

Australian/New Zealand Standard™

**Methods for sampling and analysis of
ambient air**

**Part 14: Meteorological monitoring for
ambient air quality monitoring
applications**



AS/NZS 3580.14:2014

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Australian/New Zealand Standard™

Methods for sampling and analysis of ambient air

Part 14: Meteorological monitoring for ambient air quality monitoring applications

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PREFACE

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee EV-007, Methods for Examination of Air, to supersede AS 3580.14—2011, *Methods for sampling and analysis of ambient air, Part 14: Meteorological monitoring for ambient air quality monitoring applications*.

The Committee acknowledges reference material provided by both the World Meteorological Organization and the United States Environmental Protection Agency (US EPA).

The objective of this Standard is to provide users with methods for the collection of meteorological data for ambient air quality monitoring and modelling applications. The objective of the revision is to allow for its use in New Zealand.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE.....	5
1.2 REFERENCED DOCUMENTS.....	5
1.3 DEFINITIONS.....	6
1.4 TEST REPORT.....	8
SECTION 2 WIND SPEED AND DIRECTION	
2.1 SCOPE OF SECTION	10
2.2 APPLICATION	10
2.3 PRINCIPLE	10
2.4 APPARATUS	10
2.5 INSTRUMENT	11
2.6 PROCEDURE.....	12
2.7 OBSTRUCTIONS	13
2.8 INSTALLATION	14
2.9 WIND SENSOR ORIENTATION	16
2.10 INSTRUMENT CALIBRATION	20
2.11 OPERATION AND MAINTENANCE	22
2.12 MEASUREMENT UNCERTAINTY.....	24
SECTION 3 AMBIENT TEMPERATURE AND TEMPERATURE GRADIENT	
3.1 SCOPE OF SECTION	25
3.2 APPLICATION	25
3.3 PRINCIPLE	25
3.4 APPARATUS	25
3.5 PROCEDURE.....	27
3.6 MEASUREMENT UNCERTAINTY.....	31
SECTION 4 RELATIVE HUMIDITY	
4.1 SCOPE OF SECTION	32
4.2 APPLICATION	32
4.3 PRINCIPLE	32
4.4 APPARATUS	32
4.5 PROCEDURE.....	33
4.6 MEASUREMENT UNCERTAINTY.....	37
SECTION 5 GLOBAL SOLAR RADIATION	
5.1 SCOPE OF SECTION	38
5.2 APPLICATION	38
5.3 PRINCIPLE	38
5.4 APPARATUS	38
5.5 PROCEDURE.....	40
5.6 MEASUREMENT UNCERTAINTY.....	43

SECTION 6 ATMOSPHERIC PRESSURE

6.1	SCOPE OF SECTION	44
6.2	APPLICATION	44
6.3	PRINCIPLE	44
6.4	APPARATUS	44
6.5	PROCEDURE.....	45
6.6	MEASUREMENT UNCERTAINTY.....	48

SECTION 7 PRECIPITATION

7.1	SCOPE OF SECTION	49
7.2	APPLICATION	49
7.3	PRINCIPLE	49
7.4	APPARATUS	49
7.5	PROCEDURE.....	50
7.6	MEASUREMENT UNCERTAINTY.....	52

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Australian/New Zealand Standard
Methods for sampling and analysis of ambient air

Part 14: Meteorological monitoring for ambient air quality monitoring
 applications

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out methods for the collection of meteorological data for use in ambient air quality monitoring and modelling applications. Requirements and guidance are provided for the *in situ* monitoring of primary meteorological variables being: wind speed, wind direction, temperature, humidity, atmospheric pressure, precipitation and solar radiation.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS/NZS

1768 Lightning protection

ISO

9060 Solar energy—Specification and classification of instruments for measuring hemispherical solar and direct solar radiation

ISO/IEC

Guide 98-3 Uncertainty of measurement Part 3: Guide to the expression of uncertainty in measurement

ASTM

E104 Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

E563

Standard Practice for Preparation and Use of an Ice-Point Bath as a Reference Temperature

Environment Protection and Heritage Council

National Environment Protection (Ambient Air Quality) Measure, Technical Paper No.5, Data Collection and Handling

US Environmental Protection Agency (EPA)

Meteorological Monitoring Guidance for Regulatory Modelling Applications. EPA-454/B-08-002. March 2008

Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements. Version 2.0 (Final). EPA-454/B-08-002. March 2008

World Meteorological Organization

Guide to Meteorological Instruments and Methods of Observation. WMO-No.8. Seventh edition 2008

Instruments and Observing Methods Report No. 81, 'Initial Guidance to Obtain Representative Meteorological Observations at Urban Sites'

1.3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.3.1 Accuracy

The degrees of closeness of measurements of a quantity to its actual (true) value.

1.3.2 Air temperature

The temperature indicated by a thermometer exposed to the air in a place sheltered from direct solar radiation.

1.3.3 Anemometer

A device for measuring wind speed or wind speed and direction.

1.3.4 Atmospheric pressure

The force per unit area exerted against a surface by the weight of air above that surface in the Earth's atmosphere.

1.3.5 Azimuth

The horizontal angle measured clockwise from any fixed reference plane or easily established base direction line, usually defined as true north.

1.3.6 Black body

An idealized object that absorbs all electromagnetic radiation falling on it and emits a temperature-dependent spectrum of light which is termed 'black-body radiation'.

1.3.7 Calm

Calm conditions occur when the wind speed is below the starting threshold of the anemometer or vane, whichever is greater.

1.3.8 Cosine response

The response to beam radiation that varies with the cosine of the angle of incidence; i.e. full response at when the solar radiation hits the sensor perpendicularly (normal to the surface), zero response when the sun is at the horizon.

1.3.9 Damping ratio (of a wind vane)

A constant that is dimensionless and independent of wind speed. Refer to *Guide to Meteorological Instruments and Methods of Observation*, WMO-No.8, for further information.

1.3.10 Distance constant (of a wind speed sensor)

The distance the air flows past a wind speed sensor during the time it takes to indicate 63% of a step change in wind speed.

NOTE: This definition applies only for wind speeds above the threshold speed, and the value for a particular anemometer is only approximately constant over its operating range.

1.3.11 Distance constant (of a wind vane)

The distance the air flows past a wind vane during the time it takes the vane to respond to 63% of a step change in wind direction.

NOTE: This definition applies only for wind speeds above the threshold speed, and the value for a particular anemometer is only approximately constant over its operating range.

1.3.12 Full scale

The nominated maximum value for which an instrument has been calibrated. The full scale should be selected to cover the normal range of values expected in the test environment.

1.3.13 Humidity

A general term related to the amount of moisture in the air.

1.3.14 Linearity

The deviation of a sensors output from a linear best fit line when subjected to varying test conditions.

1.3.15 Noise

Spontaneous, short duration deviations in sensor output, about the mean output, which are not caused by input level changes. Noise level is determined as the standard deviation about the mean.

1.3.16 Overshoot (of a wind vane)

The amount of movement past the final settled position of a wind vane following a step change in wind direction.

1.3.17 Parameter

One of the characteristics related to a quantifiable property (e.g. wind speed, temperature).

1.3.18 Precipitation

Rain, drizzle, dew, hail, snow and other forms of moisture from the atmosphere that reaches the ground.

1.3.19 Precision

Variation about the mean of repeated measurements of the same parameter on the same instrument, expressed as one standard deviation about the mean.

1.3.20 Range

The region between the limits within which a quantity is measured, received or transmitted, expressed by stating the lower and upper range values.

1.3.21 Relative humidity

The ratio as a percentage of the observed vapour pressure to the saturation vapour pressure with respect to water at the same temperature and pressure.

1.3.22 Resolution

The smallest change in the underlying physical quantity that produces a response in the measurement.

1.3.23 Run-down time

The elapsed time for the cup wheel or propeller of an anemometer to cease rotation after being subjected to a nominated rotation rate in a still air environment.

1.3.24 Sigma theta (σ)

The unbiased estimate of the standard deviation of variations from the mean horizontal wind direction.

1.3.25 Solar radiation

The electromagnetic energy in the solar spectrum (0.10 to 4.0 μm wavelength).

1.3.26 Span

The upper limit of the calibration range.

1.3.27 Starting threshold (of a mechanical wind speed sensor)

The lowest wind speed at which the sensor (cup wheel or propeller) of an anemometer starts and continues to turn and produces a measurable signal when the anemometer is mounted in its normal operating attitude.

1.3.28 Starting threshold (of a mechanical wind vane)

The lowest wind speed at which a vane will start to turn towards the wind direction from an initial displacement of 10°.

1.3.29 Static head

A length of tube between the exterior atmosphere and the inlet port of the sensor.

1.3.30 Surface roughness

The surface roughness over a given area is a measure of both man-made and natural obstructions, and general surface features.

1.3.31 Temperature gradient (ΔT)

The difference between ambient temperature measurements at two or more levels above ground. Temperature gradient is commonly known as 'delta-temperature' and is abbreviated ΔT .

1.3.32 Time constant

The time taken to respond to 63% of a step change in the ambient air temperature.

1.3.33 Transfer standard

A measurement standard that is used in comparison with a primary standard, also known as a 'secondary' standard.

1.3.34 U_{95}

A measurement of uncertainty at a confidence interval of 95% according to ISO Guide 98-3.

1.3.35 Wind direction

The direction from which the wind blows.

1.3.36 Zero

The lower limit of the calibration range

1.4 TEST REPORT

The following information shall be reported:

- (a) Reference to this Standard, i.e. AS/NZS 3580.14.
- (b) The reporting organization.
- (c) The recorded value for each measured parameter in the appropriate unit as detailed in Table 1.
- (d) For each reported parameter—
 - (i) the type of instrument used to obtain the recorded value, including the starting thresholds for wind direction and wind speed sensors;
 - (ii) the calibrated measurement range in the corresponding reporting units; and
 - (iii) the measurement height above ground level, in metres.

- (e) The dates, time (expressed as local or standard time) and period of sampling.
NOTE: Consideration should be given to the averaging times and date/time conventions used. Users of this Standard should ensure that these parameters are considered when applying the Standard. An example of a commonly used convention is the National Environment Protection (Ambient Air Quality) Measure, Technical Paper No.5, Data Collection and Handling.
- (f) Sampling location—all relevant details, including a coordinate reference and height above ground level, classification of area with a description of the sampling location.
NOTE: A global positioning system (GPS) can provide a convenient means of determining the position of the station. If a GPS system is used, care should be taken to ensure the appropriate datum and format are used and reported with the data.
- (g) Any nonconformances with this Standard.
- (h) The uncertainty associated with the measurement along with the confidence interval and coverage factor.
- (i) Any other relevant data.

NOTE: The manner of presentation of results will depend on their end use. Additional relevant information which could be reported includes the following:

- Mean values (e.g. hourly, daily, monthly or annual).
- Maximum values (e.g. hourly, daily, monthly or annual).
- Times per day, month or year, certain values are exceeded.
- Frequency distribution (e.g. based on hourly, daily, monthly or annual values).

TABLE 1
METEROLOGICAL PARAMETER REPORTING UNITS

Parameter	Units
Wind speed	Metres per second (m/s)
Wind direction	Degrees from true north (°)
Ambient temperature	Degrees Celsius (°C)
Relative humidity	Percent (%)
Global solar radiation	Watts per square metre (W/m ²)
Barometric pressure	Hectopascals or pascals (hPa, Pa)
Precipitation	Millimetres (mm)

SECTION 2 WIND SPEED AND DIRECTION

2.1 SCOPE OF SECTION

This Section sets out methods for the measurement of horizontal wind speed and direction using automated electronic sensors and data logging devices.

2.2 APPLICATION

This Section applies to the determination of wind speed and direction for the purpose of air quality applications at wind speeds ranging from the lowest measurable with this type of equipment, i.e. less than 0.5 m/s up to gale force and above, in various terrain categories and environmental conditions at heights typically from 10 m to 100 m above ground level. This Section has been developed for use in air quality monitoring applications, however, it may be applied in other fields of study.

2.3 PRINCIPLE

Wind velocity is a three-dimensional vector quantity with small-scale random fluctuations in space and time superimposed upon a larger-scale organized flow. However, for the purpose of air quality monitoring applications, surface wind is considered as a two-dimensional vector quantity specified by two numbers representing direction and speed.

The output of these sensors is typically connected to data logging systems to both convert the signal into engineering units and to record the data. These sensors are mounted at a standard height to ensure uniformity for this type of measurement.

2.4 APPARATUS

2.4.1 General

Surface wind is usually measured by mechanical or ultrasonic devices. The instruments and techniques specifically discussed here are only a few of those more commonly used and do not comprise a complete list. Sensors shall meet or exceed the instrument performance specifications listed in Tables 2 and 3.

2.4.2 Cup anemometer and vane systems

The cup anemometer has cups that relate the rate of rotation to the wind speed. The cup anemometer's dynamic performance characteristics (starting threshold and distance constant) are density-dependent, but its transfer function (rate of rotation versus wind speed) is independent of density. The cup is not very efficient and creates turbulence as the air flows through and around it. The cup anemometer is omni-directional in a horizontal flow situation but exhibits a complicated reaction to vertical flow situations. It may indicate speed slightly greater than the total speed when the flow is not horizontal.

The wind vane is perhaps the simplest of instruments. A fin is fixed to a vertical shaft so that when force is applied to the area by the wind, it will turn the shaft, seeking a minimum force position. The relationship of the shape, size, and distance from the fin's axis of rotation to the bearing assembly and transducer torque determines the starting threshold. These attributes of the fin area, along with its counterweight, determine the dynamic performance characteristics of overshoot (damping ratio) and delay distance (distance constant) of the direction vane.

Vane design is of little importance if average wind direction is the only requirement. If turbulence parameters are of interest, the design of the vane becomes important.

The vane transducer is usually a potentiometer. It is common that the range of the sensor is 355° rather than the physically true 360°. The reason is related to the problem of a continuous range (a circle) with a discontinuous output (zero to a defined reference voltage). Knowing how the transducer works is important if the performance of the wind vane will be challenged for quality assurance purposes.

2.4.3 Propeller anemometer and vane systems

The propeller anemometer is a more efficient shape. The helicoid propeller is so efficient that its transfer function can be specified from theory. It creates little turbulence because the air flows mostly through it. The propeller measures wind speed when it is oriented into the wind by a vane. Its errors from imperfect alignment with the mean vector are small and are nearly proportional to the cosine of the angle of misalignment.

2.4.4 Ultrasonic anemometers

Ultrasonic anemometer systems are based on the principle that wind changes the transit time of a sound pulse across a fixed distance. Ultrasonic systems can be designed in two dimensions for horizontal wind speed and direction as a replacement for the cup and vane or propeller units, or in three dimensions for both horizontal and vertical wind measurements. For those applications where the contribution of small eddies is important, ultrasonic systems are an excellent choice.

2.5 INSTRUMENT

A continuous direct-reading instrument that meets or exceeds the specifications given in Tables 2 and 3 for wind speed and wind direction sensors respectively is required. The manufacturer's published performance specifications shall be deemed as acceptable evidence of conformance to the given requirements if accompanied by a statement of uncertainty.

TABLE 2
INSTRUMENT PERFORMANCE SPECIFICATIONS
FOR WIND SPEED SYSTEMS

Parameter	Minimum requirements
Range	0.5 to 30 m/s
Total accuracy	3% or ± 0.2 m/s*
Resolution	≤ 0.25 m/s
Starting threshold	≤ 0.4 m/s
Distance constant	≤ 3 m
Maximum averaging interval	10 min
Data sampling frequency	5 s

* Whichever is the greater.

TABLE 3
INSTRUMENT PERFORMANCE SPECIFICATIONS
FOR WIND DIRECTION SYSTEMS

Parameter	Minimum requirements
Range	
Mechanical	0 to 360°
Output	0 to 355°
Total accuracy*	±3°
Resolution	1°
Starting threshold	≤0.5 m/s at 10°
Damping ratio	0.25 to 0.6
Maximum averaging interval	10 min
Minimum number of data samples	>60 for scalar/vector means >360 for sigma theta

* Excludes measurement deadband range.

2.6 PROCEDURE

2.6.1 Siting

In the siting, installation and assessment of the number of anemometers required, consideration should be given to mounting, exposure and protection in adverse conditions. Additional information about siting of meteorological sensors in urban areas can be obtained from the WMO, Instruments and Observing Methods, Report No. 81.

Location of the instrument is critical for wind measurement. In a sheltered location or on a small building or hill of low relief, the measured wind may easily differ by –50% to +100% in speed and 90° or more in direction from the wind representative of a wider area. To identify suitable locations for anemometers in difficult sites, it is advisable to make a detailed wind survey under various conditions of wind speed, wind direction and atmospheric stability or to obtain the advice of a meteorologist.

In many applications wind measurements are made in order to estimate dispersion over a horizontal scale of about 100 m to 10 km. On this scale the representative wind is the wind measured at a height of 10 m over a flat open area substantially free of obstructions, where the anemometer is distant from any obstruction by at least 10 times the height of the obstruction (see Figure 1). It is generally considered that the appropriate measurement height for air quality applications is 10 m. Special projects may dictate measurement at greater heights.

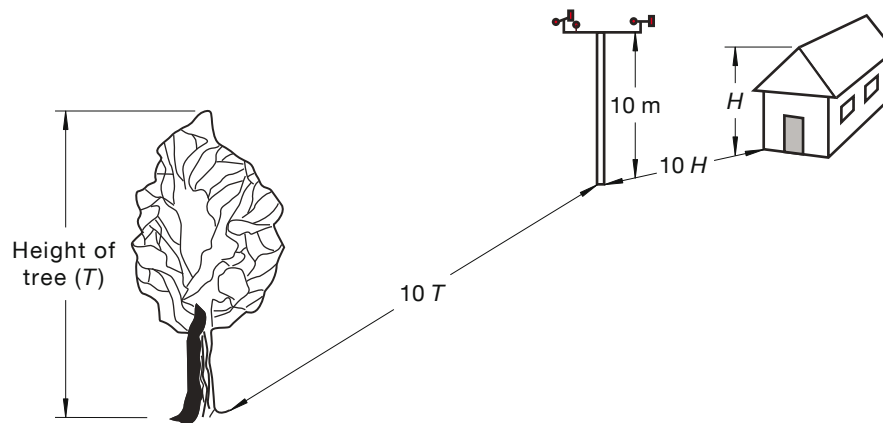


FIGURE 1 EXAMPLE OF SITING WIND INSTRUMENTS

2.6.2 Vertical variation of the wind—Atmospheric stability

Consideration of wind variation with height may influence the choice of height for an anemometer or indicate the need for more than one anemometer set at various heights. In an atmosphere which is unstable, or neutral, or stable to a small degree, the average wind speed in undisturbed flow increases with height in an approximately logarithmic manner, i.e. the ratio of wind speeds at two levels, above at least twice the height of surface roughness elements, is proportional to the logarithm of the ratio of their heights. There is also a slight anti-clockwise turn of the wind with height in the southern hemisphere.

When the flow is disturbed, e.g. when it has recently passed over a change in the roughness of the ground surface, the wind speed still increases with height, but in a more complex manner. In a stable atmosphere there may be strong variation of both wind speed and wind direction with height, therefore wind observations made at one height cannot be used without further information as an indication of the wind at another height.

2.7 OBSTRUCTIONS

2.7.1 General

The effect of obstructions does not lend itself to simple description. Wind flow over buildings will result in an exposure downwind that will be unrepresentative. A site on a roof, solid fence or wall will be unrepresentative unless the anemometer is on a mast high enough to clear the area of increased wind speed or decreased flow in the lee eddy or wake where the flow is turbulent. Porous structures such as rows of trees or mesh fences have similar but lesser effects. As a general rule, obstructions should not project above the horizon by more than 6° at the sensor height.

2.7.2 Multiple obstructions

In a built up area, or in an area with many trees, the atmospheric motion responsible for dispersion on scales of 100 m to 10 km is represented by the wind in the undisturbed flow clear of the obstructions. Structures with gaps or rows (spaces between buildings, or streets) cause funnelling of the airflow with local crowding of streamlines and changes of direction. None the less, suitable locations may be found in open level spaces where the 10 times height rule (Clause 2.6.1) is satisfied. Failing this, the anemometer may be placed among the obstructions, typically 5 m to 10 m above their general level but, if on a building, well above the disturbed flow. It should be located away from obstructions which are higher than the anemometer, at distances not less than 10 times the difference of the heights of the anemometer and the obstructions.

2.7.3 Measurements among obstructions

In some special cases, such as estimation of dispersion on small scales, measurements of wind may be required within the disturbed flow among buildings or trees. In such locations the wind will be very variable and no representative location may exist. It will then be necessary to make measurements at more than one location to obtain estimates of ventilation rates or other quantities.

2.7.4 Hills, valleys and uneven terrain

Wind in hilly terrain varies strongly in the vertical and horizontal directions, and with time of day. The effect of hills may be observed on flat country many kilometres away from the hills, and at such a site it is unwise to infer the wind at 50 m or above from measurements made at 10 m in stable air. Wind on exposed ridges of any size may be two or three times as strong as the representative wind because of the streamline crowding effect. Valleys usually have lighter winds but may experience very strong flows in a markedly different direction from the representative wind if a funnel effect is present. No general guidance to anemometer exposure can be given for hilly or dissected terrain. Choice of a site shall be determined with regard to a precise statement of objectives, as to what feature of the flow is to be described, and on what scale. Measurements at more than one location may be needed.

2.8 INSTALLATION

2.8.1 Mounting

Wind measuring equipment should be mounted solidly. Horizontal and vertical alignment should each be checked with a good quality spirit level at two points 90° apart. Wind direction sensors should be oriented so that wind directions are measured clockwise from true north. If wind vanes or anemometers are mounted on a tower or mast, they should be located in such a way that the tower does not significantly alter air flow at the point where sensors are located. The preferred procedure is to mount the wind vane and anemometer on top of the tower. If they are to be mounted part-way up on a large tower, they should be mounted away from that tower on a bracket or boom by at least twice the maximum width of the tower at that level.

Anemometers and wind vanes should be mounted on the side of the tower best exposed to the wind that is most significant for the purpose the data are to serve. If there is no significant direction, they should be mounted on the side from which the wind blows most frequently. A wind instrument should be securely mounted on a mast that will not twist, rotate, or sway. Leads connecting the sensors and display or recording instruments should be shielded from extraneous signals and protected from physical damage.

2.8.2 Protection in adverse conditions

Sensors and other instruments exposed to the ambient atmosphere should be capable of operation without significant degradation in the environment to which they are exposed over the measurement program period. As a guide, the following conditions may be expected and where appropriate, equipment, design and construction should allow operation in these conditions:

- (a) Temperature: -20°C to +55°C.
- (b) Relative humidity: 0 to 100%.
- (c) Heavy, driving rain.
- (d) Solar radiation heat load.
- (e) Corrosive conditions (e.g. marine, industrial).
- (f) Abrasive dusty conditions.

- (g) Lightning.
- (h) Ice build-up.
- (i) Extremely strong winds (in tropical cyclones).

Manufacturers should be consulted where particular adverse conditions are prevalent.

2.8.3 Lightning

Wind measurement systems are prone to damage by lightning. AS/NZS 1768, provides advice on lightning damage risk levels and areas and on protective measures. Damage to measurement systems is mainly caused by ground potential surges from nearby strikes which, depending on the strike location, can result in electrical damage to sensors, recording systems or both. Anemometer cables should be enclosed within metal masts and in underground or metal conduits to reduce noise pick-up during thunderstorms. The mast should be earthed as described in AS/NZS 1768.

2.8.4 Data acquisition system (DAS) configuration

2.8.4.1 General

The correct configuration of the DAS is imperative as some calculated outputs cannot be corrected in post-acquisition processing.

2.8.4.2 Wind vane potentiometer full scale

Most wind vane sensors have a single potentiometer that has an electrical range less than that of its mechanical range due to the open space. The open space in the potentiometer, if one is used, shall be measured and adjusted for. The typical electrical range of a wind vane is around 355° with a mechanical range of 359° . Significant error can be introduced into the system if this open space is not accounted for (as detailed in the example below). For the purposes of this Standard, the electrical range of the sensor (as opposed to the mechanical range) shall be used when calculating the gain of the sensor.

For example, if the maximum 'full scale' voltage output, set by shorting the potentiometer wiper to the high side of the potentiometer, is 1.000 V and the data acquisition system (DAS) is configured such that the gain is 359° , then these readings will be observed for any position between 355° and 359° . If the sensor is then turned mechanically 180° from the 355° position, it will read 182° on the DAS.

These linearity errors can be avoided by adjusting the full scale reading on the DAS to the maximum electrical range, in this case 355° . At mechanical positions of 355° to 359° , the DAS response will be 355° . At 180° , the DAS response is 180 degrees (assuming no linearity error in the sensor). All the error between 355° and 359° is in the 4° sector.

2.8.4.3 Handling of calm conditions

There are wide-spread differences in how calm conditions should be handled when recording wind speed and wind direction. For the objective determination of calm conditions applicable to *in situ* monitoring, a calm occurs when the wind speed is below the starting threshold of the anemometer or vane, whichever is greater. Wind speed data should be recorded as zero for periods where the wind speed is below the starting threshold of the wind speed sensor. Wind direction data should also be invalidated for periods where the wind speed is below the starting threshold of the wind direction sensor.

2.8.4.4 Average wind speed direction and sigma theta calculations

The wind is a vector quantity and as such should be averaged using vector averaging techniques. This is simple if the raw data is processed digitally in the field using modern data acquisition systems. Vector averaging is usually used for air pollution studies and is the preferred averaging method.

Scalar averaging is sometimes used as an approximation to vector averaging. If the wind is steady, the two techniques yield identical results, but in a fluctuating wind the results will differ. The magnitude of the differences is generally only a few percent and for many purposes this can be considered insignificant. Both vector and scalar wind averaging are acceptable in the application of this Standard.

Sigma theta calculations are used to quantify the variation in wind direction over the averaging interval. These calculations are based on statistical evaluation techniques or algorithms that approximate these (e.g. Yamartino, as detailed in US EPA, *Meteorological Monitoring Guidance for Regulatory Modelling Applications*).

The recommended sampling rate for a digital DAS depends on the end use of the data. Substantial evidence and experience suggest that 360 data values evenly spaced during the sampling interval will provide estimates of the standard deviation to within 5% or 10%. Estimates of the mean should be based on at least 60 samples to obtain a similar level of accuracy. Sometimes fewer samples will perform as well, but no general guide can be given for identifying these cases before sampling; in some cases, more frequent sampling may be required.

Details of the mathematical processing of wind data are set out in US EPA *Meteorological Monitoring Guidance for Regulatory Modelling Applications*. As most data acquisition systems will have inbuilt algorithms that comply with one of these methods, they are not reproduced here. Nonetheless, when applying this Standard, manufacturers' specifications and manuals shall be assessed to ensure calculations are being performed in a manner described in the above reference.

2.9 WIND SENSOR ORIENTATION

2.9.1 General

The largest source of error in a wind direction measurement is the wind sensor orientation to true north. Orientation error is a fixed bias that can be removed from a data set. However, every effort should be undertaken to ensure these errors are avoided. The method of wind sensor orientation shall be capable of aligning the sensor to true north within $\pm 3^\circ$ U_{95} . Two steps necessary to achieve wind sensor orientation are as follows:

- (a) True north location shall be determined accurate to within $\pm 1^\circ$.
- (b) Wind sensor 'reference position' shall be fixed to true north accurate to within $\pm 2^\circ$.

Sensors using vanes may have a mechanical means to fix them into position (usually mechanical north). In the event that this is not possible or the orientation target is not true north, a hose clamp or the like can be used to prevent the vane from turning and in windy conditions the fin may also be removed. The vane should be set so that the output is the correct value for the orientation target. The clamp should be tightened so the output is both correct and constant. The clamped sensor should be mounted on the tower and turned until the vane points at the orientation target. The sensor should be fixed in place. Verify that the output is still correct before the sensor clamp is removed. In some instances it is preferable to align the crossarm to the orientation target which is then fixed in position. The sensor can then be aligned to the crossarm at any stage.

2.9.2 Magnetic declination methods

To determine true north, a compass reading may be taken to ascertain the magnetic orientation of the wind direction device. This reading must then be corrected to true north. This can be done by determining the magnetic declination (sometimes called the magnetic variation 'D'), being the angle between the horizontal component of the magnetic field and true north. It is positive when the compass points east of true north, and negative when the compass points west of true north. Declination is normally given in degrees however it does change slowly over time (years). Figure 2 shows the approximate values for magnetic