

Technical Specifications
Air Quality Monitoring Program

May 2004

Introduction

As part of the Environmental Management Support Project (EMSP), the World Bank is improving the air quality monitoring capacity of the Iranian Department of Environment (DOE). This project is a part of an ongoing process for establishing an integrated and comprehensive Air Quality Monitoring network initially in the cities of Arak, Esfahan, Mashhad, and Tehran out of seven most polluted large cities in Iran. The primary objective of DOE's air monitoring program is to determine if air quality standards (WHO standards) are being met and measure progress towards achieving the standards. The program will also help to develop air quality data for public information needs, quantifying trends to identify future problems or progress in achieving management control targets, and developing and validating management tools such as air pollution dispersion models.

Background

In Iran, air quality monitoring is normally the responsibility of DOE. Regional offices of DOE plan and operate monitoring activities and send information to the central authority.

In Tehran, DOE operates seven (7) fixed ambient air monitoring stations. In Arak, regional DOE office operates one (1) ambient air monitoring station. In Esfahan and Mashhad there are two (2) ambient air monitoring stations in each city under operation with the gathered data sent to central DOE. The data gathering in all stations is done by responsible staff of DOE but services and maintenance (calibration and routine checks) is done by respective providers. Due to its specific needs, Municipality of Tehran has also created a specialized structure for air quality monitoring -- Air Quality Control Company (AQCC) -- which operates four (4) ambient air monitoring stations including two (2) fixed and two (2) mobile stations (for more information refer to Annex 1).

With this project, DOE is enhancing and strengthening the existing system of air quality monitoring at national level (central DOE) and local level (at the provincial DOE level) through developing air quality monitoring network between the existing and future stations and establishing a monitoring center in each city under the project. These monitoring centers have to operate, manage and collect data from monitoring stations and send it to central DOE. The central monitoring at national level, which would be localized in central DOE, will collect the information from these cities and produce periodical reports (daily, weekly, monthly and annually).

The supplier will provide goods and services for establishing and enhancing existing continuous air quality monitoring networks in the cities of Arak, Esfahan, Mashhad and Tehran. The new stations should be fully integrated with existing stations and networks. The operation of these stations should comply with the local regulatory authority's requirements for valid data capture.

The supplier will supply and install monitoring stations and meteorological equipments according to specifications listed in this document as well as providing and installing hardware and software for data processing at station, city and national level. The supplier will provide parts, documentation, maintenance services, and deliver hands-on training for DOE staff on how to operate, calibrate and maintain the equipment, and offer warranties on all delivered goods and services. More details are provided in the following paragraphs.

A. Monitoring Stations

The supplier will provide a total of forty-four (44) monitoring stations according to the following breakdown:

Type of Station	Total
Urban Station I (CO, NO _x , SO ₂ , PM _{2.5} , Met)	19
Urban Station II (CO, NO _x , O ₃ , VOC, PM _{2.5} , PM ₁₀ , Met)	5
Traffic Station (CO, VOC, NO _x , PM _{2.5})	8
Downwind Station (CO, NO _x , O ₃ , PM _{2.5} , Met)	4
Upwind Station (CO, NO _x , O ₃ , SO ₂ , VOC, PM _{2.5} , PM ₁₀ , Met)	4
Mobile Station (CO, SO ₂ , NO _x , O ₃ , VOC, NH ₃ , PM _{2.5} , PM ₁₀ , Met)	4
Total Number of Monitoring Stations:	44

Met = Meteorological Parameters
PM = Continuous Ambient Particulate

The stations should provide proper shelter for monitoring equipment and include air-conditioning for temperature control at 20-30 °C, internal ventilation systems, electrical supply protection and conditioning, monitoring of electrical supply upset events, calibrations systems and zero air generators, security systems, rack cabinets, computerized data acquisition and data processing systems. For QA/QC purposes, temperature and relative humidity sensors should be installed inside all monitoring stations. Semi-permanent shelters are preferred. DOE will ensure that civil works including construction and installation of platforms for monitoring stations and meteorological towers on selected sites will be finalized before stations are to be installed. Below are more specifications.

Shelter Description of Semi-Permanent Stations

The equipment and instrumentation for the monitoring station should be housed in a shelter with approximate dimensions of 3m x 2m x 2.5m (LxWxH). Temperature within the shelter should be environmentally controlled by efficient air conditioner for protection and stable operation of the instrumentation. The material used for the construction of the shelter should be able to withstand the extreme weather conditions that prevail in Iran¹. A 2.5 meter high wire fence with locked doorway shall be installed around the perimeter of the station as a security measure.

The meteorological sensors should be mounted atop a four (4) stage, ten (10) meter high crank-up meteorological tower attached to the side of the shelter. A heated glass intake, sample manifold with eight (8) ports and blower, Teflon and stainless steel sample handling valve train and sample lines should be provided with the shelter. The sampling inlet for the continuous particulate monitor shall be installed two (2) meters above the shelter roof, passing through the roof directly to the monitor. A PVC exhaust manifold vented to the bottom of the shelter should be provided to prevent exhaust gas from building up inside the shelter. The shelter should be equipped as follows:

- Gas bottle rack for securing expendable gas cylinders
- Meteorological tower

¹ In Iran, the general climate is hot & dry in summer, cool in winter (November - February). Temperature varies between 15 to 40°C in summer and minimum average temperature during winter is -10°C. Average rainfall is 250 mm annually and wind speeds vary from calm to about 4 m/s

- 220 VAC, 50Hz power supply
- Power conditioning capacity sufficient to assure uninterrupted power of sufficient quality to avoid data loss and meet instrument requirements.
- Working bench and storage shelves and filing cabinet with desk light
- Interior lighting, smoke detector, fire extinguisher and telephone jacks for the work desk
- Instrumentation rack
- Lockable, heavy duty tamper proof door
- High quality vinyl flooring with wood paneling on the walls
- Insulated walls, ceiling, and floor minimum R-16 rating
- Gas sample inlet probe, heated eight (8) port glass sample manifold/handling system with blower
- PVC exhaust manifold
- The shelter roof shall be constructed as a sampling platform suitable for frequent station operator use with non-skid materials. A safety railing shall extend around the roof and an exterior ladder will be provided from the ground to the roof.
- Uninterrupted Power Supply (UPS) with battery backup for monitors, data logger, and inlet pumps for continuous operation of minimum 1 hour (220v input) shall be provided.

Mobile Stations

The caravan (trailer) should be dual axle and conform to all safety requirements for use on Iranian roads. The caravan should be leaf spring suspended and it should be equipped with brakes. Four (4) stabilizing jacks one for each corner for leveling the shelter must be provided. The caravan should be fitted with a towing coupling suitable for use with a land vehicle or SUV.

- Chassis - Steel box section galvanized steel construction
- Suspension - Leaf springs
- Brakes - Electric
- Tires - Light truck R185 x 14 on steel rims
- Instrument shelter dimensions (approximate)- L 3m x W 2m x H 2.5m
- All other semi-permanent specifications, above.

B. Air Quality Samplers and Monitors

The supplier will provide and install the following number of analyzers in the continuous air quality monitoring stations and connect them to the station's data processing system:

Analyzer	Total Number
Carbon Monoxide (CO)	44
Sulfur Dioxide (SO ₂)	27
Nitrogen Oxides (NO _x)	44
Ozone (O ₃)	17
Continuous Ambient Particulate (PM ₁₀)	13
Continuous Ambient Particulate (PM _{2.5})	44
High Volume Sampler (PM ₁₀)	12

Low Volume Sampler (PM _{2.5})	12
Volatile Organic Compounds (VOC)	21
Ammonia (NH ₃)	4

All analyzers (with the exception of the VOC and NH₃ monitors) should be USEPA Federal Reference Method or equivalent methods. More detailed technical specifications for each analyzer can be found in the following paragraphs.

Sulphur Dioxide (SO₂)

Principle: Pulsed UV fluorescent

Ability: Microprocessor controlled analyzer with automatic calibration using an external gas dilution calibrator and calibration gas standards.

Shall comply with USEPA Automated Reference/Equivalent Method Designation.

Specifications:

Ranges:	Auto-ranging 0-1.0 ppm, resolution 0.001 ppm or 0.1% reading
Noise (at zero):	Less than 0.25 ppb or 1% reading whichever is less
Lower Detectable Limit:	Less than 0.50 ppb or 0.2% of concentration reading
Total Interference Equivalent:	Less than 12 ppb
Zero Drift:	Less than 1 ppb/7 days and Less than 1 ppb/24 hours
Span Drift:	Less than 0.5%/24 hours
Lag Time:	Less than 10 sec
Rise Time:	Less than 60 sec to 95%
Fall Time:	Less than 120 sec to 95%
Precision:	1 ppb or 1% reading
Sample Flow Rate:	0.5 lpm (nominal)
Temperature Range:	5 to 45 deg C
Digital Outputs:	DB50 status and multi-drop RS-232 ports.
Power:	220 VAC 50 HZ
Chassis:	Rack mounted, 19 inch.

Nitrogen Oxide/Oxides of Nitrogen/Nitrogen Dioxide (NO/NO₂/NO_x)

Principle: Chemiluminescence

Ability: Microprocessor controlled analyzer with automatic calibration using an external gas dilution calibrator and calibration gas standards.

Shall comply with USEPA Automated Reference/Equivalent Method Designation.

Specifications:

Ranges:	Auto ranging 0-2.0 ppm, resolution 0.001 ppm or 0.1% reading
Noise (at zero):	Less than 0.25 ppb or 1% reading whichever is less
Lower Detectable Limit:	Less than 0.5 ppb
Zero Drift:	Less than 1 ppb/ ppb/24 hours, 1 ppb/30 days
Span Drift:	Less than 1 ppb - 24 hours

Lag Time:	Less than 25 sec
Rise/Fall Time:	Less than 60 sec
Precision:	1 ppb or 1 % of reading
Sample Flow Rate:	0.6 lpm (nominal)
Temperature Range:	5 to 45°C
Digital Outputs:	DB50 status and multi-drop RS-232 ports.
Power:	220 VAC 50 HZ
Chassis:	Rack mounted, 19 inch.

Carbon Monoxide (CO)

Principle: Non-Dispersive Infrared Photometry – Gas Filter Correlation

Ability: Microprocessor controlled analyzer with automatic calibration using an external gas dilution calibrator and calibration gas standards.

Shall comply with USEPA Automated Reference/Equivalent Method Designation.

Specifications:

Ranges:	Auto ranging 0-100 ppm, resolution 0.01 ppm or 0.1% reading
Noise (at zero):	Less than 0.03 ppm or 1% of reading
Lower Detectable Limit:	Less than 0.06 ppm or 0.2% of concentration
Zero Drift:	Less than 0.1 ppm/24 hours, 0.2 ppm/30 days
Span Drift:	Less than 1.0%
Lag Time:	Less than 30 seconds
Rise/Fall Time:	Less than 60 seconds
Precision:	0.1 ppm or 1% of reading
Sample Flow Rate:	0.5-2.0 lpm (nominal)
Temperature Range:	5 to 45°C
Rejection Ratio:	Negligible interference from H ₂ O vapor and CO ₂
Digital Outputs:	DB50 status and multi-drop RS-232 ports.
Power:	220 VAC 50 HZ
Chassis:	Rack mounted, 19 inch.

Ozone (O₃)

Principle: UV Photometry

Ability: Microprocessor controlled analyzer with automatic calibration using an external gas dilution calibrator and calibration gas standards.

Shall comply with USEPA Automated Reference/Equivalent Method Designation.

Specifications:

Ranges:	Auto ranging 0-1.0 ppm, resolution 0.001 ppm or 0.1% reading
Noise (at zero):	Less than 0.50 ppb or 1% of reading whichever is less
Lower Detectable Limit:	Less than 1 ppb or 0.1% of reading
Zero Drift:	Less than 1 ppb/12 hours, 1 ppb/30 days
Span Drift:	Less than 1%/24 hours
Lag Time:	Less than 20 sec
Rise/Fall Time:	Less than 60 sec
Precision:	1 ppb or 1 % of reading

Continuous Ambient Particulate (both PM₁₀ and PM_{2.5})

Principle: True Micro Weighing

Ability: Real time analyzer capable of measuring PM-10/2.5 with calibration facility.

Shall comply with USEPA Automated Reference/Equivalent Method Designation.

Specifications:

Range:	0 - 5,000,000 ug/m ³
Resolution:	0.1 ug/m ³
Precision:	±1.5 ug/m ³ (1 hour avg.), ±0.5 ug/m ³ (24 hours)
Accuracy:	±0.75 % (mass measurement)
Measuring Cycle:	Real time mass concentration
Temperature:	1 to 60°C
Data Output Rate:	less than 60 seconds
Out Value:	Mass concentration in terms of volumetric flow rate
Output:	DB50 status and multi-drop RS-232 ports
Power:	220 VAC, 50 Hz
Inlets:	Separate PM ₁₀ & PM _{2.5} inlets

High Volume PM-10 Particulate Samplers

These samplers shall comply with USEPA Manual Reference Method Designation.

Specifications:

Vacuum Supply:	Squirrel cage motor without brushes or axial blower with model GB1 carbon brushes with sealed bearing ensuring maintenance free continuous operation. All parts shall be corrosion resistant.
Flow Rate:	Constant flow rate of 40ACFM
Flow Control Accuracy:	±2.5 % deviation over 24 hour
Flow Controller:	Sensor controlled, not sensitive to high humidity and temperature.
Filter Media:	Standard 8-in.x 10-in. Glass or quartz fiber filter media
Filter Holder:	Heavy-duty corrosion resistance, leak proof frame designed to accommodate filter media.
Timer:	Programmable timer
Sampler Housing:	Heavy-duty powder coated or marine grade anodized aluminum housing.
Size Selective Inlets:	PM ₁₀ and PM _{2.5} to be provided
Power Required:	220 VAC, 50 Hz.
Flow Calibration:	Complete kit required
Filter Media supplies:	1200 units

Low Volume PM-2.5 Particulate Samplers

These samplers shall comply with USEPA Manual Reference Method Designation

Specifications:

Environmental Conditions:	-30°C to +45°C; 600mm Hg to 800mm Hg
Inlet:	WINS Impactor
Flow Rate:	Fixed at 16.67 lpm

Flow Control:	+/- 5% of 16.67 lpm with CV of < 2%
Filter Media:	47mm PTFE Teflon
Data Storage:	> 15 days of 5-minute interval average flow data and 50 events
Sampler Controls:	Keypad with system menus to program sampling schedules
Data Port:	RS-232 serial port for data retrieval
Filter Media supplies:	2400 units

C. Meteorological Instrumentation

The supplier will provide and properly install meteorological sensors for wind speed, wind direction, temperature, precipitation, solar radiation, and relative humidity at air quality monitoring stations except traffic stations (as indicated below). The supplier will connect the sensors to the monitoring station's data processing system. Mobile stations will be equipped with ten (10) meter towers.

Configuration of Meteorological Towers (10 meters)	Total
Urban Station I (WS, WD)	19
Urban Station II (WS, WD)	5
Downwind Station (WS, WD, Temp., RH, Pre., SR)	4
Upwind Station (WS, WD, Temp., RH, Pre., SR)	4
Mobile Station (WS, WD, Temp., RH, Pre., SR)	4
Total Number of Meteorological Stations:	36

WS: Wind Speed, WD: Wind Direction, Temp: Ambient Temperature
 RH: Relative Humidity, Pre: Precipitation, SR: Solar Radiation

Also the supplier will provide and install sensors for eight (8), twenty-four (24) meter meteorological towers with lightening protection, two (2) in each city. The supplier will supply and install sensors to measure temperature and humidity at two (2) meters; temperature difference (10-2 meters) and wind speed at ten (10) meters; and temperature difference (24-10 meters) and horizontal and vertical wind speed and direction at twenty-four (24) meters. Proper data processing systems should be installed (if not available already) and connected to the local network.

The meteorological instrumentation should be interfaced directly with the Data Acquisition System after passing through a lightning protection isolation box.

All meteorological equipment should comply with highest international standards. More detailed technical specifications for each analyzer can be found in the following paragraphs.

Wind Direction

The sensor has to provide low starting threshold, fast response and accuracy over a wide operating range in adverse environmental conditions.

Specifications are as follows:

Accuracy:	+/- 4%
Wind Direction Operating Range:	0 to 360 degrees
Starting Threshold:	0.5 m/s

Distance Constant: 1.1 m of air maximum
Damping Ratio: 0.4 at 10 initial angle of attack
Temperature Operating Range: -40°C to 60°C

Wind Speed

The anemometer has to provide a low starting threshold, wide dynamic response and high accuracy over a wide range of wind speeds and a variety of environmental conditions.

Specifications for the wind speed sensor are as follows:

Maximum Operating Range: 0-50 m/s
Distance Constant:
 Vinyl: 1.5 m of air maximum
 Stainless Steel: 2.4 m of air maximum
 Heavy Duty: 3m of air maximum
Temperature Range: -40°C to 60°C
Accuracy: 0.2 m/s or 1%, whichever is greater
Threshold: 0.22 m/s (0.5 mph)
Impedance: 4.7 k ohm
Power Requirement: 12 Vdc, 4.5 mA or 6Vdc at less than 1mA

Ambient Temperature

Temperature measurement system specifications are as follows:

Calibrated Temperature Range: -50°C to 60°C
Response: 10 seconds in still air
Linearity: +0.1°C
Accuracy: 0.15°C

Relative Humidity

Specifications are as follows:

Measuring Range: 0 to 100% RH
Accuracy: +/- 1.0% (5-95% RH)
 +/- 2.0% (<5, >95% RH)
Response Time: < 2 minutes for RH 10% to 90%
 < 5 minutes for RH 40-90%
 Typically 20 seconds
Linearity: Better than +/- 2%
Reproducibility: 0.5%
Temperature Range: -40 to 60°C

Precipitation

The Precipitator specifications are as follows:

Operation: Tipping bucket operation
Operating Range: 0-100 mm
Resolution: 0.25 mm
Dimensions: 8 inch diameter orifice
Accuracy: +/- 3% at 7-250 mm per hour

Solar Radiation

The detector should be able to measure short-wave radiation, which is comprised of the direct component of sunlight and the diffuse component of skylight.

Specifications are as follows:

Sensitivity:	80 micro amps per 1000 W m ²
Temperature Dependence:	0.15% per C max
Linearity:	1% from 0 to 3000 watts m ²
Response Time:	10 microseconds
Cosine Response:	Corrected up to 80 angle of incidence
Orientation:	No effect on instrument performance
Calibration:	Calibrated against an Eppley Precision. Spectral Pyranometer (PSP) under natural day light conditions. Absolute error under these conditions is 5% maximum, typically 3%

Telescoping Crank-up Meteorological Tower for Mobile Stations

Specifications are as follows:

Extended Height:	10 meters
Retracted Height:	Less than 3 meters
Wind Load Limit:	8.5 sq. ft at 50 mph
Number of Sections:	4
Construction Materials:	Galvanized steel or aluminum

Note: The remaining 32 ten-meter towers and 8 twenty four-meter towers will be provided and installed by the DOE

D. Calibration Equipments

Calibration equipments should be provided for the calibration of the air quality analyzers, particulate samplers, data acquisition system, meteorological equipment, and gas calibration system.

Gas Calibration System

The calibration system for the air monitoring equipment (listed above) should incorporate an automatic gas dilution calibrator, calibration gas standards, and a high performance zero air generator to calibrate all of the analyzers in the system. The calibration cycles should be configurable through the Data Acquisition System at any specific time during the day or night.

The dilution calibrator should be able to perform mixing of source gas (from the calibration gas bottles) with zero air (from the zero air generator) in order to generate a wide range of calibration gas concentrations and minimizing the number of calibration gas standards required.

Meteorological, Flow, and Electronics Calibration

Supplier should provide calibration devices for all the meteorological and other electrical equipment mentioned above per specifications of the manufactures. The following list is a minimum requirement:

- Wind Direction Calibrator - Degree Wheel
- Telescopic Orientation Sight
- Wind Speed Sensor Accuracy - Synchronous Motors
- Temperature - Precision Resistors and Thermometers
- Portable Aneroid Pressure Calibrator
- Relative Humidity Calibrator
- Data Acquisition System - Voltage, Frequency, Resistor Standards and Calibrated Multi-meters
- Calibrator Flow - NBS Traceable Bubble Meter and Flow with Water Manometer
- Gases - EPA Protocol NBS Traceable 2% of Analysis

Calibration and Zero Gases

All stations must be equipped with zero-air generators and span gas dilution systems that can be activated by the DAS system. The gas dilution calibrator must provide a simple means of obtaining precise gas dilution calibrations for each of the instruments at the station. If an ozone analyzer is at the station, the calibrator must provide gases for precision checks and gas phase titration.

Specifications:

- Front panel-accessed or station PC-accessed setup system for single point or multipoint instrument calibrations
- Remote control provided via the DAS
- Mass Flow controller zero stability of less than 0.6% of full scale per year
- Not less than four (4) external span gas tank connections
- Stable, internal ozone generator to provide ozone precision checks

E. Data Acquisition System

The supplier will provide and install data acquisition systems in each station (hardware and software) that run on Windows operating systems. The system should provide full control over the entire system enabling automatic calibration cycles to be performed and system errors to be detected and reported. The data acquisition system should feature automatic data validation software complete with data capture percentage. The system should preferably collect data directly from the instruments in digital format. The data acquisition system should have a minimum of 60 Gb Hard Disk Drive, 256 Mgb. Ram and have sufficient data storage to hold twenty (20) years worth of historical data. It should also feature internal CD Read/Write drive and at least two (2) USB ports.

The Data Acquisition System (DAS) should be able to collect and store meteorological data and air quality data from all instruments listed above. The DAS should be a low powered data logger designed to be used for recording and storing data. DAS should include following minimum features:

- "Industry Standard" RS-232 Communication enables digital/analog communication with all supported monitoring and meteorological equipment.
- Supports remote communication enabling full control over the pollution monitoring system and direct interfacing with supported analyzers.
- Online and remote communication through radio, switched telephone, cellular telephone, as well as short hauls modems.
- Data storage space for minimum thirty (30) days of five (5) minute historical data.
- Captures minimum, maximum, average values and standard deviations.
- Lightning & surge protection facilities.

- Full control over calibration cycle periods
- Password protection

F. Analytical Software

The supplier shall provide and install data collection, evaluation and, reporting systems (including required remote connections, hardware and software) to interrogate and control each station's data acquisition system and collect data into a centrally-located computer at local and at national level. These collection systems should simplify the tasks of automatically and manually retrieving and viewing measurement data, collating and storing data into a central database at city and national level, and evaluating and summarizing data into comprehensive reports. It should be capable of real-time viewing of measurement and diagnostic data and control calibration sequences and other system functions. The system should also be able to retrieve information directly from the station's data acquisition system following validation and support remote communication with full user interface via a TCP/IP network or dial up network.

The data collection, evaluation and reporting systems should be able to collect and process data from a wide variety of data acquisitions systems and, in particular, those used by DOE and AQCC in Tehran at the moment (for more information refer to Annex 1). The system shall compute and report, in a daily summary format, concentrations of all pollutants which exceed ambient air quality standards adopted by Iran, the time of day that the exceedence occurred and the number of times within the preceding twenty-four (24) hour period that the standard(s) were exceeded. The system shall also calculate and report the air quality index as specified by Iran DOE on an hourly basis at each station using valid data collected over the preceding twenty-four (24) hours.

The software should be able to generate graphs and reports in the standard Windows format in definable periodic categories including hourly, daily, weekly, monthly and yearly as indicated below:

Line and Bar Graphs of Average, Maximum and Minimum, of Running Averages, of Standard Deviation, of Percentile, of Log Mean.

Reports and graphs of Average Pollution Plots, Percentage Pollution Concentrations, Frequency Distribution Histogram, Cumulative Frequency Distribution, Wind Rose, Polar Scatter Plots, and Pollution Indices.

The supplier will include regular upgrades of software and/or replace software if required and provide full documentation of the DAS-data system including how reported pollutant averaging times and air quality standards are done.

In summary, the Windows-based software should possess the following minimum features:

- Windows OS compatible.
- File format conversation
- Statistical analysis of data for maximum, minimum, average, standard deviation for various time intervals using the monitored data.
- Tabular and graphical format for report production.
- Wind rose graphs.
- File export facility.
- Windows based printer support.

G. Installation

The whole system shall be tested and an inspection report based on ISO-9001 procedure be prepared and made available prior to shipment by the supplier. The supplier shall install and operationalize all of the components of the monitoring system by factory trained service engineers in Iran. The supplier will calibrate all installed air

quality monitoring equipments and meteorological sensors. The supplier will also carry out a detailed equipment and system's check to ensure proper installation and operation of all components for seven (7) days -- minimum two (2) days of which must be in the presence of authorized DOE representative -- prior to handing it over to DOE operation. The final hand-over will be formally verified through official certification of the 'acceptance certificate'.

The supplier must possess all necessary items such as sample manifold, sample intake, instrument rack, exhaust manifold, tubing, connections, etc. for complete general assembly of the equipment in all stations. Two (2) sets of manuals and drawings (Pneumatic, Mechanical, Electrical) depicting connections should be provided in English for each monitoring station.

H. Training

Once the stations are operational, the supplier shall provide on-job training for technical staff from DOE offices in Arak, Esfahan, Mashhad, and Tehran. The training program should be conducted by and include supplier's staff, local agent or distributor. The training course will be conducted in English. Training materials must be provided in Farsi with one duplicate set in English.

The first two training programs listed below will be held in first phase delivery and installation in Tehran. The third training program will be held in cities Arak, Esfahan, Mashhad and Tehran during station installation in each city. Relatedly, other than the factors mentioned above, the DOE will undertake all remaining necessary arrangements and logistic expenses (including transportation, accommodation and meal for trainee, printing facility, workshop space and equipment, translator and etc.).

The following 6 training activities will be organized and provided by the supplier:
1- *Equipment basics, maintenance, calibration and diagnostics (One Training)*

For: DOE engineers, equipment maintenance technicians, field technicians from Tehran, Arak, Esfahan and Mashhad.

Duration: One week

Location: Tehran

Subject: Description, operation, maintenance and calibration of equipment to ensure proper data quality with maximum efficiency. Actual measurement, recognition of bad data, maintenance and calibration should be performed using manuals and actual equipment supplied.

2- *Data handling: acquisition, collection, evaluation and reporting (One Training)*

For: DOE engineers, assigned technicians to data processing and reporting software specialists from Tehran, Arak, Esfahan and Mashhad.

Duration: One week

Location: Tehran

Subject: Understanding all procedures necessary for proper data acquisition, quality assurance and quality control. Learn to use software, perform basic functions and recognize and solve basic problems.

3- *On site equipment maintenance, calibration and diagnostics (Four Trainings)*

For: DOE engineers, equipment maintenance technicians, field technicians

Duration: One week in each city

Location: Tehran, Arak, Esfahan, Mashhad

Subject: On site, description, operation, maintenance and calibration of equipment to ensure proper data quality with maximum efficiency. Actual measurement, recognition of bad data, maintenance and calibration should be performed using manuals and actual equipment supplied.

I. Special Conditions

It is the responsibility of the supplier to make sure all equipments, parts, and consumables selected can be legally exported to Iran for the duration of the contract. This provision is designed to protect the investment of the Purchaser from enforced trade barriers of all sorts, including sanctions.

If for any reasons, the supplier/manufacturer either changes or goes out of business, it must provide the Purchaser with design plans necessary for the alternative production of all needed spare parts and consumables covered by the contract.

The costs' estimates for provision of material detailed in Technical Specifications should be provided for each item separately.

J. Additional Services and Maintenance

The supplier will provide a detailed maintenance schedule together with a proposal service contract which shall be customized to meet DOE's needs and requirements for three (3) years from commissioning. This should include repair, maintenance, calibration and operation of the system and the collection and validation of data based on quality assurance and quality control. These services should be designed to keep instrument in proper conditions for valid data capture.

**Annex 1: Specification and Configuration of Existing Ambient Air Quality
Monitoring Stations in Cities, Arak, Esfahan,
Mashhad, and Tehran**

Tehran: DOE Stations

	CO	SO ₂	NO _x	PM-10	TSP	O ₃	THC	Data Logger	Provider
Station 1	√	√	√		√	√	√		Horiba
Station 2	√	√	√		√	√			Horiba
Station 3	√		√		√	√			Horiba
Station 4	√	√	√		√		√		Horiba
Station 5	√	√	√			√	√		Horiba
Station 6	√	√	√		√	√			Horiba
Station 7	√	√	√		√		√		Horiba

These seven (7) stations were installed in 1994 and are presently under operation. The stations do not have data loggers and hence, information is recovered manually and transferred by diskette and stored in central computer in DOE provincial office. The instruments' model is Horiba-350.

Tehran: Municipality Stations

	CO	SO ₂	NO _x	PM-10	TSP	O ₃	THC	Data Logger	Provider
Station 1	√	√	√	√		√	√	√	Thermo-Envi.
Station 2	√	√	√	√		√	√	√	Thermo-Envi.
Station 3	√	√	√	√		√	√	√	Thermo-Envi.
Station 4	√	√	√			√	√		Horiba

The first three stations were installed in 1994, the last one in 1998. All are under operation at this time.

The stations 1 to 3 have data loggers (Odesa DSM-3260) and collect, process and send data to the central office via telephone line.

The instruments' model of station 4 is Horiba-360 and its information is recovered manually and transferred by diskette to the central office.

The data gathering, services and maintenance (calibration and routine checks) in all stations are done by AQCC responsible staff.

Arak

	CO	SO ₂	NO _x	PM-10	TSP	O ₃	THC	Data Logger	Provider
Station 1	√	√	√	√		√	√		Horiba

The instrument model in station 1 is Horiba-360 and information is recovered manually and transferred by diskette to central office.

Esfahan

	CO	SO ₂	NO _x	PM-10	TSP	O ₃	THC	Data Logger	Provider
Station 1	√	√	√				√		Enviro-Tech
Station 2	√	√	√	√					Enviro-Tech

The instruments' stations' model is Enviro-Technology. From these stations, the data is recovered manually and transferred by diskette to the central office.

Mashhad

	CO	SO ₂	NO _x	PM-10	TSP	O ₃	THC	Data Logger	Provider
Station 1	√	√	√	√		√			Horiba
Station 2	√		√		√		√		Horiba

The instruments' model of station 1 is Horiba-360, station 2 is Horiba-2000. For station 1, the data is recovered manually and transferred by diskette to central office, but the data for station 2 is extracted from the strip chart recorder.

NOTE: The information provided in Annex 1 is intended to bring to the attention of the supplier the necessity to provide a networking system that would integrate information processing of existing equipment with those of prospective equipment in a fashion that would enable DOE to collect comparable data at both provincial centers and the national center.

Schedule of Installation and Delivery of Monitoring and Meteorological Stations

The monitoring and meteorological stations with all necessary equipments and services for proper operation, maintenance, and calibration including data acquisition system will be installed and delivered in two phases covering a total period of eighteen (18) months from the date of contract signature.

Number	Description	Quantity	Delivery schedule (Completion of each Phase) in months
1 (Phase I)	Supplying and Installing Air Quality Monitoring Stations and Meteorological Equipments and Related Training Programs	27	Ten months to the day from signing of contract
2 (Phase II)	Supplying and Installing Air Quality Monitoring Stations and Meteorological Equipments and Related Training Programs	17	Eighteen months to the day from signing of contract or eight months from the end of phase one, whichever comes first

- **Phase I:** The supplier will provide twenty-three (23) fixed monitoring stations in cities of Esfahan and Tehran and four (4) mobile stations (including 4 telescoping crank-up towers for meteorological parameters) in the same two cities with equipment and data acquisition systems installed and fully operationalized, and begin developing central data collection systems. Also the supplier will provide the four (4) meteorological stations in cities of Esfahan and Tehran. The supplier will provide a training course to selected DOE staff in accordance with Section H of the Technical Specifications. An agreement regarding extended maintenance and calibration services should have been reached.
- **Phase II:** The supplier will finalize the installation of seventeen (17) fixed monitoring stations and the four (4) meteorological stations and fully integrate them into local air quality monitoring networks and with a national air quality monitoring database in Tehran. The central data collection system must become fully functional and followed by on the job training course in accordance with Section H of Technical Specifications. By this time, the DOE staff should be able to operate all equipment and software. The stations should be accessible remotely and proper quality assurance and quality control procedures should be fully in place.

Total Stations: 44

Type of Station	City	Number of Station				
		Tehran	Esfahan	Mashhad	Arak	Total
Urban Station I		8	5	5	1	19
Urban Station II		3	1	1	0	5
Traffic Station		3	2	2	1	8
Downwind Station		1	1	1	1	4
Upwind Station		1	1	1	1	4
Mobile Station		3	1	0	0	4
Total Number of Stations		19	11	10	4	44

NOTE: for more information regarding type of stations refer to Section A of Technical Specifications

The delivery and installation of monitoring stations and meteorological parameters in each city shall be based on the following schedule:

Phase I

City	Tehran	Esfahan	Mashhad	Arak	Total
Urban Station I	5	5	0	0	10
Urban Station II	3	1	0	0	4
Traffic Station	3	2	0	0	5
Downwind Station	1	1	0	0	2
Upwind Station	1	1	0	0	2
Mobile Station	3	1	0	0	4
Total Number of Stations	16	11	0	0	27

Sensors	Tehran	Esfahan	Mashhad	Arak	Total
Meteorological Parameters (10 meters tower)	13	9	0	0	22
Meteorological Parameters (24 meters tower)	2	2	0	0	4

Phase II

City	Tehran	Esfahan	Mashhad	Arak	Total
Urban Station I	3	0	5	1	9
Urban Station II	0	0	1	0	1
Traffic Station	0	0	2	1	3
Downwind Station	0	0	1	1	2
Upwind Station	0	0	1	1	2
Mobile Station	0	0	0	0	0
Total Number of Stations	3	0	10	4	17

Sensors	Tehran	Esfahan	Mashhad	Arak	Total
Meteorological Parameters (10 meters tower)	3	0	8	3	14
Meteorological Parameters (24 meters tower)	0	0	2	2	4

Indicative Schedule of Shipment, Delivery and Installation of Goods and Training Program

Time (month)

Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1- Contract Conclusion																				
2- First Phase Equipment Delivery																				
a- Equipment Shipment and Custom Clearance																				
b- Installation and Delivery																				
c- Training Program																				
3- Second Phase Equipment Delivery																				
a- Equipment Shipment and Customs Clearance																				
b- Installation and Delivery																				
c- Training Program																				