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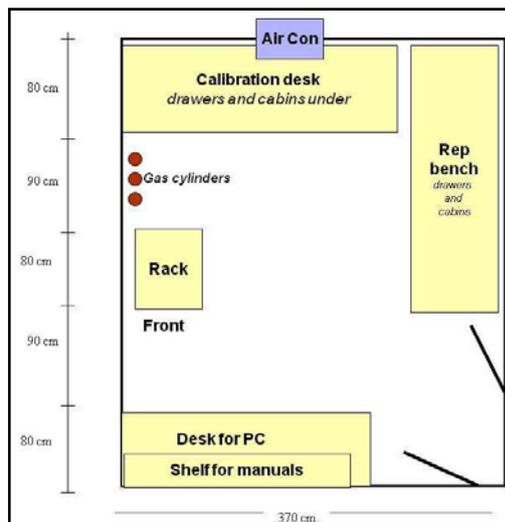
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<b>Project:</b>	<b>Bangladesh Air Pollution Management (BAPMAN)</b>
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## Task 2: Monitoring and Laboratory Procedures

### Deliverable D2.4: Technical Specifications for a National Reference Laboratory in Bangladesh

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## Preface

The Bangladesh Air Pollution Management (BAPMAN) project is NORAD funded institutional-building program (2010-2013) where NILU lends the necessary Air Quality Management tools and associated training to the Clean Air and Sustainable Environment (CASE) program at the Bangladesh Department of Environment (DoE). BAPMAN project Tasks include:

1. Emission Inventories (Top-down and Bottom-up)
2. Monitoring, Laboratory Procedures, and Data Acquisition
3. Air Quality Management Tools and Data Analysis
4. Health Impact and Scenario Research

Project outcomes are to document the necessary training in the tasks above (as well as tools given), in addition to presenting corresponding results from the exercises, if applicable.

This report (as Deliverable 2.4 for Task 2 of the BAPMAN Project) contains all relevant physical technical specifications as well as manning requirements for the Reference laboratory for air quality measurements. The report also includes commissioning, testing and training requirements.



## Contents

<b>Preface</b> .....	<b>1</b>
<b>Contents</b> .....	<b>3</b>
<b>Summary</b> .....	<b>5</b>
<b>1 Introduction</b> .....	<b>6</b>
<b>2 General requirements</b> .....	<b>6</b>
2.1 Instructions.....	6
<b>3 Technical specifications for the equipment for the Reference Laboratory ...</b>	<b>8</b>
3.1 Equipment specifications.....	9
3.1.1 Thermometer for measuring room temperature.....	9
3.1.2 Barometer for measuring room pressure.....	10
3.1.3 Hygrometer for measuring room humidity.....	11
3.1.4 Reference lab air conditioner.....	12
3.1.5 CO detector.....	13
3.1.6 H <sub>2</sub> S detector.....	14
3.1.7 Zero air generator.....	15
3.1.8 Multi gas multipoint calibration system.....	16
3.1.9 O <sub>3</sub> multipoint calibrator.....	17
3.1.10 Primary calibration gas standard of NO.....	18
3.1.11 Primary calibration gas standard of SO <sub>2</sub> .....	19
3.1.12 Primary calibration gas standard of H <sub>2</sub> S.....	20
3.1.13 Primary calibration gas standard of CO.....	21
3.1.14 Primary calibration gas standard of CH <sub>4</sub> + C <sub>3</sub> H <sub>8</sub> .....	22
3.1.15 Primary calibration gas standard of BTX.....	23
3.1.16 Secondary calibration gas standard of NO.....	24
3.1.17 Secondary calibration gas standard of SO <sub>2</sub> .....	25
3.1.18 Portable calibration system as a secondary calibration standard of H <sub>2</sub> S.....	26
3.1.19 Secondary calibration gas standard of CO.....	27
3.1.20 Secondary calibration gas standard of CH <sub>4</sub> + C <sub>3</sub> H <sub>8</sub> .....	28
3.1.21 Secondary calibration gas standard of BTX.....	29
3.1.22 Nitrogen as carrier gas for BTX and NMHC monitors.....	30
3.1.23 Gas flow calibrator.....	31
3.1.24 NO, NO <sub>x</sub> , NO <sub>2</sub> ambient air monitor.....	32
3.1.25 SO <sub>2</sub> monitor ambient air monitor.....	33
3.1.26 H <sub>2</sub> S monitor ambient air monitor.....	34
3.1.27 O <sub>3</sub> monitor ambient air monitor.....	35
3.1.28 CO monitor ambient air monitor.....	36
3.1.29 NMHC monitor ambient air monitor.....	37
3.1.30 Hydrogen and Zero Air Generator.....	38
3.1.31 BTX monitor ambient air monitor.....	39
3.1.32 Rack for monitors, calibrators, etc.....	40
3.1.33 Table equipment.....	41
3.1.34 Reference lab data acquisition and control system.....	42
3.1.35 Reference lab repair and maintenance tools kit.....	43

3.1.36	Reference laboratory items .....	45
3.1.37	Reference lab computer .....	46
3.1.38	Reference lab portable computer .....	47
3.1.39	Reference lab printer.....	48
3.1.40	Chair .....	49
3.1.41	Shelf for manuals .....	50
<b>4</b>	<b>Manpower requirements for Reference laboratory.....</b>	<b>51</b>
<b>5</b>	<b>Commissioning and testing requirements.....</b>	<b>51</b>
<b>6</b>	<b>Training requirements.....</b>	<b>51</b>
	<b>Appendix A Vendor list .....</b>	<b>53</b>
	<b>Vendor list.....</b>	<b>55</b>

## Summary

*This report provides the technical specifications as well as the manpower requirements for a future Reference laboratory at the Bangladesh Department of Environment (DoE). The Reference laboratory will be responsible for the development, administration and maintenance of the Quality Assurance and Quality Control system for the Continuous Air Monitoring Station (CAMS) Network. It will also perform independent audits in the measurements network to assess the actual quality of the measurements.*

## Deliverable D2.4: Technical Specifications for a National Reference Laboratory in Bangladesh

### 1 Introduction

An overall objective of the Reference Laboratory is to assure equal quality of the data from the different monitoring networks/stations and to assure that the same data is comparable to each other.

To fulfil the overall objectives, the Reference Laboratory at the Bangladesh Department of Environment (DoE) will be responsible for the development, administration and maintenance of the Quality Assurance and Quality Control system (QA/QC system) for the operations of the Continuous Air Monitoring (CAMS) Network. This includes preparing new standard operation procedures (SOPs), updating the quality documentation, informing the network operators on changes and updates in the QA/QC system, etc.

The Reference Laboratory will maintain the national reference calibration standards. The reference standards will represent the highest level of calibration in the traceability chain designed for the measurement network. The Reference Laboratory will provide traceability to the reference standards for all measurement instruments in the monitoring network by calibration of their reference materials as well as calibration of instruments for which the monitoring networks do not have reference standard themselves. Finally, the Reference Laboratory will perform audits in the measurement networks to assess the actual quality of the measurements.

### 2 General requirements

The following general requirements apply to all equipment specified in this procurement document.

#### 2.1 Instructions

The supplier shall provide concise and clearly written documentation in English language (or other language accepted by the customer) which provides the following data:

- a) clearly written instructions for routine use and maintenance.
- b) a specification of equipment performance characteristics and productivity.
- c) full health and safety information.

#### Accessory and spare parts

The delivery shall include a list of accessory and spare parts kit for 1 years' operation, according to supplier's experience. Budget for accessories and spare parts must be clearly specified.

The supplier must have spare parts in stock for at least five years after delivery of the instrumentation.

**Packing and delivery**

Delivery of equipment to DoE, Dhaka, including insurance, packing and transportation should be provided by the supplier.

The delivery shall take place less than two months after acceptance of the contract. If otherwise, the time of delivery shall be specified by the supplier.

The bidder is responsible for a packaging that ensures against damage during transportation to DoE, Dhaka.

Installation

The instruments shall contain instructions in English that enable installation and start of operation by a person with a degree in science.

**After sales facilities/incidental services**

Name and location of nearest organization for incidental services shall be specified.

**Warranty**

Warranty of a minimum of 1 year for overall equipment is required. The warranty period shall be specified.

### 3 Technical specifications for the equipment for the Reference Laboratory

The Reference Laboratory will reside in an air-conditioned room without windows of approx. 30 m<sup>2</sup>. Necessary electrical power consumption will be approx. 8 kW not included the air conditioner. 10 nos. 220V mains twin sockets with earth contacts must be available in the room. In addition to the reference lab, a storage room for gas cylinders of approx. 10 m<sup>2</sup> is required.

An overview of the necessary equipment for the Reference laboratory is given in Table 1.

Table 1: Equipment for Reference laboratory.

<b>Monitors</b>
NO <sub>x</sub>
SO <sub>2</sub>
H <sub>2</sub> S
O <sub>3</sub>
CO
NMHC
Hydrogen and zero air generator
BTX
<b>Multipoint Calibration Unit</b>
Dynamic multipoint calibrator with ozone photometer
Zero Air Generator
Flow calibrator
<b>National primary reference gases</b>
100 ppm NO span gas in Nitrogen including regulator
100 ppm SO <sub>2</sub> span gas in Nitrogen including regulator
50 ppm H <sub>2</sub> S span gas in Nitrogen including regulator
5000 ppm CO span gas in Nitrogen including regulator
200 ppm CH <sub>4</sub> + 180 ppm C <sub>3</sub> H <sub>8</sub> in synthetic air span gas including regulator
100 ppb BTX span gas in synthetic air including regulator
<b>Secondary reference gases</b>
800 ppb NO span gas in Nitrogen including regulator
800 ppb SO <sub>2</sub> span gas in synthetic air including regulator
50 ppm CO span gas in synthetic air including regulator
2 ppm CH <sub>4</sub> + 1.8 ppm C <sub>3</sub> H <sub>8</sub> span gas in synthetic air including regulator
1 ppb BTX span gas in synthetic air including regulators
<b>Other gases</b>
5.0 Nitrogen including regulator
<b>Climate control</b>
T, P, RH-sensor with display, logged
Air conditioner

Table 1 contd.

<b>Gas alarm</b>
CO + H <sub>2</sub> S alarm
<b>Data handling</b>
Stationary PC
Portable PC
Data acquisition and control system
Data handling software
Printer
<b>Racks, tables, maintenance tools kit etc.</b>

### 3.1 Equipment specifications

The equipment in Table 1 is described in the following sections.

#### 3.1.1 *Thermometer for measuring room temperature*

**Quantity of equipment: 1**

##### **Purpose**

A Thermometer for measuring room temperature is required.

##### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Resolution: 0.1°C.
3. Display: Digital, °C.
4. Certification of calibration.
5. Output signal proportional to measured value for connecting to the reference lab data acquisition and control system.

### **3.1.2 Barometer for measuring room pressure**

**Quantity of equipment: 1**

#### **Purpose**

A barometer for measuring room pressure is required.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Resolution: 1mBar.
3. Display: Digital, mBar, if possible selectable mBar, torr or psi.
4. Certification of calibration.
5. Output signal proportional to measured value for connecting to the reference lab data acquisition and control system.

### **3.1.3 Hygrometer for measuring room humidity**

**Quantity of equipment: 1**

#### **Purpose**

A hygrometer for measuring the room humidity is required.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Resolution: 1 %.
3. Display: Digital, %.
4. Certification of calibration.
5. Output signal proportional to measured value for connecting to the reference lab data acquisition and control system.

### **3.1.4 Reference lab air conditioner**

**Quantity of equipment: 1**

#### **Purpose**

An air conditioner is required to maintain a stable temperature in the reference lab.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Temperature set point: +22 °C - +25 °C.
3. Stability:  $\pm 1^{\circ}\text{C}$
4. Energy dissipation from instruments inside the room (approx.): 8 kW.
5. Condensing water must be removed from the air.
6. Reference lab room air must be ventilated out in order to keep the span gas concentration levels at a minimum.

### **3.1.5 CO detector**

**Quantity of equipment: 1**

**Purpose**

A CO detector is required to detect hazardous levels of CO in the room air.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Audible alarm.
3. Measurement range: 1000 ppm.
4. Alarm limit: 100 ppm.
5. Output signal proportional to measured value for connecting to the reference lab data acquisition and control system.

### **3.1.6 H<sub>2</sub>S detector**

**Quantity of equipment: 1**

#### **Purpose**

A H<sub>2</sub>S detector is required to detect hazardous levels of H<sub>2</sub>S in the room air.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Audible alarm.
3. Measurement range: 1000 ppm.
4. Alarm limit: 10 ppm.
5. Output signal proportional to measured value for connecting to the reference lab data acquisition and control system.

### **3.1.7 Zero air generator**

#### **Quantity of equipment: 1**

#### **Purpose**

A zero air generator is required to produce zero air for diluting span gases in the multi gas multipoint calibrator.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Capable of delivering zero air free from CO (<0.025 ppm), SO<sub>2</sub> (<0.5 ppb), NO (0.5 ppb), NO<sub>x</sub> (<0.5 ppb), NO<sub>2</sub> (<0.5 ppb), O<sub>3</sub> (<0.5 ppb) and hydrocarbons (<0.02 ppm).
3. Water trap included.
4. Pump included.
5. Output pressure: Minimum 7 bar or sufficient to supply the multigas multipoint calibration system.
6. Output flow rate: Minimum 10 l/min or sufficient to supply the multigas multipoint calibration system.
7. Tubing in inert material, e.g. teflon or stainless steel.

### **3.1.8 Multi gas multipoint calibration system**

**Quantity of equipment: 1**

#### **Purpose**

A multi gas multipoint calibration system is required for dynamic calibrations of ambient air monitors.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Number of calibration gas input ports: 6.
3. Dilution air flow range: 0 - 10 l/min.
4. Cylinder gas flow range: 0 - 100 ml/min.
5. Certification of calibration of the mass flow controllers.
6. O<sub>3</sub> generator for gas phase titration and dynamic calibration of O<sub>3</sub> monitors.
7. Programmable calibration sequence for automatic unattended operation.
8. Output values (measured dilution air and cylinder gas flow rates or output gas concentration) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
9. Complete control of calibrator (setting flow rates/ output concentrations) via RS232 communication port using the laboratory data acquisition and control system.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. Operating temperature: +15 °C to 30 °C.
13. Necessary tubing in inert material for assembling the multi gas multipoint calibration system with the different gas cylinders.

### **3.1.9 O<sub>3</sub> multipoint calibrator**

**Quantity of equipment: 1**

#### **Purpose**

An O<sub>3</sub> multipoint calibrator is required for dynamic calibrations of ambient air O<sub>3</sub> monitors. The calibration will be transported to measurement stations during audits. The O<sub>3</sub> calibrator can be an integrated part of the multi gas multipoint calibration system, see above.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. U.V. photometer with O<sub>3</sub> generator for dynamic calibration of O<sub>3</sub> monitors.
3. O<sub>3</sub> output: 6 ppm litres, maximum flowrate: 6 l/min.
4. Programmable calibration sequence for automatic unattended operation.
5. Output values (O<sub>3</sub>) via RS232 serial communication port for connecting to the laboratory data acquisition and control system.
6. Complete control of calibrator (setting flow rates/ output concentrations) via RS232 communication port using the laboratory data acquisition and control system.
7. Complete documentation of RS232 communication commands.
8. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
9. Operating temperature: +15 °C to +30 °C.
10. Necessary tubing in inert material for assembling the O<sub>3</sub> multipoint calibrator.

**3.1.10 Primary calibration gas standard of NO****Quantity of equipment: 1****Purpose**

A primary calibration gas cylinder of NO is required as the national reference calibration gas standard for NO in the traceability chain.

**Qualification requirements**

1. 100 ppm NO in N<sub>2</sub>
2. Uncertainty < 1%
3. Including two stage stainless steel regulator
4. Traceable certification of calibration
5. 5 years validity

**3.1.11 Primary calibration gas standard of SO<sub>2</sub>****Quantity of equipment: 1****Purpose**

A primary calibration gas cylinder of SO<sub>2</sub> is required as the national reference calibration gas standard for SO<sub>2</sub> in the traceability chain.

**Qualification requirements**

1. 100 ppm SO<sub>2</sub> in N<sub>2</sub>
2. Uncertainty < 1%
3. Including two stage stainless steel regulator
4. Traceable certification of calibration
5. 5 years validity

**3.1.12 Primary calibration gas standard of H<sub>2</sub>S****Quantity of equipment: 1****Purpose**

A primary calibration gas cylinder for H<sub>2</sub>S is required as the national reference calibration gas standard for H<sub>2</sub>S in the traceability chain.

**Qualification requirements**

1. 50 ppm H<sub>2</sub>S in N<sub>2</sub>
2. Uncertainty < 1%
3. Including two stage stainless steel regulator
4. Traceable certification of calibration
5. 5 years validity

**3.1.13 Primary calibration gas standard of CO****Quantity of equipment: 1****Purpose**

A primary calibration gas cylinder of CO is required as the national reference calibration gas standard for CO in the traceability chain.

**Qualification requirements**

1. 5000 ppm CO in N<sub>2</sub>
2. Including two stage stainless steel regulator
3. Traceable certification of calibration
4. Uncertainty < 1%
5. 5 years validity

**3.1.14 Primary calibration gas standard of CH<sub>4</sub> + C<sub>3</sub>H<sub>8</sub>****Quantity of equipment: 1****Purpose**

A primary calibration gas cylinder of CH<sub>4</sub> + C<sub>3</sub>H<sub>8</sub> is required as the national reference calibration gas standard for CH<sub>4</sub> + C<sub>3</sub>H<sub>8</sub> in the traceability chain.

**Qualification requirements**

1. 200 ppm CH<sub>4</sub> + 180 ppm C<sub>3</sub>H<sub>8</sub> in synthetic air
2. Including two stage stainless steel regulator
3. Traceable certification of calibration
4. Uncertainty < 1%
5. 5 years validity

**3.1.15 Primary calibration gas standard of BTX****Quantity of equipment: 1****Purpose**

A primary calibration gas cylinder of BTX is required as the national reference calibration gas standard for BTX in the traceability chain.

**Qualification requirements**

1. 100 ppb BTX in synthetic air
2. Including two stage stainless steel regulator
3. Traceable certification of calibration
4. Uncertainty < 1%
5. 5 years validity

### **3.1.16 Secondary calibration gas standard of NO**

**Quantity of equipment: 1**

#### **Purpose**

A secondary gas cylinder of NO is required as a travelling calibration standard to control NO<sub>x</sub>-monitors at the stations during audit visit.

#### **Qualification requirements**

1. 800 ppb NO in N<sub>2</sub>
2. Uncertainty < 10%
3. Including two stage stainless steel regulator
4. Traceable certification of calibration
5. 1 year validity

**3.1.17 Secondary calibration gas standard of SO<sub>2</sub>****Quantity of equipment: 1****Purpose**

A secondary gas cylinder of SO<sub>2</sub> is required as a travelling calibration standard to control SO<sub>2</sub>-monitors at the stations during audit visit.

**Qualification requirements**

1. 800 ppb SO<sub>2</sub> in synthetic air
2. Uncertainty < 10%
3. Including two stage stainless steel regulator
4. Traceable certification of calibration
5. 1 year validity

**3.1.18 Portable calibration system as a secondary calibration standard of H<sub>2</sub>S****Quantity of equipment: 1****Purpose**

A portable calibration system to be used as a secondary calibration standard of H<sub>2</sub>S is required as a travelling calibration standard to control H<sub>2</sub>S -monitors at the stations during audit visit. The calibration system is based permeation tubes.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Dynamic generation of H<sub>2</sub>S by permeation.
3. 2 permeation chambers.
4. 1 dilution channel with mass flowmeter
5. Possible to program via keyboard such as permeation rate, ppm, mg/m<sup>3</sup>, flow, automatic multipoint calibrations routines etc.
6. Must include zero air scrubber and flow controlled by mass flowmeter
7. U.S. EPA designated
8. Must be able to connect to any type of ambient air analyser.
9. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
10. Complete spare part list with prices.
11. The supplier must have spare parts in stock for at least five years after delivery of monitor.
12. Operating temperature: +15 °C to +30 °C.

**3.1.19 Secondary calibration gas standard of CO****Quantity of equipment: 1****Purpose**

A secondary gas cylinder of CO is required as a travelling calibration standard to control CO -monitors at the stations during audit visit.

**Qualification requirements**

1. 50 ppm CO in synthetic air
2. Uncertainty < 3%
3. Including two stage stainless steel regulator
4. Traceable certification of calibration
5. 1 year validity

**3.1.20 Secondary calibration gas standard of CH<sub>4</sub> + C<sub>3</sub>H<sub>8</sub>****Quantity of equipment: 1****Purpose**

A secondary gas cylinder of CH<sub>4</sub> + C<sub>3</sub>H<sub>8</sub> is required as a travelling calibration standard to control CH<sub>4</sub> + C<sub>3</sub>H<sub>8</sub> -monitors at the stations during audit visit.

**Qualification requirements**

1. 2 ppm CH<sub>4</sub> + 1.8 ppm C<sub>3</sub>H<sub>8</sub> in synthetic
2. Including two stage stainless steel regulator
3. Traceable certification of calibration
4. Uncertainty < 10%
5. 1 year validity

**3.1.21 Secondary calibration gas standard of BTX****Quantity of equipment: 1****Purpose**

A secondary gas cylinder of BTX is required as a travelling calibration standard to control BTX -monitors at the stations during audit visit.

**Qualification requirements**

1. 1 ppb BTX in synthetic air
2. Including two stage stainless steel regulator
3. Traceable certification of calibration
4. Uncertainty < 10%
5. 1 year validity

**3.1.22 Nitrogen as carrier gas for BTX and NMHC monitors**

**Quantity of equipment: 1**

**Purpose**

To be used as carrier gas for BTX and NMHC monitor.

**Qualification requirements**

1. N<sub>2</sub> of quality 5.0
2. Including regulator
3. 1 year validity

**3.1.23 Gas flow calibrator****Quantity of equipment: 1****Purpose**

A gas flow calibrator is required to calibrate gas meters.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Range: 0 – 500 sccm (l/min).
3. Traceable certification of calibration of the gas flow meter.
4. It must be possible to both push and pull the air through the meter.
5. Accuracy: 0.25% of full scale.
6. Output signal proportional to measured value for connecting to the reference lab data acquisition and control system.

**3.1.24 NO, NO<sub>x</sub>, NO<sub>2</sub> ambient air monitor****Quantity of equipment: 1****Purpose**

A NO, NO<sub>x</sub>, NO<sub>2</sub> ambient air monitor is required for measuring NO and NO<sub>2</sub> span gases at ambient pressure.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Measurement principle: Chemiluminescence.
3. Measurement range: 1 – 2000 ppb.
4. Permapure drier for drying air to the O<sub>3</sub> generator.
5. The use of silica gel as air drier shall be avoided.
6. Data averaging time: Instantaneous values approx. every 10 seconds.
7. U.S. EPA designated.
8. Rack mountable with rails included.
9. RS232 serial communication port for operation of monitor.
10. Output values (NO, NO<sub>x</sub>, NO<sub>2</sub>) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
11. Complete documentation of RS 232 communication commands.
12. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
13. Complete spare part list with prices.
14. The supplier must have spare parts in stock for at least five years after delivery of monitor.
15. Operating temperature: +15 °C to +30 °C.
16. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

**3.1.25 SO<sub>2</sub> monitor ambient air monitor****Quantity of equipment: 1****Purpose**

A SO<sub>2</sub> ambient air monitor is required for measuring SO<sub>2</sub> span gas at ambient pressure.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Measurement principle: U.V. fluorescence.
3. Measurement range: 1 – 2000 ppb.
4. The use of silica gel as air driers shall be avoided.
5. Data averaging time: Instantaneous values approx. every 10 seconds.
6. U.S. EPA designated.
7. Rack mountable with rails included.
8. RS232 serial communication port for operation of monitor.
9. Output values (SO<sub>2</sub>) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. Complete spare part list with prices.
13. The supplier must have spare parts in stock for at least five years after delivery of monitor.
14. Operating temperature: +15 °C to +30 °C.
15. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

**3.1.26 H<sub>2</sub>S monitor ambient air monitor****Purpose**

A H<sub>2</sub>S ambient air monitor is required for measuring H<sub>2</sub>S span gas at ambient pressure.

**Qualification requirements**

1. Power requirements: 220-240 V
2. Measurement principle: U.V. fluorescence with H<sub>2</sub>S converter.
3. Internal zero and span with permeation tube.
4. Measurement range: 1 – 2000 ppb.
5. The use of silica gel as air driers shall be avoided.
6. Data averaging time: Instantaneous values approx. every 10 seconds.
7. U.S. EPA designated.
8. Rack mountable with rails included.
9. RS232 serial communication port for operation of monitor.
10. Output values (H<sub>2</sub>S) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
11. Complete documentation of RS232 communication commands.
12. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
13. Complete spare part list with prices.
14. The supplier must have spare parts in stock for at least five years after delivery of monitor.
15. Operating temperature: +15 °C to +30 °C.
16. The bidder must specify air intake and outlet dimension and unit (metric or imperial).
17. Selectable measuring range: 0-50ppb to 0-2 ppm.

**3.1.27 O<sub>3</sub> monitor ambient air monitor****Quantity of equipment: 1****Purpose**

An O<sub>3</sub> ambient air monitor is required as the national reference standard for O<sub>3</sub>.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Measurement principle: U.V. absorption.
3. Measurement range: 1 – 1000 ppb
4. The use of silica gel as air drier shall be avoided.
5. Data averaging time: Instantaneous values approx. every 10 second.
6. U.S. EPA designated.
7. Internal zero air and O<sub>3</sub> generator.
8. Rack mountable with rails included.
9. RS232 serial communication port for operation of monitor.
10. Output values (O<sub>3</sub>) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
11. Complete documentation of RS232 communication commands.
12. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
13. Complete spare part list with prices.
14. The supplier must have spare parts in stock for at least five years after delivery of monitor.
15. Operating temperature: +15 °C to +30 °C.
16. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

**3.1.28 CO monitor ambient air monitor****Quantity of equipment: 1****Purpose**

A CO ambient air monitor is required for measuring CO span gas at ambient pressure.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Measurement principle: Gas filter correlation.
3. Measurement range: 0.1 – 100 ppm
4. The use of silica gel as air drier shall be avoided.
5. Data averaging time: Instantaneous values approx. every 10 second.
6. U.S. EPA designated.
7. Rack mountable with rails included.
8. RS232 serial communication port for operation of monitor.
9. Output values (CO) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. Complete spare part list with prices.
13. The supplier must have spare parts in stock for at least five years after delivery of monitor.
14. Operating temperature: +15 °C to +30 °C.
15. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

**3.1.29 NMHC monitor ambient air monitor****Quantity of equipment: 1****Purpose**

A non-methane ambient air HC monitor is required for measuring HC in span gas at ambient pressure.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Measurement principle: Flame ionisation detection (FID).
3. Methane and non-methane hydrocarbons converter.
4. Zero air generator.
5. Electrolytic hydrogen generator.
6. U.S. EPA designated.
7. Rack mountable with rails included.
8. RS232 serial communication port for operation of monitor.
9. Output values (HC) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
10. Complete documentation of RS232 communication commands.
11. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
12. Complete spare part list with prices.
13. The supplier must have spare parts in stock for at least five years after delivery of monitor.
14. Operating temperature: +15 °C to +30 °C.
15. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

### **3.1.30 Hydrogen and Zero Air Generator**

#### **Quantity of equipment: 1**

#### **Purpose**

A hydrogen and zero air generator is required for the detector in the NMHC monitor. The zero air generator is also needed for the BTX monitor.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Measurement principle: Electrolyse of water going through a membrane in polymer.
3. Rack mountable with rails included.
4. Compressor included
5. Generated outflow from hydrogen generator:
6. Outlet pressure from hydrogen generator: adjustable between 0.1 and 6 bar
7. Purity hydrogen generator: >99.99%
8. Humidity hydrogen generator: < -60° DP
9. Outflow of generated Zero air: 1 to 5 litres/minute at the atmospheric conditions
10. Outlet pressure zero air generator: Adjustable between 1 and 3.5 bar. Internal tank 1.5 L
8. Capable of delivering zero air free from HC nm < 50 ppb, HCm < 50 ppb, H<sub>2</sub>O < 100 ppm
11. RS232 serial communication port for operation of generator.
12. Complete documentation of RS232 communication commands.
13. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
14. Complete spare part list with prices.
15. The supplier must have spare parts in stock for at least five years after delivery of monitor.
16. Operating temperature: +15 °C to +30 °C.
17. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

### **3.1.31 BTX monitor ambient air monitor**

#### **Quantity of equipment: 1**

#### **Purpose**

A BTX (Benzene, Toluene, Xylenes) ambient air monitor is required for measuring BTX span gas at ambient pressure.

#### **Qualification requirements**

1. Power requirements: 220-240 V.
2. Measurement principle: Gas Chromatograph (GC).
3. Detector: Photo Ionisation Detector (PID).
4. Carrier gas: Nitrogen.
5. Measuring cycle time: Maximum 30 minutes (2 measurements per hour).
6. Ranges: 0 – 200 ppb.
7. Lower detectable limit: 0.15 ppb.
8. Lag time: 15 minutes.
9. Noise: 0.07ppb.
10. Rack mountable with rails included.
11. RS232 serial communication port for operation of monitor.
12. Output values (BTX) proportional to measured values for connecting to the laboratory data acquisition and control system via RS232 serial communication port.
13. Complete documentation of RS232 communication commands.
14. Complete schematic layout of all electric and pneumatic circuits for repair and maintenance.
15. Complete spare part list with prices.
16. The supplier must have spare parts in stock for at least five years after delivery of monitor.
17. Operating temperature: +15 °C to +30 °C.
18. The bidder must specify air intake and outlet dimension and unit (metric or imperial).

**3.1.32 Rack for monitors, calibrators, etc.**

**Quantity of equipment: 2**

**Purpose**

A rack is required for the reference lab ambient air monitors, calibrators, zero air generator and data logger.

**Qualification requirements**

1. Floor mounted rack for mounting the ambient air monitoring calibration lab equipment.
2. Number of units in the rack: 6 - 9 including data logger.

**3.1.33 Table equipment****Quantity of equipment: 6****Purpose**

Solid tables are required for various equipment.

**Qualification requirements**

1. Table dimension (approx.), W, D, H: 120 cm, 80 cm, 90 cm.
2. Work load: 150 kg.
3. A solid shelf under the table top.

### **3.1.34 Reference lab data acquisition and control system**

#### **Quantity of equipment: 1**

#### **Purpose**

A data acquisition and control system is required to log data from ambient air monitor sensors and the multi gas multipoint calibration system during calibration and tests.

#### **Qualification requirements**

1. Power requirements: 220 - 240 V.
2. PC based.
3. Capable of collecting data including status parameters from the ambient air monitors, data from room temperature, pressure and relative humidity sensors and data from calibrators in the laboratory depending on the instrument configuration.
4. Capable of controlling the gas calibrators.
5. Minimum sampling rate: 10 sec.
6. Compute and store 5 min. and 1 hour averages, 1 year each minimum.
7. The data communication between the instruments and the data logger shall be based on RS232 serial communication.
8. Data presentation software capable of displaying and printing both historical and on line data in charts and listings.
9. Operating temperature: +15 °C to +30 °C.

### 3.1.35 Reference lab repair and maintenance tools kit

#### Quantity of equipment: 1

#### Purpose

A complete set of repair and maintenance tools including a toolbox is required for repair and maintenance work in the laboratory.

ITEM	Quantity
Toolbox, suitcase type, including:	1
Screwdriver, slotted, 2.5x80 mm	1
Screwdriver, slotted, 4x100 mm	1
Screwdriver, slotted, 5.5x100 mm	1
Screwdriver, supadriv, No 0x80	1
Screwdriver, supadriv, No 1x80	1
Screwdriver, supadriv, No 2x100	1
Multimeter AC/DC, digital, V, A, Ohm	1
Spanner, adjustable, 15 mm jaw	1
Spanner, adjustable, 35 mm jaw	1
Knife, cut, 100 mm blade	1
Rod, measuring, 1 m	1
Tweezer, flat nose	1
Optical inspection mirror, 165mm	1
Spanner, combination, 7 mm	1
Spanner, combination, 8 mm	1
Spanner, combination, 9 mm	1
Spanner, combination, 10 mm	1
Spanner, combination, 11 mm	1
Spanner, combination, 12 mm	1
Spanner, combination, 13 mm	1
Spanner, combination, 14 mm	1
Spanner, combination, 15 mm	1
Spanner, combination, 16 mm	1
Spanner, combination, 17 mm	1
Spanner, combination, 3/16"	1
Spanner, combination, 1/4"	1
Spanner, combination, 5/16"	1
Spanner, combination, 3/8"	1
Spanner, combination, 7/16"	1
Spanner, combination, 1/2"	1
Spanner, combination, 9/16"	1
Spanner, combination, 5/8"	1
File, needle, warding	1
File, needle, round	1

Cutter, wire, 150 mm	1
Ball hexagon driver, L shaped, 9 piece set, 1.5 mm - 10 mm	1
Ball hexagon driver, L shaped, 9 piece set, 0.05" - 5/16"	1
Pliers, combination, 160 mm	1
Hacksaw, small incl. spare blades	1
Wire stripper	1
Soldering iron, 230 V, 18 W	1
Caliper, 7" / 180 mm	1
Pocket, handlamp	1

### 3.1.36 Reference laboratory items

#### Purpose

General items for reference lab.

ITEM	Minimum quantity	Other properties
1/4" teflon tubing	30 m	Unit (metric or imperial) depends on unit used in ambient air monitors
1/8" teflon tubing	10 m	
4 mm inner/ 10 mm outer silicon tubing	10 m	
Reducing union SS 1/4" - 1/8"	5	
Union SS 1/8"	5	
Union SS 1/4"	5	
Union elbow SS 1/4"	5	
Union tee SS 1/4"	5	
Union tee SS 1/8"	5	
Plug SS 1/8"	10	
Plug SS 1/4"	10	
Cap SS 1/8"	5	
Cap SS 1/4"	5	
Nut SS 1/4"	10	
Nut SS 1/8"	10	
Ferrule-pak SS 1/4"	1 á 100 pcs	
Ferrule-pak SS 1/8"	1 á 100 pcs	
Port connector SS 1/4"	5	
Male elbow B 1/4"-1/4"	10	
Union B 1/4"	5	
Union tee B 1/4"	5	
Nut B 1/4"	10	
Ferrule-pak B 1/4"	1 á 100 pcs	
1/4" Y-piece	100	

**3.1.37 Reference lab computer****Quantity of equipment: 1****Purpose**

A PC is required for data acquisition and data display and control of the calibration system.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Minimum clock rate: 2,0 GHz.
3. Minimum RAM capacity: 2 Gbyte.
4. Minimum hard disk capacity: 250 Gbyte.
5. Serial port or USB to serial adapter.
6. Windows, latest version.
7. MS Office, latest version.
8. Data acquisition and control software as specified in 3.1.34 Reference lab data acquisition and control system.
9. Calibration software as specified in 3.1.8 Multi gas multipoint calibration system.
10. Necessary interface and cables for connecting the PC to the data logger and calibration system.
11. The bidder must specify additional specifications if any of the specifications above do not meet the necessary conditions.

**3.1.38 Reference lab portable computer****Quantity of equipment: 1****Purpose**

A portable PC is required for data acquisition and data display and control of the calibration system. To be used during field audits.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Minimum clock rate: 2,0 GHz.
3. Minimum RAM capacity: 2 Gbyte.
4. Minimum hard disk capacity: 250 Gbyte.
5. Serial port or USB to serial adapter.
6. Data acquisition and control software as specified in 3.1.34 Reference lab data acquisition and control system.
7. Calibration software as specified in 3.1.8 Multi gas multipoint calibration system.
8. Windows, latest version.
9. MS Office, latest version.
10. The bidder must specify additional specifications if any of the specifications above do not meet the necessary conditions.

**3.1.39 Reference lab printer**

**Quantity of equipment: 1**

**Purpose**

A printer is required for printing data from the Reference lab PC.

**Qualification requirements**

1. Power requirements: 220 - 240 V.
2. Any laser or ink jet printer.
3. Single sheet feeder.

**3.1.40 Chair****Quantity of equipment: 1****Purpose**

A Chair is required for the reference lab.

**Qualification requirements**

1. Swivel-chair.

**3.1.41 Shelf for manuals**

**Quantity of equipment: 1**

**Purpose**

A shelf is required for manuals etc.

**Qualification requirements**

1. Shelf dimension (approx), W, D: 200 cm, 30 cm, at 2 heights, vertical distance of 35 cm.

#### 4 Manpower requirements for Reference laboratory

To assure a satisfactory operation of the Reference laboratory, certain personnel need to be allocated to the laboratory. Table 2 shows the functions that need to be covered for running the Reference laboratory.

Table 2: Resources/Manpower requirements for the Reference Laboratory.

Function	Number	Yearly work load
1	Laboratory Manager	50%
1-2	Operators	50%

The number of people necessary to operate the Reference laboratory will depend on the workload.

#### 5 Commissioning and testing requirements

The entire system shall be tested as a site acceptance test for at least one week (minimum 168 hours). The bidder shall provide a test protocol for approval and witness to document this shake-down period by summarizing as a minimum (where applicable):

- Instruments:
  - Mechanical and electrical inspection
  - Adjustments and calibrations
  - Span drift, 1 day and 7 days
  - Zero drift, 1 day and 7 days
- Shelter, tubing and wiring
- Alarm handling
- Data communication between
  - Shelter and central data base
  - Performance test results on data flow

The bidder shall provide engineering drawings (as built) of the system installation, including structural pad design, electrical design and communication solution.

#### 6 Training requirements

To ensure correct operation of instruments and data collection system a training program shall be developed and carried out. The training programme shall commence right after commissioning and testing. It should last for at least 2 weeks and consist of both classroom training and hands-on training in instrument operations.

The following topics shall as a minimum be included in the training programme for instrument operations and maintenance:

- Instrument installations
- Instrument calibrations
- Instrument operations
- Preventive maintenance
- Data acquisition system
- Status checking
- Simple repairs
- QA/QC system relating to instrument operations
- Data collection from sensors
- Data system maintenance and operation

**Appendix A**  
**Vendor list**



## Vendor list

Environnement S.A  
111, bd Robespierre  
78300 Poissy, France  
[www.environnement-sa.com](http://www.environnement-sa.com)

Environics, Inc.  
69 Industrial Park Rd. E.  
Tolland, CT 06084-2805  
USA  
Phone: (860) 872-1111  
[www.environics.com](http://www.environics.com)

Horiba Instruments Incorporated  
9755 Research Drive  
Irvine California 92618  
USA  
Phone: +1 949 250 4811  
[www.horiba.com](http://www.horiba.com)

Teledyne - Advanced Pollution  
Instrumentation, Inc.  
9480 Carroll Park Drive  
San Diego, California 92121-5201  
USA  
Phone: (858) 657-9800  
[www.teledyne-api.com](http://www.teledyne-api.com)

Casella Measurement  
Regent House  
Wolseley Road  
Kempston  
Bedford  
MK42 7JY  
UK  
Tel: +44 (0)1234 844 100  
[www.casellameasurement.com](http://www.casellameasurement.com)

Ecotech Pty Ltd  
1492 Ferntree Gully Road,  
Knoxfield, VIC, 3180  
Australia  
Phone: (+61 3) 9730 7800  
<http://www.ecotech.com/>

Thermo Electron Corporation  
27 Forge Parkway  
Franklin, MA 02038  
USA  
(508) 520-0430 / (866) 282-0430  
[www.thermo.com](http://www.thermo.com)

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REPORT PREPARED FOR Clean Air and Sustainable Environment Project, Department of Environment (CASE-DOE) in Bangladesh			
ABSTRACT This report contains all relevant physical technical specifications as well as manning requirements for the Reference laboratory for air quality measurements. The report also includes commissioning, testing and training requirements.			
NORWEGIAN TITLE Tekniske spesifikasjoner for et nasjonalt referanselaboratorium i Bangladesh			
KEYWORDS Air quality	Urban traffic pollution	Environmental monitoring	
ABSTRACT (in Norwegian) Denne rapporten inneholder tekniske spesifikasjoner og bemanningsbehov for et referanselaboratorium for luftkvalitetsmålinger. Rapporten inneholder også krav til installasjon, testing og opplæring.			

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