relevant facts.
 - f) During the hearing, the Contractor, the Employer, and the Engineer or his nominee shall each have ample opportunity to be heard and to offer evidence. The Board's Recommendations for resolution of the dispute will be given in writing, to the Employer, the Contractor and the Engineer or his nominee as soon as possible, and in any event not more than 28 days after the Board's final hearing on the dispute.
12. Conduct of Hearings:
- a) Normally hearing will be conducted at the Site, but any location that would be more convenient and still provide all required facilities and access to necessary documentation may be utilized by the Board. Private Sessions of the Board may be held at any location convenient to the Board.
 - b) The Employer, the Engineer or his nominee and the Contractor shall have representatives at all hearings.
 - c) During the hearings, no Board Member shall express any opinion concerning the merit of any facet of the case. After the hearings are concluded, the Board shall meet privately to formulate its Recommendations. All Board deliberations shall be conducted in private, with all individual views kept strictly confidential. The Board's Recommendations, together with an explanation of its reasoning shall be submitted in writing to both parties and to the Engineer or his nominee. The Recommendations shall be based on the pertinent contract provisions, applicable laws and regulations, and the facts and circumstances involved in the dispute.

The Board shall make every effort to reach a unanimous Recommendation. If this proves impossible, the majority shall decide, and the dissenting member any prepare a written minority report for submission to both parties.

[Note: Delete if it is one member Board]

13. If during the contract period, the Employer and the Contractor are of the opinion that the Dispute Review Board is not performing its functions properly; the Employer and the Contractor may together disband the Disputes Review Board. In such an event, the disputes shall be referred to Arbitration straightaway.

The Employer and the Contractor shall jointly sign a notice specifying that the Board shall stand disbanded with effect from the date specified in the notice. The notice shall be posted by a registered letter with AD or delivery of the letter, even if he refuses to do so.

APPENDIX – II

TO SPECIAL CONDITIONS OF CONTRACT
PRE CONTRACT INTEGRITY PACT AGREEMENT

General

This pre-bid pre-contract Agreement (hereinafter called the Integrity Pact) is made on _____ day of the month of _____ 20__, between, on one hand, the Board of Members of New Mangalore Port Authority acting through _____, Chief Engineer (Civil), (Name & Designation of the Officer) New Mangalore Port Authority (hereinafter called the 'BUYER/EMPLOYER', which expression shall mean and include, unless the context otherwise requires, his successors in office and assigns) of the First Part and M/s _____ represented by Shri _____, Chief Executive Officer (hereinafter called the 'BIDDER' which expression shall mean and include, unless the context otherwise requires, his successors and permitted assigns) of the Second Part.

WHEREAS the 'BUYER/EMPLOYER' has invited bids for Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender and the BIDDER is submitting his bid for the same and

WHEREAS the BIDDER is a Private company / Public company / Government undertaking / registered partnership firm, constituted in accordance with the relevant law in the matter and the 'BUYER/EMPLOYER' is New Mangalore Port Authority.

NOW, THEREFORE,

To avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:-

Enabling the 'BUYER/EMPLOYER' to obtain the desired said stores/equipment/services/works at a competitive price in conformity with the defined specifications by avoiding the high cost and the distortionary impact of corruption on public procurement, and

Enabling BIDDERS to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that their competitors will also abstain from bribing and other corrupt practices and the 'BUYER/EMPLOYER' will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows:

Commitments of the 'BUYER/ EMPLOYER'

93.1 The 'BUYER/EMPLOYER' undertakes that no official of the

'BUYER/EMPLOYER', connected directly or indirectly with the contract, will demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the BIDDER, either for themselves or for any person, organization or third party related to the contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the contract.

- 93.2 The 'BUYER/EMPLOYER' will, during the pre-contract stage, treat all BIDDERS alike and will provide to all BIDDERS the same information and will not provide any such information to any particular BIDDER which could afford an advantage to that particular BIDDER in comparison to other BIDDERS.
- 93.3 All the officials of the 'BUYER/EMPLOYER' will report to the appropriate Government office any attempted or completed breaches of the above commitments as well as any substantial suspicion of such a breach.
94. In case any such preceding misconduct on the part of such official(s) is reported by the BIDDER to the 'BUYER/ EMPLOYER' with full and verifiable facts and the same is prima facie found to be correct by the 'BUYER/EMPLOYER' necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the 'BUYER/ EMPLOYER' and such a person shall be debarred from further dealings related-to the contract process. In such a case while an enquiry is being conducted by the 'BUYER/ EMPLOYER' the proceedings under the contract would not be stalled.

Commitments of BIDDERS

95. The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract or in furtherance to secure it and in particular commit itself to the following.:-
- 3.1. The BIDDER will not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the 'BUYER/EMPLOYER' connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.
- 3.2. The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the 'BUYER/EMPLOYER' or otherwise in procuring the Contract or forbearing to do or having done any act in relation to the obtaining or execution of the contract or any other contract

with the Government for showing or forbearing to show favour or disfavour to any person in relation to the contract or any other contract with the Government.

- 3.3. BIDDERS shall disclose the name and address of agents and representatives and Indian BIDDERS shall disclose their foreign principals or associates.
- 3.4. BIDDERS shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid/contract.
- 3.5. The BIDDER further confirms and declares to the 'BUYER/EMPLOYER' that the BIDDER has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to the 'BUYER/EMPLOYER' or any of its functionaries, whether officially or unofficially to the award of the contract to the BIDDER, nor has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or recommendation.
- 3.6. The BIDDER, either while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of the 'BUYER/EMPLOYER' or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.
- 3.7. The BIDDER will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract.
- 3.8. The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.
- 3.9. The BIDDER shall not use improperly, for purposes of competition or personal gain, or pass on to others, any information provided by the 'BUYER/EMPLOYER' as part of the business relationship, regarding plans, technical proposals and business details, including information contained in any electronic data carrier. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.
- 3.10. The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.
- 3.11. The BIDDER shall not instigate or cause to instigate any third person to commit any of the actions mentioned above.
- 3.12. If the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of the 'BUYER/EMPLOYER' or alternatively, if any relative of an officer of the 'BUYER/EMPLOYER' has financial interest/stake in the BIDDER's firm, the same shall be disclosed by the BIDDER at the time of

filing of tender.

The term 'relative' for this purpose would be as defined in Section 6 of the Companies Act 1956.

- 3.13. The BIDDER shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of the 'BUYER/EMPLOYER'.
- 3.14. The bidder signing IP shall not approach courts while representing the matters to IEMs and he / she / they will wait their decision in the matter.

96. Previous Transgression

- 96.1 The BIDDER declares that no previous transgression occurred in the last three years immediately before signing of this Integrity Pact, with any other company in any country in respect of any corrupt practices envisaged hereunder or with any Public Sector Enterprise in India or any Government Department in India that could justify bidder's exclusion from the tender process.
- 96.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

97. Earnest Money (Security Deposit)

- 97.1 While submitting commercial bid, the BIDDER shall deposit an amount Rs.416600/- (Rupees Four Lakh Sixteen Thousand Six Hundred Only) as Earnest Money/Security Deposit, with the 'BUYER/ EMPLOYER' through any of the following instruments:

i) Paid by RTGS in favour of FA and CAO, NMPA

The benefit of Exemption of EMD to all Micro and small enterprises (MSE) will allowed. Shall upload with their offer, the proof of their being MSE registered with district industries center (DIC) or Khadhi and village industries commission or Khadhi and Industries board (KVIV) or Coir board or National Small Industries Corporation (NSIC) or Directorate of handicrafts and handlooms or Udhog Aadhar Memorandum or Udyam Registration Certificate or any other body specified by Ministry of MSME.

- 97.2 The Earnest Money/Security Deposit shall be valid up to a period of 148days or the complete conclusion of the contractual obligations to the complete satisfaction of both the BIDDER and the 'BUYER/EMPLOYER', including warranty period, whichever is later.
- 97.3 In case of the successful BIDDER, a clause would also be

incorporated in the Article pertaining to Performance Security in the Project Contract that the provisions of Sanctions for Violation shall be applicable for forfeiture of Performance Security in case of a decision by the 'BUYER/EMPLOYER' to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.

97.4 No interest shall be payable by the 'BUYER/EMPLOYER' to the BIDDER on Earnest Money/Security Deposit for the period of its currency.

98. Sanctions for Violations

98.1 Any breach of the aforesaid provisions by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle the 'BUYER/EMPLOYER' to take all or any one of the following actions, wherever required:-

- i) To immediately call off the pre contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.
- ii) The Earnest Money Deposit (in pre-contract stage) and/or Security Deposit/Performance Bond (after the contract is signed) shall stand forfeited either fully or partially, as decided by the 'BUYER/EMPLOYER' and the 'BUYER/ EMPLOYER' shall not be required to assign any reason therefore.
- iii) To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.
- iv) To recover all sums already paid by the 'BUYER/EMPLOYER', and in case of an Indian BIDDER with interest thereon at 2% higher than the prevailing Prime Lending Rate of State Bank of India, while in case of a BIDDER from a country other than India with interest thereon at 2% higher than the LIBOR. If any outstanding payment is due to the BIDDER from the 'BUYER/EMPLOYER' in connection with any other contract, such outstanding payment could also be utilized to recover the aforesaid sum and interest.
- v) To encash the advance bank guarantee and performance bond/warranty bond, if furnished by the BIDDER, in order to recover the payments, already made by the 'BUYER/EMPLOYER', along with interest.
- vi) To cancel all or any other Contracts with the BIDDER. The BIDDER shall, be liable to pay compensation for any loss or damage to the 'BUYER/EMPLOYER' resulting from such

cancellation/rescission and the 'BUYER/EMPLOYER' shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.

- vii) To debar the BIDDER from participating in future bidding processes for a minimum period of five years, which may be further extended at the discretion of the 'BUYER/EMPLOYER'.
- viii) To recover all sums paid in violation of this Pact by BIDDER(s) to any middleman or agent or broker with a view to securing the contract.
- ix) In cases where irrevocable Letters of Credit have been received in respect of any contract signed by the 'BUYER/EMPLOYER' with the BIDDER, the same shall not be opened.
- x) Forfeiture of Performance Guarantee in case of a decision by the 'BUYER/ EMPLOYER' to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.

98.2 The 'BUYER/EMPLOYER' will be entitled to take all or any of the actions mentioned at para 6.1(i) to (x) of this Pact also on the Commission by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.

98.3 The bidder the decision of the 'BUYER/EMPLOYER' to the effect that a breach of the provisions of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER. However, the BIDDER can approach the Independent Monitor(s) appointed for the purposes of this Pact.

99. Fall Clause

99.1 Undertakes that it has not performed/is not performing similar project at a price lower than that offered in the present bid in respect of any other Ministry/Department of the Government of India or PSU and if it is found at any stage that similar project was performed by the BIDDER in any other Ministry/Department of the Government of India or a PSU at a lower price, then that very price, with due allowance for elapsed time, will be applicable to the present case and the difference in the cost would be refunded by the BIDDER to the 'BUYER/EMPLOYER', if the contract has already been concluded.

100. Independent Monitors

100.1 The 'BUYER/EMPLOYER' has appointed the following Independent Monitor (hereinafter referred to as Monitor) for this Pact in consultation

with the Central Vigilance Commission Name and Address of the Monitor: Shri Prem Chand Pankaj, Ex CMD, NEEPCO, M 402, Pioneer Park, Sector 61, Golf Course, Extn., Road, Gurgaon
 Mob No. 9717433886
 E-mail ID: prempankaj@gmail.com

- 100.2 The task of the Monitor shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.
- 100.3 The Monitor shall not be subject to instructions by the representatives of the parties and perform his functions neutrally and independently.
- 100.4 Both the parties accept that the Monitor has the right to access all the documents relating to the project/bidding, including minutes of meetings.
- 100.5 As soon as the Monitor notices, or has reason to believe, a violation of this Pact, he will so inform the Authority designated by the 'BUYER/EMPLOYER'.
- 100.6 The BIDDER(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the 'BUYER/EMPLOYER', including that provided by the BIDDER. The BIDDER will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to Subcontractors. The Monitor shall be under contractual obligation to treat the information and documents of the BIDDER/Subcontractor(s) with confidentiality.
- 100.7 The 'BUYER/EMPLOYER', will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the parties. The parties will offer to the Monitor the option to participate in such meetings.
- 100.8 The Monitor will submit a written report to the designated Authority of 'BUYER/EMPLOYER' within 8 to 10 weeks from the date of reference or intimation to him by the BUYER / EMPLOYER / BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.

101. Facilitation of Investigation

In case of any allegation of violation of any provisions of this pact or payment of commission, the 'BUYER/EMPLOYER' or its agencies shall be entitled to examine all the documents including the Books of

Accounts of the BIDDER and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

102. Law and Place of Jurisdiction

This Pact is subject to Indian Law.' The place of performance and jurisdiction is the seat of the 'BUYER/EMPLOYER'.

103. Other Legal Actions

The actions stipulated in this Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

104. Validity

104.1The validity of this Integrity Pact shall be from date of its signing and extend upto 5 years or the complete execution of the contract to the satisfaction of both the 'BUYER/EMPLOYER' and the BIDDER, including warranty period, whichever is later. In case BIDDER is unsuccessful, this Integrity Pact shall expire after six months from the date of the signing of the contract.

104.2 Should one or several provisions of this Pact turn out to be invalid, the remainder of this Pact shall remain valid. In this case, the parties will strive to come to an agreement to their original intentions.

104.3If the BIDDER is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

105. The parties hereby sign this Integrity Pact at _____ on _____

BUYER/EMPLOYER

BIDDER

Name of the Officer
OFFICER
and Designation

CHIEF EXECUTIVE

Witness

Witness

1. _____

1. _____

2. _____

2. _____,

* Provisions of these clauses would need to be amended/ deleted in line with the policy of the BUYER/ EMPLOYER in regard to involvement of Indian agents of



NEW MANGALORE PORT AUTHORITY
Panambur, Mangalore

“Supply, Errection,Installation, Testing and Commissioning of
Continuous Ambient Air Quality Monitoring System at NMPA-
Retender”

TENDER DOCUMENT
Volume - II

NEW MANGALORE PORT AUTHORITY
CIVIL ENGINEERING DEPARTMENT

Tender no: 55/2022-23

Tender for

“Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Air Quality Monitoring System at NMPA-Retender”

<u>Volume I</u>	Section I	i) Notice Inviting Tenders i) Instructions to Tenderers ii) Annexure (1 to 13)
	Section II	i) Form of Agreement
	Section III	i) Conditions of Contract: Part A - E: General Conditions ii) Conditions of Contract : Part F: Special Conditions iii) Contract Data iv) Form of Securities (A & B) v) Appendix – I and Appendix - II
<u>Volume II</u>	Section IV	i) Technical Specifications
	Section V	ii) Drawings
<u>Volume II</u>	<u>Section VI</u>	i) Preamble ii) Bill of Quantities iii) For of tender
	Section VII	i) Schedules (A & B)

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SECTION IV**A. GENERAL****1. INTRODUCTION**

The intent of this technical specification covers construction of all civil works as covered in the scope of contract as per drawings supplied by Owner. All civil works shall be carried out as per design / drawings standardized by the Consultant / Owner and the specification provided by the Consultant / Owner. All standard drawings are enclosed with the tender documents. In case any item is not covered under specification then the same shall be carried out as per CPWD specification and applicable Standards and Codes. Any item for which specification is not provided herein and is not covered under CPWD specification shall be executed as per manufacturer guidelines. All materials shall be of best quality conforming to relevant Standards and Codes. In case of any conflict between Standards / Code and Technical Specification, the provisions of Technical Specification shall prevail, and the Engineer's decision on interpretation shall be final.

The Contractor shall furnish all labor, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with drawings, specifications and direction of Owner.

Excavated earth is to be disposed from site as instructed, only into approved landfill areas and dump yard. The cost of excavation to include for necessary lead and lift as specified.

All materials including cement, reinforcement steel and structural steel etc. shall be arranged by the Contractor. All testing required shall be arranged by the Contractor at his own cost. The contractor shall execute the work as per the standard Field Quality Plan (FQP) of NMPA.

The bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon patterns, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

Level and date of concreting shall be marked on the building from outside at every floor level with proper paint, etc. All levels and survey work shall be measured by total station and electronic level machine at all floors and places.

Brief Description of Works

The scope of work is defined in the Notice Inviting Tender. The Contractor shall provide all necessary materials, equipment and labour etc. for the execution and maintenance of the work till completion.

The work shall be executed in accordance with the specification stipulated in the Bill of Quantity and other bidding documents read along with CPWD (Central Public Works Department) specifications for civil works and IS codes with up-to-date revisions. For non-schedule items specification as given along with tender document and similar items of CPWD shall be applicable.

The list of references for civil works are CPWD specifications, relevant IS codes and best practices.

For deep excavations, necessary shoring is to be done, the design of which will be provided by the contractor, after assessing site and soil conditions, and work only to be commenced on site after the same is duly approved by NMPA. Any approval if required from the Mineral department or any other statutory body that has jurisdiction on such excavations has to be obtained by the contractor.

All earth used for back filling should be of approved quality.

Portland Cement of IS 8112 shall be used for all cement & concrete works. This will supersede other specifications of cement to be used for the works.

For ready mixed cement concrete, in addition to the CPWD specification, the following also to be noted:

The cost towards cement quantity reduced from the specified quantity in the item due to mixing of fly ash shall be deducted as per relevant BOQ item. The design mix shall be submitted to Engineer in Charge for approval. All hard ware fittings shall be of best quality and shall be selected as per the Instructions of Engineer in Charge.

Site location, Boundaries and Possession

The location and boundaries of the Site are shown on the Drawing. The Contractor shall confine his activities strictly to the allotted site area(s) and shall not allow his personnel to trespass upon any other areas occupied by the Employer.

1.4 Site Datum and Base Lines

A base line shall be established within the working area by the Contractor. The base line shall be referenced to the site co-ordinate system (based on the Local Coordinates of New Mangalore Port). This bench mark and base line will be the basis for the setting-out for all the Works. The main levels and lines for each portion of the Works shall be established from the bench mark and base line by the Contractor.

1.5 Site Conditions

1.5.1 Location of Work

As per enclosed location plan.

1.5.2 Climate

The climate at Mangalore is tropical with high humidity and a maximum shade temperature of 36°C. The average annual rainfall is approximately 3330 mm and concentrated in the south-west monsoon months of June, July, August and September during which period the average rainfall is as much as 82% of the total annual rainfall.

1.5.3 Wind

The wind in the monsoon months of June, July and August are predominantly from south-west and west with a maximum intensity of 5 on the Beaufort Scale. The winds in the remaining months of the year are predominantly from the north-west and the maximum intensity during this period is also of 5 on the Beaufort Scale.

1.5.4 Cyclones

Even though Mangalore is within the cyclonic area of storms originating in the Arabian Sea and those that enter across the Indian Peninsula from Bay of Bengal, cyclones are not as severe or frequent as in the Bay of Bengal. The maximum wind speed so far recorded in cyclonic storm, generally does not exceed 62 kmph (16.9 m/sec.) except one during 1965 when the maximum speed recorded was 97 kmph (26.9 m/sec.)

1.5.5 Visibility

Thirty year period observations conducted by the Indian Meteorological Department reveal that poor visibility (visibility less than 4 Kms) is encountered for about 10 days in the south-west monsoon period. The maximum number of foggy days in a year is only 3.

1.5.6 Site Preparation

The Contractor shall furnish all necessary supervision, labour, materials, equipment and tools for Site Preparation, clearing and all other works. Clearing shall mean to completely demolish, remove and dispose with all leads, lifts and descents from the area marked, trees, bushes, deadfalls, embedded logs, dislodged roots, stumps, snogs, boulders, mounds, existing structures and other objectionable materials. The areas required to be cleared shall consist of the work Site, ditches, borrow pits, diversions and all other areas necessary for the construction work as directed by the Engineer-in-Charge.

Before any Temporary Works are commenced, the Contractor shall submit his proposal along with complete drawings of all Temporary Work, he may require for the execution of

the Works in advance to the Engineer for approval. The Contractor shall also submit his calculations relating to the design of temporary works, strength, etc. if required by the Engineer and shall carry out the modifications that the Engineer may require of such temporary works at Contractor's own cost. The Contractor shall be solely responsible for the stability and safety of all Temporary Work.

It will be the responsibility of the Contractor to make timely procurement of all materials and mobilize all essential equipment for both Temporary and Permanent Works.

1.6 Site Information

The detailed drawing of the construction site for adaptation of methodology for the construction. However, on account of this change in the geographical profile of site, no extra cost for additional arrangement required to be made will be paid for.

1.7 The Nature of Soil Profile

The site comprises of ordinary soil. The details furnished herein are only for the information/guidelines of the tenderers and the successful contractor shall not claim for any deviation in the actual subsoil profile encountered at site.

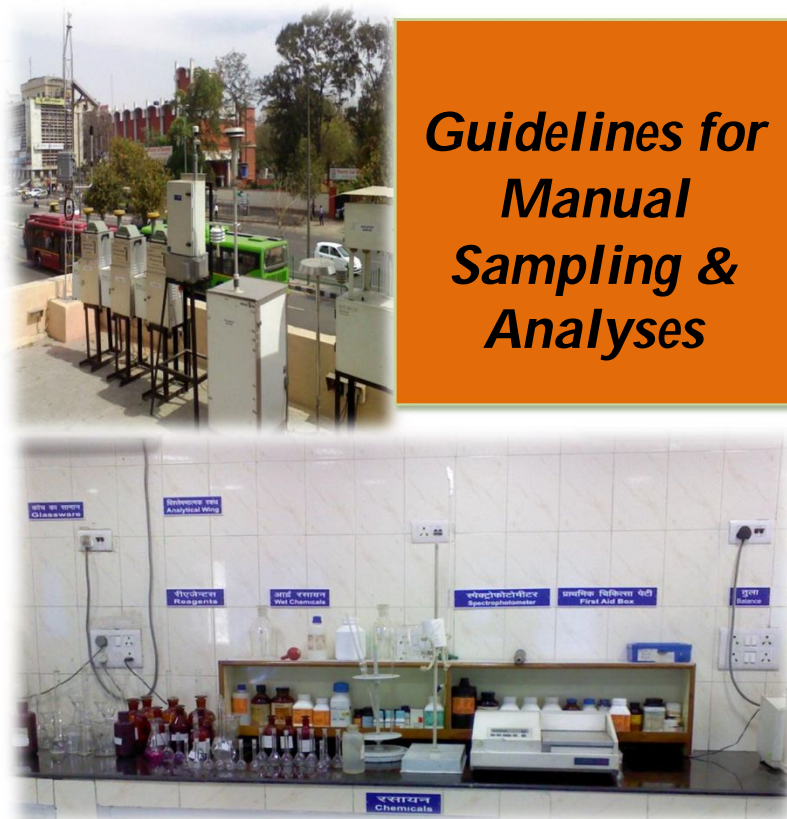
1.8 Records

Complete records of all operations connected with the work shall be kept by the Contractor. The Contractor shall submit to the Engineer-in-charge for approval his proposal of the manner of presentation of these records. Three copies of all such records shall be furnished to the Engineer-in-charge on completion of each test or operation.

2. Works

2.1 Guidelines for the Measurement of Ambient Air Pollutants

(VOLUME-I)



CENTRAL POLLUTION CONTROL BOARD
(Ministry of Environment & Forests, Govt. of India)

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Background

Guidelines for Sampling and Measurement of notified Ambient Air Quality Parameters (NAAQS 2009)

Under the provisions of the Air (Prevention & Control of Pollution) Act, 1981, the CPCB has notified fourth version of National Ambient Air Quality Standards (NAAQS) in 2009. This revised national standard aims to provide uniform air quality for all, irrespective of land use pattern, across the country. There are 12 identified health based parameters, which are to measure at the national level and with a view to have data comparison, need for uniform guidelines for monitoring, sampling, analyses, sample flow chart, data sheet based on standard method has been felt.

The methods prescribed in the notification for respective parameters are the combination of physical method, wet-chemical method and continuous on-line method. Therefore, to meet the NAAQS requirement, a combination of both manual and continuous method is invariably required at each monitoring location, besides good laboratory set up and infrastructure.

In addition to the above, an in house exercise for applicability of all prescribed / recommended analytical methods was also felt necessary. After review and demonstration in the Central Laboratory, Delhi, guidelines are being prepared and documented, as under:

1. Volume -I: Guidelines for manual sampling and analyses (along with sampleflow chart and data sheets);
2. Volume-II: Guidelines for continuous sampling and real time analyses
3. Volume-III: Reference methods for manual sampling and analyses(compilation)
4. Volume-IV: Reference methods for continuous sampling and real time analyses (compilation)

Note: Guidelines are laboratory and infrastructure specific thus may not be applicable uniformly and need to develop based on infrastructure and expertise

NATIONAL AMBIENT AIR QUALITY STANDARDS (2009)

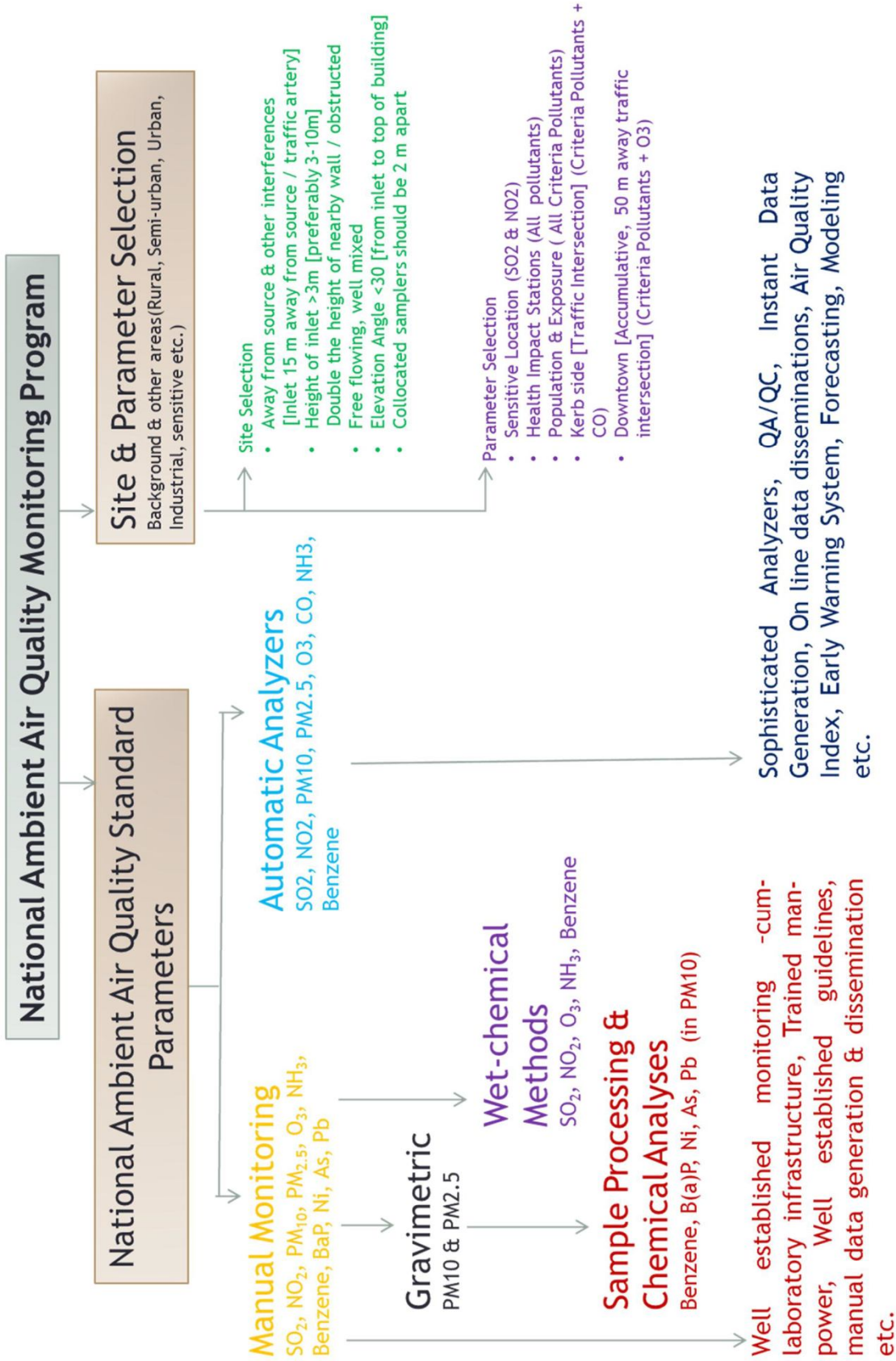
Pollutants	Time	Concentration in Ambient Air		Methods of Measurement
		Weighted Average	Industrial, Residential, Rural and other Areas	
Sulphur Dioxide (SO ₂), µg/m ³	Annual *	50	20	-Improved West and Gaeke Method
	24 Hours **	80	80	-Ultraviolet Fluorescence
Nitrogen Dioxide (NO ₂), µg/m ³	Annual *	40	30	-Jacob & Hochheiser modified (NaOH-NaAsO ₂) Method
	24 Hours **	80	80	-Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM ₁₀ , µg/m ³	Annual *	60	60	-Gravimetric
	24 Hours **	100	100	-TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or PM _{2.5} , µg/m ³	Annual *	40	40	-Gravimetric
	24 Hours **	60	60	-TEOM -Beta attenuation
Ozone (O ₃) µg/m ³	8 Hours *	100	100	-UV Photometric
	1 Hour **	180	180	-Chemiluminescence -Chemical Method
Lead (Pb) µg/m ³	Annual *	0.50	0.50	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
	24 Hours **	1.0	1.0	-ED-XRF using Teflon filter
Carbon Monoxide(CO), mg/m ³	8 Hours **	02	02	-Non dispersive Infrared (NDIR)
	1 Hour **	04	04	Spectroscopy
Ammonia (NH ₃), µg/m ³	Annual *	100	100	-Chemiluminescence
	24 Hours	400	400	-Indophenol blue method

	**			
Benzene (C₆H₆), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

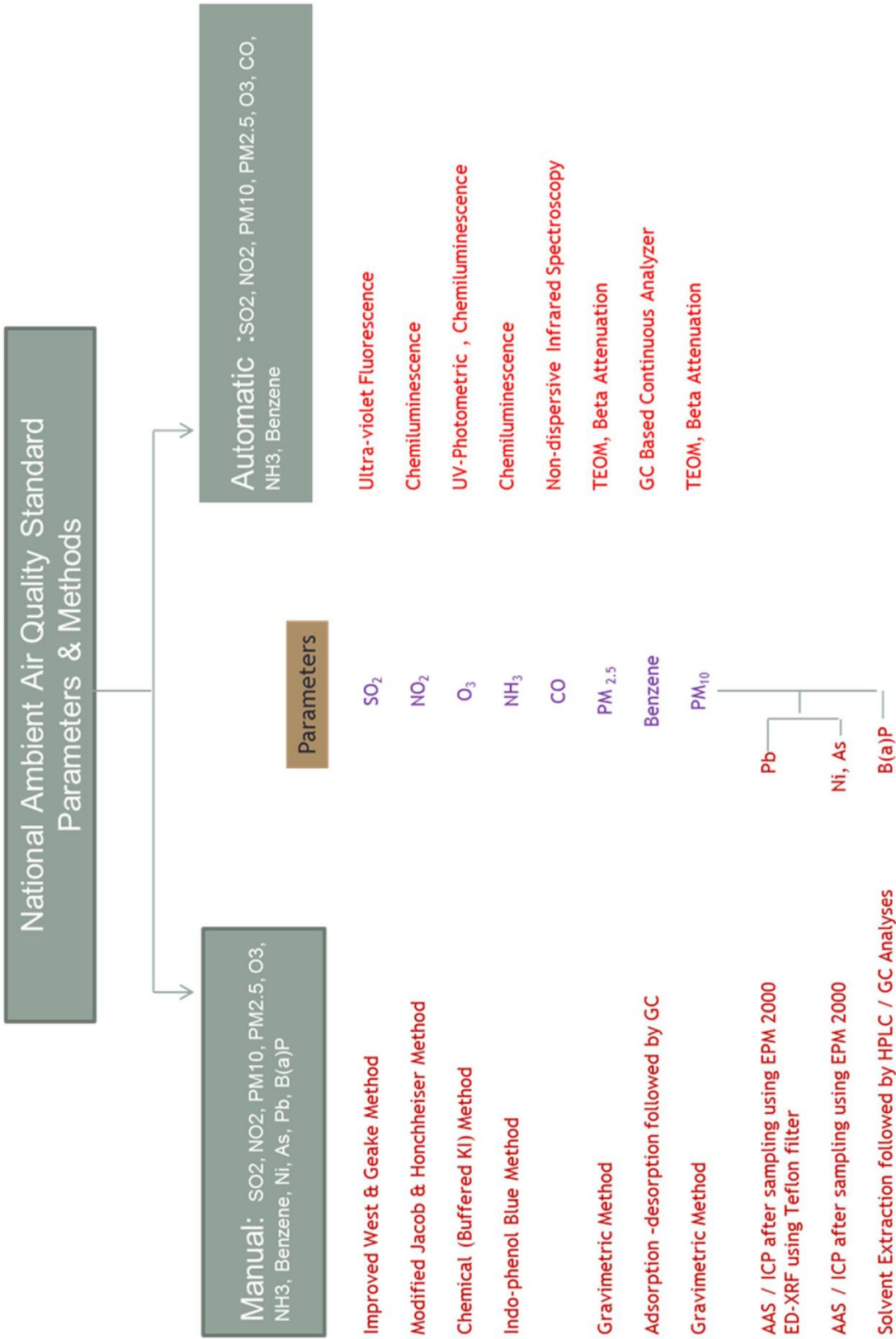
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.



National Ambient Air Quality Monitoring Program



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3.	Guidelines for sampling and analysis of ParticulateMatter (PM10) in ambient air (Gravimetric Method) Page 11	11-14
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7.	Guidelines for sampling and Analysis of Benzo(a)pyrene & other PAHs in Ambient Air (Solvent Extraction & GC Analysis) Page No. 39	39-46
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Guidelines for sampling and analysis of sulphur dioxide in ambient air (Improved West and Gaeke method)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring and analysis of sulphur dioxide in ambient air.

2. Standard

The national ambient air quality standards for sulphur dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO ₂), µg/m ³	Annual *	50	20
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

3. Principle of the method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide).

Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro-mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely coloured pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer.

4. Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of nitrogen dioxide in ambient air:

-
- Analytical balance:
 - Vacuum pump : Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate
 - Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.
 - Absorber: all glass midget impinger
 - Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.
 - Glass wares: low actinic glassware must be used for analysis

5. Reagents / Chemicals

All the chemicals should meet specifications of Analytical Reagent grade

- Distilled water
- Mercuric chloride
- Potassium chloride / Sodium chloride
- EDTA di sodium salt
- Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolve 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and bring to the mark in a 1 litre volumetric flask. *Caution : highly poisonous if spilled on skin, flush off with water immediately.* The pH of this reagent should be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, a precipitate forms, discard the reagent after recovering the mercury.
- Sulphamic Acid (0.6%) - Dissolve 0.6 g sulphamic acid in 100 ml distilled water. Prepare fresh daily.
- Formaldehyde (0.2%) - Dilute 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water. Prepare fresh daily.
- Purified Pararosaniline Stock Solution (0.2% Nominal) Dissolve 0.500 gm of specially purified pararosaniline (PRA) in 100 ml of distilled

water and keep for 2 days (48 hours).

- Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.
- Stock Iodine Solution (0.1 N) - Place 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water. Stir until all is dissolved, then dilute to 1 litre with distilled water.
- Iodine Solution (0.01 N) - Prepare approximately 0.01 N iodine solution by diluting 50 ml of stock solution to 500 ml with distilled water.
- Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and add the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.
- Potassium iodate

Stock Sodium Thiosulfate Solution (0.1 N) - Prepare a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolve using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allow the solution to stand one day before standardizing.

To standardize, accurately weigh to the nearest 0.1 mg, 1.5 g primary standard potassium iodate dried at 180°C, dissolve, and dilute to volume in a 500 ml volumetric flask. Into a 500 ml Iodine flask, transfer 50 ml of iodate solution by pipette. Add 2 g potassium iodide and 10 ml of N hydrochloric acid and stopper the flask. After 5 min, titrate with stock thiosulfate solution to a pale yellow. Add 5 ml starch indicator solution and continue the titration until the blue colour disappears. Calculate the normality of the stock solution.

- Sodium Thiosulphate Titrant (0.01 N) - Dilute 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.
- Standardized Sulphite Solution for Preparation of Working Sulphite-TCM Solution - Dissolve 0.30 g sodium metabisulphite ($\text{Na}_2\text{S}_2\text{O}_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important

to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO₂.

- Working Sulphite-TCM Solution - Measure 2 ml of the standard solution into a 100 ml volumetric flask by pipette and bring to mark with 0.04 M TCM. Calculate the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days if kept in the refrigerator at 5°C. If not kept at 5°C, prepare fresh daily.

6. Sampling

Place 30 ml of absorbing solution in an impinger and sample for four hours at the flow rate of 1 L/min. After sampling measure the volume of sample and transfer to a sample storage bottle.

7. Analysis

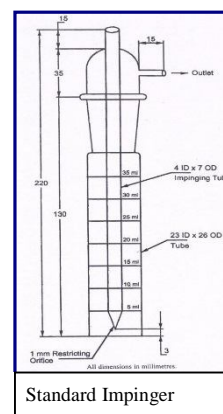
Replace any water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mix thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Add 1 ml 0.6%

sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting

from oxides of nitrogen. Add 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and make up to 25 ml with distilled water. Prepare a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min colour development interval and before 60 minutes, measure and record the absorbance of samples and reagent blank at 560 nm. Use distilled water; not the reagent blank, as the optical reference

8. Calibration

The actual concentration of the sulphite solution is determined by adding excess iodine and back titrating with standard sodium thiosulfate solution. To back-titrate, measure, by pipette, 50 ml of the 0.01 N iodine solution into each of two 500 ml iodine flasks A and B. To flask A (blank) add 25 ml distilled water and into flask B (sample) measure 25 ml sulphite solution by pipette. Stopper the flasks and allow to react for 5 minutes. Prepare the working sulphite-TCM solution at the same time iodine solution is added to the flasks. By means of a burette containing standardized 0.01 N



thiosulfate, titrate each flask in turn to a pale yellow. Then add 5 ml starch solution and continue the titration until the blue colour disappears.

Preparation of Standards

Measure 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Add sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then add the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Read the absorbance of each standard and reagent blank

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

9. Calculation

Concentration of sulphite solution:

$$C = \frac{(V1-V2) \times N \times K}{V}$$

Where,

C = SO₂ concentration in $\mu\text{g/ml}$

V1 = Volume of thiosulfate for blank, ml

V2 = Volume of thiosulfate for sample,

mIN = Normality of thiosulfate

K = 32000 (Milliequivalent weight SO₂/μg)

V = Volume of standard sulphite solution, ml

$$C (\text{SO}_2 \mu\text{g/m}^3) = (A_s - A_b) \times CF \times V_s / V_a \times$$

V_t Where,

C SO₂ = Concentration of Nitrogen dioxide,

$\mu\text{g/m}^3$ A_s = Absorbance of sample

A_b = Absorbance of reagent

blank CF = Calibration factor

V_a = Volume of air sampled,

m^3 V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

10. Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

11. Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger□
Connect it to the gas-sampling manifold of gas sampling device(RDS/HVS). □
Draw air at a sampling rate of 1 lpm for four hours□
Check the volume of sample at the end of sampling and record it□
Transfer the exposed samples in storage bottle and preserve□
Prepare calibration graph as recommended in method□
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask□
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)□
Add 1 ml Sulphamic acid. Keep it 10 minutes□
Add 2 ml formaldehyde□
Add 2 ml working PRA□
Make up to mark (25 ml.) with distilled water.□
Keep it 30 minutes for reaction□
Set Zero of spectrophotometer with Distilled water□
Measure absorbance at 560 nm□
Calculate concentration using calibration graph□
Calculate concentration of Sulphur Dioxide in $\mu\text{g}/\text{m}^3$

Guidelines for sampling and analysis of Nitrogen dioxide in ambient air (Modified Jacob and Hochheiser Method)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring of nitrogen dioxide in ambient.

2. Standard

The national ambient air quality standard for nitrogen dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen dioxide (NO ₂), µg/m ³	Annual *	40	30
	24 Hours **	80	80
<p>* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.</p> <p>** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.</p>			

3. Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO₂) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO⁻²) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

4. Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of nitrogen dioxide in ambient air:

- Analytical balance:

- Vacuum pump: Capable of maintaining a vacuum of at least 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml per minute through the sampling solution
- Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.
- Absorber: a midget impinger
- Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.
- Glass wares: low actinic glassware must be used for analysis

5. Reagents / Chemicals

All the chemicals should meet specifications of ACS Analytical Reagent grade

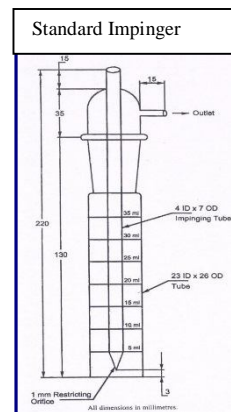
- Distilled water
- Sodium hydroxide
- Sodium Arsenite
- Absorbing solution (Dissolve 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and dilute to 1,000 ml with distilled water)
- Sulphanilamide - Melting point 165 to 167°C
- N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used
- Hydrogen Peroxide - 30%
- Phosphoric Acid - 85%
- Sulphanilamide Solution - Dissolve 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and dilute to 1,000 ml. This solution is stable for one month, if refrigerated
- NEDA Solution - Dissolve 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, if refrigerated and protected from light
- Hydrogen Peroxide Solution - Dilute 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution may be used for one

month, if, refrigerated and protected from light

- Sodium nitrite - Assay of 97% NaNO_2 or greater
- Sodium Nitrite stock solution (1000 $\mu\text{g NO}_2/\text{ml}$)
- Sodium Nitrite solution (10 $\mu\text{g NO}_2/\text{ml}$.)
- Sodium Nitrite working solution (1 $\mu\text{g NO}_2/\text{ml}$)
(Dilute with absorbing reagent, prepare fresh daily)

6. Sampling

Place 30 ml of absorbing solution in an impinger and sample for four hour at the flow rate of 0.2 to 1 L/min. After sampling measure the volume of sample



and transfer to a sample storage bottle.

7. Analysis

Replace any water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipette out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and

1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepare a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measure and record the absorbance of samples and reagent blank at 540 nm.

Use distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples should be re-analyzed as apart of an internal quality assurance program.

8. Calibration

Preparation of Standards

Pipette 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15 and 20 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in

the procedure for analysis. Read the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

9. Calculation

$$C (\text{NO}_2 \text{ } \mu\text{g}/\text{m}^3) = (A_s - A_b) \times \text{CF} \times V_s / V_a \times V_t \times 0.82$$

Where,

C NO₂ = Concentration of Nitrogen dioxide,

$\mu\text{g}/\text{m}^3$ A_s = Absorbance of sample

A_b = Absorbance of reagent blank

CF = Calibration factor

V_a = Volume of air sampled, m³

V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

0.82 = Sampling efficiency

10. Quality Control

Quality Control (QC) is the techniques that are used to fulfil requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

11. Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger □
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS). □
Draw air at a sampling rate of 1 lpm for four hours □
Check the volume of sample at the end of sampling and record it □
Transfer the exposed samples in storage bottle and preserve □

Prepare calibration graph as recommended in method <input type="checkbox"/>
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask <input type="checkbox"/>
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank) <input type="checkbox"/>
Add 1 ml hydrogen peroxide, <input type="checkbox"/>
Add 10 ml sulphaniamide <input type="checkbox"/>
Add 1.4 ml NEDA <input type="checkbox"/>
Make up to mark (50 ml.) with distilled water. <input type="checkbox"/>
Keep it 10 minutes for reaction <input type="checkbox"/>
Set Zero of spectrophotometer with Distilled water <input type="checkbox"/>
Measure absorbance at 540 nm <input type="checkbox"/>
Calculate concentration using calibration graph <input type="checkbox"/>
Calculate concentration of Nitrogen Dioxide in $\mu\text{g}/\text{m}^3$

Guidelines for sampling and analysis of Particulate Matter (PM₁₀) in ambient air (Gravimetric Method)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring and analysis of Particulate Matter PM₁₀ in ambient air.

2. Standard

The national ambient air quality standards for Particulate Matter PM₁₀ is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM ₁₀ , µg/m ³	Annual *	60	60
	24 Hours **	100	100

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

3. Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM₁₀ in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

4. Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of Particulate Matter PM₁₀ in ambient air:

- Analytical balance:
- Sampler : High Volume Sampler with size selective inlet for PM₁₀ and automatic volumetric flow control
- Calibrated flow-measuring device to control the airflow at 1132 l/min.

- Top loading orifice kit

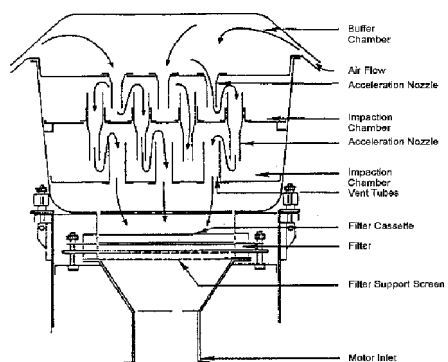
5. Reagents / Chemicals

Filter Media – A Glass fibre filter of 20.3 X 25.4 cm (8 X 10 in) size

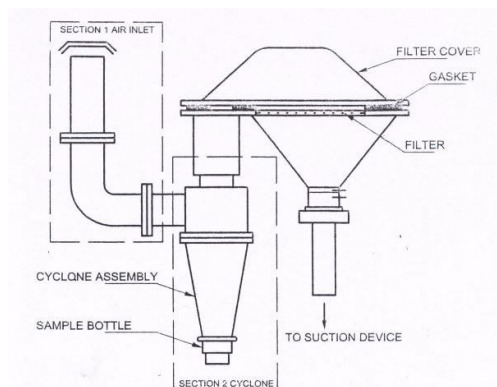
6. Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. For automatically flow-controlled units, record the designated flow rate on the data sheet. Record the reading of the elapsed time meter. The specified length of sampling is commonly 8 hours or 24 hours. During this period, several reading (hourly) of flow rate should be taken.

After the required time of sampling, record the flow meter reading, take out the filter media from the sampler, and put in a container or envelope.



PM10 Sampler (Impaction Inlet)



PM10 Sampler (Cyclonic Inlet)

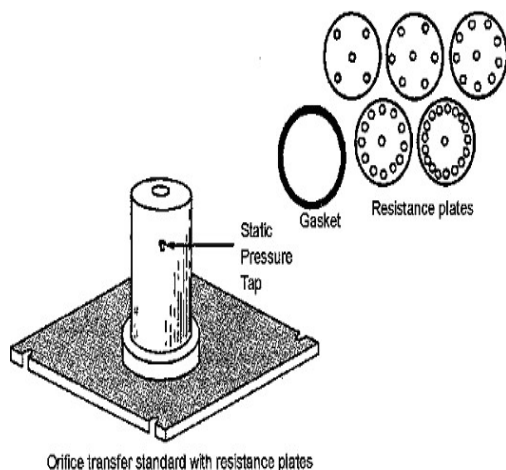
7. Analysis

Filter inspection: Inspect the filter for pin holes using a light table. Loose particles should be removed with a soft brush. Apply the filter identification number or a code to the filter if it is not a numbered. Condition the filter in conditioning room maintained within 20-30°C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Take initial weight of the filter paper (W_i) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30°C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Take final weight of the filter paper (W_f)

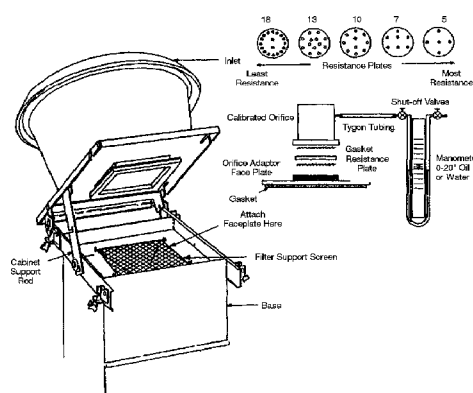
8. Calibration

Periodical calibration of the sampler is being done by Orifice Transfer Standard

- The PM10 sampler calibration orifice consists of a 3.175 cm (1.25 in) diameter hole in the end cap of 7.62 cm (3 in) diameter by 20.3 cm (8 in) long hollow metal cylinder. This orifice is mounted tightly to the filter support in place of the inlet during calibration. A small tap on the side of the cylinder is provided to measure the pressure drop across the orifice. A flow rate of 1132 L/min through the orifice typically results in a pressure difference of several inches of water. The relationship between pressure difference and flow rate is established via a calibration curve derived from measurements against a primary standard such as a Roots meter at standard temperature and pressure. Flow resistances that simulate filter resistances are introduced at the end of the calibrator opposite the orifice by a set of perforated circular disks.



Top loading Orifice kit



9. Calculation

$$C_{PM10} \mu\text{g}/\text{m}^3 = (W_f - W_i) \times 106 / V$$

Where,

C_{PM10} = Concentration of Nitrogen dioxide,
 $\mu\text{g}/\text{m}^3$

W_f = Initial weight of filter in g

W_i = Initial weight of filter in g

106 = Conversion of g to μg

V = Volume of air sampled, m^3

10. Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

11. Reference

- Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.
- IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique
- Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages <input type="checkbox"/>
Mark identification number on the filter <input type="checkbox"/>
Condition the filter in conditioning room / desiccator for 24 hours <input type="checkbox"/>
Record initial weight <input type="checkbox"/>
Place the filter on the sampler <input type="checkbox"/>
Run the sampler for eight hours <input type="checkbox"/>
Record the flow rate on hourly basis <input type="checkbox"/>
Remove the filter from the sampler <input type="checkbox"/>
Keep the exposed filter in a proper container <input type="checkbox"/>
Record the total time of sampling & average flow rate <input type="checkbox"/>
Again condition the filter in conditioning room / desiccator for 24 hours

160

□

Record final weight

□

Calculate the concentration of PM10 in $\mu\text{g}/\text{m}^3$

Guidelines for determination of PM_{2.5} in ambient air (Gravimetric Method)

1.0 Purpose

The purpose of this protocol is to provide guidelines for monitoring and analysis of Particulate Matter PM_{2.5} in ambient air.

2.0 Definition

PM_{2.5} refers to fine particles that are 2.5 micrometers (μm) or smaller in diameter. Ambient air is defined as any unconfined part of the Earth's atmosphere, that the surrounding outdoor air in which humans and other organisms live and breathe.

FRM – Federal Reference Method

FEM – Federal Equivalent Method

3.0 Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM _{2.5} , $\mu\text{g}/\text{m}^3$	Annual *	40	40
	24 Hours **	60	60
<p>* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.</p> <p>** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.</p>			

4.0 Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a mass flow / volumetric flow controller coupled to a microprocessor into specially designed inertial particle-size separator (i.e. cyclones or impactors) where the suspended particulate matter in the PM_{2.5} size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the

ambient air is computed as the total mass of collected particles in the PM_{2.5} size ranges divided by the actual volume of air sampled, and is expressed in $\mu\text{g}/\text{m}^3$. The microprocessor reads averages and stores five-minute averages of ambient temperature, ambient pressure, filter temperature and volumetric flow rate. In addition, the microprocessor calculates the average temperatures and pressure, total volumetric flow for the entire sample run time and the coefficient of variation of the flow rate.

Interferences and Artefacts

The potential effect of body moisture or oils contacting the filters is minimized by using non-serrated forceps to handle the filters at all times. This measure also moderates interference due to static electricity.

Teflon filters accumulate a surface electrical charge, which may affect filter weight. Static electricity is controlled by treating filters with a "Static Master" static charge neutralizer prior to weighing. Placement of filters on a "Static Master" unit is required for a minimum of 30 seconds before any filter can be weighed.

Moisture content can affect filter weight. Filters must be equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post-weighing. The balance room's relative humidity must be maintained at a mean value range of $45 \pm 5 \%$ and its air temperature must be maintained at a mean value range of $25.0 \pm ^\circ\text{C}$.

Airborne particulate can adversely affect accurate mass measurement of the filter. Filters undergoing conditioning should not be placed within an airflow path created by air conditioning ductwork, computer printers, or frequently opened doorways. Cleaning laboratory bench-tops and weighing areas daily, installing "sticky" floor mats at doorway entrances to the balance room and wearing clean lab coats over regular clothing can further minimize dust contamination.

Precision and Accuracy

The performance segment of the PM_{2.5} FRM specifies strict guidelines for controls that must be observed, as well as the range of precision and accuracy of those controls. The flow rate through the instrument is specified as 16.67 lpm ($1 \text{ m}^3/\text{hr}$). This flow must be volumetrically controlled to a precision of 5% and an accuracy of 2%. The flow control must be upgraded at least every 30 seconds and recorded (logged) every five minutes. Barometric pressure, ambient temperature and filter temperature should be measured on the same schedule. Filter temperature, it must not exceed the ambient temperature by more than 5°C for more than 30 minutes. A fan blowing

filtered ambient air through the enclosure provides the necessary cooling effect. It is necessary for the entire apparatus to provide accurate performance over a temperature range of -20 to 50° C. The supporting run-time (interval) data, which are stored in detailed 5- minute intervals in the sampler's microprocessor, as well as 24-hour integrated performance (filter) data, must be capable of being extracted at the completion of a 24-hour run. The FRM mandates the provision of an RS232 port for this purpose. Data may be extracted to a portable computer.

Mass of the filter deposit, flow rate through the filter, and sampling time have typical precision of ± 0.2 mg, $\pm 5\%$, and ± 30 seconds, respectively. These uncertainties combine to yield a propagated precision of approximately $\pm 5\%$ at $10 \mu\text{g}/\text{m}^3$ and approximately $\pm 2\%$ at $100 \mu\text{g}/\text{m}^3$.

6.0 Sitting Requirements

Samplers should be sited to meet the goals of the specific monitoring project. For routine sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines shall apply

The monitoring should be done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet must be 3 – 10 m above the ground level. And at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, must be more than two times the height of the obstacle above the sampler.

There should be unrestricted airflow in three of four quadrants.

Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts. These can be avoided by locating samplers by placing them > 20 m from nearby trees.

If collocated sampling has to be performed the minimum distance between two Samplers should be 2 m.

Apparatus and Materials

- Sampling equipment designated as FRM (Federal Reference Method) or FEM (Federal Equivalent Method)
- Certified Flow Transfer Standard for Flow Calibration

Following established EPA methods and procedures, all calibration transfer standards (i.e. temperature, pressure and flow) must be certified against traceable standards at least once per year. Calibration of these transfer standards will be conducted by the transfer standard manufacturer.

- Certified Standards for Pressure and Temperature (Optional)
- Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance must be positioned on a vibration-damping balance support table.
- Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class 1 category with a tolerance of 0.025 mg.

-
- Non-serrated forceps for handling filters.
 - Non-metallic, non-serrated forceps for handling weights.
 - Digital timer/stopwatch.
 - 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene support ring or filters as recommended by FRM / FEM sampler manufacturer.
 - Filter support cassettes and covers.
 - Filter equilibration racks.
 - Relative Humidity / Temperature recorder.
 - NIST-certified or ISO traceable Hygrometer for calibration of relative humidity readings.
 - NIST-certified ISO traceable Thermometer for calibration of temperature readings.
 - Light box.
 - Radioactive (alpha particle) Polonium-210 ("Static Master") antistatic strips for static charge neutralization however static charge gives low-moderate interference in stability of reading of balance.
 - Antistatic, nitrate-free, phosphate-free, sulphate-free, and powder free vinyl gloves.
 - Plastic petri-slide filters containers (Filter Cassette).

- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Filter equilibration cabinets.
- Impactor oil/grease

Sampling and Analytical Procedure

Calibration and performance check of Sampler

External Leak Check:

Upon initial installation of the sampler, following sampler repair or maintenance and at least monthly, perform a sampler external leak check according to the manufacturer's guidelines.

Internal Leak Check:

Upon initial installation of the sampler, following sampler repair or maintenance, and at least monthly, perform a sampler internal leak check according to the manufacturer's guidelines

Single-point Ambient Temperature and Filter Temperature Verification Check:

A single-point temperature verification check of both the ambient temperature and filter temperature sensors must be performed at least once every month. The Temperature check is performed following manufacturer's guidelines

Ambient Temperature Calibration:

The ambient temperature calibration is to be performed upon initial installation, yearly after site installation after any major maintenance that might affect the temperature reading, and at any time thereafter when the sampler fails a verification check following manufacturer's guidelines.

Filter Temperature Calibration

The filter temperature calibration is to be performed upon initial installation, yearly after site installation, and at any time thereafter when the sampler fails either a single-point or multi-point temperature verification check. To perform the temperature calibrations of filter follow the manufacturer's instructions.

Pressure Verification Check

Single-point pressure verification must be performed at least once every month. The pressure check is performed following manufacturer's instructions.

Pressure Calibration

The pressure calibration is to be performed upon initial installation, yearly after site installation, and at any time thereafter when the

sampler fails a single-point pressure verification check. Pressure calibration shall be performed following manufacturer's instructions.

Single-point Flow Verification Check

A single-point flow verification check must be performed at least every month. The flow check is performed following manufacturer's instructions.

Multi-Point Flow Calibration Procedure

A multi-point flow calibration must be performed upon initial installation and once per year thereafter. In addition, the multi-point calibration must be performed whenever a single-point flow verification check indicates that the sampler flow deviates from the flow transfer standard by more than $\pm 4\%$. The multi-point calibration is performed following manufacturer's instructions.

Selection and Procurement of Filters

The quality of filter papers to be used should technically meet the desired specifications. It is preferable to prepare the estimate for whole requirement and order the same in bulk with a request to supply the same batch/lot of filters to control analytical quality and blank values. During the selection of filters following points should be considered:

- Mechanical stability;
- Chemical stability;
- Particle or gas sampling efficiency;
- Flow resistance;
- Loading capacity;
- Blank values;
- Artefact formation;
- Compatibility with analysis method; and
- Cost and availability.

47 mm (diameter) Teflon (PTFE) filter paper with Polypropylene support ring manufactured by M/s Whatman or M/s Pall Life Sciences or equivalent having 2 μm pore sizes. The filter papers should have very low background concentrations for ion and elements.

Filter Inspection and Conditioning of Filter Papers

Filter papers selected for different analytical objectives should be conditioned by following steps:

- Inspect all the filter papers for holes or cracks. Reject, if any deformity is found.

- Note down the batch/lot in log sheet.
- Label all the filters following a general lab coding technique, which should be unique to represent a sample.
- Put the marked filters in petri dishes.
- Use always proper (blunt) tweezers/forceps (made of non-reactive material) to handle the filter papers in lab and field as well.
- Prepare a sample-tracking sheet for each filter paper or a batch of filterpaper.

Filter Inspection and Stability

To equilibrate, the filters are transferred from their sealed manufacturer's packaging to a filter-handling container such as a plastic petri-slide. The filters are handled with non-serrated forceps. Lab personnel must wear vinyl gloves as secondary when filters are being prepared for conditioning and weighing. Before any filter is placed in a filter-handling container, it must be inspected for defects. This is done by an examination of the filter on a "light table". A filter must be discarded if any defects are identified. Specific defects to look for are:

- Pinhole – A small hole appearing as a distinct and obvious bright point of light when examined over a light table.
- Separation of ring – Any separation or lack of seal between the filter and the filter support ring.
- Chaff or flashing – Any extra material on the reinforcing ring or on the heat-seal area that would prevent an airtight seal during sampling.
- Loose materials – Any extra loose materials or dirt particles on the filter.
- Discoloration – Any obvious discoloration that might be evidence of contamination.
- Other – A filter with any imperfection not described above, such as irregular surfaces or other results of poor workmanship.

Filter Conditioning

A one-month storage period in a controlled environment, followed by one week equilibration in the weighing environment, found acceptable deviations in reweighing. Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as

described in SOPs. To minimize particle volatilization and aerosol liquid water bias, PM_{2.5} reference methods require that filters be equilibrated for 24 hours at a constant (within $\pm 5\%$) relative humidity 45 % and at a constant (within $\pm 2^\circ\text{C}$) temperature between 25°C . These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Lot Blanks Check

Randomly select three filters as lot blanks from each new lot received and place in individual containers. Equilibrate the exposed filters in a filter equilibration cabinet in the Balance Room that allows air circulation, but still reduces extraneous airborne particles from settling on filters. Weigh lot blanks every 24 hours on a designated balance.

Record the lot number, filter number, mass, and dates of the lot blanks in the assigned quality control logbook. Once the mass difference between weighing is less than 0.015 mg for all three lot blanks, the filters have stabilized. Note the time taken from initial exposure of the filters to attainment of mass stability. This information is designated as the minimum equilibration period required before filters from the same lot can be pre-weighed and used for routine sampling. Once this minimum equilibration period is determined, the lot blanks become lab blanks which are set aside for long-term exposure in the same equilibration cabinet where routine samples, field blanks, and trip blanks are equilibrated prior to pre- or post-weighing.

Laboratory Conditions for Weighing

Gravimetric analysis of the filters needs to be performed with a microbalance. The sensitivity and reliability of the electro-balance is about + 0.001 mg or 1 μg . Though tolerances on re-weights of Teflon-membrane filters are typically ± 0.010 mg, these sensitive balances require isolation from vibration and air currents. Balances placed in laminar flow hoods with filtered air minimize contamination of filters from particles and gases in laboratory air. Electrostatic effects contribute another main interference in gravimetric analysis of filters. It is established that residual charge on a filter could produce an electrostatic discharge between the filter on the pan and the metal

casing of the electro balance, which induces non-gravimetric forces. This charge can be removed from most filter media by exposing the filter to a low-level radioactive source (500 Pico curies of polonium210) prior to and during sample weighing.

Electro Balance Controls and Calibration

Gravimetric mass analysis is performed using single pan electronic balance. If possible, polonium strip ionization units are used to reduce electrostatic effects in the weighing cavity and on individual filters. A segregated laboratory area is used to control human traffic and to stabilize the temperature and relative humidity of the weighing environment. The area is cleaned with a high efficiency vacuum cleaner, and a tacky floor covering is installed at the entrance to the sample handling room to minimize dust artifact. Gravimetric analysis of filters currently uses the difference method to determine the mass of the collected aerosol. The pre weight of each filter is measured prior to being sent into the field for sampling. Once exposed and returned to the sample handling room, the filter is removed petri dishes and the post weight of the filter is measured after conditioning. The mass of the aerosol is determined by calculating the difference between the pre and post weights.

Cleaning and Maintenance of the Sample Handling Room

The requirements for a sample handling room include a reduced dust environment, and, over the twenty-four hour period prior to analysis of exposed filters, temperature in the range of 25° C with variation less than $\pm 3^{\circ}$ C, and relative humidity 45% \pm 5%. Every last working day, the sample handling room should be thoroughly cleaned, after insuring that all filters have been protected against contamination. To reduce fugitive dust levels, all surfaces are cleaned with a high efficiency vacuum. The floors are cleaned with a mild cleaning solution, if necessary. Finally, all work surfaces are cleaned with reagent grade alcohol (or another reagent grade solvent, if necessary) and Kimwipes™. This procedure reduces the possibility of contamination if a filter falls to the work surface. Following the Friday cleaning, no analysis shall occur for at least twenty-four hours to reduce the potential for contamination of filters by compounds used in the cleaning process.

Calibration and Maintenance of balance

The balance is cleaned and calibrated every day for ranges at the start of operation. It is also recalibrated if the balance fails a "zero" test that is performed periodically. A calibration log database is maintained for each balance. Significant events concerning the balance and any balance maintenance other than routine procedures are recorded in the log of the lab manager.

Cleaning

Regular cleaning should be performed as following:

- Clean the metal and plastic forceps with ethanol and a Kimwipe™.
- Clean the work surface around the balance with ethanol and a Kimwipe™.
- Clean the top surface and the strips of the anti static ionizing units by gently rubbing with a Kimwipe™ wetted with ethanol. Do not neglect to clean the ionizing unit in the electro balance.
- Replace the clean ionizing unit in the center back of the balance cavity, and close the door on the weighing chamber (if polonium strip is used).

Thorough Calibration of Balance (Once in 6 Months)

-
- o Allow the balance to stabilize with no weights on the pan. The computer will automatically record the mass to the screen when the balance has stabilized; this is the "zero" mass. It should be within 0.010 mg of 0.000. If not, contact the lab manager (see step 3, section 4.3.2.1 for lab manager procedures).
 - o Set the zero on the balance by pressing the tare button on the balance. This forces the "zero" mass to be exactly 0.000.
 - o Calibrate the balance. Momentarily ground yourself by touching the balance casing. Use nylon forceps to remove the certified calibration weight from its container. Gently place it in the center and allow the mass reading to stabilize and stop decreasing. Take readings.
 - o Use a 200.000 mg or suitable mass of graded Calibration weight.
 - o Use a 20.000 mg or suitable mass graded Calibration weight.
 - o Remove the calibration weight from the bail, using the nylon forceps, and replace it in its storage container.
 - o Check the calibration of the balance using the test weight.

Momentarily ground yourself by touching the balance casing. Use the nylon forceps to remove the test weight from its container.

- o Place the test weight in the center of the balance pan and allow the mass reading to stabilize and stop decreasing. The computer will record a reading to the screen when the balance has stabilized. The test weight is an old 50.000 gm calibration weight.
 - o Allow the balance to return to "zero." Compare the zero value and the value determined for the 50.000 mg mass to the expected values posted on the balance. If they exceed 02 micrograms, repeat the procedure. If variations greater than 10 micrograms are observed, report to the laboratory manager so that he/she can take appropriate action (section 4.3.2.1 step 3).
 - o On a random basis, but at least semiannually, the laboratory supervisor shall request a comparison of the normal calibration standards with a master set of reference standard masses maintained by the laboratory supervisor. After calibration, measure these 200.000, 50.000, and 20.000 mg standards and report their masses to the supervisor. The results are used to verify the integrity of the electro balance and the standard masses used in daily calibrations.
 - o The electro balance is available to run controls or for routine determination of mass.
 - o Linearity checks (Once in a year otherwise after every repair/shifting of balance). To run a linearity check on the balance (if the balance is suspected to be damaged), utilize the series of four standard weights stored in the lab manager's desk. The four weights, 200 mg, 100 mg, 50 mg, and 20 mg, must be weighed and a regression line developed. Take following steps for performing Linearity checks:
 - o Use the nylon forceps to remove a weight from its container and place it on the weighing pan.
-
- o Wait until the balance has stabilized (approximately one minute). Then, record the displayed weight as the 'y' value and the certified mass as the 'x' value.
 - o Remove the weight from the pan, using the plastic forceps, and replace it in its protective container.

- o Repeat steps (i) through (iii) for the other three weights.
- o Linearly regress the 'y' value versus the 'x' value. Calculate the r² value.
- o If the R² is not better than 0.995, the balance requires maintenance.

Stability Check of Balance (Once in Month)

To check the stability of the balance, reweigh the last 20 archived control filters, and develop a regression line comparing the re-weight values to the original values. Use following steps:

- Reweigh the series of 20 old controls filters on the suspect balance.
- Plot the re-weights versus the original weights.
- Derive the best line fit equation correlating the original weights to the re- weights.
- Calculate the standard deviation and the r² of the line fit.
- If the standard deviation is greater than ±3 micrograms, and the r² is not better than 0.995, the balance should be carefully inspected and submitted for maintenance.

Daily Calibration of Balance

Internal Calibration should be performed daily before any Pre- or Post-sampling weighing.

Internal Calibration

Open the draft shield door for at least one minute to allow the balance-weighing chamber to equilibrate to room temperature, then, close the draft shield door. Press the "TARE" key when readout has stabilized to ensure zero-readout. The liquid crystal display (LCD) should display "0.000 mg". Press the key for ensuring the internal calibration.

External Calibration

Open the draft shield door. Place a 100 mg working reference standard calibration weight onto the microbalance pan with non-metallic forceps. Close the draft shield door. Record the date, temperature and relative humidity of the balance room, and mass readout in the quality control logbook assigned to the microbalance. Remove the calibration weight and tare the microbalance as described above. Enter the calibration data into logbook records and assign to the calibration session in the quality control logbook assigned to the microbalance. External calibration must be performed for each day on which filters are pre-weighed and/or post- weighed.

Weighing of Filters

- o Take out pre-conditioned filters by forceps one by one and weigh properly. Record the mass in data sheet and log books against respective filter numbers or code. Always use gloved hands and blunt tweezers to handle filters.
- o Replace and close the filter container (Petri dishes). Weigh one Control Filters (Archived one) with each batch of ten weighing. Keep separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- o Put the values of all control measurement in Quality Control Charts against dates.
- o Put Lab code on from Plastic petri-slide filter containers (Filter Cassette).
- o Take out conditioned filter from Plastic petri-slide filter containers (Filter Cassette).
 - Weigh the preconditioned filter.
- o Record and store it in laboratory coded filter cassette.
- o Follow the same procedure for exposed filter
- o Place the weighed filter into a petri-slide, close tightly, and store at 4°C for at least one year after sampling.

Shipment of Pre-weighed filters

Put the marked pre-weighed filters in Zip pouch. Transport the filters in a dry clean box (temperature control is optional) to the field.

Field sampling

- On the Field Data Log, fill in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.
 - Perform all necessary pre-sampling procedures as described above.
 - Perform QA/QC checks or maintenance, if required.
 - Record all maintenance activities in the field log book; include time, date, and any concerns that might affect the quality of the sample.
 - Remove the filter to be installed from its protective filter cassette carrier.
 - Fix the filter following manufacturer's instructions into place against the bottom of the WINS impactor.
 - Check the system clock and make sure it is within 1 min of NIST time.
-
- Strictly follow operator's manual for setting up the sampling programme (24 hours)
 - The Filter Setup Screen shows the start date and time and the end date

and time for the next sample. To change the sampling parameters follow the operator's manual

- Start Sampling run
- Wait until the auto diagnosis for all relevant parameters finishes and the sampler automatically switch over to SAMPLING mode. Check flow (16.7LPM) and Sample volume displays rightly on screen.

Recovering the Sample and Data from a Completed Sample Run

- From the Main Screen, note the current sampler-operating mode (top line, right side of display). If the sampler is in the WAIT mode or the SAMP (sampling) mode, the sampler has not completed the previously scheduled sampling run. Do not disturb the sampler unless necessary.
- If the sampler is in the DONE mode or the ERR mode, press STOP. This allows the sampler to write the final information into storage for the current sample run and must be performed prior to filter exchange. The sampler mode should now indicate STOP.
- Open the filter exchange mechanism by pulling straight back on the black handle. The filter holder will lower away from the WINS impactor.
- Remove the filter carrier from the filter holder.
- Place the filter carrier in the filter cassette case.
- From the Main Screen, access to the Filter Data screen following operator's instruction.
- Using the information displayed on the Filter Data screen, complete the Field Data Log with the following information from the completed sample run:
 - a) Total Sample Volume – from the Vol. field
 - b) Average Flow Rate – from the Ave. Flow field
 - c) Coefficient of Variation – from the %CV field
 - d) Total Run Time – from the Tot field
 - e) Maximum Temperature Difference – from the Temp Diff field
 - f) Minimum, Average and Maximum Ambient Temperatures – from the AmbT fields
 - g) Minimum, Average and Maximum Filter Temperatures – from the FltT fields
 - h) Minimum, Average and Maximum Pressures – from the Pres fields
 - i) If the sampler indicated there was an error, note the error in the field

log book and make any repairs as needed. Any fixes should be done prior to the next run date.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$$M_{2.5} = (M_f - M_i) \text{ mg} \times 10^3$$

μg Where,

$M_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

M_f = final mass of the conditioned filter after sample collection (mg)
 M_i = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (μg)

- Field records of PM_{2.5} samplers are required to provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$$V = Q_{\text{avg}} \times t \times 10^{-3}$$

m^3 Where,

V = total sample value (m^3)

Q_{avg} = average flow rate over the entire duration of the sampling period (L/min)

t = duration of sampling period (min)

10^3 = unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine PM_{2.5} mass concentration:

$$\text{PM}_{2.5} = M_{2.5} / V$$

Where,

$\text{PM}_{2.5}$ = mass concentration of PM_{2.5} particulates ($\mu\text{g}/\text{m}^3$)

$M_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

V = total volume of air sampled (m^3)

9.0 Reporting

Data reporting should be done in prescribed Format. The Format shall contain all information including calibration. The data sheet must be accompanied by Sample Tracking sheet.

10.0 References

- 1.0 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM_{2.5} and Ambient Air Quality Surveillance for Particulate Matter; Final Rule
- 2.0 CARB SOP MLD 055
- 3.0 Aerosol Science & Technology: The PM 2.5 Federal Reference Method (FRM)." 35(4):339-342
- 4.0 Federal Register/Vol. 72, No. 112/Tuesday, June 12, 2007/Rules and Regulations

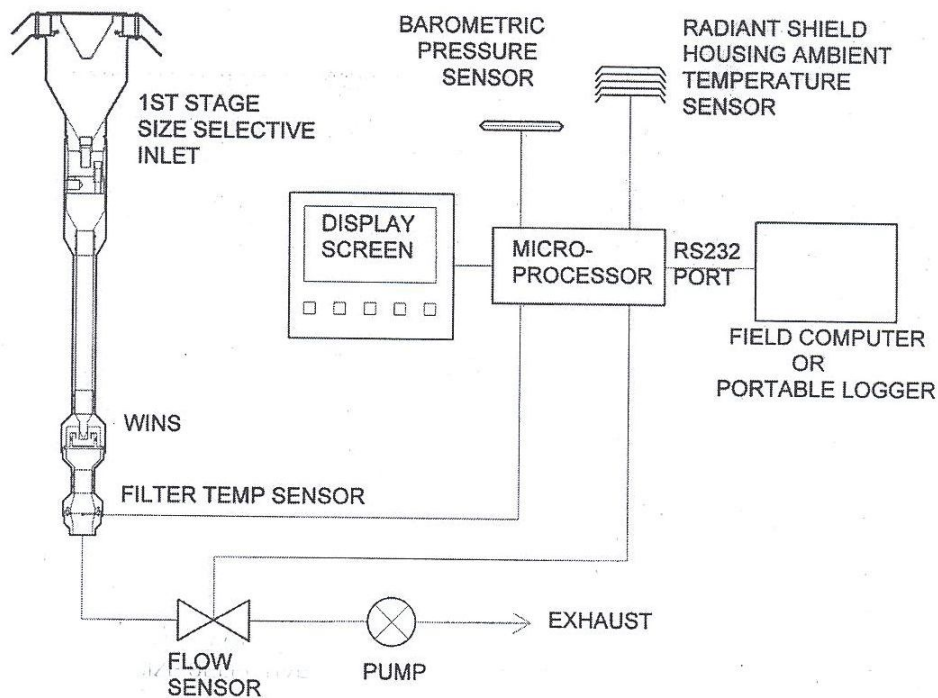


Figure 1. Schematic diagram of a single-channel PM_{2.5} FRM sampler.

- 5.0 PM_{2.5} Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

FLOW CHART FOR MEASUREMENT OF PM _{2.5}
Check the filter for any physical damages <input type="checkbox"/>
Mark identification number on the filter <input type="checkbox"/>
Condition the filter in conditioning room / desiccator for 24 hours <input type="checkbox"/>
Record initial weight <input type="checkbox"/>
Place the filter on the sampler <input type="checkbox"/>
Run the sampler for eight hours <input type="checkbox"/>
Record the flow rate on hourly basis <input type="checkbox"/>
Remove the filter from the sampler <input type="checkbox"/>
Keep the exposed filter in a proper container <input type="checkbox"/>
Record the total time of sampling & average flow rate <input type="checkbox"/>
Again condition the filter in conditioning room / desiccator for 24 hours <input type="checkbox"/>
Record final weight <input type="checkbox"/>
Calculate the concentration of PM _{2.5} in $\mu\text{g}/\text{m}^3$

Guidelines for sampling and analysis protocol for ozone in ambient air (Chemical Method)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring of ozone in ambient air.

2. Standard

The national ambient air quality standards for ozone is presented in the table

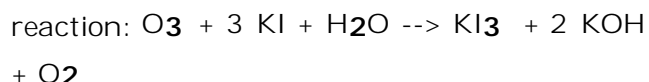
Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O ₃), µg/m ³	8 Hours *	100	100
	1 Hour **	180	180
<p>* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.</p> <p>** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.</p>			

3. Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere)

Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 ± 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following



4. Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

- Analytical balance:
- Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

-
- Calibrated flow measuring device to control the air flow from 1 to 2 l/min.
 - Absorber: All glass midget impinger
 - Spectrophotometer: Capable of measuring absorbance at 352 nm.
 - Glass wares: low actinic glassware must be used for analysis

5. Reagents / Chemicals

All the chemicals should meet specifications of ACS Analytical Reagent grade

- Distilled water
- Absorbing Solution (1% KI in 0.1 M Phosphate Buffer) - Dissolve 13.6 g of potassium dihydrogen phosphate (KH_2PO_4), 14.2 g of disodium hydrogen phosphate (Na_2HPO_4) or 35.8 g of the dodecahydrate salt ($\text{Na}_2\text{HPO}_4 \cdot 12 \text{H}_2\text{O}$), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Keep at room temperature for at least 1 day before use. Measure pH and adjust to 6.8 ± 0.2 with NaOH or KH_2PO_4 . This solution can be stored for several months in a glass stoppered brown bottle at room temperature without deterioration. It should not be exposed to direct sunlight.
- Stock Solution 0.025 M I_2 (0.05N) - Dissolve 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and dilute the mixture to exactly 500 ml with water. Keep at room temperature at least 1 day before use. Standardize shortly before use, against 0.025 M $\text{Na}_2\text{S}_2\text{O}_3$. The sodium thiosulfate is standardized against primary standard bi-iodate [$\text{KH}(\text{IO}_3)_2$] or potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$).
- *M I₂ Solution* - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml low actinic volumetric flask and dilute to the mark with absorbing solution. Protect from strong light. Discard after use.

6. Sampling

Place 10 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Do not expose the absorbing reagent to direct sunlight. After sampling measure the volume of sample and transfer to a sample storage bottle.

7. Analysis

If, appreciable evaporation of the absorbing solution occurs during sampling, add water to bring the liquid volume to 10 ml.

Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water.

Measure the absorbance of the unexposed reagent and subtract the value from the absorbance of the sample.

8. Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration purposes exactly 5.11 ml of the 0.001 M I₂ solution (or equivalent volume for other molarity) is diluted with absorbing solution just before use to 100 ml (final volume) to make the final concentration equivalent to 1 µl of O₃/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25°C. Discard this solution after use.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 10.0 ml of solution. Prepare by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Bring each to the calibration mark with absorbing reagent.

Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

9. Calculation

$$C (\text{O}_3 \text{ } \mu\text{g}/\text{m}^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

$C \text{ NH}_3$ = Concentration of Ammonia in

$\mu\text{g}/\text{m}^3$ A_s = Absorbance of sample

A_b = Absorbance of reagent

blank CF = Calibration factor

V_a = Volume of air sampled in

m^3 1.962 = Conversion factor, μl to

μg

10. Quality Control

Quality Control (QC) is the techniques that are used to fulfil requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

11. Reference

Method 411, Air Sampling and Analysis, 3rd Edition
(Determination of oxidizing substances in the atmosphere)

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place 10 ml of absorbing media in an impinger <input type="checkbox"/>
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS). <input type="checkbox"/>
Draw air at a sampling rate of 1 lpm for 60 minutes <input type="checkbox"/>
Do not expose the absorbing reagent to direct sunlight <input type="checkbox"/>
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml. <input type="checkbox"/>

Prepare calibration graph as recommended in method <input type="checkbox"/>
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water <input type="checkbox"/>
Calculate concentration using calibration graph <input type="checkbox"/>
Calculate concentration of Ozone in $\mu\text{g}/\text{m}^3$

Guidelines for sampling and analysis protocol for ammonia in ambient air (Indophenol Blue Method)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring of ammonia in ambient air.

2. Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH ₃), µg/m ³	Annual *	100	100
	24 Hours **	400	400
<p>* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.</p> <p>** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.</p>			

3. Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) Ammonia in the atmosphere is collected by bubbling a measured volume of air through a dilute solution of sulphuric acid to form ammonium sulphate. The ammonium sulphate formed in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

4. Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

- Analytical balance
- Vacuum pump to maintain a flow rate up to 5 litre per minute
- Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

- Absorber: a midjet impinger or a fritted bubbler
- Spectrophotometer capable of measuring absorbance at 630 nm.
- Glass ware: low actinic glass wares must be used for analysis

5. Reagents / Chemicals

All the chemicals should meet specifications of ACS Analytical Reagent grade

- Distilled water
- N Sulphuric Acid (Absorbing solution)
- Sodium Nitroprusside
- 6.75 M sodium hydroxide
- Sodium hypochlorite solution
- Phenol solution 45% v/v
- Sodium phosphate
- Ammonium chloride or Ammonium Sulfate
- Hydrochloric acid
- Ammonia stock solution (1 mg NH₃/ml)
- Ammonia working solution (10 µg NH₃/ml) (Prepare fresh daily)

6. Sampling

Place 10 ml of absorbing solution in an impinger and sample for one hour at the flow rate of 1 to 2 L/min. After sampling measure the volume of sample and transfer to a sample storage bottle.

7. Analysis

Transfer contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintain all the solutions and sample at 25 °C. Add 2 ml buffer. Add 5 ml of working phenol solution, mix, and fill to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mix. Dilute to 25 ml, mix and store in the dark for 30 minutes to develop colour. Measure the absorbance of the solution at 630 nm on a spectrophotometer using 1 cm cells. Prepare a reagent blank and field blank and measure the absorbance as done in the analysis of samples.

8. Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Fill to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents

to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

9. Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

10. Calculation

$$C (\text{NH}_3 \mu\text{g}/\text{m}^3) = (A_s - A_b) \times \text{CF}$$

/ V_a Where,

$C \text{ NH}_3$ = Concentration of Ammonia in

$\mu\text{g}/\text{m}^3$ A_s = Absorbance of sample

A_b = Absorbance of reagent

blank CF = Calibration factor

V_a = Volume of air sampled in m^3

11. Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

12. Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water Wash the glassware with the water and finally rinse it thrice with distilled water <input type="checkbox"/>
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx <input type="checkbox"/>

<p>Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter & holder, flowmeter, impinger and pump Sample at the rate of 1L/min for 1hour duration</p> <p style="text-align: center;">□</p>
<p>Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis</p> <p style="text-align: center;">□</p>
<p>Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution</p> <p style="text-align: center;">□</p>
<p>Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain pH) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer</p> <p style="text-align: center;">□</p>
<p>Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H₂SO₄). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Plot the calibration curve</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Calculate the concentration of NH₃ in µg/m³</p>

Guidelines for sampling and Analysis of Benzo(a)Pyrene & other PAHs in Ambient Air (Solvent Extraction & GC Analysis)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring of Benzo (a) Pyrene (BaP) in ambient air.

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is $C_{20}H_{12}$ having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

2. Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)

Benzo(a)pyrene	Annual	01	01
<p>* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.</p> <p>** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.</p>			

3. Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m³/min) sampling method capable of detecting sub.ng/m³ concentration of PAH in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m³ sampling volume of air).

Equipment/Instruments

PM10 high volume sampler, Whatman Glass fibre (EPM-2000) or Equivalent Filter Paper, Ultra Sonicator (~40kHz frequency), Rotary Evaporator (Buchi type), Gas Chromatograph with Flame Ionization Detector fitted with Capillary Column (H.P.

/ Agilent Ultra 2 or equivalent, length 25 meter x 0.320mm, 0.17µm or more), Syringes (5 & 10 micro litre capacity), Variable volume micropipettes (0.5 & 1.0 ml capacity), Beakers (250 ml), Amber colour Vials 3ml and 5ml capacity, Chromatographic column (200-250 mm*10mm with Teflon stopcock).

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P, other PAHs, Triphenyl benzene (internal standard, ultra residue grade) solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

4. Sampling

Instrument/Filter Selection

24 hr. sampling using PM10 high volume sampler with 8 hourly samples using EPM- 2000 glass fibre or equivalent filter.

Sampling Frequency

Sampling is done twice a week, total of 104 days monitoring in a year. Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000 or equivalent) using PM10 sampler at a flow rate of more than 1m³/min per minute, at selected location(s).

Sampling Height

Sampling height may be between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25°C) in an envelope marked with necessary identification information if processed immediately, otherwise wrap the filters in Aluminium foil & kept it in refrigerator at 4°C in dark to avoid photo oxidation of PAHs.

Sample Processing

a. Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips using scissors and transfer to 250 ml beaker. Add ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeat the procedure twice (50ml x 2 times) for complete extraction. Alternatively, sample can be extracted using soxhlet extraction apparatus for about 8 hr. with Toluene and repeat it twice. Sample processing steps are shown in Figure – 1.

b. Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture)

c. Concentration:

After filtration, the filtrate is concentrated using Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Figure – 1: Sample Processing

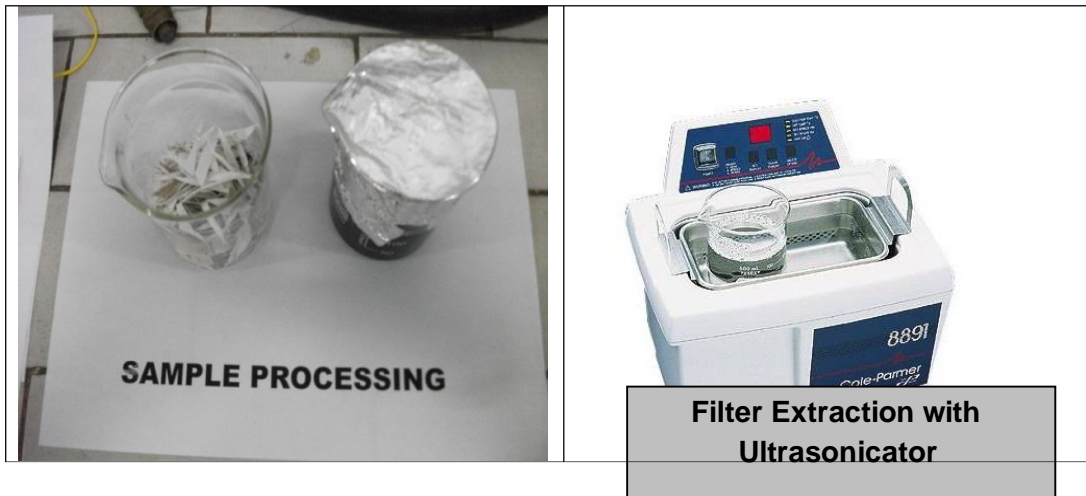


Figure – 2: Rotary Evaporator for Sample Concentration



d. Clean-up with silica Gel:

To clean up the impurities, pass 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning add 5ml cyclohexane and collect the elute in 25 ml beaker. Repeat the process for at least 3 times and collect it in the same beaker. Alternatively Solid Phase Extraction (SPE) may be used for clean up the impurities of sample.

e. Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

f. Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

g. Extracted Sample Storage:

Cover/Cap the sample vials /tubes and mark with necessary identification. Keep it in refrigerator at 4°C prior to the analysis as in Figure -3

Figure -3: Ready to Inject B(a)P Samples



4. Analysis/ Instrument Set-Up

GC Conditions:

Injector: 300°C

FID Temp: 320°C

Column: Ultra -2 (25m Length, 320µm diameter, 0.17µ) or equivalent
Oven: 120°C → 2 min hold → 7°C/min → 300°C → 10 min hold

Run Time: 37.71 minutes

Carrier gas flow (N₂): 0.50 ml/min

Gases for FID Flame:

H₂ flow: 40 ml/min

Zero grade air flow: 400 ml/min

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l (or 1000ng/µl) in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) in triplicate and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-FID and plot the area of analyte viz. PAH Compound [i.e.B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various PAHs compounds are obtained under the above GC conditions.

Sample injection

Take 2µl of sample from the amber vial using standard gas tight syringe and inject in the Capillary GC-FID instrument for analysis. Record the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards are to be injected in GC/FID instrument with every batch of samples. As a control Internal Standard of 10 ng/µl conc. is added to each sample prior to the analysis in case of internal calibration is used.

5. Calculations

Calculate the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculate the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q =Average flow rate of sampling

m³/min T = sampling time, in min.

V = total sample volume at ambient conditions in

m³ Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng/m^3 in the air sampled is given by:

$$C (\text{ng}/\text{m}^3) = C_s * V_e / V_i * V_s$$

Where,

C_s : Concentration of Benzo (a) pyrene in $\text{ng}/\mu\text{l}$ in the sample extract recorded by GC.

V_e : Final volume of extract in μl (i.e

1000) V_i : Injection Volume (i.e 1 μl)

V_s : Volume of air sample in m^3

6. Quality Control

For recovery efficiency isotopically labelled B(a)P or other PAH surrogate standards are added to the samples prior to extraction & analysis. The recoveries should fall between 75- 125 % preferably.

A 10 $\text{ng}/\mu\text{l}$ concentration B(a)P or other PAH standards are to be injected in GC/FID instrument with every batch of samples or daily as a control. If substantial variation is found in observed concentration, instrument should be recalibrated.

Internal Standard of 10 $\text{ng}/\mu\text{l}$ conc. is added to each sample prior to the analysis in case of internal calibration is used.

7. Detection Limit

The minimum detectable concentration in terms of B(a)P for a sampling period of 8hour (with about 480 m^3 of air passed) will be 1 ng/m^3 assuming 1.0 ml as the final volume of sample extract after clean-up and detectable concentration of 1 $\text{ng}/\mu\text{l}$ of that sample extract. High resolution capillary mass spectrometry or high pressure liquid chromatography can improve sensitivity down to 1 ng/m^3 .

8. References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper □
Ultrasonic extraction with Toluene (50 ml □ 3 times) □

Filter & dry with Anhydrous Sodium Sulphate □	
Concentration with Rotary Evaporator □	
Clean up with Silica Gel Column Chromatography □	
Elution with Cyclo-Hexane (5 ml □ 3 times) □	
Evaporate to nearly dryness under Nitrogen □	
Re-dissolved in 0.5 to 1.0 ml Toluene □	Re-dissolved in 2.5 ml Methanol □
Capillary GC-FID or GC-MS	HPLC/UV-Fluorescence Detector

Guidelines for sampling and analysis of Lead, Nickel and Arsenic in ambient air (Atomic Absorption Spectrophotometer Method)

1. Purpose

The purpose of this protocol is to provide guidelines for monitoring of lead, nickel and arsenic in ambient air.

2. Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb) , $\mu\text{g}/\text{m}^3$	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic(As), ng/m^3	Annual *	06	06
<p>* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.</p> <p>** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.</p>			

3. Principle of the method

The Atomic Absorption Spectroscopy (AAS) technique makes use of absorption spectrometry to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by atomic absorption spectrophotometer.

4. Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead and nickel in ambient air:

- PM10 sampler (high volume design based)
- Hot plate
- Microwave Digestive System
- Analytical balance

Digestion chamber

- Polyethylene or polypropylene bottle
- Glasswares
- Top loading orifice kit
- FAAS (Flame Atomic Absorption Spectrophotometer) or GFAAS (Graphite Furnace Atomic Absorption Spectrophotometer)

5. Reagents / Chemicals

- Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)
- Hydrochloric Acid (HCl) Concentrated (AR grade)
- Nitric Acid (HNO₃) Concentrated (AR grade)
- Sulphuric Acid (H₂SO₄) Concentrated (AR grade)
- Metal Standard Solutions (Certified standard)
- Sodium borohydride (GR/AR grade).
- Potassium iodide (GR/AR grade)
- Distilled / De-ionized

6. Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the face-plate wing-nuts and remove the face plate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. For automatically flow-controlled units, record the designated flow rate on the data sheet. Record the reading of the elapsed time meter. The specified length of sampling is commonly 8 hours or 24 hours. During this period, several reading (hourly) of flow rate should be taken.

After the required time of sampling, record the flow meter reading and take out the filter media from the sampler and put in a container or envelope.

Sample storage

After collecting samples, transport the filters to the laboratory, taking care to minimize contamination and loss of the sample. Glass fibre filters should be transported or shipped in a shipping envelope. Store these protective envelopes up to 30°C until analysis. The maximum sample holding times is usually 180 days. Analyze the samples within 180 days.

7. Analysis

Extraction of Samples

The collected sample on glass fibre filters may be extracted by either hot plate procedure or by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1" x 8" strip or half the filter from the 8"x10" filter sample and place on its edge in a labelled centrifuge tube using vinyl gloves or plastic forceps. Using the plastic forceps, crush the filter strip down into the lower portion of the centrifuge tube to ensure acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO₃ and 8% conc. HCl). Place the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Place the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Place the vessels in the microwave carousel. Connect each sample vessel to the overflow vessel using the Teflon connecting tubes. Place the carousel containing the 12 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 23 min.

Allow the pressure to dissipate, then remove the carousel containing the vessels and cool in tap water for 10 min. using the capping station uncap the microwave vessels, remove the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Cap the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filter the extracted fluid with Whatman No. 41 and make up the final volume to 100 ml, the filtered sample is now ready for analysis.

Hot plate procedure

Cut a 1" x 8" strip or half the filter from the 8" x 10" filter using a stainless steel pizza cutter. Place the filter in a beaker using vinyl gloves or plastic forceps.

Cover the filter with the extraction solution (3% HNO₃ & 8% HCl). Place beaker on the hot- plate, contained in a fume hood, and reflux gently while covered with a watch glass for 30 min. Do not allow sample to dry. Remove the beakers from the hot-plate and allow to cool. Rinse the beaker walls and wash with distilled water. Add approximately 10 mL reagent water to the remaining filter material in the beaker and allow to stand for at least 30 min. Transfer the extraction fluid in the beaker to a 100 mL volumetric flask or other graduated vessel. Rinse the beaker and any remaining solid material with distilled water and add the rinses to the flask. Dilute to the mark with distilled water (Type I) water and shake. The final extraction solution concentration is 3 % HNO₃/8% HCl. The filtered sample is now ready for analysis.

Analysis of samples

Instrument / Equipment

A light beam containing the corresponding wavelength of the energy required to raise the atoms of the analyte from the ground state to the excited state is directed through the flame or furnace. This wavelength is observed by a monochromator and a detector that measure the amount of light absorbed by the element, hence the number of atoms in the ground state in the flame or furnace. A hollow cathode lamp for the element being determined provides a source of that metal's particular absorption wavelength.

The method describes both flame atomic absorption (FAA) spectroscopy and graphite furnace atomic absorption (GFAA) spectroscopy. Atomic Absorption Spectrophotometer - analyze the metals by Flame, if results are below detection limit then go for GTA. Arsenic is analyzed by Flame – VGA.

Flame Procedure

Set the atomic absorption spectrophotometer for the standard condition as follows: choose the correct hollow cathode lamp, align the instrument, position the monochromator at the value recommended by the manufacturer, select the proper monochromator slit width, set the light source current, ignite the flame, regulate the flow of fuel and oxidant, adjust the burner for maximum absorption and stability and balance the meter. Run a series of standards of the metal of interest and construct a calibration curve. Aspirate the blanks and samples. Dilute samples that exceed the calibration range. For Lead (Pb) and Nickel (Ni), the wavelength required for analysis is 217nm and 232nm

respectively. Where as in case of Arsenic (As), the VGA should attach with Flame and the wavelength required for analysis is 193.7nm.

Furnace Procedure

As a general rule, samples that can be analyzed by flame or furnace may be more conveniently run with flame since flame atomic absorption is faster, simpler and has fewer interference problems. Tube life depends on sample matrix and atomization temperature. A conservative estimate of tube life is about 50 firings. Read the metal value in $\mu\text{g/L}$ from the calibration curve or directly from the read-out of the instrument.

8. Calibration

Prepare standard solutions from the stock solutions. Select at least three standards to cover linear range as recommended by method. Aspirate the standards into the flame or inject the standards into the furnace and record the absorbance. Prepare the calibration graph by plotting absorbance and concentration in $\mu\text{g/ml}$.

Preparation of Standards

For each metal that is to be determined, standards of known concentration must be acquired commercially certified standards.

Standard Curve

Standard curve is prepared by using standard solutions of known concentration.

9. Quality Control

To produce good quality data, perform quality control checks and independent audits of the measurement process; document their data and use materials, instruments and measurement procedures that can be traced to an appropriate standard of reference. Shewart's analytical quality control chart should be maintained for good quality data. Detection limit and working range for each metal should be followed of the working instrument.

Precision

Analyze the pretreated sub-samples. Calculate the standard deviation (S) and coefficient of variation (CV) where $CV = S.100/\text{mean value}$. If the CV is greater than 10%, check the whole procedure for possible errors and/or contamination. The precision of the method is normally better than $\pm 5\%$ at the 95% confidence level.

Accuracy

Analyze the pretreated Certified Reference Material (CRM) or internal reference material. Calculate the mean and the standard deviation. If the value given for the CRM is within the interval of mean \pm standard deviation, the method has the required accuracy. If not, check the whole procedure.

10. Calculations**Sample Air Volume**

Sample air volume can be calculated by using the following equation: $V = (Q) (t)$

Where,

V = volume of air, m^3

Q = average sampling rate,
 $m^3/min.$

t = time in minutes.

Metal Concentration

$C = (M_s - M_b) \times V_s \times F_a / V \times F_t$ Where,

C = concentration, $\mu g/m^3$.

M_s = metal concentration $\mu g/mL$

M_b = blank concentration $\mu g/mL$

V_s = total volume of extraction in mL

F_a = total area of exposed filter in cm^2

V = Volume of air sampled in m^3

F_t = Area of filter taken for digestion in cm^2

11. References

- Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler
- Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.
- IS 5182 Part 23 Method of Measurement of Air Pollution :Respirable Suspended Particulate Matter (PM10) cyclonic flow technique
- EPA compendium method IO 3
- EPA compendium method IO 3.1
- EPA compendium method IO 3.2
- Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

FLOW CHART FOR SAMPLE PROCESSING OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR
Collect the particulate matter on glass fibre filter (EPM 2000 or equivalent) using PM10 sampler (High Volume Sampling). <input type="checkbox"/>
Divide the filter paper in two equal parts <input type="checkbox"/>
Half portion of filter paper for the measurement of lead, nickel and arsenic <input type="checkbox"/>
Extract the sample by either hot plate procedure or by microwave extraction <input type="checkbox"/>
Analysis of extracted sample using recommended method

FLOW CHART FOR MEASUREMENT OF LEAD AND NICKEL BY FLAME-ATOMIC ABSORPTION SPECTROPHOTOMETER: Method I (Method IO-3 ,IO-3.2)
Switch on Atomic Absorption Spectrophotometer <input type="checkbox"/>
Select and set the Hollow Cathode Lamp of desired metal and programming the instrument accordingly <input type="checkbox"/>
Adjust and align the instrument as per requirement <input type="checkbox"/>
Switch on Compressor for Air and Open the required gas cylinders (Air - Acetylene for Flame analysis), Ignite the Flame
Calibration with metal standards as recommended in method <input type="checkbox"/>
Prepare calibration graph <input type="checkbox"/>
Analyze the digested samples <input type="checkbox"/>

Calculate the concentration using calibration graph

<p style="text-align: center;">FLOW CHART FOR MEASUREMENT OF LEAD, NICKEL AND ARSENIC BY GRAPHITE TUBE-ATOMIC ABSORPTION SPECTROPHOTOMETER: Method II (Method IO-3,IO-3.2)</p>
<p style="text-align: center;">Switch on Atomic Absorption Spectrophotometer</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Place the furnace, adjust and align the instrument as per requirement of GTA.</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Select and set the Hollow Cathode Lamp of desired metal and programming the instrument accordingly for standards and samples</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Switch on Chiller and keep the Temperature at 20⁰ C. Open the Nitrogen gas</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Clean the Graphite Tube with a firing</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Click the START Button</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Calibration with metal standards as recommended in method</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Prepare calibration graph</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Analyze the digested samples</p> <p style="text-align: center;">□</p>
<p style="text-align: center;">Calculate the concentration using calibration graph</p> <p style="text-align: center;">□</p>
<p>Note: Always follow the instructions of the Instrument/ Operational manual given by the supplier</p>

<p style="text-align: center;">FLOW CHART FOR MEASUREMENT OF ARSENIC BY FLAME- ATOMIC ABSORPTION SPECTROPHOTOMETER USING VAPOUR GENERATION ASSEMBLY (VGA): Method III (Standard Method- American Public Health Association (APHA), 20th Edition, 1998.)</p>
<p style="text-align: center;">Switch on Atomic Absorption Spectrophotometer <input type="checkbox"/></p>
<p style="text-align: center;">Select and set the Hollow Cathode Lamp of Arsenic and programming the instrument accordingly <input type="checkbox"/></p>
<p style="text-align: center;">Adjust and align the instrument as per requirement –VGA <input type="checkbox"/></p>
<p style="text-align: center;">Switch on Compressor for Air and Open the required gas cylinders (Air - Acetylene for Flame analysis and Nitrogen for Hydride Generator) <input type="checkbox"/></p>
<p style="text-align: center;">Ignite the Flame <input type="checkbox"/></p>
<p style="text-align: center;">Check the flow rate of Hydride Generator <input type="checkbox"/></p>
<p style="text-align: center;">Calibration with Arsenic standards as recommended in method <input type="checkbox"/></p>
<p style="text-align: center;">Prepare calibration graph <input type="checkbox"/></p>
<p style="text-align: center;">Analyze the digested samples <input type="checkbox"/></p>
<p style="text-align: center;">Calculate the concentration using calibration graph</p>
<p>Note: Always follow the instructions of the Instrument / Operational manual given by the supplier</p>

DISCLAIMER

The guidelines for the measurement of Ambient Air Pollutants (NAAQS 2009) are based on the reference methods (Viz. Indian Standards, United States Environment Protection Agency and Inter Society Committee) based on field and laboratory experiences.

Efforts have been made to make it user friendly and easily understandable, however comments and suggestions towards its improvement are solicited.

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CENTRAL POLLUTION CONTROL BOARD
FIELD DATA SHEET FOR GASEOUS POLLUTANTS

Station:	Date:			Graph Factor	SO ₂		Graph Factor	NO ₂				
Shift	Ist Shift			IInd Shift			IIIrd Shift					
Monitoring Period	06:00A- 10:00AM	10:00AM- 02:00 PM		02:00PM- 06:00PM		06:00PM- 10:00PM		10:00PM- 02:00AM	02:00AM- 06:00AM			
Parameter	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂
Hourly Flow Rate (Ipm)												
Average Flow Rate (Ipm)												
Total Operation Time (Minutes)												
Initial Volume of Sample (ml)												
Final Volume of Sample (ml)												
Volume Taken For Analysis (ml)												
Total Volume of Air Sampled (lit.)												
Absorbance (Blank)												
Absorbance (Sample)												
Concentration (µg/m³)												
24 Hourly Average SO₂ (µg/m³):					24 Hourly Average NO₂ (µg/m³):							
Remarks:												
Name & Signature of Official on duty												

Analyzed by:	
--------------	--

**CENTRAL POLLUTION CONTROL BOARD
RESULTS DATA SHEET FOR GASEOUS
POLLUTANTS**

Location:

Month:

Year:

TIME (Hrs.)	06-10		10-14		14-18		18-22		22-02		02-06		4 HRS. MAX		24 HRS.AV G		8 HRS. AVG PM ₁₀			24 HRS. AVG		
PARAMETER /DATE	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	SO ₂	NO ₂	06-14	14-22	22-06	PM ₁₀		

Note: All values are expressed in $\mu\text{g}/\text{m}^3$

Weather Condition: Clear/Cloudy/Rainy

Name & Signature of Official on Duty:

Checked by:

CENTRAL POLLUTION CONTROL BOARD
DATA SHEET FOR PARTICULATE MATTER (Size less than 10 μm)
or PM₁₀

Station:	Date:		
Shift			
Monitoring Duration			
Filter Paper No.			
Hourly Flow Rate (m³/minute)			
Average Flow Rate (m³/minute)			
Total Operation Time (Minutes)			
Initial Weight of Filter Paper (gms.)			
Final Weight of Filter Paper (gms.)			
Dust Contents (gms.)			
Total Volume of Air Sampled (m³)			
Concentration ($\mu\text{g}/\text{m}^3$)			
24 Hourly Average SPM ($\mu\text{g}/\text{m}^3$):			
Remarks:			
Name & Signature of Official			
on Duty:			
Analyzed by:			

SAMPLE TRACKING SHEET (PM2.5)

Filter Paper Nos.					Sender's or Operator's Signature	Received by (Signature)
F.Paper Type						
Lot/Batch No.						
Site Description						
Date of Sampling						
Inspection	Date of inspection	Inspection done by	Certified by			
Lab Code						
Pre-conditioning	Nature	Date and Time	Done by	Certified by		
Pre-weighing	Date and Time	Weighed by	Balance Calibration (Y/N)	Control weight Status		
Dispatch detail	Date	To (Specify Sites)				
Filter Receiving	Date & Time	Sites	Sampling date & time	Condition of filters		
Post Conditioning	Nature	Date and Time	Done by	Certified by		
Post-weighing	Date & Time	Weighed by	Balance Calibration (Y/N)	Control weight Status		
Dispatch Detail	Date & time	To (Specify Lab)	Parameters	Results Expected by the date		

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CENTRAL POLLUTION CONTROL BOARD
PM2.5 ANALYSIS REPORT

Name of the Project :
 Name of Executing Agency :
 Sampling Location ID and Name :
 Monitoring Season :
 Date and Time of Monitoring :
 ID of Instrument used :
 Last date of Calibration :
 Field Sampling Done by :
 Analysis Done By :
 Filter ID :

Start time	Closing time	Initial Weight (mg)	Final weight (mg)	Flow rate (LPM)	Air Volume (m ³)

Calculation:

Volume of air passed (V) = Sampling Duration (Min) X LPM (Average) Dust
 collected on Filter (M) = (Final weight - Initial weight) * 1000 µg
 Concentration = M / V µg/m³

Remarks:

Meteorological conditions: Temperature - (Min & Max)
 % RH - (Min & Max)
 Rain fall-

Sampling Stoppage time (if any) with reason:

Name & Signature of Field Operator

Name & Signature of Analyst

Report Checked by (Supervisor)

Report Approved by
 (Officer in charge)

DATA SHEET FOR OZONE IN AMBIENT AIR

Monitoring Duration	Average Flow Rate (lpm)	Total Sampling Time (Minutes)	Total Volume of Air Sampled (lit.)	Volume of Sample (ml)	Absorbance(Blank)	Absorbance (Sample)	Conc. ($\mu\text{g}/\text{m}^3$)
0600-0700							
0700-0800							
0800-0900							
0900-1000							
1000-1100							
1100-1200							
1200-1300							
1300-1400							
1400-1500							
1500-1600							
1600-1700							
1700-1800							
1800-1900							
1900-2000							
2000-2100							
2100-2200							
2200-2300							
2300-2400							
2400-0100							
0100-0200							
0200-0300							
0300-0400							
0400-0500							
0500-0600							

CENTRAL POLLUTION CONTROL BOARD
AIR LAB DIVISION
Data Sheet for Ozone

Month:

Station:

Duration	06-	07-	08-	09-	10-	11-	12-	13-	14-	15-	16-	17-	18-	19-	20-	21-	22-	23-	24-	01-	02-	03-	04-	05-	
Date <input type="checkbox"/>	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	01	02	03	04	05	06	

Concentrations in $\mu\text{g}/\text{m}^3$

CENTRAL POLLUTION CONTROL BOARD AIR LAB DIVISION

FIELD DATA SHEET (BaP/PAH MONITORING)

Monitoring Location Details:

Sheet No.-----

Date & time of start	Date & time of close	Run Time in Minutes
Instrument Make & S.No	Average Flow Rate	Total Air Volume
Filter Paper No	Final Weight (gm)	Initial Weight (gm)
Net Weight (gm)	PM10 Conc. (ug/m ³)	Special Weather Note (Rainy/cloudy/Sunny/ Windy/stormy Day)
PI fill which ever Shift applicable		

Monitoring team members (Names with Signatures & Dates):

Time	Mano- meter Reading m ³ /min	Timer Reading	Time	Mano- meter Reading m ³ /min	Timer Reading	Time	Mano- meter Reading m ³ /min	Timer Reading
6.00			14.00			22.00		
7.00			15.00			23.00		
8.00			16.00			24.00		
9.00			17.00			01.00		
10.00			18.00			02.00		
11.00			19.00			03.00		
12.00			20.00			04.00		

13.00			21.00			05.00		
14.00			22.00			06.00		
Avg. Flow m3/min			Avg. Flow m3/min			Avg. Flow m3/min		

1. _____ 2. _____ 3. _____

Project Coordinator (Name with Signature): _____

CENTRAL POLLUTION CONTROL BOARD AIR LAB DIVISION**BaP/PAH ANALYSIS REPORT**

Report S. No. _____

Date: _____

S.No.	Sampling Location	Sample details	Date of Sampling	Time of sampling	Benzo(a)Pyrene (ng/m ³)	TPAH (ng/m ³) (if analysed)
1.						
2.						
3.						
4.						
5.						
6.						

Note: Sample analyzed using Capillary GC-FID.

(Analyst)

(Supervisor)

(I/C -Laboratory)

CENTRAL POLLUTION CONTROL BOARDDATA SHEET FOR PARTICULATE MATTER (Size less than 10 μm) orPM₁₀

Station:		Date:	
Shift			
Monitoring Duration			
Filter Paper No.			
Hourly Flow Rate (m³/minute)			
Average Flow Rate (m³/minute)			
Total Operation Time (Minutes)			
Initial Weight of Filter Paper (gms.)			
Final Weight of Filter Paper (gms.)			
Dust Contents (gms.)			
Total Volume of Air Sampled (m³)			
Concentration ($\mu\text{g}/\text{m}^3$)			
24 Hourly Average SPM ($\mu\text{g}/\text{m}^3$):			
Remarks:			
Name & Signature of Official on Duty:			
Analysed by:			

CENTRAL POLLUTION CONTROL BOARD

Parivesh Bhawan, East Arjun Nagar, Delhi-110 032

Trace Metals Analysis Report

1. Report no. & issue date :
2. Name of the Project :
3. Sample matrix :
4. Date & time of sample collection :
5. Samples collected by :
6. Date & time of sample receipt :
7. Date of sample analysis :
8. Sample registration no. & date :
9. Sampling plan reference :
10. Test method reference :
11. Report sent to (Name & Address) :

S. No.	Sample Code	Pb ($\mu\text{g/ml}$)	Ni ($\mu\text{g/ml}$)	As ($\mu\text{g/ml}$)

Statement:

1. The results relate only to the samples tested.
2. The report shall not be reproduced except in full, without the written approval of the laboratory.

Analyst**Supervisor****In-Charge**

CENTRAL POLLUTION CONTROL BOARD
Parivesh Bhawan, East Arjun Nagar, Delhi-110 032

Analysis report of Metals

Month:

Station:

Date	24 hour average concentration		
	Lead ($\mu\text{g}/\text{m}^3$)	Nickel (ng/m^3)	Arsenic (ng/m^3)

Analyst

Supervisor

Incharge

K

2.2 Guidelines for the Measurement of Ambient Air Pollutants
VOLUME-II



***Guidelines for
Real Time
Sampling &
Analyses***



CENTRAL POLLUTION CONTROL BOARD
(Ministry of Environment & Forests, Govt. of India)

Parivesh Bhawan, East Arjun Nagar

Delhi- 110032

Website: <http://www.cpcb.nic.in>

May, 2011

Contribution

Overall Guidance & Supervision

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Laboratory experiments & Drafting of Guidelines

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Sh. Vedparkash
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Setting**

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Ms. Shaveta Kohli

Background

Guidelines for Sampling and Measurement of notified Ambient AirQuality Parameters (NAAQS 2009)

Under the provisions of the Air (Prevention & Control of Pollution) Act, 1981, the CPCB has notified fourth version of National Ambient Air Quality Standards (NAAQS) in 2009. This revised national standard aims to provide uniform air quality for all, irrespective of land use pattern, across the country. There are 12 identified health based parameters, which are to measure at the national level and with a view to have data comparison, need for uniform guidelines for monitoring, sampling, analyses, sample flow chart, data sheet based on standard method has been felt.

The methods prescribed in the notification for respective parameters are the combination of physical method, wet-chemical method and continuous on-line method. Therefore, to meet the NAAQS requirement, a combination of both manual and continuous method is invariably required at each monitoring location, besides good laboratory set up and infrastructure.

In addition to the above, an in house exercise for applicability of all prescribed / recommended analytical methods was also felt necessary. After review and demonstration in the Central Laboratory, Delhi, guidelines are being prepared and documented, as under:

1. Volume -I: Guidelines for manual sampling and analyses (along with sample flow chart and data sheets);
2. Volume-II: Guidelines for real time sampling and analyses
3. Volume-III: Reference methods for manual sampling and analyses (compilation)
4. Volume-IV: Reference methods for continuous sampling and real time analyses (compilation)

Note: Guidelines are laboratory and infrastructure specific thus may not be applicable uniformly and need to develop based on infrastructure and expertise

**NATIONAL AMBIENT AIR QUALITY STANDARDS
(2009)**

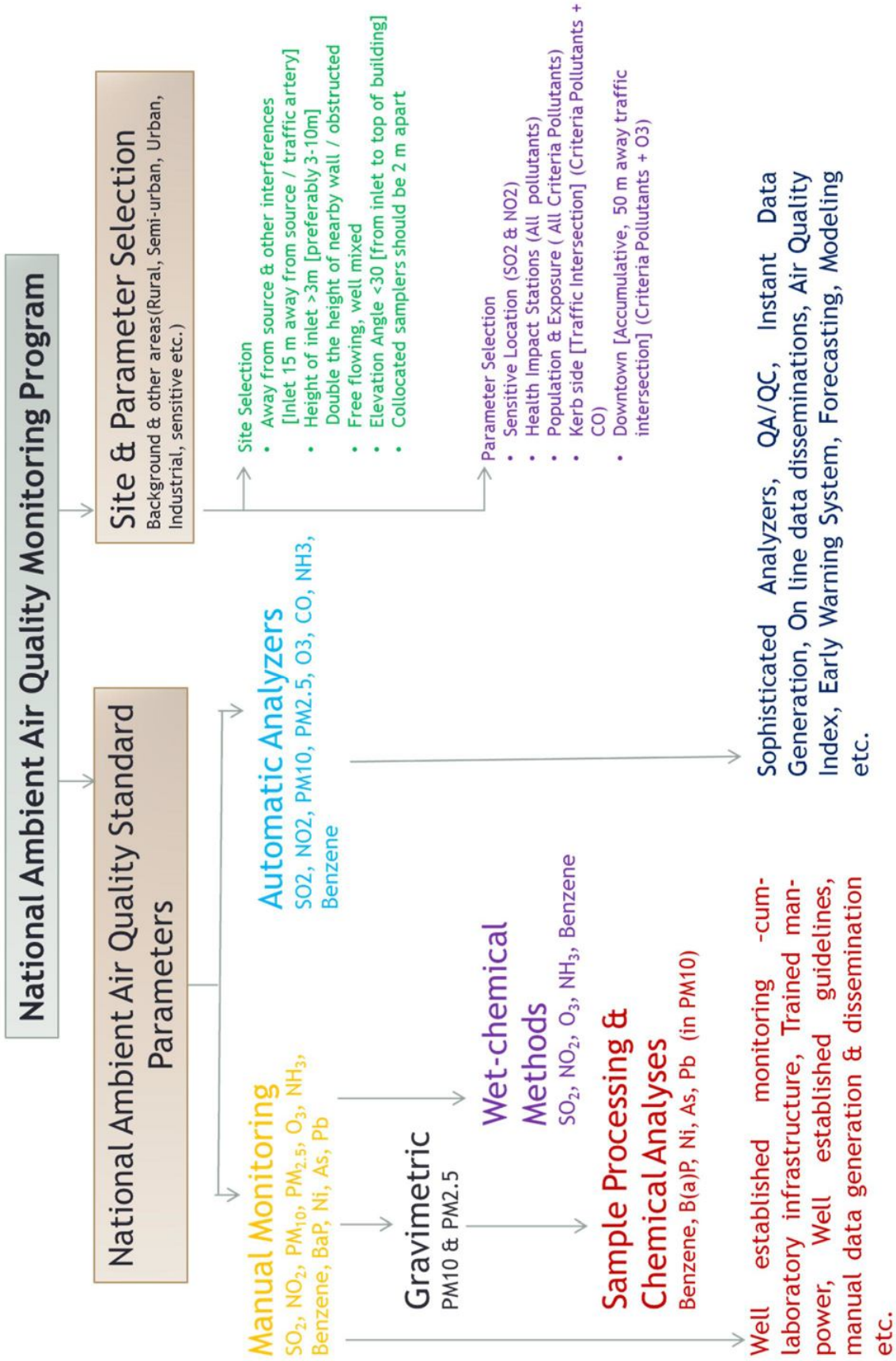
Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO ₂), µg/m ³	Annual *	50	20	-Improved West and Gaeke Method
	24 Hours **	80	80	-Ultraviolet Fluorescence
Nitrogen Dioxide (NO ₂), µg/m ³	Annual *	40	30	-Jacob & Hochheiser
	24 Hours **	80	80	modified (NaOH- NaAsO ₂) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM ₁₀ , µg/m ³	Annual *	60	60	-Gravimetric
	24 Hours **	100	100	-TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or PM _{2.5} , µg/m ³	Annual *	40	40	-Gravimetric
	24 Hours **	60	60	-TEOM -Beta attenuation
Ozone (O ₃) µg/m ³	8 Hours *	100	100	-UV Photometric
	1 Hour **	180	180	-Chemiluminescence -Chemical Method
Lead (Pb) µg/m ³	Annual *	0.50	0.50	-AAS/ICP Method after sampling on
	24 Hours **	1.0	1.0	EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter

Carbon Monoxide (CO), mg/m ³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH ₃), µg/m ³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C ₆ H ₆), µg/m ³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m ³	Annual *	01	01	-Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m ³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m ³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

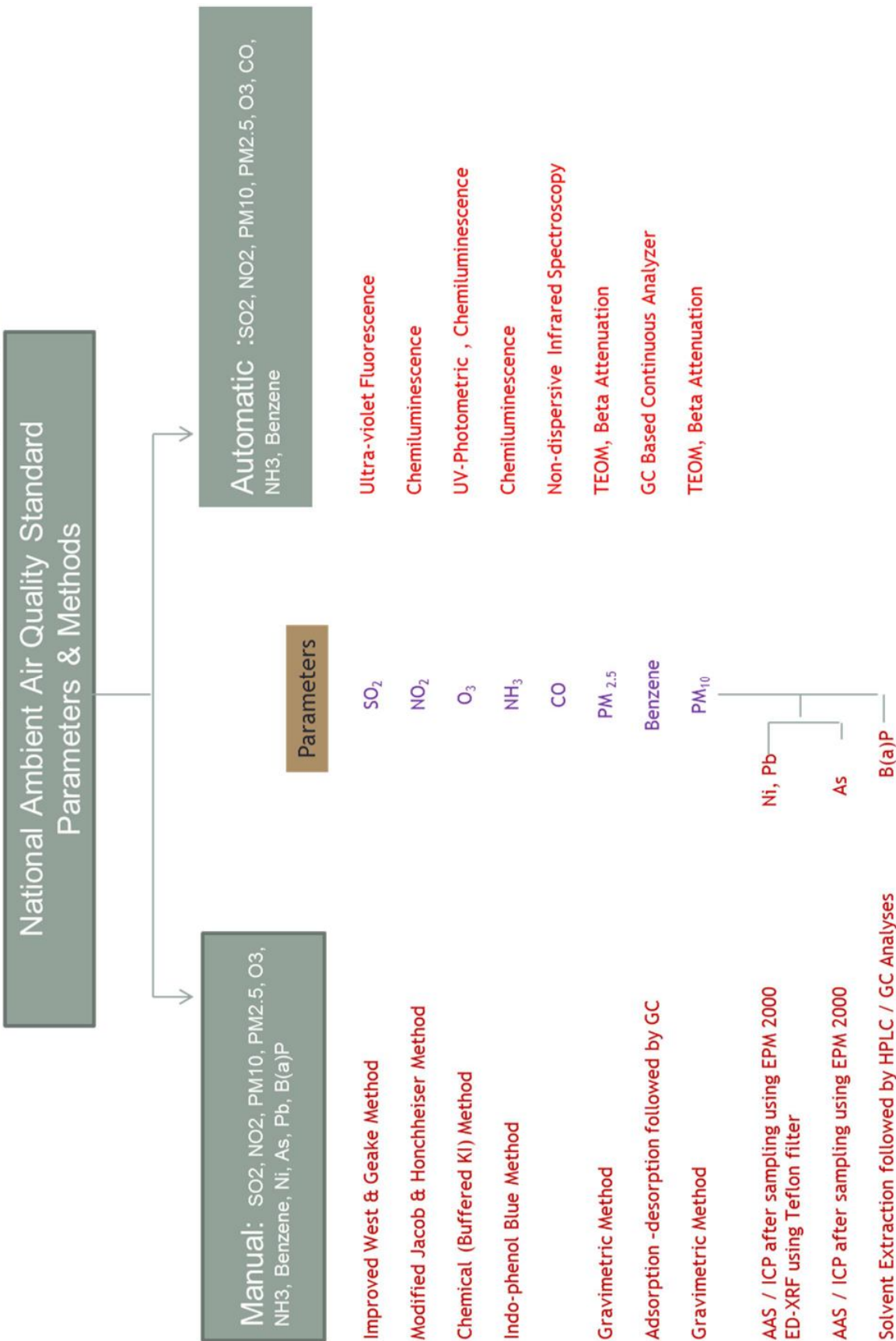
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.



National Ambient Air Quality Monitoring Program



Contents

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1.	Guidelines for Automatic Measurement of Sulphur Dioxide in ambient air (UV Fluorescence Method) Page No.1	1-11
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4.	Guidelines for Automatic Measurement of Oxides of Nitrogen (NO – NO₂ - NO_x) and Ammonia (NH₃) in ambient air (Chemiluminescence Method) Page No. 23	23-34
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Guidelines for Automatic Measurement of Sulphur Dioxide in ambient air (UV fluorescence method)

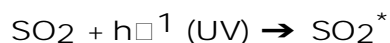
1.0 Purpose

The purpose of this protocol is to provide guidelines for monitoring of Sulphur Dioxide (SO₂) in ambient air.

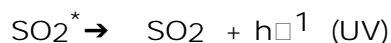
2.0 Principle

The UV fluorescence method is based on the fluorescence emission of light by SO₂ molecules previously excited by UV radiation.

The first reaction step is:



Then in the second step, the excited SO₂^{*} molecule returns to the original ground state, emitting an energy $h\nu^1$ according to the reaction:



The intensity of the fluorescent radiation is proportional to the number of SO₂ molecules in the detection volume and is therefore proportional to the concentration of SO₂.

Therefore:

$$F = k [\text{SO}_2]$$

Where:

F	=	is the intensity of fluorescence radiation;
K	=	is the factor of proportionality;
[SO ₂]	=	concentration of SO ₂

The air sample flows into the inlet of the analyser where it is scrubbed to remove any interference by aromatic hydrocarbons that may be present. A hydrocarbon scrubber device usually accomplishes this.

Then the air sample flows into a reaction chamber, where it is irradiated by UV radiation with a wavelength range of (200-220) nm. The UV fluorescence light, in the wavelength range of (240-420) nm, is optically filtered and then converted to an electrical signal by a UV detector, for example, a photomultiplier tube.

The response of the analyser is proportional to the number of SO₂ molecules in the reaction chamber. Therefore, either temperature or pressure has to be kept constant, or if variation of these parameters is expected, the

measured values have to be corrected. For this UV fluorescence method to yield accurate concentration measurements, it must be calibrated against some primary standard (see clause 5.4).

3.0 Instrument/Equipment

3.1 UV fluorescence Analyser - for measurement of Sulphur Dioxide in air

The analyser should be complete with analyser section, sample pump, detector amplifier/control section, meter, and recording system. The UV fluorescence analyser shall meet the performance specifications as prescribed. The main components are described below.

3.2 Selective Traps for Interfering Agents

One or more selective traps should be used before the reaction chamber to remove interfering gases such as aromatic hydrocarbons. These selective traps shall not retain any SO₂ and shall be changed in accordance with manufacturer's instruction manual.

If high concentrations of H₂S are expected in the ambient air, a selective scrubber should be used.

3.3 Optical Assembly and Fluorescence Cell

The UV lamp emission may be pulsed electronically or mechanically for synchronous detection and amplification of the signal. The lamp shall have a stabilised power supply to ensure a stable emission of light. An optical filter is used to restrict the wavelengths to a range, which allows excitation of the SO₂ molecule and yet minimise the interference of water vapour, aromatic hydrocarbons or nitric oxide.

The UV detector, for example, the photomultiplier tube, detects the fluorescence light emitted by the SO₂ molecules in the reaction chamber. A selective optical filter placed in front of the UV detector, reduces the signal due to scattering of the incident light. The reaction chamber shall be made of material inert to SO₂ and UV radiation. The cell should be heated above the dew point to avoid water condensation, and temperature fluctuations. The optical trap of the chamber prevents reflection of the exciting UV radiation. The optical assembly should be placed in a heated enclosure.

3.4 Pressure Regulator

The output signal of the analyser depends on the pressure in the reaction chamber and is therefore proportional to the density of SO₂ (number of SO₂ molecules) present in the reaction chamber. Variations of internal pressure shall be measured and the signal corrected or controlled by means of a regulator. The signal may have to be corrected also for external pressure and temperature fluctuations. Significant pressure corrections are due to synoptic meteorological changes (up to + 3%) or by the attitude of the measurement site (about 10% decrease in pressure for an 800 m rise in attitude).

Note: One of the main causes of a reduced pressure in the reaction chamber is a pressure drop in the sample line.

3.5 Flow Rate Controller and Indicator

It is recommended that the flow rate be kept constant by means of a flow controller. A flow rate indicator should be included in the instrument.

3.6 Air Pump

A pump, which draws air through the analyser, is placed at the end of the sample flow path. If the use of UV lamp produces ozone, it is recommended to vent this ozone outside the room and far away from the sampling inlet, or a suitable charcoal filter may trap it.

4.0 SO₂ Calibration Gas Mixtures

4.1 Primary Calibration Method - Several equivalent methods for primary calibration can be used:

- static volumetric dilution
- permeation tube sources
- TCM – Tetra-chloromercurate method
- gravimetric preparation of gas mixture in combination with various dilution systems

Several methods for generating SO₂ calibration gas standard mixtures are proposed below. Whatever method is chosen, it is recommended that it be compared periodically against another independent traceable calibration

method. The range of SO₂ calibration concentrations selected shall be in between 10% to 90% of the SO₂ concentration range in use.

4.2 Transfer Standard Calibration Method

Other methods to prepare calibration standard gases may also be used, if they are compared to one or more of the above mentioned methods. Even though any of the primary calibration methods may be used as transfer standards, in practice, it is easier to use a laboratory calibrated permeation source or cylinder of SO₂. The latter may be used either directly (with cylinders containing 0.1 mg/m³ to 10.0 mg/m³ (0.03 ppm to 5 ppm) of SO₂ in air), or with appropriate quantitative dilution (using cylinders containing ten to several hundred µg/m³ of SO₂ in air).

Note: Gas cylinders shall be made of an inert material or have been passivated to ensure stability of +/-3% for the period of use expected. Low concentration cylinder must be checked regularly against primary standards.

4.3 Operational (Field) Span Check

To aid in the quality control of the routine operation of the analyser on-site, span checks may be performed regularly (e.g. daily or weekly). For example, an internal permeation device may form an integral part of the apparatus, or an external calibrated cylinder, with appropriate dilution if necessary, may be used.

The described span check system is suitable for quality control in routine operation to verify that the analyser is operating correctly, but may not be suitable for proper calibration as described in 5.1. The span check system should regularly be compared to a laboratory-based calibration system as described in 5.1.

4.4 Zero Gas

Zero air used in the calibration of the analyser should not contain a concentration of SO₂ detectable by the analyser under calibration. The concentration of O₂ in the zero air shall be within +/-2% of the normal composition of air (20.9%).

4.5 Span Gas (Calibration Gas)

The span gas must be capable of providing an accurate, stable and reliable concentration of measured gas.

4.6 Multipoint Calibration

Multipoint calibration consists of three or more test concentrations including zero concentration. A concentration between 80% and 90% of the full-scale range of the analyzer under calibration, and one or more intermediate concentrations spaced approximately equally over the scale range are required. Multipoint calibrations are used to establish or verify the linearity of analyzer on initial installation and after any major repair. If a non-linear analyzer is being calibrated, additional calibration points should be included to adequately define the calibration relationship, which should be a smooth curve. Multipoint calibrations are likely to be more accurate than two point's calibration because of the averaging effect of the multiple points. The analyzers have zero and span adjustment controls, which should be adjusted based on the zero and highest test concentration to provide the desired scale range within the analyzer's specifications. Zero and span controls adjustment often affect the zero/span value, so the adjustments may have to be repeated several times to obtain consistent values i.e. zero or span concentrations.

5.0 Physical Zero and Span adjustments

All ambient monitoring analyzer have provision for zero and span adjustments. These adjustments are used to obtain the desired nominal scale range, to provide convenient scale units, and to periodically adjust the analyzer response to correct for calibration drift. Zero and span adjustments must always be followed by a calibration. Allow sufficient time between the adjustments and the calibration for the analyzer to stabilize.

1.0 Quality Control

There should be a quality control plan, which allows for modification of the frequency and number of points required for calibration. Such a quality control program assures the accuracy and reliability of the air quality data collected. The calibration program must include information of dates of calibration, atmospheric conditions, control setting and other pertinent data.

The analyzer should be calibrated or re-calibrated:

- (a) on its initial installation;
- (b) following its relocation;
- (c) after every repair or service;
- (d) if an interruption in operation of more than a few days; and
- (e) on detection of malfunction or changing of the analyzer in calibration.

In routine operation calibration of analyzer should be checked periodically defining period (once a week) to maintain close agreement between the calibration values used to convert analyzer responses to concentration measurements and the actual response of the analyzer. The frequency of

routine periodic calibration is a matter of judgment and is a trade-off among several considerations, including:

- (i) the inherent stability of the analyzer under the prevailing conditions of temperature, pressure, line voltage, etc. at the monitoring site;
- (ii) the quality of the ambient measurement needed;
- (iii) the risk of collecting invalid data because of a malfunction or invalid data or response problem with the analyzer that would not be discovered until the calibration is carried out.

When a new monitoring instrument is installed, zero and span calibration should be very frequent, may be daily. After obtaining enough data on the drift performance of the analyzer, the calibration frequency can be adjusted to provide a suitable compromise among the various considerations mentioned above. To facilitate the process of determining calibration frequency, it is strongly recommended that control charts should be used to monitor the zero and span drift performance of each analyzer. If the drift becomes excessive, then the corrective action has to be taken.

7.0 Precautions

- a) Operate the analyser in air- conditioned and dust proof room
- b) Follow standard safety practices for the handling and storage of calibration gas cylinders & the installation and use of the analyser.
- c) Do not expose calibration cylinders to direct sunlight or excessive heat.
- d) Maintain the same sample cell flow rate during sampling and calibration. Use the same sample pump.

8.0 Sampling

When sampling the outside ambient from an enclosure, utilize a sampling line or probe extending at least 1 metre from the enclosure, and protected against the entry of precipitation. Place the analyser in an enclosure with atmospheric control so the temperature remains constant within $\pm 5^{\circ}$ C. Record the temperature and pressure of the atmosphere sample.

9.0 Operation of the analyzer

Install the instrument in a suitable location. Follow the manufacturer's operating instructions to set the various parameters correctly, including UV source lamp intensity, sample flow rate, and (if applicable) the activation of the electronic temperature/pressure compensation. Check to ensure that the manufacturer's performance specifications are met or exceeded. If necessary,

the location shall also be temperature controlled to minimise the effect of the temperature dependence of the instrument.

Sample air through the instrument and record the SO₂ concentration by means of a suitable recording device (for example, chart recorder, electronic data acquisition system, etc.). During continuous operation of the instrument, checks of the instrument zero, span, and operational parameters shall be made at least one a week. In order to ensure optimum analyser performance, follow the maintenance schedule as detailed in the manufacturer's instruction manual. It is recommended that the analyser be fully either serviced every 6 month or annually as appropriate based on the performance of the analyser. A full calibration of the instrument should be carried out before and after this service.

10.0 Calibration System and Equipment

10.1 Requirements – Prior to Calibration or Zero/Span Check

- a) The analyzer under calibration should be in operation for at least overnight so that it is fully warmed up and stabilized.
- b) Allow the analyzer to sample test atmosphere with known concentration of pollutants.
- c) During calibration, the analyzer should be operating in its normal sampling mode and it should sample the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal ambient sampling and through as much of the ambient air inlet system as is practicable.
- d) Complete all operational adjustments of the analyzer.

10.2 Preparation of Primary Test Gases

10.3 Static Injection System

Static calibration mixtures are prepared by introducing a known volume of pure gas into a given volume of dilution gas. The use of static injection system greatly reduces the possibilities of error. The only disadvantage with this system is availability of a small quantity of air for analysis. The availability of air quality depends on the size of the container and the maximum permissible excessive pressure.

Generally, glass bottles and flasks are used for static injection system. The exact determination of volume of the container is a basic prerequisite for static injection. The exact volume of glass bottle can be determined by filling the bottle with distilled water and then measure the volume of water by taking out from the bottle. The bottle volume is again determined by increasing

the glass bottle pressure by 1.0 bar. The excess pressure allows the water to pass through a calibrated wet gas meter.

The volume of gas obtained from glass bottle should be corrected to normal conditions (25°C at 1013 hPa). A precision measuring manometer with a tolerance of 0.1% or an electronic pressure calibration standard may be used to ascertain the exact pressure of the container. The glass bottle is evacuated and filled with dilution gas (zero gas) and a measured quantity of pure gas (100%) is injected by calibrated syringe (micro syringes) directly into the glass bottle through the septum. The gases (pure and dilution) are mixed inside the glass bottle by an externally controlled stirrer. This gas mixture is now used for calibration of analyzers.

10.5 Calculation

The concentration by volume of a pure gas can be calculated from the following equation:

$$\text{Calibration concentration of gas} = \frac{\text{Concentration of pure gas} \times \text{Volume of Injection Gas}}{\text{Volume of Dilution Gas}}$$

10.6 Permeation System

A permeation device is a gas source, which permanently emits a constant known quantity of a pure gas. It consists of a small container with a permeable wall, typically consisting entirely of PTFE (Teflon) or of stainless steel with a small PTFE wafer. The gases to be used (SO₂, NO₂, H₂S etc.) to generate standard gas mixture of variable concentration, is kept pure in liquid form. Since the compound is liquid, it will always have a constant vapour pressure, if temperature is constant.

Gravimetric method is used for calibrating the permeation tube at different flow rate. The pre-weighted permeation tube (SO₂, NO₂, H₂S etc.) are kept in permeation oven for constant temperature. After an interval of about 10 days, the tubes are taken out and weighed. The permeation rate of tubes is calculated by dividing the weight loss by time period.

10.7 Calculation

Permeation Rate (PR)

=

Concentration (C) =

$$\frac{\text{Difference in Weight}}{(\square\text{g})\text{Time Period (Min)}}$$

$$\frac{\text{Permeation Rate } (\square\text{g} / \text{min})}{\text{Dilution Gas Flow } (\text{m}^3 / \text{min})}$$

$$C = \square\text{g} / \text{m}^3$$

10.8 Procedure for Calibration with Permeation Tube

- i) Take a new permeation tube and put it into permeation oven of a calibration unit for stabilisation at least for 48 hours.
 - ii) After the stabilisation take the initial weight (w_1) of permeation tube in a balance, which can measure up to 5 decimal value and record date & time (t_1). Put back the tube again in permeation oven in same condition as earlier.
-
- iii) Take out the permeation tube from oven approximately after 10 days and weight it again (w_2) and note down the date & time (t_2) and put back the tube into permeation oven.

iv) Calculations:

$$\text{Permeation Rate (PR)} = \frac{\text{Difference in Weight (} w_1 - w_2 \text{)}}{\text{Difference in Time (} t_2 - t_1 \text{) in min}}$$

$$\text{SO}_2 \text{ Concentration} = \frac{\text{Permeation Rate (PR) (} \mu\text{g / min.)} \times S^* \times \text{Dilution Flow (m}^3 \text{ / min)}}{S^*}$$

S^* = SO₂ Concentration at 25 Degree

Centigrade, 1.0 ppb = 2.618 $\mu\text{g / m}^3$

10.9 Example

Let us take the permeation tube of Sulphur dioxide for calibration: Date = 20.05.09, Time = 11 a.m. (t_1)

Weight of permeation tube = 0.05250 gms.

(w_1) Date = 31.05.09, Time = 10.30 a.m.

(t_2)

Weight of permeation tube = 0.04936 gms. (w_2)

Difference in weights ($w_1 - w_2$)

0.05250 - 0.04936 = 0.00314 gms

Time Difference (t₂ - t₁)

10 days, 23 hrs., 30 minutes = 15810 minutes

$$\text{Permeation Rate} = \frac{0.00314 \text{ gms.}}{15810 \text{ minutes}} = 0.199 \text{ } \mu\text{g} / \text{min.}$$

Sulphur Dioxide concentration at different flow rates:

$$\begin{aligned} 50 \text{ liters / hr.} &= \frac{0.199 \text{ } \mu\text{g} / \text{min.}}{0.833 \times 10^{-3} \text{ m}^3 / \text{min} \times 2.618 \text{ } \mu\text{g} / \text{m}^3} \\ &= 91.25 \text{ ppb} \end{aligned}$$

$$100 \text{ litres / hr.} = 45.52 \text{ ppb}$$

$$150 \text{ litres / hr.} = 30.83 \text{ ppb}$$

$$200 \text{ litres / hr.} = 22.83 \text{ ppb}$$

11.0 Calibration of the Ambient SO₂ Analyser

11.1 Principle - During this procedure, the ambient SO₂ analyser shall be operated at its normal flow rate and temperature. The calibration includes measurements of zero air, span gas and at least five SO₂ concentrations (using a primary calibration gas standard described in section 11.3 & 11.6) which shall be spaced to cover the ambient range. For all calibrations, flow of calibration gases to the manifold shall exceed, by at least 20%, the total flow required by the instrument attached to the manifold, with the excess appropriately vented at atmospheric pressure.

11.2 Calibration Procedure

11.3 Zero Calibration – Switch on the analyzer at ZERO mode and zero gas from internal source will be measured by the analyzer. After the reading has stabilized, check the display of the zero value. In case of derivation, adjust the zero value.

11.4 Span Calibration – After the ZERO calibration has been done, switch the analyzer at SPAN mode. SO₂ span gas (pre-determined concentration) from permeation tube, kept in permeation oven, would be measured by the analyzer. In case of any deviation in the displayed value and the span gas concentration adjust the reading of analyzer to the span value. Repeat ZERO and SPAN calibration for atleast three times or till stable and true values are indicated. After ZERO and SPAN calibration, switch the analyzer at SAMPLE mode. Now, analyzer will measure SO₂ present in the ambient air.

11.5 Field Calibration Procedure with a Transfer Standard - A two-point calibration of the analyser with a transfer standard calibrated previously against a reference calibration system is acceptable in field conditions.

12.0 OPERATIONAL CHECKS

12.1 Zero and Span Settings

If the required zero and span corrections performed in accordance with calibration procedure are greater than 80% of the range, have the analyser serviced.

12.2 Sample Flow Rate

If the sample flow rate has changed by more than $\pm 20\%$ of the initial value, check the particulate filter for blockage, and the sample pump for proper operation. Check the filter monthly by measuring the flow rate with and without the filter in place. Replace the filter if the drop is more than 5%.

12.3 Temperature Control

Check the temperature of the shelter or room in which the analyser is located. If, it has changed by more than $\pm 5^{\circ}\text{C}$, have the heating-cooling system serviced.

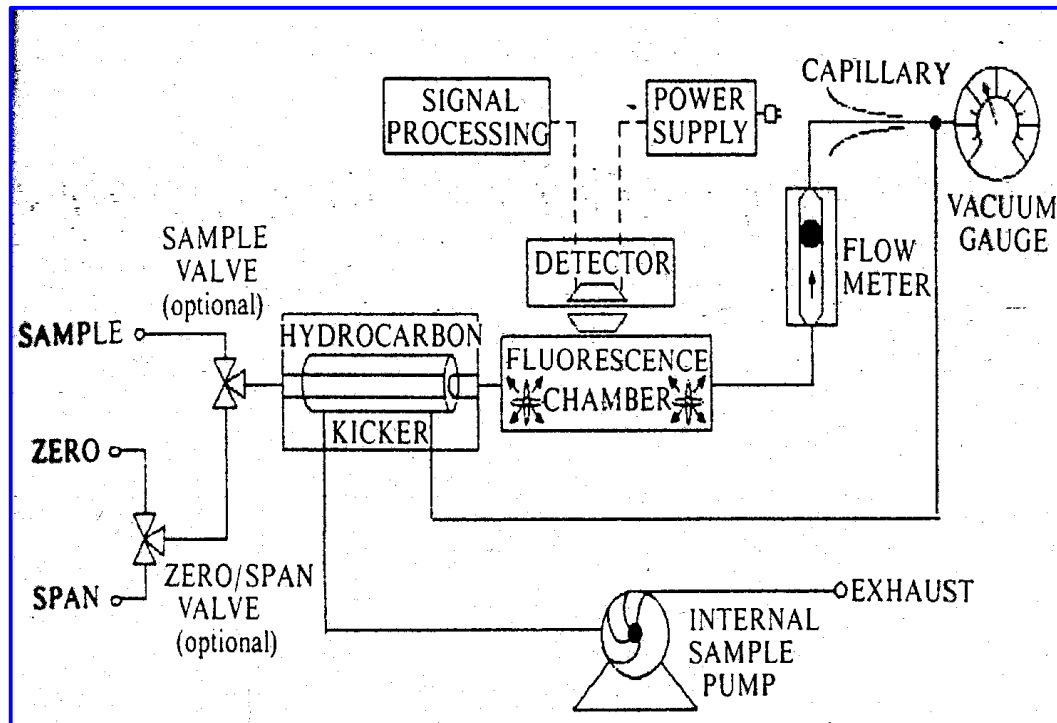
13.0 Record

The calibration record of analyzer with details like calibration data, calibration equation, analyzer identification, analyzer location, calibration standards used and their traceability, identity of calibration equipment used shall be maintained by the concerned laboratory staff.

14.0 References

1. ISO 10498.2. 1999 Ambient Air - Determination of Sulphur Dioxide - Ultraviolet Fluorescence method.
2. CPCB DOC: CB/CL/SOP/5.6/8, Issue No. 01, Issue date: 17.07.2003, Procedure for calibration of ambient air quality monitoring analyzers

Schematic Flow Diagram of Sulphur Dioxide Analyser



Guidelines for Automatic Measurement of Particulate Matter (PM_{2.5} and PM₁₀) in ambient air (Beta Attenuation Method)

1.0 Purpose

The purpose of this protocol is to provide guidelines for monitoring of particulate matter (PM_{2.5} and PM₁₀) in ambient air.

2.0 Principle

The Dust monitor automatically measures and records airborne particulate concentration levels (in milligrams or micrograms per cubic meter) using the principle of beta ray attenuation. Each hour, a small C¹⁴ (Carbon-14 or Krypton 85) element emits a constant source of high-energy electrons (known as beta rays) through a spot of clean filter tape. These beta rays are detected and counted by a sensitive scintillation detector to determine a zero reading. The Monitor automatically advances this spot of tape to the sample nozzle, where a vacuum pump then pulls a measured and controlled amount of dust-laden air through the filter tape, loading it with ambient dust (PM_{2.5} or PM₁₀, depending upon the sampling head). At the end of the hour, this dirty

spot is placed back between the beta source and the detector thereby causing an attenuation of the beta ray signal which is used to determine the mass of the particulate matter on the filter tape and the volumetric concentration of particulate matter in ambient air.

3.0 Instrument/Equipment

3.1 Beta Ray Attenuation - for measurement of particulate matter (PM2.5 and PM10) in air

The monitor consists of three basic components: the detector / logger, the pump and a sampling inlet (PM2.5 or PM10). Each of these components is self-contained and may be easily disconnected for servicing or replacement. The Beta Ray Attenuation monitor shall meet the performance specifications as prescribed.

4.0 Calibration

4.1 Factory Calibration Method

The entire particulate matter monitor is tested to traceable standards and then operated in a chamber with dust laden atmosphere. The results of this testing provide data points that are used in the data regression and final calibration. The built in membrane calibrator is tested to assure conformity during test period.

4.2 Automatic Calibration Method

The monitor has a built in Mass Membrane Calibrator. The membrane is automatically moved into the beta Pathway to determine the 'mass' of the membrane each hour or when the filter tape advances. Each membrane has a factory verified mass and that value is stored in the monitor. When the hourly membrane calibration is made, the computed value is compared to the stored factory value to determine proper operation.

4.3 Zero testing

Zero testing of blank filter paper is performed at the beginning and end of each sample period to insure the stability of the measurement system. Zero testing is based on the ability of the monitor to hold a constant output when measuring blank filter paper. If the difference between the two values exceeds a preset limit a data error message is logged in the error log and the digital value is marked.

5.0 Operation of the Particulate Matter Monitor

5.1 Normal Operation Mode

Every cycle of the normal operation mode consists of three main parts, automatic calibration, sampling, counting and calculation. Logging of data collected occurs after each calculation.

5.2 Operation Cycle

The particulate matter monitor uses a sampling algorithm that optimizes the total time required to complete a cycle. The basic cycle always includes an automatic calibration that is performed during the sampling period, but at a different point on the filter, as the data is being sampled. The process is as follows:

- i) The initial measurement of clean filter tape (I0) is performed at the beginning of the cycle for a period of four minutes.
- ii) The filter tape is advanced 50 mm approximately and the sampling (depends upon the sampling head PM2.5 or PM10) begins on the spot in which I0 was just measured. Air is drawn through this spot on the filter tape for 50 minutes.
- iii) At the same time the second measurement (I1) occurs (at a point on the tape 50 mm back) for a period of four minutes. The purpose for this measurement is to perform verification for instrument drift caused by varying external parameters such as temperature and relative humidity. A third measurement (I2) occurs with the reference membrane extended over the same place on the tape. The sample time should be chosen greater than or equal to 5 minutes, so as allow for overlapping Auto calibration time. The purpose of this measurement is to verify that the instrument is operational.
- iv) The tape is moved back app. 50 mm to measure the beta ray absorption through the section that has collected dust (I3). Finally the concentration calculation is performed to complete the cycle.
- v) A new measurement cycle then begins.

5.3 Sampling

During the sampling period incoming dust – laden air may be pumped through an optional external PM10 (or PM2.5) inlet head to remove particles greater than

10 (or 2.5) μm in diameter. The air then goes through the filter tape, where particles less than or equal to 10 (or 2.5) μm in diameter are deposited. First the filter tape is advanced 50 mm approximately from the counting station to the sampling nozzle. Next the nozzle is lowered to the tape surface and the

vacuum pump is turned ON. At the end of the sampling period the pump is turned OFF, the nozzle is raised and the tape is moved backward the same distance of 50 mm approximately.

5.4 Counting and Calculation

The final part of the operation mode is the counting of the beta particles through the dusty section of tape and then the calculation and logging of the dust concentration. The tape is then advanced 12.5 mm approximately to begin the next cycle.

5.5 Logging

Data that is computed every sample period is logged in the local memory for the current day. Normal measurement mode starts immediately after the operation mode of the meter is set ON by the operator, cycling indefinitely until the mode is set OFF.

5.6 Software Description – Setup Mode

The monitor saves various setup parameters needed to perform the desired calculations. These includes date, time, Average reference membrane mass density (ABS), Background concentration (BKGD), Regression factor (K), Absorption coefficient (μ_{sw}), Pressure flow proportionality (CV), Flow offset (QO) and the sample period t_s . Once stored these numbers do not need to be reloaded. ABS, BKGD, K, μ_{sw} , CV and QO are constants established at the factory by extensive test and calibration.

5.7 Calculations

The software uses the constant and the input variables available with each monitor to calculate the output data. The output data is used for to calculate daily statistics. The monitor measures the beta ray attenuation at several times during the sampling cycle.

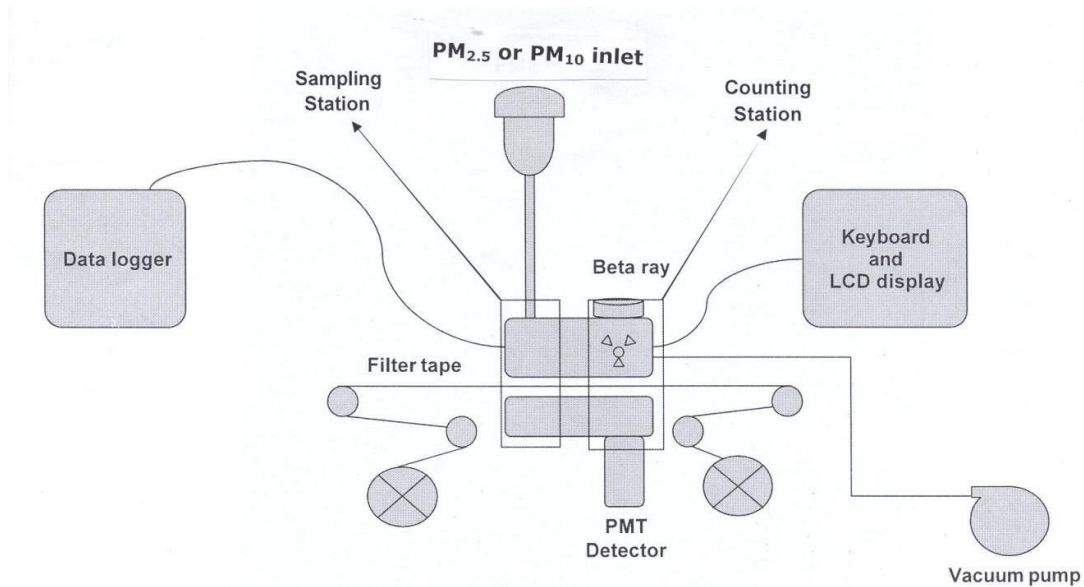
6.0 Record

The time to time calibration record of each particulate matter monitor with details like calibration data, calibration equation, monitor identification number, location, calibration foil used and their traceability used shall be maintained by the concerned laboratory staff.

7.0 References

1. Designated as an Automated Equivalent Methods: EQPM-0308-170 for PM_{2.5} and EQPM-0798-122 for PM₁₀ by USEPA

Schematic Flow Diagram of Particulate Matter (PM_{2.5} or PM₁₀) Monitor



Guidelines for Automatic Measurement of Carbon Monoxide (CO) in ambient air (Non-Dispersive Infrared Method)

1.0 Purpose

The purpose of this protocol is to provide guidelines for monitoring of carbon monoxide (CO) in ambient air.

2.0 Principle

Non Dispersive Infra-Red (NDIR) photometry provides a method of utilising the integrated absorption of infra-red energy over most of the spectrum for a given compound to provide a quantitative determination of the concentration of Carbon Monoxide (CO) in ambient air. The spectrometer measures the absorption by CO at 4.7 μm using two parallel infrared beams through a sample cell, a reference cell and a selective detector. The detector signal is led to an amplifier control section and the analyser output measured on a meter and recording system. Some instruments use gas filter correlation to compare the IR absorption spectrum between the measured gas and other gases present in the sample, in a single sample cell. These instruments utilize a highly concentrated sample of CO as a filter for the IR transmitted through the sample cell, to yield a beam that cannot be further attenuated by the CO in the sample and thus acts as a reference beam. The broad-band radiation that passes through the sample cell and the CO filter is filtered again by a narrow-band-pass filter that allows only the CO-sensitive portion of the band to pass to the detector. The removal of wavelength sensitive to other gases reduces interferences.

3.0 Instrument/Equipment

3.1 NDIR Analyser - for measurement of carbon monoxide in air

The analyser should be complete with analyser section, sample pump, amplifier/control section, meter, and recording system. The NDIR analyser shall meet the performance specifications as prescribed.

3.2 Calibration Standards and Equipment

The calibration of ambient air quality measuring carbon monoxide analyzer require a stable, homogeneous gas mixture having the concentration suitable for measuring range of the analyzer to be calibrated. All such test concentrations must be derived from local or working standards that are certified and traceable to primary standards.

3.2.1 Zero Gas

Zero gas is defined as gas, which does not contain the parameters to be monitored (any impurity). The concentration of zero gas must be zero in respect of pollutant being calibrated.

3.2.2 Span Gas (Calibration Gas)

The span gas must be capable of providing an accurate, stable and reliable concentration of measured gas.

3.2.3 Multipoint Calibration

Multipoint calibration consists of three or more test concentrations including zero concentration. A concentration between 80% and 90% of the full-scale range of the analyzer under calibration, and one or more intermediate concentrations spaced approximately equally over the scale range are required. Multipoint calibrations are used to establish or verify the linearity of analyzer on initial installation and after any major repair. If a non-linear analyzer is being calibrated, additional calibration points should be included to adequately define the calibration relationship, which should be a smooth curve. Multipoint calibrations are likely to be more accurate than two point's calibration because of the averaging effect of the multiple points.

The analyzers have zero and span adjustment controls, which should be adjusted based on the zero and highest test concentration to provide the desired scale range within the analyzer's specifications. Zero and span controls adjustment often affect the zero/span value, so the adjustments may have to be repeated several times to obtain consistent values i.e. zero or span concentrations.

3.2.4 Pressure Regulators for the CO Cylinders

A two-stage regulator with inlet and delivery pressure gauges will be required for the CO calibration standard cylinder. Procure regulators for each cylinder if individual cylinders are to be used for individual calibration points. Ensure the cylinders have a non-reactive diaphragm and suitable delivery pressure. Consult the supplier from whom the CO cylinders are to be obtained for the correct cylinder fitting size required for the regulator.

3.2.5 Flow Controller

The flow controller can be any device (valve) capable of adjusting and regulating the flow from the calibration standard. If the dilution method is to be used for calibration, a second device is required for the zero-air. For dilution, the controllers shall be capable of regulating the flow $\pm 1\%$.

3.2.6 Flow Meter

A calibrated flow meter capable of measuring and monitoring the calibration standard flow rate. If, the dilution method is used, a second flow meter is required for the zero-air flow. For dilution, the flow meters shall be capable of measuring the flow with an accuracy of $\pm 2\%$.

3.2.7 Output Manifold

The output manifold should be of sufficient diameter to ensure an insignificant pressure drop at the analyser connection. The system shall have a vent designated to ensure atmospheric pressure at the manifold and to prevent ambient air from entering the manifold.

4.0 Physical Zero and Span adjustments

All ambient monitoring analyzer have provision for zero and span adjustments. These adjustments are used to obtain the desired nominal scale range, to provide convenient scale units, and to periodically adjust the analyzer response to correct for calibration drift. Zero and span adjustments must always be followed by a calibration. Allow sufficient time between the adjustments and the calibration for the analyzer to stabilize.

5.0 Quality Control

There should be a quality control plan, which allows for modification of the frequency and number of points required for calibration. Such a quality control programme assures the accuracy and reliability of the air quality data

collected. The calibration programme must include information of dates of calibration, atmospheric conditions, control setting and other pertinent data.

The analyzer should be calibrated or re-calibrated:

- (a) on its initial installation;
- (b) following its relocation;
- (c) after every repair or service;
- (d) if an interruption in operation of more than a few days; and
- (e) on detection of malfunction or changing of the analyzer in calibration.

In routine operation calibration of analyzer should be checked periodically defining period (once a week) to maintain close agreement between the calibration values used to convert analyzer responses to concentration measurements and the actual response of the analyzer. The frequency of routine periodic calibration is a matter of judgment and is a trade-off among several considerations, including: the inherent stability of the analyzer under the prevailing conditions of temperature, pressure, line voltage, etc. at the monitoring site;

- (i) the quality of the ambient measurement needed;
- (ii) the risk of collecting invalid data because of a malfunction or invalid data or response problem with the analyzer that would not be discovered until the calibration is carried out.

When a new monitoring instrument is installed, zero and span calibration should be very frequent, may be daily. After obtaining enough data on the drift performance of the analyzer, the calibration frequency can be adjusted to provide a suitable compromise among the various considerations mentioned above. To facilitate the process of determining calibration frequency, it is strongly recommended that control charts should be used to monitor the zero and span drift performance of each analyzer. If the drift becomes excessive, then the corrective action has to be taken.

6.0 Precautions

- a) Operate the analyser in air- conditioned and dust proof room
- b) Follow standard safety practices for the handling and storage of calibration gas cylinders & the installation and use of the analyser.
- c) Do not expose calibration cylinders to direct sunlight or excessive heat.
- d) Maintain the same sample cell flow rate during sampling and calibration. Use the same sample pump.

7.0 Sampling

When sampling the outside ambient from an enclosure, utilize a sampling line or probe extending at least 1 metre from the enclosure, and protected against the entry of precipitation. Place the analyser in an enclosure with atmospheric control so the temperature remains constant within $\pm 5^{\circ}$ C. Record the temperature and pressure of the atmosphere sample.

8.0 Operation of the analyser

- (i) Press ON/OFF switch of the analyzer to ON;
 - (ii) Check that the sampling tube is connected with sampling glass manifold and the suction pump is in operation;
 - (iii) Let the analyzer warm up and stabilize for at least 30 minutes or as specified in the manual;
 - (iv) Do not change the programme or configuration of the analyzer as they are preset; and
-
- (v) After the warm up period, put the analyzer on SAMPLE mode by pressing the sample key.

9.0 Procedure of Calibration

9.1 Calibration of Working Standard

- (i) The working standard should be calibrated with Certified Reference Material (CRM);
- (ii) Established the concentration of the working standard relative to the primary standard;
- (iii) Primary standard should be traceable to NIST / BIS primary standard; and
- (iv) Confirm the stability of the working standard over a minimum period of one week.
- (v) Flow or volume measuring instruments like, bubble flow meter or gas meter shall be calibrated and certified at regular intervals against NPL, New Delhi / FCRI, Palghat standards.

9.2 Requirements – Prior to Calibration or Zero/Span Check

- a) The analyzer under calibration should be in operation for at least overnight so that it is fully warmed up and stabilized.
- b) Allow the analyzer to sample test atmosphere with known concentration of pollutants.
- c) During calibration, the analyzer should be operating in its normal

sampling mode and it should sample the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal ambient sampling and through as much of the ambient air inlet system as is practicable.

- d) Complete all operational adjustments of the analyzer.

9.3 Zero and Span Calibration Procedures

(i) Zero Calibration

Switch the analyzer at ZERO mode and zero gas (N₂) from external source is measured by the analyzer. After the reading has stabilized, check the display of zero value. In case of derivation, adjust the ZERO value.

(ii) Span Calibration

After the ZERO calibration has been done, connect the span gas cylinder, of known concentration of CO. Switch on the analyzer of SPAN mode. Open the regulator valve of the cylinder and the analyzer will start measuring the span gas concentration. In case of any variation in the measured value and SPAN gas concentration, adjust the reading of the analyzer to the SPAN gas concentration value. Repeat ZERO and SPAN calibration for at least three times till stable and true value are indicated. After ZERO and SPAN calibration, switch the analyzer at SAMPLE mode. Now, analyzer will measure the carbon monoxide present in the ambient air.

10.0 Calculation

To convert ppm volume fraction to milligrams per cubic metre, use the following equation:

$$\square 1 = \frac{\square 2 \times m_r \times 298}{24 \times 450 \times T} \times 101.3$$

Where:

- ρ_1 = is the CO mass concentration, in milligrams per cubicmetre
- ρ_2 = is the CO mass concentration, ppm volume fraction
- m_r = is the molar mass of carbon monoxide, (28 g/mol)
- 298 = is the standard absolute temperature, in Kelvin
- p = is the measured gas pressure, in kilopascals
- 24 450 = is the molecular volume of 1 mole, in millilitres
- T = is the measured absolute gas temperature, in Kelvin
- 101.3 = is the standard gas pressure, in kilopascals

11.0 OPERATIONAL CHECKS

11.1 Zero and Span Settings

If the required zero and span corrections performed in accordance with calibration procedure are greater than 80% of the range, have the analyser serviced.

11.2 Sample Flow Rate

If the sample flow rate has changed by more than $\pm 20\%$ of the initial value, check the particulate filter for blockage, and the sample pump for proper operation. Check the filter monthly by measuring the flow rate with and without the filter in place. Replace the filter if the drop is more than 5%.

11.3 Temperature Control

Check the temperature of the shelter or room in which the analyser is located. If, it has changed by more than $\pm 5^{\circ}$ C, have the heating-cooling system serviced.

12.0 Record

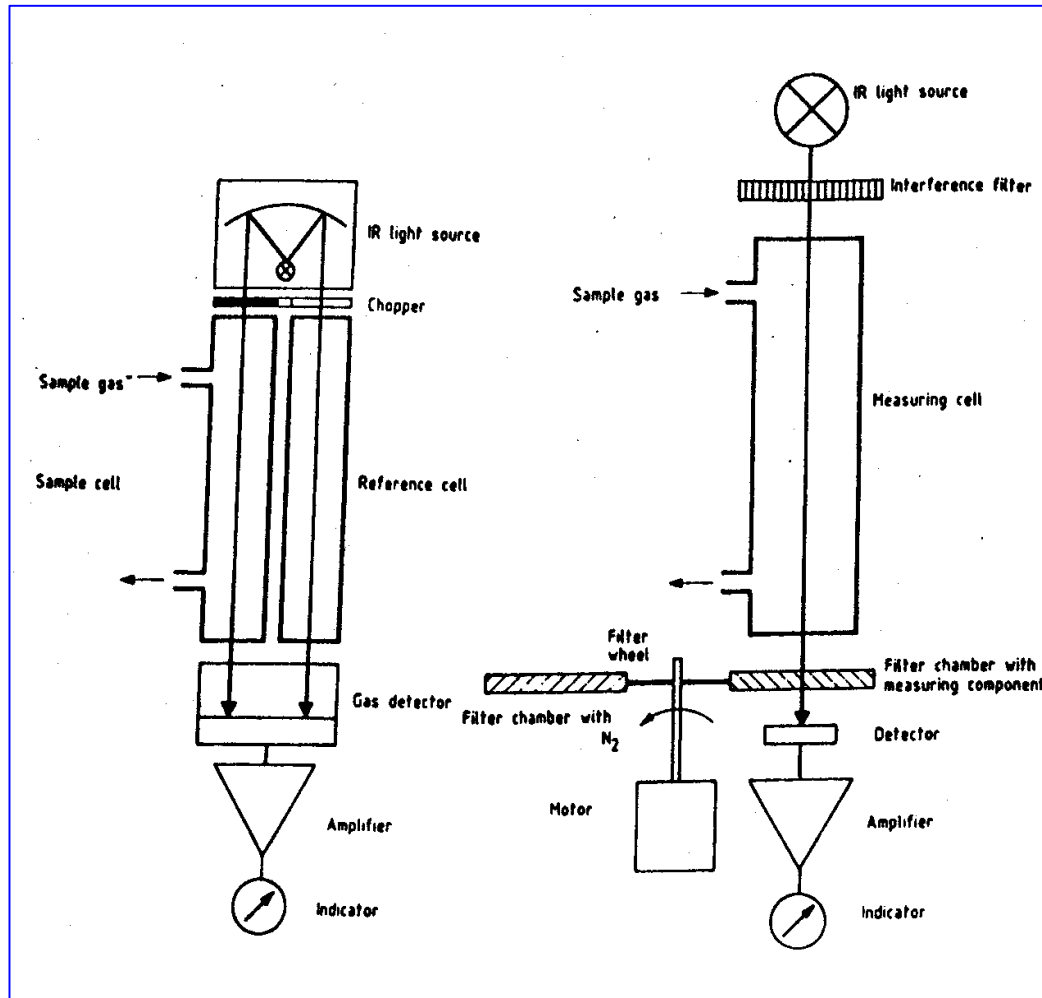
The calibration record of each analyzer with details like calibration data, calibration equation, analyzer identification, analyzer location, calibration standards used and their traceability, identity of calibration equipment used shall be maintained by the concerned laboratory staff.

13.0 References

1. ISO Method No. 4224, 1999
2. CPCB DOC: CB/CL/SOP/5.6/8, Issue No. 01, Issue date:

17.07.2003, Procedure for calibration of ambient air quality monitoring analyzers

Schematic Flow Diagram of Carbon Monoxide Analyser



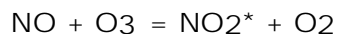
Guidelines for Automatic Measurement of Oxides of Nitrogen (NO – NO₂ – NO_x) and Ammonia (NH₃) in ambient air (Chemiluminescence Method)

1.0 Purpose

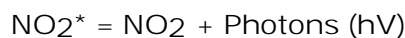
The purpose of this protocol is to provide guidelines for monitoring of oxides of nitrogen (NO – NO₂ – NO_x) and Ammonia (NH₃) in ambient air.

2.0 Principle

The measurement method is based upon the chemiluminescent reaction between Nitric oxide (NO) with Ozone (O₃) in a reaction chamber.



A portion of the resultant Nitrogen dioxide (NO₂) is produced in a highly excited energy state (NO₂^{*}) and subsequently decay to the ground level state emitting light in broad frequency band with a peak of 1200 nm.



The intensity of the light emitted is linearly proportion to the NO concentration and is measured by a photo-multiplier tube. The instrument is designed for the measurement of total Oxides of Nitrogen (NO_x), Nitric Oxide (NO) and indirect determination of Nitrogen Dioxide (NO₂) and Ammonia (NH₃). The NO₂ and NH₃ calculated by subtraction of NO from NO_x and NO_x from NO_y.

$$\text{NO}_x = \text{NO} + \text{NO}_2$$

$$\text{NO}_2 = \text{NO}_x - \text{NO} \text{-----(1)}$$

$$\text{NO}_y = \text{NO} + \text{NO}_2 + \text{NH}_3$$

$$\text{NH}_3 = \text{NO}_y - \text{NO}_x \text{----- (2)}$$

3.0 Instrument/Equipment

3.1 Chemiluminescence Analyser - for measurement of oxides of nitrogen and ammonia in air

The Chemiluminescence analyzer is a combination of NH₃ converter and an NO-NO₂-NO_x analyzer. Ammonia in the air sample is oxidized to nitric oxide (NO) with a converter. Sample air is drawn at a flow rate of 0.6 L/min from the converter into the NH₃ analyzer through a particulate filter, a glass capillary, and a solenoid valve. The solenoid valve routes the sample either directly into the reaction chamber (NO mode), through the molybdenum converter and the reaction chamber (NO_x mode), or through the ammonia converter and the reaction chamber (Nt mode).

3.2 Converters - For the accurate determination of nitrogen dioxide it is essential that the instrument converters have a high degree of efficiency (95 %+) for the conversion of NO₂ to NO. The converters employed in commercially available instruments are of two basic types.

Thermal Converters are made of a high grade stainless steel and operate at elevated temperatures, 600-800°C. At these temperatures the breakdown of NO₂ into NO and O₂ occurs readily. These converters, though adequate for the breakdown of NO₂ to NO, have the obvious disadvantage of converting ammonia into NO.

Chemical converters are to be found in the majority of Chemiluminescence instruments used for ambient monitoring. These converters have the advantage of a much lower operating temperature, 200-400°C, with efficient NO₂ conversion. Molybdenum and carbon converters have been in general use and are available in commercial instruments.

NH₃ – NO Converter consists of a ceramic cylinder bearing a heating resistor. This cylinder is surrounded by glass wool. It contains the quartz tube filled with quartz wool in order to improve the efficiency of NH₃ to NO conversion. The temperature range of these tubes is in between 950 – 1000 ° C.

3.3 Air Inlet Filter - A Teflon filter capable of removing all particulate matter greater than 5 μm in diameter.

3.4 Sample Lines – The sample lines and all parts of the instrument that come in contact with the sample stream should be made of glass, Teflon or stainless steel.

3.5 Vacuum Pump - A pump capable of a minimum vacuum of 78 kPa.

4.0 Calibration Standards

The nitric oxide (NO) in N₂ and NH₃ in air is used to calibrate the Analyser. These standard gases should be traceable to a National or International Standard. Selection of the NO and NH₃ standards concentration are dependent on the operating range of the analyzer to be calibrated and on the dilution capability of the calibration system.

NO cylinders normally used are in the 25-59 + 2% ppm v/v range in N₂. The NO calibration cylinder must be free of any nitrogen dioxide, and should be re analysed on a regular basis, preferably every six months.

4.1 Zero Gas

The air supply must be free of contaminants that would cause a detectable analyzer response, or react independently with NO.

4.2 Span Gas (Calibration Gas)

The span gas must be capable of providing an accurate, stable and reliable concentration of measured gas.

4.3 Multipoint Calibration

Multipoint calibration consists of three or more test concentrations including zero concentration. A concentration between 80% and 90% of the full-scale range of the analyzer under calibration, and one or more intermediate concentrations spaced approximately equally over the scale range are required. Multipoint calibrations are used to establish or verify the linearity of analyzer on initial installation and after any major repair. If a non-linear analyzer is being calibrated, additional calibration points should be included to adequately define the calibration relationship, which should be a smooth curve. Multipoint calibrations are likely to be more accurate than two point's calibration because of the averaging effect of the multiple points.

The analyzers have zero and span adjustment controls, which should be adjusted based on the zero and highest test concentration to provide the desired scale range within the analyzer's specifications. Zero and span controls adjustment often affect the zero/span value, so the adjustments may have to be repeated several times to obtain consistent values i.e. zero or span concentrations.

5.0 Physical Zero and Span adjustments

All ambient monitoring analyzer have provision for zero and span adjustments. These adjustments are used to obtain the desired nominal scale range, to provide convenient scale units, and to periodically adjust the analyzer

response to correct for calibration drift. Zero and span adjustments must always be followed by a calibration. Allow sufficient time between the adjustments and the calibration for the analyzer to stabilize.

6.0 Quality Control

There should be a quality control plan, which allows for modification of the frequency and number of points required for calibration. Such a quality control programme assures the accuracy and reliability of the air quality data collected. The calibration programme must include information of dates of calibration, atmospheric conditions, control setting and other pertinent data.

The analyzer should be calibrated or re-calibrated:

- a. on its initial installation;
- b. following its relocation;

- c. after every repair or service;
- d. if an interruption in operation of more than a few days; and
- e. on detection of malfunction or changing of the analyzer in calibration.

In routine operation calibration of analyzer should be checked periodically defining period (once a week) to maintain close agreement between the calibration values used to convert analyzer responses to concentration measurements and the actual response of the analyzer. The frequency of routine periodic calibration is a matter of judgment and is a trade-off among several considerations, including:

the inherent stability of the analyzer under the prevailing conditions of temperature, pressure, line voltage, etc. at the monitoring site;

the quality of the ambient measurement needed;

the risk of collecting invalid data because of a malfunction or invalid data or response problem with the analyzer that would not be discovered until the calibration is carried out.

When a new monitoring instrument is installed, zero and span calibration should be very frequent, may be daily. After obtaining enough data on the drift performance of the analyzer, the calibration frequency can be adjusted to provide a suitable compromise among the various considerations mentioned above. To facilitate the process of determining calibration frequency, it is strongly recommended that control charts should be used to monitor the zero

and span drift performance of each analyzer. If the drift becomes excessive, then the corrective action has to be taken.

Precautions

- (a) Operate the analyser in air- conditioned and dust proof room
- (b) Follow standard safety practices for the handling and storage of calibration gas cylinders & the installation and use of the analyser.
- (c) Do not expose calibration cylinders to direct sunlight or excessive heat.
- (d) Maintain the same sample cell flow rate during sampling and calibration. Use the same sample pump.

7.0 Sampling

When sampling the outside ambient from an enclosure, utilize a sampling line or probe extending at least 1 metre from the enclosure, and protected against the entry of precipitation. Place the analyser in an enclosure with atmospheric control so the temperature remains constant within ± 5 C. Record the temperature and pressure of the atmosphere sample.

8.0 Operation of the analyser

Press ON/OFF switch of the analyzer to ON;

Check that the sampling tube is connected with sampling glass manifold and the suction pump is in operation;

Let the analyzer warm up and stabilize for atleast 30 minutes or as specified in the manual;

Do not change the programme or configuration of the analyzer as they are preset; and

After the warm up period, put the analyzer on SAMPLE mode by pressing the sample key.

9.1 Requirements – Prior to Calibration or Zero/Span Check

The analyzer under calibration should be in operation for at least overnight so that it is fully warmed up and stabilized.

Allow the analyzer to sample test atmosphere with known concentration of pollutants.

During calibration, the analyzer should be operating in its normal sampling mode and it should sample the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal ambient sampling and through as much of the ambient air inlet system as is practicable.

Complete all operational adjustments of the analyzer.

10.0 Calibration System and Equipment

In the procedure that follows, NH₃, NO and NO₂ calibrations are performed using a dynamic dilution system. Ammonia and Nitric oxide calibrations are performed by dynamic flow dilution of a NH₃ & NO standard with a clean air stream. Nitrogen dioxide calibrations are performed by the rapid gas phase reaction between NO and O₃ to provide a stoichiometric quantity of NO₂, equal to the decrease in the NO concentration. The reaction is the same as shown as Section 3.0, except that the NO remains in excess rather than the ozone as described in 3.0. This reaction is commonly referred to as Gas Phase Titration (GPT). An alternative NO₂ calibration is the generation of known test atmospheres by means of a NO₂ permeation device.

10.1 Calibration System- All components in the calibration system should be made of glass, Teflon or stainless steel. The system is designed to provide dynamic dilution for NO, NH₃ and GPT for NO₂. The dilution section comprises two independent flow controls that can be varied individually to provide a dilution ration of up to 1,000 to 1. The GPT section comprises a current-regulated ozone generator through which a portion of the dilution air flows even when the ozonator is not in operation. For dynamic dilution, the metered NO combines with this portion of the dilution air and passes through the reaction chamber. It then combines with the balance of the dilution air and passes through the sampling manifold. For GPT the flow path is the same except that a portion of the oxygen in the air passing through the ozone generator is converted to ozone.

10.2 Air Flow Controller - A device capable of maintaining constant clean-air flow up to 5 L/min within + 2% of the required flow rate.

10.3 Air Flowmeter - A calibrated flowmeter capable of measuring air flow rates within + 2%.

10.4 Nitric Oxide Flow Controller - A device capable of maintaining constant NO flow within + 2% of the required flow rate.

10.5 Nitric Oxide Flowmeter - A calibrated flowmeter capable of measuring NO flow rates within + 2%.

10.6 Two-Stage Regulator - The two-stage pressure regulator for the standard NO and NH₃ cylinders must be of stainless steel to prevent any reaction of the external gas.

10.7 Ozone Generator - The generator must be capable of generating stable levels of O₃ for the GPT of NO to provide NO₂ concentrations throughout the calibration range.

10.8 Reaction Chamber - The chamber used for the reaction of O₃ with excess NO should be of sufficient volume that the residence time is not less than 2 minutes (11).

10.9 Mixing Chamber - A chamber used to allow thorough mixing of reaction products and dilution air.

11.0 Procedure of Calibration

Prior to start of calibration, for safety purposes, insure proper venting of the analyzer exhaust and the calibration system have excess flow. Insure that the analyzer and the calibration system have been on for a time sufficient to provide stable operation.

11.1 Flow Conditions - Insure that the air and gas flow systems are calibrated under the conditions of use against an authoritative standard. Different output calibration gas concentrations are obtained simply by changing the ratios of flow rates between the NO & NH₃ and dilution air channels. It is preferable to maintain a constant dilution air-flow and to vary the NO and NH₃ flow. The total flow required at the sampling manifold should equal the analyzer demand plus at least 50% excess. The following equations can be used to pre-calculate the specific gas dilution air-flow rates required for the desired calibration points, usually 20, 40, 60 and 80% of the instrument range.

Where :

$$S = \frac{STD \times FS}{FS + FD} \quad (1)$$

S	=	desired output concentrations of NO in ppm
STD	=	NO standard cylinder concentration in ppm
FS	=	NO standard cylinder flow rate
FD	=	dilution air flow rate in cm ³ /min.

Solving equation (1) for the NO or NH₃ standard flow rate (FS) that will produce the desired concentration for a given dilution flow rate (FD) gives:

$$FS = \frac{S \square FD}{STD - S} \quad (2)$$

11.2 Zero Calibration - Activate the zero air source and allow the analyzer to sample the zero air until a stable zero response is obtained. Adjust the analyzer NH₃, NO_x, NO and NO₂ zero controls as described in the instrument manual. It is good practice to recheck the zero at the end of the multipoint calibration, especially if large span adjustments were made.

11.3 Preparation for the NO and NO_x Calibration - Set the zero air and NO standard flow rates as determined in 12.1 for generating a NO concentration at 80% of the instrument range setting. Sample this NO concentration for a minimum of 15 minutes or until the NO and NO_x responses are stable.

11.4 NO and NO_x Span Adjustment - Adjust as necessary the analyzer NO and NO_x span controls to obtain recorder responses equal to the NO (NO_x in this case as well) concentration generated.

11.5 Preparation for the NO₂ Calibration - Set the dilution air and NO standard flow rates as determined in 12.1 for generating a NO concentration of about 80% of the instrument range setting. Sample this NO concentration for a minimum of 15 minutes or until the NO, NO_x and NO₂ recorder responses are stable. Record the readings.

Note: The NO₂ calibration is conveniently performed by re-establishing the 80% of scale NO-NO_x calibration point, using the same dilution air and NO standard flow rates used in 12.3.

11.6 Gas Phase Titration - Activate the ozone generator and adjust the ozone output so as to decrease the NO concentration by approximately 80%. The decrease must not exceed 90% of the NO concentration being sampled prior to the GPT. Sample this NO-NO₂ mixture for a minimum of 15 minutes or until the NO, NO_x and NO₂ recorder responses are stable. Record the readings. Calculate the indicated NO₂ concentration as per Section 11.1.

11.7 Nitrogen Dioxide Span Adjustment - Adjust as necessary the analyzer NO₂ span control to obtain a recorder response equal to the calculated NO₂ concentration.

Generate at least two additional calibration points evenly spaced across the remainder of the instrument operating scale by decreasing the O₃ output while maintaining the dilute air and NO standard flow rates constant. For each calibration point generated, calculate the NO₂ concentration, and insure that the NO₂ recorder responses are correct.

11.7 Determination of Converter Efficiency of NO₂ - Calculate the analyzer converter efficiency as per Section 13.2 for the NO₂ concentration generated in Section 12.6. The converter efficiency must be 95% or greater to be acceptable

11.8 Preparation for the NH₃ Calibration - Set the zero air and NH₃ standard flow rates as determined in 12.1 for generating a NH₃ concentration at 80% of the instrument range setting. Sample this NH₃ concentration for a minimum of 15 minutes or until the NH₃ response is stable. Adjust as necessary the analyzer NH₃ span control to obtain recorder responses equal to the NH₃ concentration generated.

11.9 Determination of Converter Efficiency of NH₃ - It is necessary to check the efficiency of the NH₃ converter every 6 months at least. In this case it is necessary to inject NH₃ gas and to check the read value with the known (span) concentration.

12.0 Calculations

12.1 Calculation of NO₂ concentration

$$\text{NO}_x = \text{NO} + \text{NO}_2$$

$$\text{NO}_2 = \text{NO}_x - \text{NO} \text{ -----(1)}$$

$$\text{NO}_Y = \text{NO} + \text{NO}_2 + \text{NH}_3$$

$$\text{NH}_3 = \text{NO}_Y - \text{NO}_x \text{ -----(2)}$$

12.2 Calculation of NO₂ Converter Efficiency (CE)

$$\text{Converter Efficiency} = \frac{[\text{NO}_x]}{[\text{NO}_x]_{\text{GPT}}} \times 100$$

12.3 Calculation of NH₃ Converter Efficiency (CE)

$$\text{Converter Efficiency} = \frac{[\text{NH}_3]_{\text{measured}}}{[\text{NH}_3]_{\text{target}}} \times 100$$

13.0 Calibration with Permeation System

A permeation device is a gas source, which permanently emits a constant known quantity of a pure gas. It consists of a small container with a permeable wall, typically consisting entirely of PTFE (Teflon) or of stainless steel with a small PTFE wafer. The gases to be used (SO₂, NO₂, NH₃, H₂S etc.) to generate standard gas mixture of variable concentration, is kept pure in liquid form. Since the compound is liquid, it will always have a constant vapour pressure, if temperature is constant. Gravimetric method is used for calibrating the permeation tube at different flow rate. The pre-weighted permeation tube (SO₂, NO₂, H₂S etc.) are kept in permeation oven for constant temperature. After an interval of about 10 days, the tubes are taken out and weighed. The permeation rate of tubes is calculated by dividing the weight loss by time period.

13.1 Calculation

$$\text{Permeation Rate (PR)} = \frac{\text{Concentration (C)}}{\text{Time}}$$

Difference in Weight

(□g) Time Period

(Min)

Permeation Rate

(□g / min)

Dilution Gas

Flow (m³ / min)

C = □g / m³

13.2 Procedure for Calibration with Permeation Tube

Take a new permeation tube and put it into permeation oven of a calibration unit for stabilisation at least for 48 hours. After the stabilisation take the initial weight (w1) of permeation tube in a balance, which can measure up to 5 decimal value and record date & time (t1). Put back the tube again in permeation oven in same condition as earlier.

Take out the permeation tube from oven approximately after 10 days and weight it again (w2) and note down the date & time (t2) and put back the tube into permeation oven.

Calculations:

$$\text{Permeation Rate (PR)} = \frac{\text{Difference in Weight (w1 - w2)}}{\text{g Difference in Time (t2 - t1) min}}$$

$$\text{NO}_2 \text{ Concentration} = \frac{\text{Permeation Rate (PR) (\mu\text{g} / \text{min.}) N^* \times \text{Dilution Flow (m}^3 / \text{min)}}{}$$

$N^* = \text{NO}_2 \text{ Concentration at } 25^\circ\text{C},$

$$1.0 \text{ ppb} = 1.88 \mu\text{g} / \text{m}^3$$

or $\text{NH}_3 \text{ Concentration at } 25^\circ\text{C},$

$$1.0 \text{ ppb} = 0.758 \mu\text{g} / \text{m}^3$$

13.3 Example

Let us take the permeation tube of Nitrogen Dioxide for calibration: Date = 20.05.09, Time = 11 a.m. (t1)

Weight of permeation tube = 0.05250 gms.

(w1) Date = 31.05.09, Time = 10.30 a.m. (t2)

Weight of permeation tube = 0.04936 gms. (w2)

Difference in weights (w1 - w2)

$$0.05250 - 0.4936 = 0.00314 \text{ g}$$

Time Difference (t2 - t1)

$$10 \text{ days, } 23 \text{ hrs. } 30 \text{ minutes} = 15810 \text{ minutes}$$

$$\text{Permeation Rate} = \frac{0.00314 \text{ g}}{15810} = 0.199 \text{ } \mu\text{g} / \text{min.}$$

minutes Nitrogen Dioxide concentration at different
flow rates:

$$\begin{aligned} & 50 \text{ liters} / \text{hr.} \\ & = \frac{0.199 \text{ } \mu\text{g} / \text{min.}}{0.833 \times 10^{-3} \text{ m}^3 / \text{min} \times 1.88 \text{ } \mu\text{g} / \text{m}^3} \\ & = 127 \text{ ppb} \end{aligned}$$

Ammonia concentration at different flow rates:

$$\begin{aligned}
 & 0.199 \text{ } \mu\text{g} / \text{min.} \\
 50 \text{ liters / hr.} &= \frac{\phantom{0.199 \text{ } \mu\text{g} / \text{min.}}}{0.833 \times 10^{-3} \text{ m}^3 / \text{min} \times 0.758 \text{ } \mu\text{g} / \text{m}^3} \\
 &= 315 \text{ ppb} \\
 100 \text{ litres / hr.} &= 157.5 \\
 \text{ppb } 150 \text{ litres / hr.} &= 105 \text{ ppb} \\
 200 \text{ litres / hr.} &= 78 \text{ ppb}
 \end{aligned}$$

14.0 OPERATIONAL CHECKS

14.1 Zero and Span Settings

If the required zero and span corrections performed in accordance with calibration procedure are greater than 80% of the range, have the analyser serviced.

14.2 Sample Flow Rate

If the sample flow rate has changed by more than + 20% of the initial value, check the particulate filter for blockage, and the sample pump for proper operation. Check the filter monthly by measuring the flow rate with and without the filter in place. Replace the filter if the drop is more than 5%.

14.3 Temperature Control

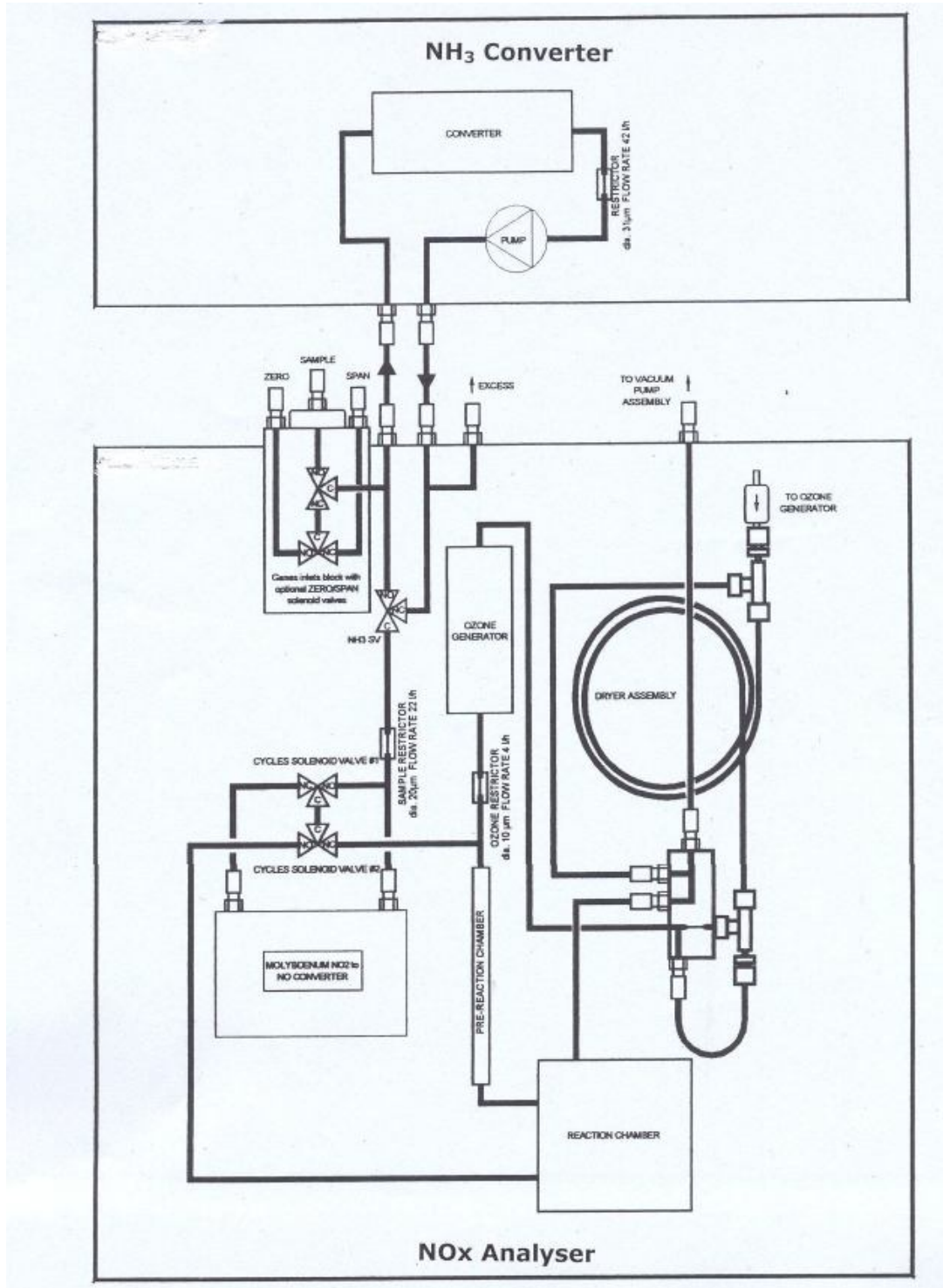
Check the temperature of the shelter or room in which the analyser is located. If, it has changed by more than + 5o C, have the heating-cooling system serviced.

15.0 Record

The calibration record of each analyzer with details like calibration data, calibration equation, analyzer identification, analyzer location, calibration standards used and their traceability, identity of calibration equipment used shall be maintained by the concerned laboratory staff.

16.0 References

1. ISC Method No. 416, 3rd Edition, 1989
 2. USEPA Environmental Technology Verification (ETV) Programme
 3. CPCB DOC: CB/CL/SOP/5.6/8, Issue No. 01, Issue date: 17.07.2003, Procedure for calibration of ambient air quality monitoring analyzers
-



Flow Diagram of Oxides of Nitrogen and Ammonia Analyser

Guidelines for Automatic Measurement of Ozone (O₃) in ambient air (UV Photometric Method)

1.0 Purpose

The purpose of this protocol is to provide guidelines for monitoring of ozone (O₃) in ambient air.

2.0 Principle

The method is based on the photometric assay of ozone (O₃) concentrations in a dynamic flow system. The concentration of O₃ is determined in an absorption cell from the measurement of the amount of light absorbed at a wavelength of 254 nm. The method is based on the absorption coefficient of O₃ at 254 nm, the optical path length through the sample, and the transmittance, temperature and pressure of the sample. The quantities above are related by the Beer-Lambert absorption law.

□

$$\text{Transmittance} = \frac{I}{I_0} = e^{-\kappa c l}$$

Where:

□₀

□ = absorption coefficient of O₃ at 254 nm = 310 atm⁻¹ c m⁻¹ at 0° C and 101.3kPa

e = O₃ concentration in units of atmosphere

l = optical path of absorption cell length in cm

I = intensity of light passing through cell with an ozone sample
 I₀ = intensity of light passing through cell with zero air

Typically, an air sample is first directed through a scrubber that removes any O₃ present, but otherwise does not affect the sample. The ozone-free sample then flows through the absorption cell, and its transmittance is measured. This constitutes the zero cycle. At a present time, solenoid switches and another air sample flows directly into the absorption cell, bypassing the scrubber and its transmittance is measured. This constitutes the ozone measurement cycle. The difference in transmittance between the two cycles is

a measure of the O₃ concentration. The complete measurement cycle takes about 20 to 30 seconds. Microprocessor-controlled electronics perform timing functions, condition the signal and perform arithmetic operations in commercially available analyzers.

3.0 Instrument/Equipment

3.1 Ozone Photometric Analyzer

Commercially available, complete with sample pump and sample flow meter. All connections to the ozone and analyzer must be constructed of glass, Teflon or other inert materials.

3.2 Air Inlet Filter

A Teflon filter capable of removing all particulate matter greater than 5 μm in diameter.

3.3 Recorder

Capable of full-scale display of voltages from the instrument DC amplifier. These are commonly found in full-scale ranges of 10 mV to 1V.

3.4 Calibration Apparatus

Ultraviolet Photometer (UV Photometer) commercially available. The UV photometers are primary standards for determinations of ozone in air. The units differ from the ozone photometric analyzer is that the UV photometers do not contain an ozone scrubber, and are designed to make pressure and temperature corrections for the measured ozone to standard conditions (25^o C and 101.3 kPa).

4.0 Quality Control

There should be a quality control plan, which allows for modification of the frequency and number of points required for calibration. Such a quality control programme assures the accuracy and reliability of the air quality data collected. The calibration programme must include information of dates of calibration, atmospheric conditions, control setting and other pertinent data.

The analyzer should be calibrated or re-calibrated:

- (a) on its initial installation;
- (b) following its relocation;
- (c) after every repair or service;
- (d) if an interruption in operation of more than a few days; and
- (e) on detection of malfunction or changing of the analyzer in calibration.

In routine operation calibration of analyzer should be checked periodically defining period (once a week) to maintain close agreement between the calibration values used to convert analyzer responses to concentration measurements and the actual response of the analyzer. The frequency of routine periodic calibration is a matter of judgment and is a trade-off among several considerations, including:

- a) the inherent stability of the analyzer under the prevailing conditions of temperature, pressure, line voltage, etc. at the monitoring site;
- b) the quality of the ambient measurement needed;
- c) the risk of collecting invalid data because of a malfunction or invalid data or response problem with the analyzer that would not be discovered until the calibration is carried out.

When a new monitoring instrument is installed, zero and span calibration should be very frequent, may be daily. After obtaining enough data on the drift performance of the analyzer, the calibration frequency can be adjusted to provide a suitable compromise among the various considerations mentioned above. To facilitate the process of determining calibration frequency, it is strongly recommended that control charts should be used to monitor the zero and span drift performance of each analyzer. If the drift becomes excessive, then the corrective action has to be taken.

5.0 Precautions

- a) Operate the analyser in air- conditioned and dust proof room
- b) Follow standard safety practices for the handling and storage of calibration gas cylinders & the installation and use of the analyser.
- c) Do not expose calibration cylinders to direct sunlight or excessive heat.
- d) Maintain the same sample cell flow rate during sampling and calibration. Use the same sample pump.

6.0 Sampling

When sampling the outside ambient from an enclosure, utilize a sampling line or probe extending at least 1 metre from the enclosure, and protected against the entry of precipitation. Place the analyser in an enclosure with atmospheric control so the temperature remains constant within $\pm 5^{\circ}$ C. Record the temperature and pressure of the atmosphere sample.

7.0 Operation of the analyser

- (a) Press ON/OFF switch of the analyzer to ON;
- (b) Check that the sampling tube is connected with sampling glass manifold and the suction pump is in operation;
- (c) Let the analyzer warm up and stabilize for at least 30 minutes or as specified in the manual;
- (d) Do not change the programme or configuration of the analyzer as they are preset; and
- (e) After the warm up period, put the analyzer on SAMPLE mode by pressing the sample key.

8.0 Requirements – Prior to Calibration or Zero/Span Check

-
- a) The analyzer under calibration should be in operation for at least overnight so that it is fully warmed up and stabilized.
 - b) Allow the analyzer to sample test atmosphere with known concentration of pollutants.
 - c) During calibration, the analyzer should be operating in its normal sampling mode and it should sample the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal ambient sampling and through as much of the ambient air inlet system as is practicable.
 - d) Complete all operational adjustments of the analyzer.

9.0 Zero and Span Calibration Procedures

(i) Zero Calibration

Switch the analyzer at ZERO mode and zero gas from internal source will be measured by the analyzer. After the reading has stabilized, check the display of the zero value. In case of any deviation, adjust the ZERO value.

(ii) Span Calibration (internal)

After the ZERO calibration has been done, switch the analyzer at SPAN mode. The analyzer has internal UV span source for providing O₃ of known concentration. The span value is pre-determined. The analyzer would measure the span value. In case of any deviation in the displayed value and the actual span concentration, adjust the voltage of the UV source corresponding to the span value. Repeat ZERO and SPAN calibration for at least three times or till stable and true values are indicated. After ZERO and SPAN calibration, switch the analyzer at SAMPLE mode. Now, analyzer will measure the O₃ gas present in the ambient air.

(iii) Span Calibration (External)

Connect the ozone analyzer to the output manifold of the calibration system. Check to insure proper operating parameters according to the instrument manual. The ozone source consists of a quartz tube into which purified air is introduced and then irradiated with a stable low-pressure mercury lamp. The level of irradiation is controlled by an adjustable metal sleeve that fits around the lamp. At a fixed level of irradiation and at a constant temperature and humidity, ozone is produced at a uniform rate. By careful control of the flow of air through the quartz tube, and/or adjustment of the irradiation level, test atmospheres can be generated that contain stable but variable concentrations of ozone. An output manifold with a vent is attached to the Ozonator. Ozone outputs must be available to cover the complete analyzer operating range, typically 0.00 to 1.00 ppm. The dilution system should have a total flow capability of a least 5 L/min. Any alternative system capable of these outputs is acceptable.

1.0 Calculation

If a UV photometer was used in the calibration, the ozone readings are the true ozone concentrations already corrected to standard conditions (25^o C and 101.3 kPa).

True Ozone (ppm) = Ozone Reading - Zero Reading
Where:

Ozone Reading = The UV photometer ozone readout for each calibration point test atmosphere

Zero Reading = The UV photometer ozone readout for the zero air stream

11.0 OPERATIONAL CHECKS

11.1 Zero and Span Settings

If the required zero and span corrections performed in accordance with calibration procedure are greater than 80% of the range, have the analyser serviced.

11.2 Sample Flow Rate

If the sample flow rate has changed by more than $\pm 20\%$ of the initial value, check the particulate filter for blockage, and the sample pump for proper operation. Check the filter monthly by measuring the flow rate with and without the filter in place. Replace the filter if the drop is more than 5%.

11.3 Temperature Control

Check the temperature of the shelter or room in which the analyser is located. If, it has changed by more than $\pm 5^{\circ}$ C, have the heating-cooling system serviced.

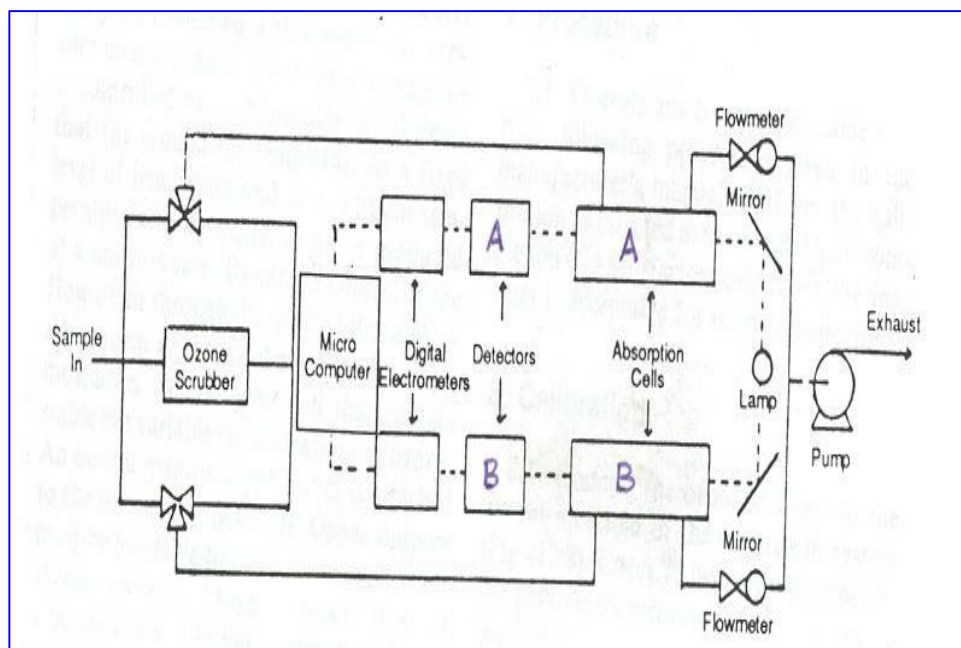
12.0 Record

The calibration record of each analyzer with details like calibration data, calibration equation, analyzer identification, analyzer location, calibration standards used and their traceability, identity of calibration equipment used shall be maintained by the concerned laboratory staff.

13.0 References

1. ISC, Method No. 417, 3rd Edition, 1989.

Schematic Flow Diagram of Dual Cell Ozone Analyser



Guidelines for Automatic Measurement of benzene (BTX) in ambient air (Gas Chromatography based Continuous Method)

1.0 Purpose

The purpose of this protocol is to provide guidelines for monitoring of Benzene (Benzene, toluene, Ethyl benzene M+P xylene and O-Xylene) in ambient air by online real time monitoring instruments.

2.0 Principle

The principal of operation of volatile organic compound is based on chromatographic separation in the gaseous phase of measured compound, coupled with a photo ionization detector for detection of these compounds. The sampling gas is drawn into a sampling tube at regulated flow. This is heated and ventilated by carrier gas, this way desorption is done. Transfer of adsorbed compound from sampling tube to pre concentration tube is carried out with a carrier gas. The sampled VOC are re adsorbed in very small volume of adsorbent, which is known as pre concentrator. A strong and fast increase in temperature of graphitized carbon at 350 c together with ventilation of carbon

with carrier gas enables desorption of the compounds, which are injected into column. The nitrogen is introduced at inlet of pre concentration tube, which causes displacement of sample in the column. The separation of each compound takes place in this column. The output is measured by a PID detector and the concentrations are displayed on the instrument.

3.0 Instrument/Equipment

VOC Analyser - for measurement of Benzene in the ambient air is used for the measurement of this compound. The analyser should be complete with analyser section, sample pump, amplifier/control section, meter, and recording system. The analyser shall meet the performance specifications as prescribed.

4.0 Sampling

When sampling the outside ambient from an enclosure, utilize a sampling line or probe extending at least 1 metre from the enclosure, and protected against the entry of precipitation. Place the analyser in an enclosure with atmospheric control so the temperature remains constant at $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$. Record the temperature and pressure of the atmosphere sample.

4.1 Operation of the Analyser

Connect the analyser with sampling line. Check if dust filter is required to be replaced. Put on the power supply. Analyser is pre programmed or can be re-configured in configuration mode where range, date time, language, measuring cycle etc. can be programmed. Return to main menu. Put the analyser in instantaneous mode and let the instrument to come out of warm up mode. Put the instrument on sample mode it will start the measurement of VOC present in the ambient air. The instrument will monitor Benzene, toluene, Ethyl benzene M+P xylene. Data will log in station computer.

5.0 Calibration

5.1 Requirements - Prior to Calibration or Zero/Span Check

- a) The analyzer under calibration should be in operation for at least overnight so that it is fully warmed up and stabilized.
- b) Allow the analyzer to sample test atmosphere with known concentration of pollutants.
- c) During calibration, the analyzer should be operating in its normal

sampling mode and it should sample the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal ambient sampling and through as much of the ambient air inlet system as is practicable.

- d) Complete all operational adjustments of the analyzer.

5.2 Standards and Equipment

The calibration of ambient air quality measuring BTX analyzer require a stable, homogeneous gas mixture having the concentration suitable for measuring range of the analyzer to be calibrated. All such test concentrations must be derived from local or working standards that are certified and traceable to primary standards. Built in bench or dilution system is used for calibration.

5.3 Pressure Regulators for the BTX Cylinders

A two-stage regulator with inlet and delivery pressure gauges will be required for the Benzene calibration standard cylinder. Procure regulators for each cylinder if individual cylinders are to be used for individual calibration points. Ensure the cylinders have a non-reactive diaphragm and suitable delivery pressure. Consult the supplier from whom the BTX cylinders are to be obtained for the correct cylinder fitting size required for the regulator.

5.4 Flow Controller/calibrator

The flow controller can be any device (valve) capable of adjusting and regulating the flow from the calibration standard. If the dilution method is to be used for calibration, a second device is required for the zero-air. For dilution, the controllers shall be capable of regulating the flow $\pm 1\%$. All the modern dilution system/calibrators have the high precision and accuracy in maintaining the critical flows. The calibrator has the facility to calibrate the instrument with gas cylinder or permeation bench. Out put of the calibrator is connected with the span port of the analyzer.

5.5 Zero Gas

Zero gas is defined as gas, which does not contain the parameters to be monitored (any impurity). The concentration of zero gas must be zero in respect of pollutant being calibrated.

5.5 Span Gas (Calibration Gas)

The span gas must be capable of providing an accurate, stable and reliable concentration of measured gas. Span gas can be gas mixtures or permeation tubes. What so ever may the span source it must be certified and traceable to NIST. The working standard should also be verified with CRM.

5.6 Zero and Span Calibration Procedures

a) Zero Calibration

Switch the analyzer at ZERO mode and connect zero gas of (N₂ of 99.995% purity) from external source. After the reading has stabilized, check the display of zero value. In case of deviation, adjust the ZERO value.

b) Span Calibration

After the ZERO calibration has been done, connect the span gas cylinder or permeation bench, of known concentration of Benzene. Switch on the analyzer to SPAN mode. Open the regulator valve of the cylinder and the analyzer will start measuring the span gas concentration. Let the instrument run for three to four cycles for stabilization of results. Observe the chromatogram of the analyzer, and in case there is any variation in the measured value and SPAN gas concentration, adjust the reading of the analyzer to the SPAN gas concentration value. Let it be stabilized again for at least three cycles. On obtaining a desired stable SPAN concentration the instrument should be flushed out with zero air for one or two cycles. After ZERO and SPAN calibration, switch the analyzer to SAMPLE mode. Now, analyzer will measure the benzene and its compounds as per its configuration in the ambient air.

c) Multipoint Calibration

Multipoint calibration consists of three or more test concentrations including zero concentration. A concentration between 80% and 90% of the full-scale

range of the analyzer under calibration, and one or more intermediate concentrations spaced approximately equally over the scale range are required. Multipoint calibrations are used to establish or verify the linearity of analyzer on initial installation and after any major repair. The analyzers have zero and span adjustment controls, which should be adjusted based on the zero and highest test concentration to provide the desired scale range within the analyzer's specifications. Zero and span controls adjustment often affect the zero/span value, so the adjustments may have to be repeated several times to obtain consistent values i.e. zero or span concentrations.

6.0 Calculation

To convert ppb volume fraction to micrograms per cubic metre, use the following equation:

$$\square 1 = \frac{\square 2 \times m_r \times 298 \square}{24\,450 \times T \times 101.3}$$

Where:

- \square_1 = is the Benzene mass concentration, in microgram /m³
- \square_2 = the Benzene mass concentration, ppb
- volume fraction m_r = is the molar mass of Benzene, (78 g/mol)
- 298 = is the standard absolute temperature, in Kelvin
- \square = is the measured gas pressure, in kilopascals
- 24.450 = is the molecular volume of 1 mole, in millilitres
- T = is the measured absolute gas temperature, in Kelvin
- 101.3 = is the standard gas pressure, in kilopascals

7.0 Precautions

- Operate the analyser in air- conditioned and dust proof room. The temperature should be between 20-25 degree Celsius
- Follow standard safety practices for the handling and storage of calibration gas cylinders & the installation and use of the analyser.
- Do not expose calibration cylinders to direct sunlight or excessive heat.
- Maintain the same sample cell flow rate during sampling and calibration. Use the same sample pump.

8.0 Quality control

There should be a quality control plan, which allows for modification of the frequency and number of points required for calibration. Such a quality control programme assures the accuracy and reliability of the air quality data collected. The calibration programme must include information of dates of calibration, atmospheric conditions, control setting and other pertinent data.

The analyzer should be calibrated or re-calibrated:

- (a) on its initial installation;
- (b) following its relocation;
- (c) after every repair or service;

(d) if an interruption in operation of more than a few days; and

(e) on detection of malfunction or changing of the analyzer in calibration.

In routine operation calibration of analyzer should be checked periodically defining period (once a week) to maintain close agreement between the calibration values used to convert analyzer responses to concentration measurements and the actual response of the analyzer. The frequency of routine periodic calibration is a matter of judgment and is a trade-off among several considerations, including:

- (a) the inherent stability of the analyzer under the prevailing conditions of temperature, pressure, line voltage, etc. at the monitoring site;
- (b) the quality of the ambient measurement needed;
- (c) the risk of collecting invalid data because of a malfunction or invalid data or response problem with the analyzer that would not be discovered until the calibration is carried out.

When a new monitoring instrument is installed, zero and span calibration should be very frequent, may be daily. After obtaining enough data on the drift performance of the analyzer, the calibration frequency can be adjusted to provide a suitable compromise among the various considerations mentioned above. To facilitate the process of determining calibration frequency, it is strongly recommended that control charts should be used to monitor the zero and span drift performance of each analyzer. If the drift becomes excessive, then the corrective action has to be taken.

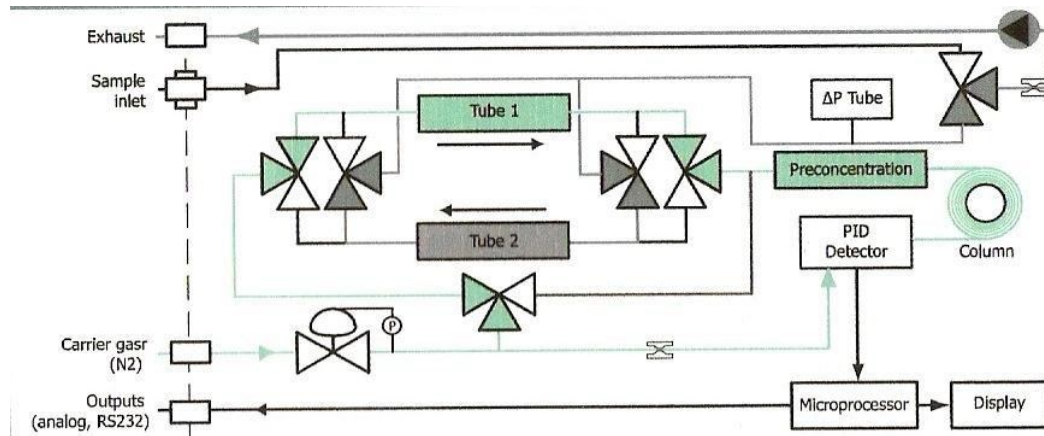
9.0 Record

The calibration record of analyzer with details like calibration data, calibration equation, analyzer identification, analyzer location, calibration standards used and their traceability, identity of calibration equipment used shall be maintained by the concerned laboratory staff.

10.0 References

1. Quantitation by Portable Gas Chromatography: Mass Spectrometry of VOCs Associated with Vapor Intrusion by Justin D. Fair, William F. Bailey, Robert A. Felty, Amy E. Gifford, Benjamin Shultes, and Leslie H. Volles

FLOW DIAGRAM OF BTX ANALYSER



DISCLAIMER

The guidelines for the measurement of Ambient Air Pollutants (NAAQS 2009) are based on the referencemethods (Viz. International Standards Organization and Inter Society Committee) based on field and laboratory experiences.

Efforts have been made to make it user friendly and easily understandable, however comments and suggestions towards its improvement are solicited.

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2.3- Technical Specifications of BOQ Item no.1

Analyzer Shelter ;Supply, Errection, Installation, Testing and Commissioning of Housing/ Container: It is designed for housing the Continuous Automatic Monitoring Stations with Sampling line, Internal fitting, Instruments racks, Electrical fittings and Gas line fittings, Tools (electrical and mechanical), Data display system, Recommended spares including instruments to protect them from dust and heat like temperature and Humidity sensors shall be installed in the Housing Container for checking the humidity and temperature inside the station as in the housing.

While Construction of the Analyzer Shelter the following details shall be incorporated

- Size: 3mtr(Width) x 3 mtr (Length) x 2.7 mtr(Height)
- MOC: 1.2 mm thick SS sheet (External walls) & 1.2 mm thick GI sheet (Internal walls)
- Door – One main door
- Insulation Thickness – 80mm with PUF insulation
- Roof thickness – 100mm with PUF
- Flooring – Anti slip sheet
- Lighting inside shelter at minimum of 300lux
- External dome lighting shall be under the overhangs
- Fire Extinguisher – 2 Nos. As directed by the Department.

2.3.1 Technical Specification for Item no 2,3,4

4.1.1 Coarse aggregate

4.1.2.1. **General** - Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved / authorised sources

a) **Stone aggregate** -It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating, and injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. It shall conform to IS: 383 unless otherwise specified.

b) **Gravel** - It shall consists of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, and loam adherent coating, alkali vegetable, matter and other deleterious substances. Pit gravel shall be washed if it contains soil materials adhering to it. These shall soil materials soil materials adhering to it. These

shall conform to IS: 383 unless otherwise specified.

c) **Brick aggregate** - Brick aggregate shall be obtained by breaking well burnt or over burnt dense bricks / brick bats. They shall be homogenous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil vegetable matter and other deleterious substances. Such aggregate should not contain more than one percent of sulphate and should not absorb more than 10% of their own mass of water, when used in cement concrete and 20% when used in lime concrete. It shall conform to IS: 383 unless otherwise specified.

d) Lightweight aggregates such as sintered fly ash aggregate may also be used provided the engineer is satisfied with the data on the proportion of concrete made with them.

4.1.2.2. **Deleterious material** - Course aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, shale or similar laminates material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to the steel reinforcement. Aggregates which are chemically reactive with alkali of cement shall not be used. The maximum quantity of deleterious material shall not more than five per cent of the weight of coarse aggregate when determined in accordance with IS: 2386 part II.

4.1.2.3. **Size and grading**

(i) Stone aggregate and gravel - It shall be either graded or single sized as specified. Normal size and grading shall be as under --

(a) Nominal sizes of graded stone aggregate or gravel shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes shall be in accordance with Table 1.

Table 1 -Graded stone aggregate or gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of			
	40 mm	20 mm	16 mm	12.5 mm
75 mm	100	-	-	-
37.5 mm	95 to 100	100	-	-
19 mm	-	95 to 100	100	100
16 mm	-	-	90 to 100	-
11.2 mm	-	-	-	90 to 100
9.5 mm	10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm	0 to 5	0 to 10	0 to 10	0 to 10
2.36 mm	-	-	-	-

Concrete work

(b). Normal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal sizes the proportion of other sizes shall be in accordance with Table 2.

Table 2 -Single sized (ungraded) stone aggregate or gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
75 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-
37.5 mm	0-30	85-100	100	-	-	-
19 mm	0-5	-20	85-100	100	-	-
16 mm	-	-	-	-85-100	100	-
11.2 mm	-	-	-	-	85-100	100
9.5	-	0-5	0-20	0-30	0-45	85-
100						
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

c). When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sizes aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal size, the proportion of other sizes in mixed aggregate shall be in accordance with Table 1. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 3.

Table 3 -Single sized (ungraded) stone aggregate or gravel

Cement Concrete	Nominal size of graded aggregate required	Parts of single size aggregate of size				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
1: 6:12	63	9	-	3	-	-
1: 6: 12	40	-	9	3	-	-
1: 5: 10	63	7 ½	-	2 ½	-	-
1: 5: 10	40	-	7 ½	2 ½	-	-
1: 4: 8	63	6	-	2	-	-
1: 4: 8	40	-	6	2	-	-
1: 3: 6	63	4 ½	-	1 ½	-	-
1: 3: 6	40	-	4 ½	1 ½	-	-
1: 3:6	20	-	-	4 ½	-	-
1: 2: 4	40	-	2 ½	1	-	½
1: 2: 4	20	-	-	3	-	1
1: 2: 4	12.5	-	-	-	3	-
1: 1 ½ : 3	20	-	-	2	-	1

Note-(i) The proportions indicated in Table 3 above are by volume when considered necessary, these proportions may be varied marginally by engineer after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the engineer. If single size coarse aggregates are not premixed at site to obtain the graded coarse aggregate required for mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.

(ii) **Brick aggregate** - Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in the Table 4 when tested for sieve.

Table 4 -Brick aggregate

IS Sieve Designation(by weight)	Percentage passing
75 mm	100
37.5 mm	95-100
19.0 mm	45-100
4.75	0-5

Note -Coarse aggregate for cement concrete shall generally conform to para 4.2.1 of IS: 456 and fine aggregate shall conform to IS: 383.

4.1.2.4. **Stacking** - Aggregate shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

4.1.2.5. **Testing** - Coarse aggregate shall be tested for the following (as per IS: 2386)

- (a) Determination of particle size and shape
- (b) Estimation of organic impurities (as per IS: 2386-Part II)
- (c) Surface moisture
- (d) Determination of 10% fine value

Measurements - The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregates nominal size below 40 mm.

4.1.2.6. **Admixtures** - When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS: 9103.

4.2. SPECIFICATIONS FOR CEMENT CONCRETE

4.2.0. This shall be prepared by mixing graded stone or brick aggregate of nominal size as specified with fine aggregate and cement in specified proportions with required quantity of water. The grading and quality of aggregates shall be such as to give

minimum compressive strength of 140 kg/cm² and 210 kg / cm² at 7 days and 28 days respectively in case of mix 1:2:4, (One cement - two coarse sand - four stone aggregate).

One sample consisting of 6 cubes 15x15x15 cm shall be taken for every 15 cubic meter or part thereof cement concrete 1:2:4. The cube tests shall not be carried out in case the quantity of cement concrete placed on any day is less than 15 cubic meter unless otherwise specific. For other details, refer section on R.C.C. work.

4.2.1. **Proportioning** - It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally 35 X 25 X40 cm deep or as otherwise approved by the engineer. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cubic meter. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulk age shall be made as given for mortar.

4.2.2. **Preparation** - This shall be prepared by mixing coarse aggregate, fine aggregate and cement in specified proportions with required quantity of water. Nominal size and quality of aggregate shall be as specified.

Except where brick aggregate is used in cement concrete, minimum compressive strength on works test for different concrete mixes shall be as specified for various grades prepared by volume basis, in Table 5 below. The work test shall be carried out for every 15 cum of a day's concreting unless otherwise specified.

Table 5

Concrete mix	Min compressive strength on 15 cm cube in Kg / cm ²	
	7 days strength	28 days strength
1:1:2	210	315
1:1½ :3		265
1:2:4	140	175

4.2.2.1. **Mixing** - Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS: 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical break down of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the engineer in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel

shall be washed with water to remove, dirt, dust and other foreign materials. For guidance, the mixing time may be 1½ to 2 minutes, for hydrophobic cement it may be taken as 2½ to 3 minutes.

4.2.2.2. **Power loader** - Mixer will be fitted with a power loader complying with the following requirements.

a). The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

Note - In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

b). The minimum inside width of the feeding edge of the hopper shall be as specified below in Table 6.

Table 6

Nominal size of mixer (T, NT or R), litre	Minimum inside width of hopper feeding edge in mm
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0

C T = tilting; NT = non-tilting; R = Reverse

a) The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the center line of the chute plate of the hopper when in discharge position, is at an angle of not less than 50° to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be provided. Even when a mechanical device is provided, it is recommended that the angle of center line of the chute plate of the hopper when in discharge position, should be as large as practicable, preferably not less than 40° to horizontal.

b) When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, there should be at least one and half drums of rope on the drum.

c) Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.

d) The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.

e) Safety device shall be provided to secure the hopper in raised position when not in use

4.2.2.3. **Mixing efficiency** - The mixer shall be tested under normal working conditions in accordance with the method specified in IS - 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete. The percentage variation between the quantities of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two halves of the batch shall not be more than the following limits -

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

4.2.2.4. **Machine mixing** - The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for at least four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the engineer. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained. Mixing shall be done for at least two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed. The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean with water.

4.2.2.5 **Hand mixing** - When hand mixing has been specifically permitted in exceptional circumstances by the engineer in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by shoveling and turning till the coarse aggregate gets evenly distributed in the cement sand mixture. Three quarter of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform

shall be washed and cleaned at the end of the day.

4.2.3. **Workability** - The quantity of water to be used for each mix shall be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means specified. Generally, the quantity of water to be used for each mix of 50 Kgs cement shall not be more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix, 30 litres for 1:1½:3 mix and 25 litres for 1:1:2 mix. In case of vibrated concrete, the quantity of water may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests as described in Annexure 4.A.1. The slump and workability for different kind of works shall be as per Table 7 below

Table 7

Placing conditions.	Degree of workability	Value of workability
Concreting of shallow Sections with vibration	Very low	0.75-0.80 Compacting factor.
Concreting of lightly reinforced section with vibration.	Low	Slump up to 25 mm, 10-5 Seconds, vee bee time 0.8-0.85 compacting factor.
Concreting of lightly reinforced Section without vibration or heavily reinforced sections with vibration.	Medium	25-75 mm, slump for 20 mm aggregate.
Concreting of heavily reinforced sections without vibration.	High	75-125 mm slump for 20 mm aggregate.

Note - Where considered necessary, the workability of the concrete may also be ascertained by compacting factor test and vee-bee consistometer method as specified in IS: 1199. For suggested ranges of value of workability of concrete by the above methods, reference may be made to IS: 456-2000.

4.2.4. **Transportation** - Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability.

4.2.5. **Placing** - The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains.

4.2.6. **Compaction** - Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical

vibrators shall conform to IS: 2505 specifications for concrete vibrators (immersion type). To prevent segregation, over vibration shall be avoided. The use of mechanical vibrator may be relaxed by the engineer at his discretion for certain items and permit hand compaction. Hand compaction shall be done with the help of tamping rods. Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the engineer in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

4.2.7. Construction joints - Connecting shall be carried out continuously up to construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the engineer. Number of such joints shall be kept minimum and shall be kept as straight as possible.

4.2.7.1. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints, neat cement slurry, of workable consistency by using 2kgs of cement per sq m shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete

4.2.7.2. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against corners and close spots; work, thereafter, shall proceed in the normal way.

4.2.8. Concreting under special conditions

4.2.8.1 **Work in extreme weather conditions** - During hot and cold weather, the concreting shall be done as per the procedure set out in IS: 7861(Part-I) and IS: 7861(Part II) respectively. Concreting shall not be done when the temperature falls below 4.5° C. In cold weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38°C.

4.2.8.2 **Under water concreting** - Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. The concrete shall contain at least 10% more cement than that required for the same mix placed in dry conditions, the quantity of extra cement varying with conditions of placing with prior written permission of the engineer. Such extra cement will be paid extra. The volume of coarse aggregate shall not be less than 1½ times nor more than twice the fine aggregate and slump not less than 100 mm nor more than 180 mm. Where found necessary to deposit any

concrete under water, the method, equipment, materials and mix shall first be got approved by the engineer. Concrete shall be deposited continuously until it is brought to required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of heaps shall be avoided. The concrete shall be deposited under water by one of the approved methods such as Tremie method, drop bottom bucket, bags, grouting etc. as per details given in IS: 456-2000. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way

4.2.9. **Curing** - When the concrete begins to harden i.e. two to three hours after compaction, the exposed surfaces shall be kept damp with moist gunny bags, sand or any other material approved by the engineer 24 hours after compaction, the exposed surface shall be kept continuously in damp or wet conditions by ponding or by covering with a layer of sacking, canvass, Hessian or similar absorbent materials and kept constantly wet for at least 7 days where ordinary Portland cement is used and 10 days, where Portland pozzolana cement is used from the date of placing of concrete. For concrete work with other types of cement, curing period shall be as directed by the engineer.

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set

4.2.9.1 **Freshly laid concrete** shall be protected from rain by suitable covering.

4.2.9.2 **Over the foundation concrete**, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall be continued along with the masonry work for at least 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing of period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

4.2.10. **Testing of concrete** will be done as described in section on R.C.C

4.2.11. **Form work** - Form work shall be as specified in R.C.C section and shall be paid for separately unless otherwise specified.

4.2.12. **Finishes** - Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

4.2.13. **Measurements**

4.2.13.1. Dimensions of length, breadth and thickness shall be measured correct to nearest cm. Except for the thickness of slab and partition which shall be measured to nearest 5 mm. Area shall be worked out to nearest 0.01 square meter and the cubic contents of consolidated concrete shall be worked out nearest 0.001 cubic meters. Any work done in excess over the specified dimension or as required by engineer is ignored.

4.2.13.2. **Concrete work executed** in the following conditions shall be measured separately

- a. At or near the ground level
- b. Work in liquid mud
- c. Work in or under foul positions

4.2.13.3. Cast-in-situ concrete and or precast concrete work shall be measured in stages described in the item of work, such as -

- a. At or near the ground level
- b. Up to specified floor level
- c. Between two specified floor levels
- d. Up to specified height above or depth below plinth level/ defined datum level
- e. Between two specified heights or depths with reference to plinth level / defined datum level

4.2.13.4. **No deduction shall be made for the following -**

- a. Ends of dissimilar materials for example beams, girders, rafters, purlins trusses corbels and steps up to 500sq. cm in cross sections.
- b. Opening up to 0.1sq meter (1000sq.cm).
- c. Volume occupied by pipes, conduits, sheathing etc. not exceeding 100sq cm each in cross sectional areas.
- c. Small voids such as shaded portions in Figure when these do not exceed 40sq cm each in cross section.

Note - In calculating area of opening, the thickness of any separate lintel or still shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

4.2.13.5. **Cast-in-situ concrete** shall be classified and measured as follows -

- a) Foundation, footings, bases for columns
- b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.
- c) Shelves
- d) Slabs
- e) Chajjas including portions bearing on the wall
- f) Lintels, beams and Bressemmers
- g) Columns, piers abutments, pillars, post and struts
- h) Stair case including stringer beams but excluding landings.
- i) Balustrades, newels and sailing
- j) Spiral staircase (including landing)
- k) Arches
- l) Domes, vaults
- m) Shell roof, arch ribs and folded plates
- n) Chimneys and shaft.
- o) Breast walls, retaining, walls, return walls
- p) Concrete filling to precast components

- q) Kerbs, steps and the like
- r) String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like
- s) Cornices and moulded windows sills.
- t) Louvers, fins, fascia.

4.2.13.6. **Precast cement concrete** solid articles shall be measured separately and shall include muse of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:2 (1 cement -2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as under -

Classification	Method of measurement
a. Wall panels	In square meters stating the thickness
b. String or lacing courses, coping, bed plats, plain windows sills, shelves, louvers, steps etc.	In cubic meters
c. Kerbs, edgings etc. In cubic meters	In cubic meters
d. Solid block work	In square meters stating the thickness or in cubic meters.
e. Hollow block work	In square meters stating the thickness or in cubic meters.
f. Light weight Partitions	In square meters stating the thickness or in cubic meters.

SPECIFICATIONS FOR FORMWORK (CENTRING & SHUTTERING)

4.6.2.1 - **Form work** shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

4.6.2.2 - **Design & tolerance in construction** - Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerances given below.

a)	Deviation from specified dimensions of cross section of columns and beams	+ 12 mm
b)	Deviation from dimensions of footings	+ 12 mm
	i) Dimension in plan	+ 50 mm
	ii) Eccentrically in plan	0.02 times the width of the footings in the direction of deviation but not more than 50 mm
	iii) Thickness	+ 0.05 times the specified thickness.

time shall be increased.

Note 6 - Work damaged through premature or careless removal of forms shall be reconstructed.

4.6.2.5. **Surface treatment**

Oiling the surface - Shuttering gives much longer service life in the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections. Typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in case when shuttering has been stored for a long time, it should be recoated with mould oil before the next use. The design of form work shall conform to sound engineering practices and relevant IS codes.

4.6.2.6. Inspection of form work - The completed form work shall be inspected and approved by the engineer before reinforcement bars are placed in position. Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discolouration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by engineer.

Shuttering surface before concreting should be free from any defect / deposits and fully cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and exclusive roughness before use.

4.6.2.7. Erection of form work (centering and shuttering) - Following points shall be borne in mind while checking during erection.

- a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.
- b) Material used should be checked to ensure that, wrong items / rejects are not used.
- c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
 - i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
 - ii) Sole plates shall be properly seated on their bearing pads or sleepers.
 - iii) The bearing plates of steel props shall not be distorted.
 - iv) The steel parts on the bearing members shall have adequate bearing areas.
- d) Safety measures to prevent impact of traffic; scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.
- e) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially

deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing device and bracing shall be tightened.

- f) The stacked materials shall be placed as catered for, in the design.
- g) When adjustable steel props are used, they should -
 - i). Be undamaged and not visibly bent.
 - ii). Have the steel pins provided by the manufacturers for use.
 - iii). Be restrained laterally near each end.
 - iv). Have means for centralizing beams placed in the fork heads.
- h) Screw adjustment of adjustable props shall not be over extended.
- i) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of props occur. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened / clamped down after adjustment to prevent their shifting.
- j) No member shall be eccentric upon vertical member.
- k) The number of nuts and bolts shall be adequate.
- l) All provisions of the design and / or drawings shall be complied with.
- m) Cantilever supports shall be adequate.
- n) Props shall be directly under one another in multistage constructions as far as possible.
- o) Guy ropes or stays shall be tensioned property.
- p) There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.
- q) Required camber shall be provided over long spans.
- r) Supports shall be adequate, and in plumb within the specified tolerances.

4.6.2.8 Measurements

4.6.2.8.1. **General** - The form work shall include the following;

- a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
- b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
- c) Bolts, wire ties, clamps, spreaders, nails or any other items to hold the sheathing together.
- d) Working scaffolds ladders, gangways, and similar items.
- e) Filling to form stop chamfered edges of splayed external angles not exceeding 20 mm wide to beams, columns and the like.
- f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before concrete.
- g) Dressing with oil to prevent adhesion and

h) Raking or circular cutting.

4.6.2.8.2. **Classification of measurements** - Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following -

a). Foundations, footings, bases of columns etc. and for mass concrete and precast shelves, b). Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc. c). Suspended floors, roofs, landings, shelves and their supports and balconies. d). Lintels, beams, girders, Bressummers and cantilevers. e). Columns, pillars, posts and struts. f). Stairs (excluding landing) except Spiral staircase. g). Spiral staircase (including landing). h). Arches. i). Domes, vaults, shells roofs, arch ribs and folded plates. j). Chimneys and shafts. k). Well steining. l). Vertical and horizontal fins individually nor forming box, louvers and bands. m). Waffle or ribbed slabs. n). Edges of slabs and breaks in floors and walls (to be measured in running meters where below 200 mm in width or thickness). o). Cornices and mouldings. p). Small surfaces, such as cantilevers ends, brackets and end of steps, caps and boxes to pilasters and columns and like. q). Chula hoods, weather shades, Chajjas, corbels etc. including edges and r). Elevated water reservoirs.

4.6.2.8.3 **Centering, and shuttering** where exceeding 3.5 meter height in one floor shall be measured and paid for separately.

4.6.2.8.4 **Where it is not specifically stated** in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

4.6.2.8.5. **No deductions from the shuttering** due to the openings / obstructions shall be made if the area of such openings / obstructions does not exceed 0.1 square meters. Nothing extra shall be paid for forming such openings.

4.6.2.8.7 **Rate** - The rate of the form work includes the cost of labour and materials required for all the operations described above.

SPECIFICATIONS FOR REINFORCEMENTS IN CONCRETE

4.6.3.1. **General requirements** - Steel conforming to para 4.6.1.2. for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coatings which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall used for removing the rust.

(1). **Assembly of reinforcement** - Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by engineer. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Over lapping of bars, where necessary shall be done as directed by the engineer. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25 mm or $1 \frac{1}{4}$ times the maximum size of the coarse aggregate whichever is greater. But where

this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. Of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps / splices shall be staggered as per directions of the engineer. But in no case the over lapping shall be more than 50% of cross sectional area at one section.

(2). **Bonds and hooks forming end anchorages** - Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice for bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

a) **U-Type hook** - In case of mild steel plain bars standard U-type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter of the bar

Note-In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawing.

b) **Bends** - Bend forming anchorage to a M.S. plain bar shall be bent with an internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

(3). **Anchoring bars in tension** - Deformed bars may be used without end anchorages provided, development length requirement is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per clause 25.2.1 of IS: 456-2000.

(4). **Anchoring bars in compression** - The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in of IS: 456-2000. The projected length of hooks, bends and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

(5). **Binders, stirrups, links and the like** - In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times the nominal size of bar.

(6). **Welding of bars** - Whenever facility for electric arc welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the engineer. Welding shall be as per IS: 2751 for mild steel bars and for cold worked bars.

4.6.3.2 **Placing in position** - Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the engineer. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Track welding in crossing bars shall also be permitted in lieu of bending with steel wire if approved by engineer.

The bars shall be kept in correct position by the following methods -

a) In case of beam and slab construction precast cover blocks of cement mortar 1:2

about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.

b) In case of cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 meter or at shorter spacing to avoid sagging.

c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of cement mortar 1:2 of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.

d) In case of R.C.C. structure such arches, domes, shells, storage tanks etc. a combination of cover blocks, spaces and templates shall be used as directed by engineer.

Tolerance on placing of reinforcement - Unless otherwise specified by the engineer, reinforcement shall be placed within the following tolerances -

Tolerance in spacing

		Tolerance in spacing
a)	For effective depth 200 mm or less	± 10
b)	For effective depth More than 200 mm	± 15

The cover shall in no case be reduced by more than one third of specified cover or 5 mm which ever is less.

Bending at construction joints - Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bars diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bars is not damaged.

4.6.3.3. **Measurements** - Reinforcement including authorised spacer bars and laps shall be measured in length of different diameters, as actually (not more than as specified in the drawings.) used in the work nearest to a centimeter and their weight calculated on the basis of standard weight given in Table 14 below. Wastage and unauthorized overlaps shall be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate reinforcement.

Wherever tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the engineer and measured separately and paid for.

Table 14 Cross-sectional area and mass of steel bar

Nominal size mm	Cross sectional area sq.mm	Mass per meter run kg
6	28.3	0.222
7	38.5	0.302
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
18	254.6	2.00
20	314.3	2.47
22	380.3	2.98
25	491.1	3.85
28	616.0	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.85
45	1591.1	12.50
50	1964.3	15.42

Note - These are as per clause 5.2 of IS 1786.

4.6.3.4. **Rate** - The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, as required of directed including tack welding on crossing of bars in lieu of binding with wires.

5. Technical Specifications of BOQ Item no.5 for O₃ Analyzer

Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Sulphur Dioxide (SO₂) Analyzer suitable for 230 V, 50 Hz. power supply, built-in solenoid valve for manual/ auto calibration, built-in zero air scrubber for zero calibration, Colour Touchscreen display, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System.

Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB)

The Analyzer shall be approved by International Certifying Agencies/Authorities such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender"

- 1). Improved West and Geake method or
- 2). Ultra Violet Fluoresce

6. Technical Specifications of BOQ Item no.6 for NO, NO₂, NOX Analyzer,

Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Oxides of Nitrogen (NO/NO₂ / NO_x) Analyzer suitable for 230 V, 50 Hz. power supply, built-in solenoid valve for manual/ auto calibration, Colour Touch screen display, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB)

The Analyzer shall be approved by International Certifying Agencies/Authorities such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender"

- 1). Jacob & Hochheiser modified (NaOH-NaAsO₂) method or
- 2). Gas Phase Chemillunescence

7. Technical Specifications of BOQ Item no.7

Supply, Errection, Installation, Testing and Commissioning of Continuous Ozone Analyzer 230V, 50 Hz .Power supply, internal solenoid valve block for zero air and span gas, Ethernet TCP/IP port & USB Port for comunication with data aquisition system. approved Methdology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) .

The Analyzer shall be approved by International Certifying Agencies/Authorities such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as

mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender”

- UV Photometric
- Chemiluminescence
- Chemical Method

8. Technical Specifications of BOQ Item no.8 for VOC Analyzer

Supply, Erection, Installation, Testing and Commissioning of Continuous Ambient VOC Analyzer suitable for measurement of Benzene, Toulene, Ethylyne Benzene, o-m-p Xylene, 230V, 50 Hz Power supply, built in solenoid valve for manual/auto calibration, built in zero air scrubber for zero calibration & Ethernet TCP/IP port for serial communication with data acquisition system.

Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board (CPCB)

The Analyzer shall be approved by International Certifying Agencies/Authorities such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender”

- 1)-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis or
- 2) Spectroscopy

9. Technical Specifications of BOQ Item no.9

Nitrogen Cyylander 47 Liters capacity, Built in carbon steel with regulator for carrier Gas for PID

10. Technical Specifications of BOQ Item no.10

Calibration Gas Cyylander Made of Aluminium with SS Regulator & Valve One Cylinder for Each Gas) for Benzene

11. Technical Specifications of BOQ Item no.11

Calibration Gas Cyylander Made of Aluminium with SS Regulator & Valve One Cylinder for Each Gas) for Nitrogen (N2)

12. Technical Specifications of BOQ Item no.12 for CO Analyzer

Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Carbon Monoxide (CO) Analyzer with Gas Filter Co-relation suitable for 230 V, 50 Hz. power supply, built-in solenoid valve for manual/ auto calibration, built-in zero air scrubber for zero calibration, Colour Touchscreen display, Ethernet TCP/IP Port & USB

Port for communication with Data Acquisition System. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB)

The Analyzer shall be approved by International Certifying Agencies/Authorities such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender”

- 1) Non dispersive Infrared(NDIR) or
- 2) Spectroscopy

13. Technical Specifications of BOQ Item no.13 for PM_{2.5} Analyzer

Supply, Errection, Installation, Testing and Commissioning of Automatic PM2.5 Particulate Matter Monitor with LCD Display suitable for 230V AC, 50 Hz. Power supply with C-14 Radioactive source, Pump, PM10 Inlet & Standard foil for calibration, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System including Sampling Inlet.

Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB)

The Analyzer shall be approved by International Certifying Agencies/Authorities such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender”

- 1) Gravimetric or
- 2) TEOM or
- 3) Beta attenuation

14. Technical Specifications of BOQ Item no.14 for PM₁₀ Analyzer

Supply, Errection, Installation, Testing and Commissioning of Automatic PM10 Particulate Matter Monitor with LCD Display suitable for 230V AC, 50 Hz. Power supply with C-14 Radioactive source, Pump, PM10 Inlet & Standard foil for calibration, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System including Sampling Inlet.

Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board (CPCB)

The Analyzer shall be approved by International Certifying Agencies/Authorities

such as US-EPA and TUV QAL-1. The Equipment Model shall be enlisted in the official website Published by the i.e Approving Agencies/Authorities in their official website. Detailed method of verification in the internet website shall be as mentioned in the page no 10(c), and at page no 21(c) in the MQC part of the Tender”

- 1) Gravimetric or
- 2) TEOM or
- 3) Beta attenuation

15. Technical Specifications of BOQ Item no.15

Supply, Errection, Installation, Testing and Commissioning of Multi calibration System for Gas calibration and Meteorological, Flow and Electronic Calibration

101 suitable for 230V AC, 50 Hz. with the following:

- Mass Flow Controller based for Dilution air & Span Gas
- Inlet ports for external span gases
- RS 232 interface
- In built Zero air generator

16. Technical Specifications of BOQ Item no.16

Supply, Errection, Installation, Testing and Commissioning of Calibration Gas Cylinder made of Aluminium with SS regulator & valve

(1 Cylinder for each Gas) for following Gases:

Note: (The supplier has to supply the calibration gas cylinder (highly polished aluminium 10 liters water capacity), along with SS Regulator, traceable to NIST for each components (SO₂, NO, CO, NH₃) along with SS regulator for the multipoint calibration).

17. Technical Specifications of BOQ Item no.17

Supply, Errection, Installation, Testing and Commissioning of Gas Sampling System & Hood; Gas Sampling system consisting of SS gas sample inlet, peltier based moisture removal facility, manifold & tubings to the analyzers. (Sampling System having 10 port manifold)

18. Technical Specifications of BOQ Item no.18

Supply, Errection, Installation and Commissioning of Standard 19” Rack Cabinet (Double Bay Rack) with Telescopic slides, Overload protection, Power Distribution box, Cooling fans, Dust filters & pneumatic plumbing to accommodate Analyzer, Calibrator & Accessories (19” Rack cabinet to accommodate all analyzers & systems)

19. Technical Specifications of BOQ Item no.19

Supply, Errection, Installation, Testing and Commissioning of 1.5 Tons Split Type Air Conditioners with auto switch over circuit of approved make air Conditioner, Split Type, Wall mounted along with voltage stabilizer (2 X 2 ton, 1 X 1 Ton) at the CAAQM Station

20. Technical Specifications of BOQ Item no.20

Supply, Errection, Installation, Testing and Commissioning of UPS, Capacity 6 KVA, 230 VAC, 50 Hz. Make: Vertiv/ APC/ Uniline or equivalent make with 1 hrs battery backup for all the Analysers only

On line UPS (1X10KVA, 1 hr. back up and 1X5 KVA, 2 hr. back up) at the CAAQM Station (UPS is only for Analyzers and DAS & not for Air conditioners.)

21. Technical Specifications of BOQ Item no.21

Supply, Errection, Installation, Testing and Commissioning of Meteorological Sensors for Wind Direction, Wind Speed, Ambient Temperature, Rainfall, Relative Humidity, Solar Radiation and Telescoping Crank – up Meteorological Tower, Weather Monitoring Station, consisting of the following Parameters,

- a) Wind Speed Sensor
- b) Wind Direction Sensor
- c) Relative Humidity Sensor
- d) Ambient Temperature Sensor
- e) Precipitation (Rain) Gauge
- f) Solar Radiation Sensor
- g) Barometric Pressure Sensor
- h) Meteorological Tower
- i) Interface Unit

22. Technical Specifications of BOQ Item no.22

Supply, Errection, Installation, Testing and Commissioning of Data Acquisition System (DAS): Local Data Logger -Central Management Software with License w.r.t. Data Acquisition: PC based Data Acquisition System with necessary Licensed Software suitable for Storing, Logging, Reporting, Printing data from above offered Analyzers. PC with specifications as under: Computer System for DAS and Computer System for AQI; ; I3 Processor, 4 GB RAM, 1 TB HDD, CD/DVD Combo Drive, 19" LED Monitor, USB, LAN ports, Standard WINDOWS Operating System, standard keyboard, mouse with pad and Color Laser printer Colour MFP, 24Ports CISCO Switch including Remote Calibration & Validation Software and Remote Connectivity Tool/Software.

23. Technical Specifications of BOQ Item no.23

Supply, Errection, Installation, Testing and Commissioning of Central Management Software with License w.r.t. Data Acquisition:

Data Acquisition System (DAS): Central Data Logger - PC based Data Acquisition System with Suitable Licensed Software suitable for Storing, Logging, Reporting, Printing data, Validation and communicating with above offered Local DAS. PC with specifications as under: Computer System for DAS and Computer System for AQI; i5 Processor, 6 GB RAM, 1 TB HDD, CD/DVD Combo Drive, 19" LED Monitor, USB, LAN ports, Standard WINDOWS Operating System, standard keyboard, mouse with pad and Color Laser printer Colour MFP, 24 Ports CISCO Switch including Remote Calibration & Validation Software and Remote Connectivity Tool/Software.

24. Technical Specifications of BOQ Item no.24

Supply, Errection, Installation, Testing and Commissioning of 4'x12', LED Display Board with connectivity Three line Display board with Day & Night Visible Data Display Board including Data display Board Transmission Device

25. Technical Specifications of BOQ Item no.25

Supply, Errection, Installation and Commissioning of Structural work for Display board (Max. Height 5 Feet) from Ground in main gate.

26. Technical Specifications of BOQ Item no.26

Supply, Errection, Installation, Testing and Commissioning of Data connectivity to SPCB & CPCB server.

27. Technical Specifications of BOQ Item no.27

Charges for Installation & Commissioning of the CAAQMS System at site.

28. Technical Specifications of BOQ Item no.28

Charges for the spares / Consumables and gas refilling during the Operation and Maintenance Contract of 5 years which rekons from the date of completion / Commissioning of the subject work.

29. Technical Specifications of BOQ Item no.29

Charges for Deploying One operator (Graduate Engineer/Diploma Engineer) & One Unskilled Worker (Assistant to the operator, House Keeping Etc) during Operation and Maintenance Contract for 5 years after commissioning of the CAAQMS System.

Note: The weekly Off of Both the persons shall be staggered since the system has to work all 365 days of an year.

RELEVANT BIS CODE FOR TECHNICAL SPECIFICATION

S. No.	IS Code	Description
<u>A. EARTHWORK IN EXCAVATION AND BACKFILLING</u>		
1	IS: 783	Code of Practice for laying of concrete pipes.
2	IS: 1200 (Part 1)	Method of measurement of building and civil engineering works - Earth Work.
3	IS: 1489	Specification for Portland Pozzolana Cement
4	IS:2720 (All Parts)	Methods of test for soils.
5	IS:2809	Glossary of terms and symbols relating to soil engineering.
6	IS:3764	Safety code for excavation work.
7	IS:4081	Safety code for blasting and related drilling operations.
8	IS:4988 (All Parts)	Glossary of terms and classifications of earth moving machinery.
<u>B. PLAIN, REINFORCED AND PRESTRESSED CONCRETE</u>		
1	IS: 269	Specification for 33 Grade Ordinary Portland Cement.
2	IS: 303	Specification for Plywood for General Purpose.
3	IS: 383	Specification for Coarse and Fine Aggregates from Natural Source for Concrete.
4	IS: 432 (All Parts)	Specifications for Mild Steel and Medium-tensile Steel Bars and Hard-drawn Steel Wire for Concrete Reinforcement.
5	IS: 432 (Part- I)	Mild Steel and Medium-tensile Bars.
6	IS: 432 (Part - II)	Hard-drawn Steel Wire.
7	IS: 455	Specification for Portland Slag Cement.
8	IS: 456	Code of Practice for Plain and Reinforced Concrete.

9	IS: 460	Specification for Test Sieves.
10	IS: 515	Specification for Natural and Manufactured Aggregates for use in Mass Concrete.
11	IS: 516	Methods of Tests for Strength of Concrete.
12	IS: 650	Standard Sand for Testing of Cement.
13	IS:1199	Sampling and Analysis of Concrete.
14	IS:1200	Method of Measurement of Building Works.
15	IS:1489	Specification for Portland Pozzolana Cement.
16	IS:1542	Sand for Plaster.
17	IS:1566	Specification for Hard-drawn Steel Wire Fabric for Concrete Reinforcement.
18	IS:1785	Specification for Plain Hard-drawn Steel Wire for Prestressed Concrete (Part - I) - Cold Drawn Stress Relieved Wire.
19	IS:1786	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
20	IS:1791	Batch Type Concrete Mixers.
21	IS:2386	Methods of Test for Aggregates for Concrete (8 Parts).
22	IS:2502	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.
23	IS:2505	General Requirements for Concrete Vibrators.
24	IS:2506	General Requirements for Screed Board Concrete Vibrators.
25	IS:2722	Specification for Portable Swing Weigh Batcher (single and double bucket type).
26	IS:2911	Code of Practice for Design and Construction of Pile Foundation.
27	IS:3366	Pan Vibrators.
28	IS:3558	Code of Practice for the use of Immersion Vibrators for Consolidating Concrete.
29	IS:3370	Code of Practice for Concrete Structures for the (All Parts) Storage of Liquids.
30	IS:4656	Form Vibrators for Concrete.

31	IS:5525	Recommendation for Detailing of Reinforcement in Reinforced Concrete Works.
32	IS:5640	Method of Test for Determining Aggregate Impact Value of Soft, Coarse Aggregate.
33	IS:5816	Method of Test for Splitting Tensile Strength of Concrete Cylinder.
34	IS:6006	Specification for Uncoated Stress Relieved Strand for Prestressed Concrete.
35	IS:6461	Cement Concrete: Glossary of Terms.
36	IS:8041	Specifications for Rapid Hardening Portland Cement.
37	IS:8043	Specifications for Hydrophobic Cement.
38	IS:8112	Specification for 43 Grade Ordinary Portland Cement.
<u>C. STEEL REINFORCEMENT</u>		
1	IS:1785	Cold Drawn Stress relieved wire (Part I).
2	IS:1786	Specification for Cold Twisted Steel Bars for Concrete Reinforcement.
3	IS:2751	Code of Practice for Welding of M.S.Bars.
4	IS:5525	Recommendation for detailing of Reinforcement in Reinforced Concrete Works.
5	IS:6006	Uncoated Stress Relieved Strand for Prestressed Concrete.
6	IS:14268	Specifications for uncoated stress Relieved Low Relaxation Seven Ply Strand for Prestressed Concrete.
7	IS:800	General Construction in Steel
8	IS:816	Metal-arc welding for general construction in mild steel
9	IS:817	Training & Testing of metal-arc welders
10	IS:226	Structural Steel Sections
11	IS:2062	Weldable Structural Steel
12	IS:814	Welding Electrodes
13	IS:919	Recommendations for limits and fits for Structural Engineering.
14	IS:1477	Code of Practice for painting of ferrous metals in buildings.
15	IS:1977	Structural Steel (Ordinary quality)

16	IS:7205	Safety Code for erection of structural steel work
17	IS:7215	Tolerances for fabrication of steel structures
18	IS:8500	Weldable structural steel (medium and high strength qualities).
<u>G. STEEL, ALUMINIUM AND IRON WORK</u>		
1	IS:1956	Glossary of terms relating to iron and steel.
2	IS:814 (Part I)	Specifications for covered electrodes for metal arc welding of structural steel - For welding products other than sheets.
3	IS:814 (Part II)	Specifications for covered electrodes for metal arc welding of structural steel - For welding sheets.
4	IS:815	Classification and Coding of covered electrodes for metal arc welding of structural steel.
5	IS:818	Code of Practice for safety and health requirements in electric and gas. welding and cutting operations.
6	IS:1182	Recommended Practice for Radiographic examination of fusion welded butt joint in steel plates.
7	IS:1148	Specification for Rivet Bars for structural purposes.
8	IS:816	Code of Practice for use of metal arc for general construction in mild steel.
9	IS:3600	Method of testing fusion welded joints and weld metal in steel.
10	IS:6227	Code of Practice for use of metal arc welding in tubular structure.
11	IS:6248	Specifications for metal rolling shutter and rolling grill.
12	IS:1081	Code of Practice for fixing and glazing of metal (steel and aluminium) Doors, Windows and Ventilators.
13	IS:1361	Specifications for steel windows for Industrial Buildings.
14	IS:1200 (part VIII)	Method of Measurement of steel work and iron work
15	IS:1038	Specifications for steel doors, windows and ventilators.
16	IS:226	Specifications for structural steel (Standard Quality).
17	IS:823	Code of Procedure for manual metal arc welding of metal steel.

18	IS:102	Ready mixed paint, brushing, red lead non-sitting, priming.
19	IS:1363	For black hexagonal bolts, nuts and lock-nuts (dia 6 to 39 mm) & black hexagonal screws (dia 6 to 24 mm)
20	IS:813	Scheme of symbols for welding.
21	IS:817	Code of Practice for training and testing of metal arc welders. (Revised)
22	IS:800	Code of Practice for use of structural steel in general building construction.

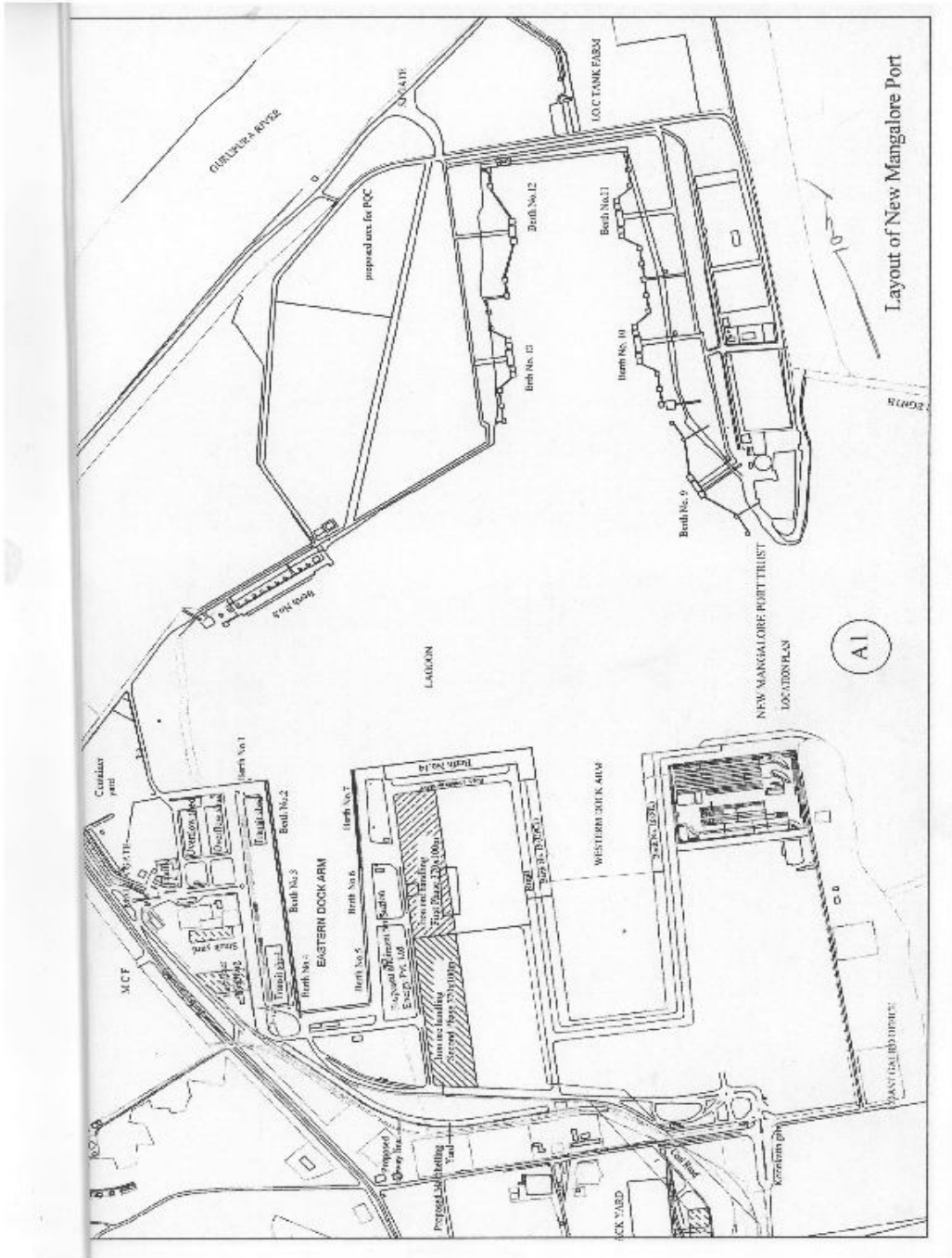
SECTION V

DRAWINGS

Brief Description of drawing

The Works are shown in the following drawings that are issued as a part of the Tender Documents:

Sl. No	Drawing No.	Description
1	3/14/CAAQM/CE(C)/2021-22/TS-LP1	LOCATION PLAN



Sl No	Drawing No.	Description
1	3/14/CAAQM/CE(C)/2021-22/TS-LP1	LOCATION PLAN



**NEW MANGALORE PORT AUTHORITY
Panambur, Mangalore**

**"SUPPLY, ERRECTION,INSTALLATION, TESTING AND COMMISSIONING
OF CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT
NMPA-RETENDER"**

**TENDER DOCUMENT
Volume - III**

BILL OF QUANTITIES

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VOLUME III**SECTION VI****(i) PREAMBLE TO BILL OF QUANTITIES****1. General Instructions****1.1 General**

- 1.1.1 This Bill of Quantities must be read with the Drawings, Conditions of Contract and the Specifications, and the Contractor shall be deemed to have examined the Drawings, Specifications, Conditions of Contract and to have acquainted himself with the detailed descriptions of the Works to be done, and the way in which they are to be carried out.
- 1.1.2 Notwithstanding that the work has been sectionalized every part of it shall be deemed to be supplementary to and complementary of every other part and shall be read with it or into it so far as it may practicable to do so.
- 1.1.3 The detailed descriptions of work and materials given in the Specifications are not necessarily being repeated in the Bill of Quantities.
- 1.1.4 The Contractor shall be deemed to have visited the Site before preparing his tender and to have examined for himself the conditions under which the work will proceed and all other matters affecting the carrying out of the works and cost thereof.
- 1.1.5 The Tenderer will be held to have familiarised himself with all local conditions, in so far as they affect the work, means of access and the locality of existing services, in order to execute the Works measured and described hereinafter. No claims for want of knowledge in this respect will be reimbursed.

1.2 Rates and Prices to be Inclusive

- 1.2.1 Rates and prices set against items are to be the all inclusive value of the finished work shown on the Drawings and/or described in the Specification or which can reasonably be inferred there from and are to cover the cost of provision of

plant, labour, supervision, materials, test charges, freight, transportation, erection, installation, performance of work, care of works, insurance, maintenance, overheads and profits and every incidental and contingent cost and charges whatsoever including taxes if any excluding GST including every kind of temporary work executed or used in connection therewith (except those items in respect of which provision has been separately made in the general condition of contract) and all the Contractor's obligations under the Contract and all matters and things necessary for the proper completion and maintenance of the Works.

- 1.2.2 The rates and prices set down against the items are to be the full inclusive value of the finished work shown on the Drawing and/or described in the Specification or which can reasonably be inferred the reform and to cover the cost of every description of Temporary Works executed or used in connection therewith (except those items in respect of which specific provision has been separately made in these Bills of Quantities) and all the Contractor's obligations under the Contract including testing, giving samples and all matters and things necessary for the proper execution, completion and maintenance of the Works.
- 1.2.3 The Specifications are intended to cover the supply of material and the execution of all work necessary to complete the works. Should there be any details of construction or material which have not been referred to in the Specifications or in the Bill of Quantities and Drawings, but the necessity for which may reasonably be implied or inferred there from, or which are usual or essential to the completion of all works in all trades, the same shall be deemed to be included in the rates and prices entered in the Bill of Quantities. The rates and prices are to cover the item as described in the Bill of Quantities and if there is inconsistency in the description between the Bill of Quantities, Specifications or Drawings, the interpretation will be done according to General Conditions of Contract.
- 1.2.4 The quantities given in the Bill are approximate and are given to provide a common basis for tendering. They are not

to be taken as a guarantee that the quantities scheduled will be carried out or required or that they will not be exceeded. The Employer / Engineer reserves the right to delete any item and / or increase / reduce quantities indicated in the Bills of Quantities at any time. Payment will be made according to the actual quantities of work ordered and carried out in the contract. However, the rates quoted shall be valid for any extent of variation in quantity of each individual item provided that the total contract value does not get altered by more than indicated in conditions of contract. No claim whatsoever for extra payment due to variation of quantities within the above said limit would be entertained.

1.2.5 The drawings for tender purposes are indicative only of the work to be carried out. However, the Tenderer must allow within his price for the items of work included in the Tender Documents for the details which will appear on subsequent drawings developed for construction purposes. Rate and price shall include any additional design/ detailing to be carried out by contractor.

1.2.6 The rates and prices shall include (except where separate items are given) for the provision and operation of the following items, for compliance with the Conditions of Contract, Special Conditions, the specifications and Tender drawings:

- i) Supervision and labour for the Works;
- ii) All materials, installation/erection, handling and transportation;
- iii) All Contractor's Equipment;
- iv) All testing, commissioning, insurance, maintenance, security, welfare facilities, overheads and profit and every incidental and contingent costs and charges whatsoever including;
- v) All temporary fencing, watching, lighting, sanitary accommodation, general security arrangements, welfare facilities and first aid provision;
- vi) Provision and maintenance of Contractor's site offices, cabins, huts, maintenance and storage areas;
- vii) Taxes if on the transfer of property in goods in the

- execution of works, other than GST, Customs Duty for materials to be permanently incorporated into the Works);
- viii) All necessary temporary services including fresh water, compressed air lines, electrical cabling and switchgear, telephone, walkie-talkie and facsimile facilities;
 - ix) The maintenance of all Contractor's services;
 - x) All insurances for the Works;
 - xi) Allowance for complying with all environmental aspects as specified;
 - xii) Detail design of components of temporary works, wherever necessary as directed by Engineer.

1.4 Method of Measurement

1.4.1 Measurement of Work shall be in accordance with IS 1200 and shall be net off the dimensions of the works shown on the drawings except as mentioned below:

1.4.2 Units of Measurement: The units of measurement used in this Bill of Quantities are in metric units as follows:

- i) Linear: Linear metre, centimeter or millimeter abbreviated to 'Rm', 'cm' or 'mm' respectively.
- ii) Superficial: Square metre or Square centimeter abbreviated to 'Sq.M' or 'sq.cm' respectively.
- iii) Volumetric: Cubic metre abbreviated to 'cu.m'. Litre abbreviated to 'L'
- iv) Weight: Tonne = 1000 Kilograms, abbreviated to 'T', / 'MT' Kilogram abbreviated to 'kg'
- v) Numbers: Numbers abbreviated to Nos. or No.
- vi) Lump sum: Lump sum abbreviated to 'L.S.'

1.5 Currency

1.5.1 All monetary reference herein and the Bill of Quantities shall be priced in Indian Rupee Currency.

2. Civil Works

2.2 Precast Concrete

2.2.1 Shuttering for precast concrete shall not be measured and paid for separately.

- 2.2.2 Effort for placement of precast concrete at the final locations shall not be measured unless a specific item is provided in the Bill of Quantities.
- 2.2.3 The precast concrete units shall be measured as shown on the detailed drawings.
- 2.3 In-situ Concrete
 - 2.3.1 Shuttering for In-situ concrete shall not be measured and paid for separately.
 - 2.3.2 No deduction will be made for chamfers smaller than 50 sq.cm. sectional area, reinforcement bolts and other embedded parts unless larger than 0.1 sq.m. sectional area and 0.03 cu.m. in volume. No extra volume will be measured for splays or fillets smaller than 50 sq.cm. sectional area.
 - 2.3.3 The rates for reinforced concrete shall include for all batching, mixing, transporting, hoisting or lowering to any height / depth, placing in position and compaction in work of any sectional area or thickness including shuttering, forming necessary construction joints, shear keys and stop ends, and for curing and protecting etc. all as specified.
 - 2.3.4 The rates shall include for preparing construction joints, shear keys and surfaces against which next stage concrete is to be cast and building in fittings including pipes and bolts except where specifically billed separately. No separate payment will be made for making openings/pockets/pits of any size and shape. Where surfaces are to receive finishes the rates shall include for leaving the surface rough or for hacking and roughening the surface to form a key.
 - 2.3.5 Unless otherwise noted, rates shall include for inserting pipes and other inserts in position accurately, concreting while they are in position and also for protecting the same as the work proceeds.
 - 2.3.6 Unless otherwise noted, the rates for concrete items shall include for finishing the top surface to levels and slopes and surface finish as specified. Rates for concrete shall include for finishing the slab to specified slope towards drains, etc.

2.4 Reinforcement

2.4.1 Steel reinforcement will be measured by weight and fixed in accordance with Drawings and Specifications. The weight of reinforcement bars -whether plain, deformed or ribbed etc., -of various diameters will be calculated in accordance with Table 1 of IS:1732 'Dimensions for Round and Square Steel Bars for Structural and General Engineering Purposes'.

2.4.2 The rates shall include for cutting, welding laps, and waste, straightening short and long lengths, bending, fixing, rolling margin and the provision of spacer bars or support, chairs, binding wire, saddles, forks and all dense concrete spacer blocks, etc., including preparing bending schedules from the Drawings.

2.4.3 The rates shall include for all necessary descaling, wire brushing and cleaning to remove all rust and mill scale, dirt, grease and other deleterious matter before fixing and whilst still exposed during construction.

2.5 Structural and Miscellaneous Steel work

2.5.1 Rates for structural steel work and iron work shall include supply, fabrication, delivery and erection/embedment in concrete at Site and all charges for welding, cutting, bending, bolting, site connections, fixing to foundations.

2.5.2 The rates for Structural Steelwork shall include:

- i) Supply, fabrication, delivery and erection
- ii) Rolling margin, cutting and waste, weld metal, bolts, fixings and fittings
- iii) Hoisting, drilling, bolting or welding and fixing in the manner specified or indicated in the drawing
- iv) Fabrication drawings
- v) Welding trials and tests
- vi) Erection trials
- vii) Protective treatment (painting, hot dip galvanizing etc), including making good any damage if provided in the BOQ item.

2.5.3 Metalwork items are described in the Bills of Quantities and the Tenderer is to include for all the fittings, etc., described. All items shall include the necessary fabrication, joints, angles, intersections and ends, all bolts or fixing lugs, all hoisting and scaffolding required and casting in fixings or later cutting out or forming pockets for same, grouting, supporting and making

good.

2.5.4 Rates are to include for all necessary scaffolding, working over water and at any height staging and hoisting and tarpaulin or other protective covers and the cleaning and removal of paint stains and spots, etc.

3.4.1 The Contractor's unit rates and prices shall include all equipment, apparatus, material indicated in the Drawings, and/or Specifications in connection with the item in question and also associated labour as well as all additional equipment, apparatus, material, consumables usually necessary to complete the system even though not specifically shown, described or otherwise referred to and also associated labour.

3.4.2 The rate for providing and fixing above items shall include all fittings, fixtures, base and sole plates, anchor bolts, including epoxy grouting, etc. all complete as specified, including the necessary additional supervision to ensure accurate alignment

3. Abbreviations

4.1.1 The following abbreviations are used in the Specifications and Bill of Quantities:

IS :	Indian Standard
BS :	British Standard
Qty. :	Quantity
mm :	Millimeters
cm :	Centimeters
M / m / MTR :	Meters
LM :	linear metre
LS :	lump sum
Rs. :	Rupees
P. :	Paise
Nos. :	Numbers
do :	Ditto
MS :	mild steel
T :	Tones
Kg :	Kilogram
EO :	Extra over (previous sum unless specified otherwise)
sq.m. /m ² /SQMT:	square metre
sq.cm. :	square centimeters

mm ² :	Square Millimetre
Cu.m/CUM. :	cubic meters
YST :	yield stress
dia :	Diameter
wt. :	Weight
Drg.No.:	drawing number
max. :	Maximum
min :	Minimum
approx :	Approximately
n.e.:	not exceeding
incl:	Including
circ:	Circular
set :	set / sets
c/c	centre to centre
@ :	at the rate of

ii) BILL OF QUANTITIES

NAME OF WORK : SUPPLY, ERRECTION, INSTALLATION, TESTING AND COMMISSIONING OF CONTINUOUS AMBIENT AIR QUALITY MONITORING SYSTEM AT NMPA-RETENDER.

Item No	DESCRIPTION OF ITEM	QTY	UNIT	RATE IN figures	AMOUNT (Rs. Ps.)
1	<p>Analyzer Shelter; Supply, Errection, Installation, Testing and Commissioning of Housing/ Container: It is designed for housing the ambient air quality monitoring instruments to protect them from dust and heat. Temperature and Humidity sensors shall be installed in the housing for checking the humidity and temperature inside the station as Below, Continuous Automatic Monitoring Stations with Sampling line, Internal fitting, Instruments racks, Electrical fittings and Gas line fittings, Tools (electrical and mechanical), Data display system, Recommended spares in a Housing Container as mentioned further, Continuous Automatic Monitoring Stations with Sampling line, Internal fitting, Instruments racks, Electrical fittings and Gas line fittings, Tools (electrical and mechanical), Data display system, Recommended spares without a Housing Container</p> <p>Dimensions: Inside length: 3000 mm Inside width: 3000 mm Inside height: 2700 mm</p> <p>With the following Minimum Requirements, Supply, Errection, Installation and Commissioning of Analyzer Shelter as below:</p> <ul style="list-style-type: none"> • Size: 3mtr(W) x 3 mtr (L) x 2.7 mtr(H) • MOC: 1.2 mm thick SS sheet (External walls) & 1.2 mm thick GI sheet (Internal walls) • Door – One main door • Insulation Thickness – 80mm with PUF insulation • Roof thickness – 100mm with PUF • Flooring – Anti slip sheet • Lighting inside shelter at minimum of 300lux 	1.00	Set	6,50,000.00	6,50,000.00

	<ul style="list-style-type: none"> • External dome lighting shall be under the overhangs • Fire Extinguisher – 2 Nos. As directed by the Department. 				
2	<p>KSRB 4.2.3 : Providing and laying in position reinforced cement concrete of nominal mix 1:2:4 with 20mm and down size graded granite metal, machine mixed, concrete laid in layers not exceeding 15CMS thick, vibrated for all works in foundation plinth and ground floor level for retaining walls, return walls, walls (any thickness) including attached plasters, columns, piers, abutments, pillars, posts, struts, buttresses, string or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window cills, fillets etc.,, including cost of all materials, labour, HOM of machinery, curing, complete as per specifications. Specification No. KBS 4.1, 4.6</p>	45.00	Cum	6,431.00	2,89,395.00
3	<p>KSRB 4-6.1 : Providing and removing centering, shuttering, strutting, propping etc., and removal of form work for foundations, footings, bases of columns for mass concrete including cost of all materials, labour complete as per specification. Specification No. KBS 4.6.2</p>	72.00	Sqm	263.00	18,936.00
4	<p>KSRB 4.9.2 : Providing T.M.T steel reinforcement for R.C.C works including straightening, cutting, bending, hooking, placing in position, lapping and or welding wherever required, tying with binding wire and anchoring to the adjoining members</p>	4.50	MT	70782.00	3,18,519.00

	wherever necessary complete as per design (laps, hooks and wastage shall not be measured and paid) cost of materials, labour, HOM of machinery complete as per specifications. Specification No. KBS 4.6.3 TMT Bars Fe500.				
5	Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Sulphur Dioxide (SO ₂) Analyzer suitable for 230 V, 50 Hz. power supply, built-in solenoid valve for manual/ auto calibration, built-in zero air scrubber for zero calibration, Colour Touchscreen display, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) 1). Improved West and Geake method or 2). Ultra Violet Fluoresce	1.00	Set	7,15,000.00	7,15,000.00
6	Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient Oxides of Nitrogen (NO/NO ₂ / NO _x) Analyzer suitable for 230 V, 50 Hz. power supply, built-in solenoid valve for manual/ auto calibration, Colour Touch screen display, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control	1.00	Set	7,15,000.00	7,15,000.00

	Board(CPCB) 1). Jacob & Hochheiser modified (NaOH-NaAsO ₂) method or 2). Gas Phase Chemilluninescence				
7	Supply, Errection, Installation, Testing and Commissioning of Continuous Ozone Analyzer , 230V, 50 Hz .Power supply, internal solenoid valve block for zero air and span gas, Ethernet TCP/IP port & USB Port for communication with data aquisition system. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) -UV Photometric -Chemiluminescence -Chemical Method	1.00	Set	7,54,100.00	7,54,100.00
8	Supply, Errection, Installation, Testing and Commissioning of Continuous Ambient VOC Analyzer suitable for measurement of Benzene, Toulene, Ethylyne Benzene, o-m-p Xylene, 230V, 50 Hz Power supply, built in solenoid valve for manual/auto calibration, built in zero air scrubber for zero calibration & Ethernet TCP/IP port for serial communication with data aquisition system. Approved Metodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) 1)-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis	1.00	Set	19,94,200.00	19,94,200.00

	or 2) Spectroscopy				
9	Nitrogen Cylinder 47 Liters capacity, Built in carbon steel with regulator for carrier Gas for PID	2.00	Set	45,000.00	90000.00
10	Calibration Gas Cylinder Made of Aluminum with SS Regulator & Valve One Cylinder for Each Gas) for Benzene	1.00	Set	45,170.00	45,170.00
11	Calibration Gas Cylinder Made of Aluminium with SS Regulator & Valve One Cylinder) for Nitrogen (N2)	1.00	Set	45,000.00	45,000.00
12	Supply, Errection, Installation, Testing and Commissioning of Continuous Carbon Monoxide(CO) Analyzer, with gas filter Co-relation suitable for 230V, 50 Hz .Power supply, Built in solenoid valve block for Auto/Manual calibration built in zero air scrubber for calibration, zero air and span gas, Ethernet TCP/IP port & USB Port for communication with data aquisition system. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) -Non dispersive Infrared (NDIR)	1.00	Set	5,30,000.00	5,30,000.00
13	Supply, Errection, Installation, Testing and Commissioning of Automatic PM2.5 (Particulate Matter) Monitor with LCD Display suitable for 230V AC, 50 Hz. Power supply with C-14 Radioactive source, Pump, PM10 Inlet & Standard foil for calibration, Ethernet TCP/IP Port & USB Port for communication with	1.00	Set	13,00,770.00	13,00,770.00

	Data Acquisition System including Sampling Inlet. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) 1) Gravimetric or 2) TEOM or 3) Beta attenuation				
14	Supply, Errection, Installation, Testing and Commissioning of Automatic PM10 (Particulate Matter) Monitor with LCD Display suitable for 230V AC, 50 Hz. Power supply with C-14 Radioactive source, Pump, PM10 Inlet & Standard foil for calibration, Ethernet TCP/IP Port & USB Port for communication with Data Acquisition System including Sampling Inlet. Approved Methodology of Measurement as per NAAQS 2009 approved by Central Pollution Control Board(CPCB) 1) Gravimetric or 2) TEOM or 3) Beta attenuation	1.00	Set	13,00,770.00	13,00,770.00
15	Supply, Errection, Installation, Testing and Commissioning of Multi calibration System for Gas calibration and Meteorological, Flow and Electronic Calibration 101 suitable for 230V AC, 50 Hz. with the following: • Mass Flow Controller based for Dilution air & Span Gas • Inlet ports for external span gases • RS 232 interface	1.00	Set	6,00,000.00	6,00,000.00

	• In built Zero air generator				
16	Supply, Errection, Installation, Testing and Commissioning of Calibration Gas Cylinders made of Aluminum with SS regulator & valve (1 Cylinder for each Gas) for following Gases: Note: (The supplier has to supply the calibration gas cylinder (highly polished aluminum 10 liters water capacity), along with SS Regulator, traceable to NIST for each components (SO2, NO, CO, NH3) along with SS regulator for the multipoint calibration).	4.00	Set	1,16,510.00	4,66,040.00
17	Supply, Erection, Installation, Testing and Commissioning of Gas Sampling System & Hood; Gas Sampling system consisting of SS gas sample inlet, peltier based moisture removal facility, manifold & tubings to the analyzers. Sampling System having 10 port manifold)	1.00	Set	30,000.00	30,000.00
18	Supply, Errection, Installation and Commissioning of Standard 19" Rack Cabinet (Double Bay Rack) with Telescopic slides, Overload protection, Power Distribution box, Cooling fans, Dust filters & pneumatic plumbing to accommodate Analyzer, Calibrator & Accessories (19" Rack cabinet to accommodate all analyzers & systems)	1.00	Set	77,630.00	77,630.00
19	Supply, Errection, Installation, Testing and Commissioning of 1.5 Tons Split Type Air Conditioners with auto switch over circuit. Make: Blue Star/ Voltas/ LG/ equivalent. Air	3.00	Set	50,000.00	1,50,000.00

	Conditioner, Split Type, Wall mounted along with voltage stabilizer (2 X 2 ton, 1 X 1 Ton). at the CAAQM Station.				
20	Supply, Erection, Installation, Testing and Commissioning of UPS, Capacity 6 KVA, 230 VAC, 50 Hz. Make: Vertiv/ APC/ Uniline or equivalent make with 1 hrs battery backup for all the Analysers only On line UPS (1X10KVA, 1 hr. back up and 1X5 KVA, 2 hr. back up) at the CAAQM Station (UPS is only for Analyzers and DAS & not for Air conditioners.)	2.00	Set	2,10,000.00	4,20,000.00
21	Supply, Erection, Installation, Testing and Commissioning of Weather Monitoring Station, with Meteorological Sensors for Wind Direction, Wind Speed, Ambient Temperature, Rainfall, Relative Humidity, Solar Radiation and Telescoping Crank – up Meteorological Tower, Weather Monitoring Station, consisting of the following Parameters, a) Wind Speed Sensor b) Wind Direction Sensor c) Relative Humidity Sensor d) Ambient Temperature Sensor e) Precipitation (Rain) Gauge f) Solar Radiation Sensor g) Barometric Pressure Sensor h) Meteorological Tower i) Interface Unit.	1.00	Set	3,00,000.00	3,00,000.00
22	Supply, Errection, Installation, Testing and Commissioning of Data Acquisition System (DAS): Local Data	1.00	Set	2,50,000.00	2,50,000.00

	<p>Logger -Central Management Software with License w.r.t. Data Acquisition: PC based Data Acquisition System with necessary Licensed Software suitable for Storing, Logging, Reporting, Printing data from above offered Analysers. PC with specifications as under: Computer System for DAS and Computer System for AQI; ; I3 Processor, 4 GB RAM, 1 TB HDD, CD/DVD Combo Drive, 19" LED Monitor, USB, LAN ports, Standard WINDOWS Operating System, standard keyboard, mouse with pad and Color Laser printer Colour MFP,24Ports CISCO Switch including Remote Calibration & Validation Software and Remote Connectivity Tool/Software.</p>				
23	<p>Supply, Errection, Installation, Testing and Commissioning of Central Management Software with License w.r.t. Data Acquisition: Data Acquisition System (DAS): Central Data Logger - PC based Data Acquisition System with Suitable Licensed Software suitable for Storing, Logging, Reporting, Printing data, Validation and communicating with above offered Local DAS. PC with specifications as under: Computer System for DAS and Computer System for AQI; i5 Processor, 6 GB RAM, 1 TB HDD, CD/DVD Combo Drive, 19" LED Monitor, USB, LAN ports, Standard WINDOWS Operating System, standard keyboard, mouse</p>	1.00	Set	5,25,000.00	5,25,000.00

	with pad and Color Laser printer Colour MFP,24Ports CISCO Switch including Remote Calibration & Validation Software and Remote Connectivity Tool/Software.				
24	Supply, Errection, Installation, Testing and Commissioning of 4'x12', LED Display Board with Cable/Remote Connectivity as directed by the depatment as per the site condition. Three line Display board with Day & Night Visible Data Display Board including Data display Board Transmission Device.	2.00	Set	150000.00	300000.00
25	Supply, Errection, Installation and Commissioning of Structural work for Display Board (Max. Height 5 Feet) from Ground in main gate.	2.00	Set	75000.00	150000.00
26	Supply, Errection, Installation, Testing and Commissioning of Data connectivity to SPCB & CPCB server	1.00	Set	80000.00	80000.00
27	Charges for Installation & Commissioning of the CAAQMS System at site.	1.00	Set	80000.00	80000.00
28	Charges for the spares / Consumables and gas refilling during the Operation and Maintenance Contract of 5 years which rekons from the date of completion/ Commissioning of the subject work.				
	1st Year(2023)	365	Days	958.90	349998.50
	2nd Year(2024)	366	Days	1232.88	451234.08
	3rd Year(2025)	365	Days	1506.85	550000.25
	4th Year(2026)	365	Days	1780.82	649999.30
	5th Year(2027)	365	Days	2054.79	749998.35
29	Charges for Deploying One operator (Graduate Engineer/Diploma Engineer) & One Unskilled Worker (Assistant to the operator, House				

Keeping Etc.) during Operation and Maintenance Contract for 5 years after commissioning of the CAAQMS System. Note: The weekly Off of Both the persons shall be staggered since the system has to work all 365 days of an year.					
1st Year(2023)	365	Days	1480.05	540218.25	
2nd Year(2024)	366	Days	1480.05	541698.30	
3rd Year(2025)	365	Days	1480.05	540218.25	
4th Year(2026)	365	Days	1480.05	540218.25	
5th Year(2027)	365	Days	1480.05	540218.25	
Total Rs.				1,76,49,331.78	
Excess / Less (In percentage in two decimals)					
Quoted amount in Figures Rs.					

(Quoted amount - Rupees

Note:

1. GST as applicable will be paid separately in the Tax invoice.
2. Contractor shall file the applicable returns with Tax department in time and submit the same as documentary evidence.
3. The tenderer shall make a detailed study of the tender document specially the specifications of contract, labour, Statutory compliance Etc. Before proposing the tender.

SPECIAL NOTE TO THE BIDDERS:-

- a) **The bidder shall provide/upload as a declaration the details of the following along with the bid Document Certifications form,**
 - i. **US-EPA; The official web-site of the US-EPA one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a "list of the Designated Reference and Equivalent Methods" where the Method/Model No, Designation Number and Method code Number allotted by the Approving Agencies i.e for PM₁₀,PM_{2.5}, SO₂, O₃ and CO, NO₂ is mentioned. This can be Accessed via internet as shown below,
<https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants>,
List of Designated Reference and Equivalent Methods in a Pdf Format (designated_ reference_ and_ equivalent)**

The bidder has to declare the make/model number, designation number and method code of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation, after Technical bid and before Price Bid.

TUV QAL-1; the official web-site of the TUV one of the authorized approving authority for the Continuous Ambient Air Quality Monitoring Equipment's has Published a list of "Certified measuring and Evaluating-Systems according to EN 15267" Where the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) allotted by the Approving Agencies i.e NO, NO₂,NOX, SO₂,CO,PM₁₀, PM_{2.5}, O₃ & Benzene, is mentioned in the Ambient Air Section. This can be Accessed via internet as shown below,

ii. <https://qal1.de/>

- a) On the Extreme Right hand top side Select Language "English".
- b) Select Manufacturer.
- c) Manufacturer's Overview screen Opens Now select the Manufacturer of the equipment and list of "certified measuring and Evaluating-Systems according to EN 15267 " here the details of the Equipment's shall be verified.

The bidder has to declare the product (Model Number), Certificate Number, Date of Certification, Test Report, Components (Parameters to be tested by the Equipment) of the intended analyzer to be supplied and installed at CAAQMS site. The same shall be verified for confirmation after Technical Bid and before Price Bid.

SIGNATURE OF THE BIDDER

(iii) FORM OF TENDER

NAME OF CONTRACT.....

To,

The Chairman
New Mangalore Port Authority
Panambur
Mangalore - 575 010

Gentlemen,

1. We have examined the Conditions of Contract, Specification, Drawings, Bill of Quantities, and Addenda No.s----- for the execution of the above-named Works, and we the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Conditions of Contract, Specifications, Drawings and Bill of Quantities and Addenda
2. We acknowledge that the Appendix forms part of our Tender.
3. We undertake, if our Tender is accepted, to commence the Works as soon as is reasonably possible after the receipt of the Engineer's notice to commence, and to complete the whole of the Works comprised in the Contract within the time stated in the Appendix to Tender.
4. We agree to abide by this Tender for the period of 120 days from the last date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
5. Unless and until a formal Agreement is prepared and executed, this Tender together with your written acceptance thereof shall constitute a binding Contract between us.

6. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this _____ day of _____ 201____
Signature _____ in the Capacity of _____
duly
authorized to sign Tenders for and on behalf of _____

(IN BLOCK LETTERS)

Address: _____

Witnesses

1. Signature : _____
Name : _____
Address : _____

2. Signature : _____
Name : _____
Address : _____

SECTION VII
SCHEDULE - A
ROYALTY
SCHEDULE II

(See sub rule (1) of Rule 36)

SI. No.	Name of the Mineral	Present Rate of Royalty	Royalty to be revised	
			Export	Domestic
1	Ornamental and Decorative Building Stones as defined under clause(m) of Rule 2 A) Dyke Rock (i) Black granites: (a) Chamarajanagar District:	15% of Sale Value or of Average Selling Price on advalorem basis or Rs.4,500 per m ³ which is higher.	Rs.1,200 per MT	Rs.600 per MT
	(b) All other Districts other than (a) above	15% of Sale Value or of Average Selling Price on advalorem basis or Rs.1,500 per m ³ which is higher.	Rs.1700 per MT	Rs.400 per MT
	(ii) Other varieties of dyke other than black granites (Entire State)	15% of Sale Value or of Average Selling Price on advalorem basis or Rs.1,500 per m ³ which is higher.	Rs.500 per MT	Rs.375 per MT
	(B)(I) Pink and Red Granites (Ilkal Pink Variety) (i) Hungunda and Badami Taluk of Bagalkot District, Kustagi of Koppal District.	15% of Sale Value or of Average Selling Price on advalorem basis or Rs.1,200	Rs.1,000 per MT	Rs.400 per MT
	(ii) Pink and Red Granites, Gneisses and their structural varieties (other than Ilkal Pink Variety)	15% of Sale Value or Average Selling Price on advalorem basis or Rs.1,800 per m ³ which is higher	Rs.600 per MT	Rs.350 per MT
	C) Grey and White Granites	15% of Sale Value or		

	and their varieties: (i) Very fine grained Grey granite (Siragrey Variety) Price on Chintanmi, Siddlaghatta of Chikkaballapura District Hoskote of Bangalore District.	of Average Selling Price on advalorem basis Rs.1,350 per m ³ which is higher.	Rs.500 per MT	Rs.350 per MT
	(ii) Grey and white granites and textural varieties having shades of grey, black and white colours (other than (i) above) Entire State.	15% of Sale Value or of Average Selling Price on advalorem basis Rs.1,050 per m ³ which is higher.	Rs.375 per MT	Rs.250 per MT
	(iii) Grey granite of Devanahalli Taluk of Bangalore Rural District and Chikkaballapur Taluk of Chikkaballapur District	15% of Sale Value or of Average Selling Price on advalorem basis Rs.600 per m ³ which is higher.	Rs.300 per MT	Rs.200 per MT
2	Felsite and its varieties suitable for use as Ornamental Stone-Entire State	15% of Sale Value or of Average Selling Price on advalorem basis Rs.1800 per m ³ which is higher.	Rs.900 per MT	
3	Quartzite and sand stone and their varieties suitable for use as Ornamental Stone-Entire State	15% of Sale Value or of Average Selling Price on advalorem basis Rs.1800 per m ³ which is higher.	Rs.900 per MT	
4	Marble and Crystalline Limestone as ornamental Stone-Entire State	15% of Sale Value or of Average Selling Price on advalorem basis Rs.1800 per m ³ which is higher.	Rs.1000 per MT	
5	Bentonite-Entire State	Rs.400 per MT	Rs.500 per MT	
6	Fuller Earth-Entire State	Rs.125 per MT	Rs.125 per MT	
7	Buff colour (waste) the permits not exceed 20%	Rs.60 per MT	Rs.70 per MT	

	of permit issued For Fullers Earth		
8	Limestone under the title "Shahabad Stone"	Rs.70 per 10 Sqmeters or Rs.70 per MT	Rs.50 per 10 Sqmeters or Rs.50 per MT
9	Limestone(non-cement) when used for building stone-Entire State	Rs.25 per MT	Rs.60 per MT
10	Ordinary Building Stone(Entire State as defined under clause(g) of Rule2(1))	Rs.60 per MT	Rs.70 per MT
11	Limeshell-Entire State	100 per MT	120 per MT
12	Lime Kankar(non cement) Entire State	50 per MT	80 per MT
13	Agate, Chalcedony, Flint-Entire State	240 per MT	300 per MT
14	Ordinary Sand-Entire State	60 Per MT	80 Per MT
15	Steatite and sand stone used formakinghousehold utensils / articles-Entire State.	40 Per MT	80 Per MT
16	(i)Murrum (All types of soils)-Entire State	20 per MT	40 per MT
	(ii)Clay used for manufacturing tile sand bricks	40 per MT	60 per MT
17	Waste rocks generated in ornamental stone quarry-which is suitable for ornamental purpose Entire State (See explanation under Rule36)	300 per MT or 850 CUM	300perMT
18	Irregular shaped waste rock generated in Ornamental stone quarry, which is not suitable for ornamental purpose (used for making aggregates and m-sand) Entire State.	60 per MT	40 per MT
19	Waste rocks generated in Shahabad stone quarry-Entire State (See explanation under Rule-36)	60 per MT	40 per MT
20	Finished Kerb stones/cubes not exceeding 30 cms each	110per MT	150 per MT

	face-Entire State.		
21	Barytes (i) A Grade (Grey colour) (ii) B Grade (Greycolour) (iii) C, D Grade & Waste	6.5% of average selling price or of sale value whichever is higher on ad-valorem basis	400 per MT 300 per MT 200 per MT
22	Calcite	15% of average selling price or of sale value whichever is higher on ad-valorem basis	80 per MT
23	China clay and Kaolin (including Ball clay, White shell, Fireclay and white clay) i) Crude/Raw ii) Processed	8% of average selling price or of sale value whichever is higher on ad-valorem basis. 12% of average selling price or of sale value whichever is higher on ad-valorem basis	80 Per MT 600 per MT
24	Corundum	12% of average selling price or of sale value whichever is higher on ad-valorem basis	15% of Sale Value or of Average Selling Price on ad valorem basis which is higher.
25	Dolomite	Rs.75 per MT	100 per MT
26	Dunite and Pyroxenite	Rs.30 per MT	60 per MT
27	Felsite (Other than for ornamental purpose)	12% of average selling price or of sale value whichever is higher on ad-valorem basis	120 per MT
28	Gypsum	20% of average selling price or of sale value whichever is higher on ad-valorem basis	150 per MT
29	Jasper	12% of average selling price or of sale value whichever is higher on ad-valorem basis	150 per MT
30	Quartz, feldspar	15% of average selling price or of sale value whichever is higher on ad-valorem	100 per MT

		basis	
31	Mica i. Crude ii. Waste	4% of average selling price or of sale value whichever is higher on ad-valorem basis	1500 per MT 500 per MT
32	Quartzite & Fuchsite Quartzite not suitable for use as Ornamental /Gemstones	12% of average selling price or of sale value whichever is higher on ad-valorem basis	100 per MT
33	Laterite i) dispatched for use in cement or chemical industries or Abrasive or Refractory purpose (below threshold value as specified by IBM from time to time) ii) For use as building stone (below threshold value as specified by IBM)	Rs.60 per MT	160 per MT 60 per MT
34	Ochre	Rs.24 per MT	60 per MT
35	Pyrophyllite	20% of average selling price or of sale value whichever is higher on ad-valorem basis	200 per MT
36	Shale	Rs.60 per MT	150 per MT
37	Slate	Rs.45 per MT	150 per MT
38	Silica Sand	10% of average selling price or of sale value whichever is higher on ad-valorem basis	100 per MT
39	Steatite or Soapstone (Other than for household articles)	18% of average selling price or of sale value whichever is higher on ad-valorem basis	200perMT

	Talc	--	200perMT
40	All other minerals (which is not specified in schedule-II) Entire State	30% of sale value on ad-valorem basis	30% of Sale Value or of Average Selling Price on ad-valorem basis which is higher.

As per order of Deputy Director mines and Geological department dated 11-11-2021. The prevailing rates as per the updated order of the Geological Department during the course of the project will be applicable.

Note: Except where otherwise stated, the contractor shall pay to the authority all tonnage and other royalties, rent and other payments or compensation if any, for getting stone, sand, gravel, clay or other materials by him and his subordinates and his subcontractors and required for the works, at the rates and such conditions as notified by the State Government. The contractor should submit the Mineral Dispatch Permit (MDP) in original for the quantity executed by the contractor for the requisite quantity of material incorporated in works for which MDP is issued by the authorized supplier. If contractor fails to submit the MDP in original the amount will be deducted at 5 times the royalty charges from the contractor's bills as per prevailing orders issued by the Authority.

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SECTION VII**SCHEDULE – B****MINIMUM RATES OF WAGES****ABSTRACT OF MINIMUM RATES OF WAGES FROM RELEVANT NOTIFICATIONS**

MINIMUM RATES OF WAGES APPLICABLE IN THE BEAT OF ALC(C), MANGALORE WITH EFFECT FROM **01.10.2022**

Minimum Wages applicable "Construction or maintenance of roads, runways or in building operations including laying down underground electric, wireless, radio, television, telephone and overseas communication cables and similar other underground cabling work, electric lines, water supply lines and sewerage pipelines" -

Category			
	Area: A	Area:B	Area:C
Unskilled	711.00	595.00	477.00
Semiskilled/ Unskilled Supervisory	788.00	671.00	557.00
Skilled/Clerical	866.00	788.00	671.00
Highly Skilled	940.00	866.00	788.00

(Kindly Note: Area A: Bangalore (UA), Area B: Mangalore (UA), Mysore (UA), Belgaum (UA), Hubli-Dharwad, Area C: All other places in Karnataka not specified above as per Ministry of Labour and Employment F.No.1/16 (3)/2022-LS-II dated 28.09.2022)

"Employment of Sweeping and Cleaning excluding activities prohibited under the Employment of Manual Scavengers and Construction of Dry latrines (Prohibition) Act, 1933".

Area	Rates of wages Rs.
'A'	711.00
'B'	595.00
'C'	477.00

"Employment of Watch and Ward"-Rates of wages for employees employed in watch and ward – Govt. of India, Ministry of Labour

	Without arms	With arms
Area	Rates of wages Rs.	Rates of wages Rs.
'A'	866.00	940.00
'B'	788.00	866.00
'C'	671.00	788.00

For further details log on to Ministry of Employment.