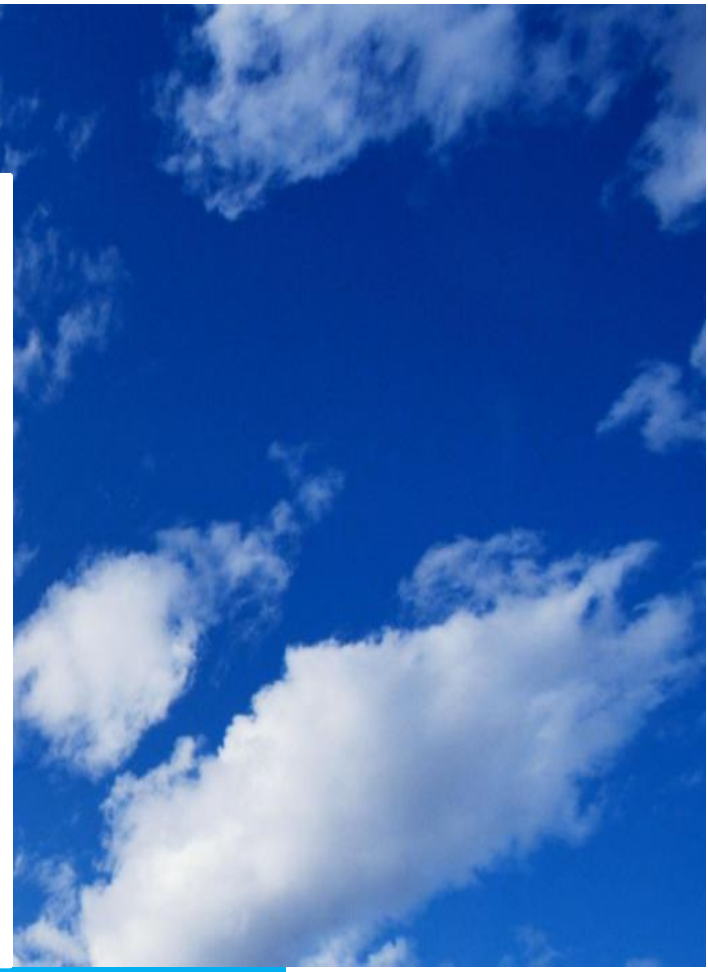

INTRODUCTION TO AIR QUALITY MONITORING STATIONS

Air Quality Monitoring stations are required to house the equipment required to monitoring the state of air that we breathe.

South African Weather Service

What is an ambient air quality monitoring station

Ambient air quality can only be measured using specialized equipment, the equipment used needs to be housed in a room or area that meets certain criteria and possesses systems to control environmental factors to ensure the accuracy of measurements and reliability of instrumentation.

Air quality monitoring stations are used to ensure the safety of instrumentation and that the necessary environment is created for ambient air quality measurements to take place in any area where measurement is required.

Figure 1.1: Representation of an air quality monitoring station

Air Quality Monitoring stations

Air quality monitoring stations are used to measure air pollution in ambient air in any specific area and are required to create an optimum environment for the instrumentation used to measure specific pollutants. These stations can be any area such as a room or insulated container in which environmental factors such as temperature and dust can be controlled. The requirements/factors for an ambient air quality monitoring station consist of the following:

- **Safety** – The instrumentation and supporting equipment must be kept safe.
- **Accessibility** – Station and instrumentation must be easily accessible to perform required maintenance.
- **Temperature** – The internal temperature needs to be maintained.
- **Cleanliness** – Dust inside the station must be kept at a minimum.
- **Electrical** - Stable electrical supply is required to power the station and equipment being used.
- **Sampling** – Sampling of the ambient air quality in the surrounding area must be effective.
- **Mast** – Meteorological equipment must be installed above ground on a safe structure such as a mast.

Accurate measurement of the surrounding ambient air quality can only be achieved if the instrumentation being used are functioning optimally.

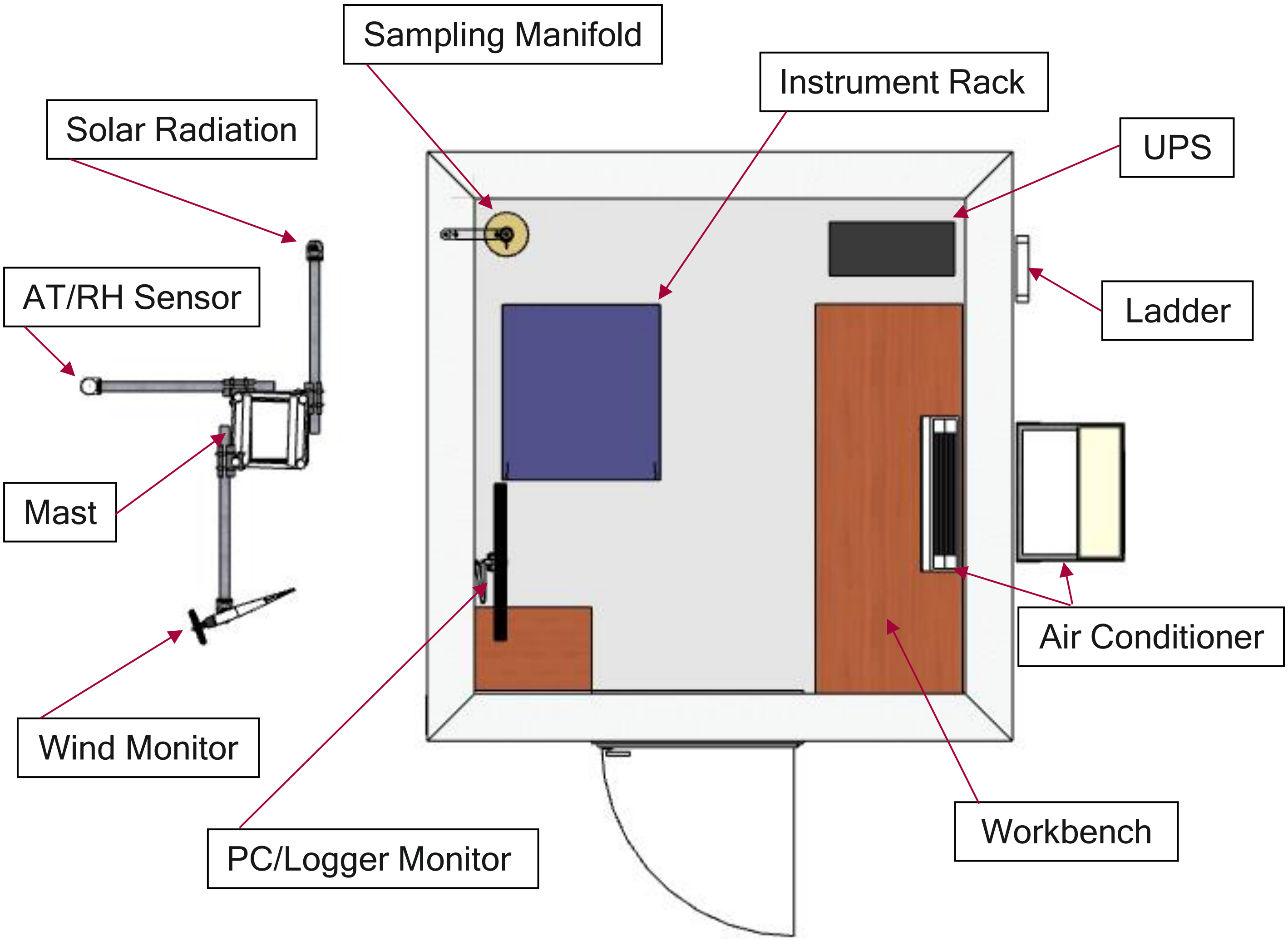

Figure 1.2: Air Quality Monitoring station layout.

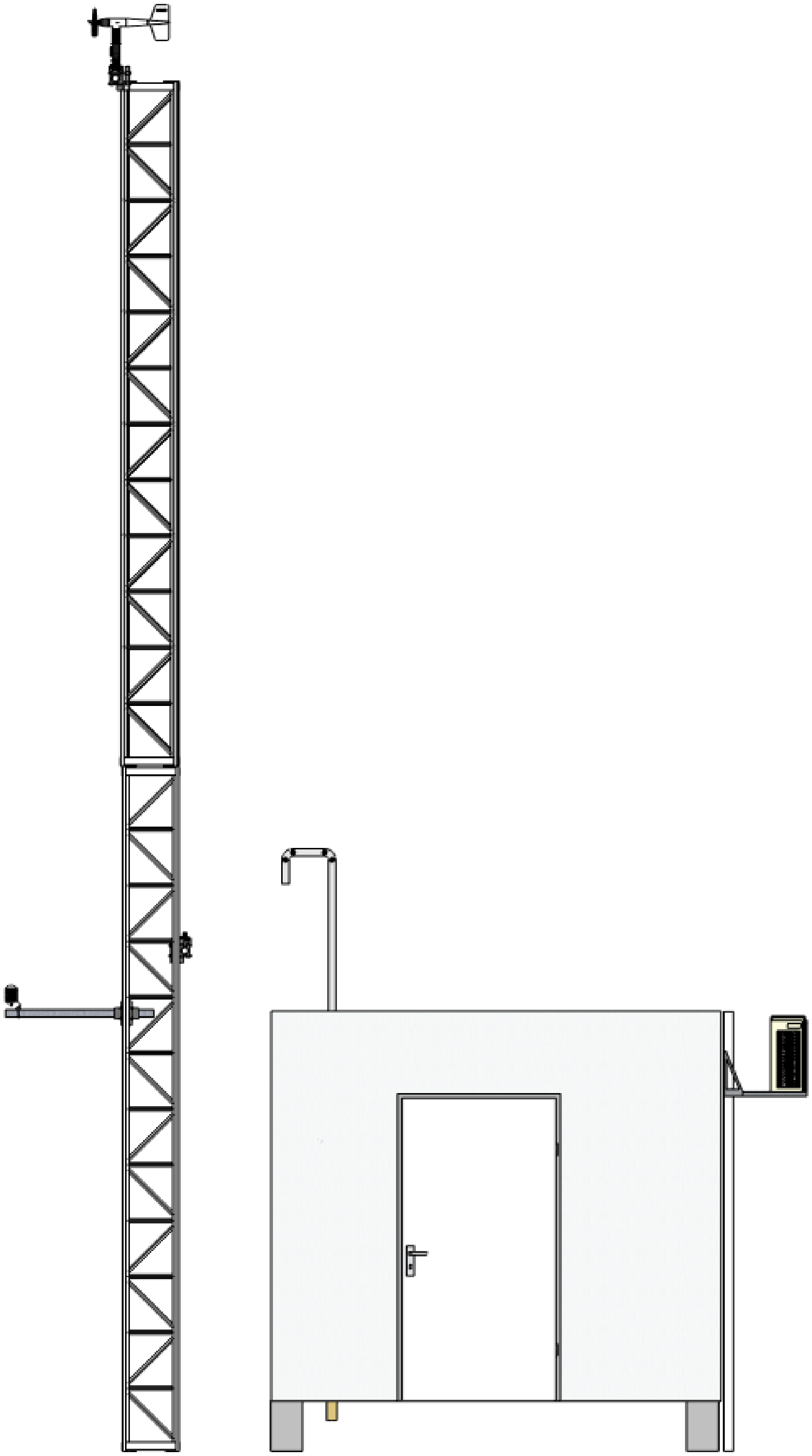

Figure 1.3: Air Quality Monitoring station from the front.

Components of an ambient air quality monitoring station – supporting equipment

Shelter

The area that will be used to house the specialized instrumentation and supportive equipment must be protected from weather elements and environmental factors that can influence or damage the instruments. Stations can be any area, room or container that can safely house the required equipment.

Insulated containers are widely used for this purpose due to their ability to maintain temperature effectively and their insulation to weather elements. These containers can also easily be altered to install the necessary supportive equipment required.

Figure 1.4: Insulated container used to house instrumentation used for measuring air pollution.

Instrument Rack

The instruments should be installed in a manner that will keep instruments safe and easily accessible for the required maintenance work. For this purpose instrument racks are normally used.

Instrument racks are also used to minimize the transfer of vibrations from external sources to the instruments.

Figure 1.5: Instrument rack used to install monitoring instrumentation.

Sampling Manifold

A sampling system is required to extract ambient air at a constant flow from the surrounding area. The sampling manifold is usually made from glass or Teflon to ensure minimal particle matter and other material gets stuck inside the sampling system.

The sampling system is installed in such a manner to ensure easy access to clean the manifold during maintenance.

Figure 1.6: Sampling manifold used to draw air into the shelter.

Sampling Manifold

The sampling system is fitted with a blower motor that constantly draws ambient air from the outside of the shelter through the glass/Teflon sampling manifold, the instruments draw air from sampling manifold for measurement.

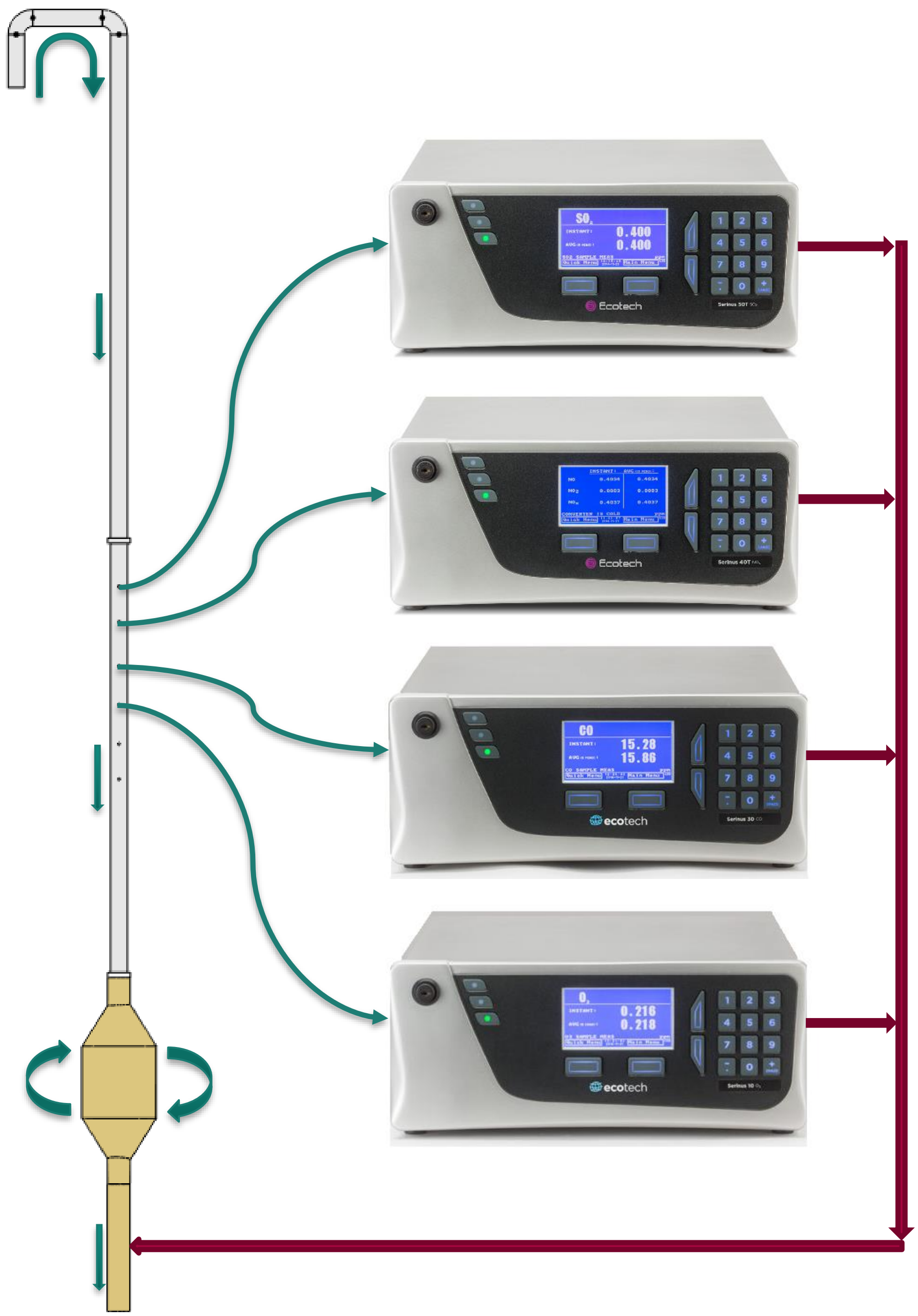

Figure 1.7: Sampling manifold reticulation layout.

Air Conditioner

To ensure that measurements are accurate the instrumentation must be protected from over-heating and their temperature maintained, temperature fluctuations can affect the accuracy of measurements. To maintain a constant temperature inside the shelter an Air-conditioner is used.

SANAS regulations require that the temperature is controlled at 25 degrees Celsius with a deviation of ± 5 degrees Celsius.

Figure 1.8: Air-conditioner is used to control and maintain the internal temperature of the station.

Internal Temperature Sensor

The internal temperature inside a station should be measured and monitored to ensure accurate measurements are taking place.

Internal temperature sensors are used to monitor the inside temperature of a station, these sensors are usually integrated with a shut off system can switch off the power to the instruments should the temperature not be within range. This is done to protect instrumentation against over-heating and damage.

Figure 1.9: Internal temperature sensor is used to monitor the inside temperature of the station.

UPS

The electrical supply used by the instrumentation should be stable to ensure accurate measurements and to protect the equipment from damage caused by power fluctuations.

Uninterruptable power supplies (UPS) are used to ensure a stable supply of electricity is provided to the instruments and supporting equipment. The UPS is also equipped with batteries that will allow instruments to remain powered up during a power failure from the main supply network.

Figure 1.10: Uninterruptable power supply installed inside the station to protect equipment against power fluctuations.

Logging System

The measurements from instruments should be logged in one minute intervals, this can be done by making use of a data logging system.

The logging system collects all data from the monitoring equipment as well as some of the supporting equipment and stores the data to keep the data safe. Logging systems use different ways of communicating with the monitoring equipment and in some instances allow users to remotely access the monitoring equipment to perform remote diagnostics.

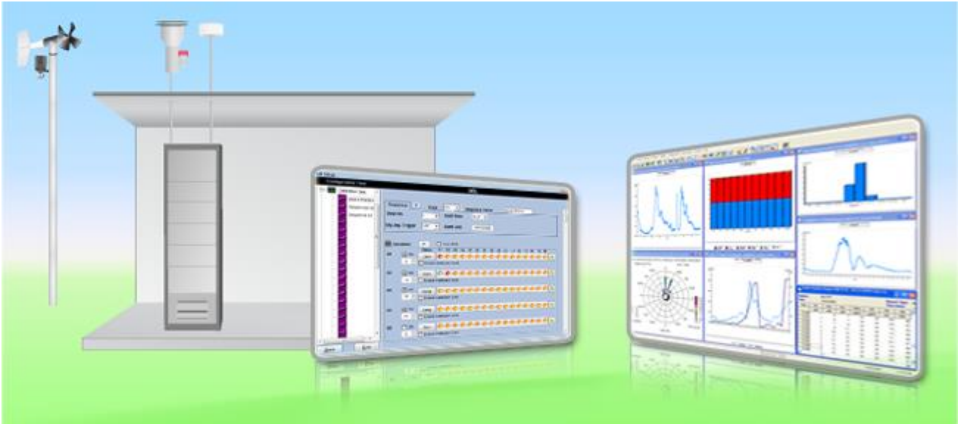

Figure 1.11: Data logging system required to log the data from monitoring equipment.

Dilution Calibrator

To ensure accurate measurements and reliability of data the monitoring equipment must be calibrated. There are different options of calibrating monitoring equipment but the most accurate way of calibrating is by using a dilution calibrator to calibrate and verify the response of an instrument on numerous levels.

Definition

Calibration: is the documented comparison of the measurement device to be calibrated against a traceable reference device.

The reference standard may be also referred as a "calibrator." Logically, the reference is more accurate than the device to be calibrated. The reference device should be also calibrated traceably.

Dilution calibrators make use of taking a known gas with a high concentration and diluting the concentration down to a concentration that can be used for calibration purposes. Zero air (air that is scrubbed from all possible components that may interfere with the calibration gas) is used to dilute the concentration by making use of mass air flow sensors inside the calibrator.

The span gas is the gas we use to perform a calibration, span gas is the output gas from the calibration unit and this gas is specifically mixed to match the chemical composition of the gas being measured at 80% of the instruments measurement range.

For example, if the measurement range is 500 ppb, the span gas should have a concentration of 400ppb.

Dilution Calibrator

Definition
ppb: Abbreviation for parts per billion; the amount of a chemical in relation to the substance that contains it.

Figure 1.12: Dilution calibrator used to calibrate monitoring equipment.

Zero Air Generator

In order to perform a zero point calibration clean air is required. Ambient/compressed air needs to be scrubbed from any impurities that can interfere with measurements, scrubbing material such as Purafil and Activated charcoal is used to scrub impurities from air.

Definition
Zero Air: Atmospheric air purified to contain less than 0.1 ppm total hydrocarbons.

Definition
ppm: Abbreviation for parts per million; the amount of a chemical in relation to the substance that contains it.

Zero air is supplied to the dilution calibrator and is used to perform zero calibrations as well as span calibrations on monitoring equipment.

Zero Air Generator

Figure 1.13: Zero air generator used to supply zero air to the calibration system.

Calibration Gases

Gas with a known concentration, usually a high concentration is required to calibrate the span point on an instrument. The dilution calibrator is used in conjunction with the high concentration gases to perform a calibration and subsequently a multi-point calibration check on the instrumentation.

High concentration gases such as NO, CO and SO2 gas is used for calibration purposes, the gases are supplied in gas cylinders in different sizes (eq. 10 L cylinder) and supplied with the exact measured concentration contained and a specific relative analytical tolerance.

- NO: 3 % relative analytical tolerance (RAT)
- CO: 2 % RAT
- SO2: 3.1 % RAT

Figure 1.14: High concentration gases with their exact concentration and relative analytical tolerances.

Components of an ambient air quality monitoring station – monitoring equipment

PM Analysers

The PM instruments can measure different size particles of particulate matter, these include PM_{10}, $PM_{2.5}$, PM_1 and TSP. Different methods of measuring PM is also available which include gravimetric weighing, beta gauge measurement and the light scattering measurement.

PM instruments make use of their own sample inlet which can be a heated sample probe or air dried sampling probe, this is done to remove moisture from the dust particles. Below is an example of each.

Figure 1.15: PM instrument using the gravimetric weighing method.

PM Analysers

Figure 1.16: PM instrument using the beta gauge method.

Figure 1.17: PM instrument using the light scattering method

SO_2 Analysers

The measurement of Sulphur dioxide (SO_2) is based on Fluorescence Spectroscopy principles.

Fluorescence Spectroscopy is the analysis of UV light that excites the electrons in molecules of certain compounds causing them to emit light, the emitted light is measured.

Figure 1.18: Sulphur dioxide instruments.

NO_x Analysers

The measurement of oxides of nitrogen (NO_x) is performed by gas phase Chemiluminescence.

Chemiluminescence is the production of light from a chemical reaction that takes place inside the instrument, the light that is emitted from this reaction is measured.

Figure 1.19: Oxides of Nitrogen instruments.

CO Analysers

The measurement of Carbon Monoxide (CO) is based on Infrared radiation (IR) absorption.

CO absorbs IR at a wavelength near 4.7 microns. The CO instrument makes use of a sensor that measures IR, the strength of signal received is proportional to the amount of CO in the sample.

Figure 1.20: Carbon Monoxide instruments.

O_3 Analysers

The measurement of Ozone (O_3) is based on ultraviolet (UV) absorption and these instruments uses an ultraviolet source.

The UV light lights up the sample inside the measurement cell and the O3 in the sample is absorbed by the UV, the detector will then determine how much ozone is present in the sample.

Figure 1.21: Ozone instruments.

Air Quality Monitoring station setup

Air Quality Monitoring stations are comprised of several components that when combined and connected together provides a powerful system that can measure the ambient air quality and provide clients and the public with much needed information about the state of the air that we breathe. Below is a full station setup using all the required supportive equipment as well as the monitoring equipment.

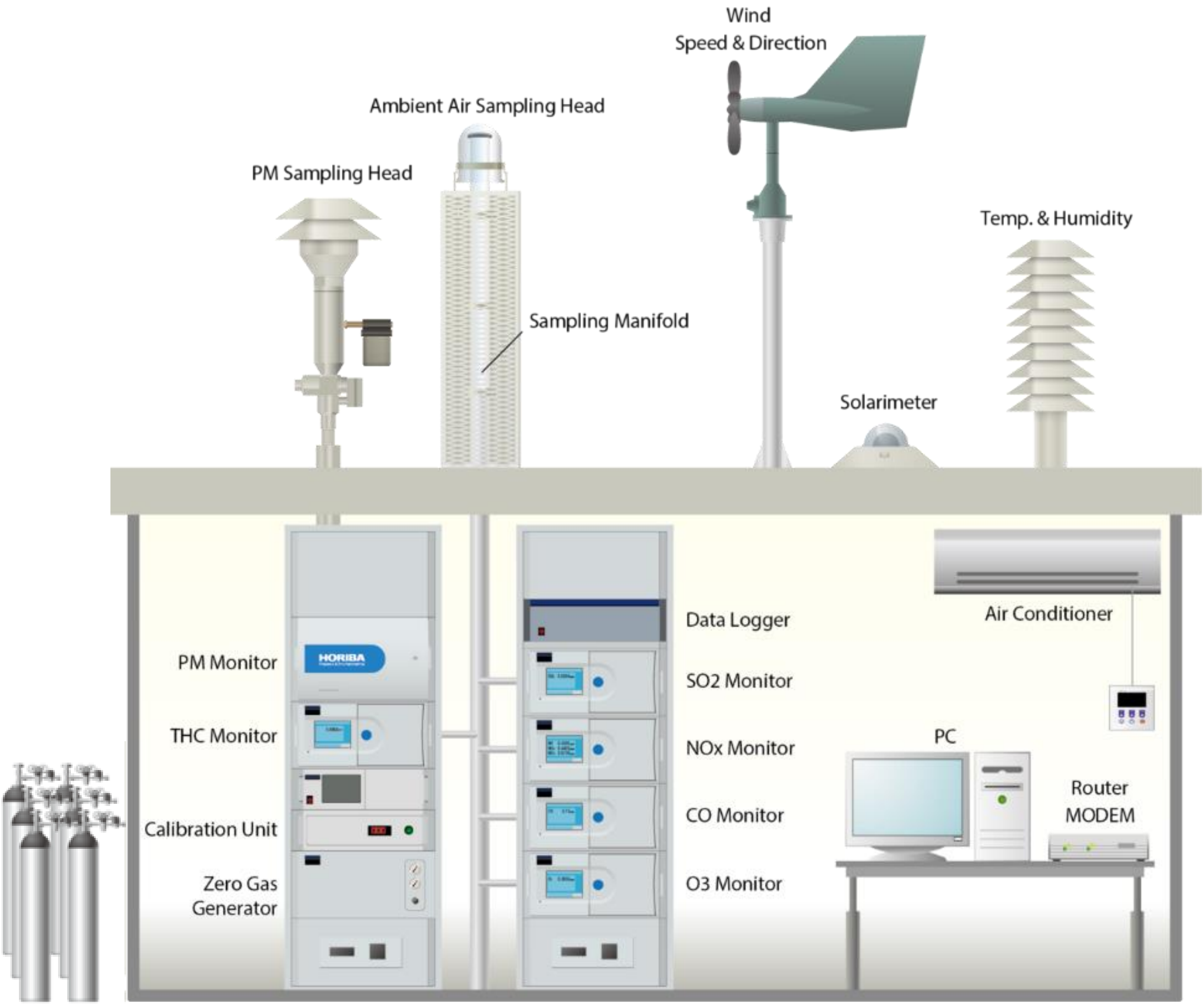

Figure 1.22: Full Air Quality Monitoring station setup.

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