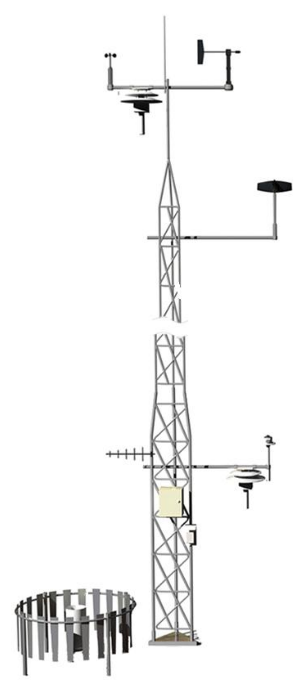
Met One Instruments, Inc.

Meteorological

Guidance for Instrument Siting

Wind Speed, Wind Direction, Temperature, Humidity, Radiation, Precipitation & Towers



Met One Instruments, Inc.

1600 Washington Blvd. Grants Pass, Oregon 97526 **Phone:** 541.471.7111

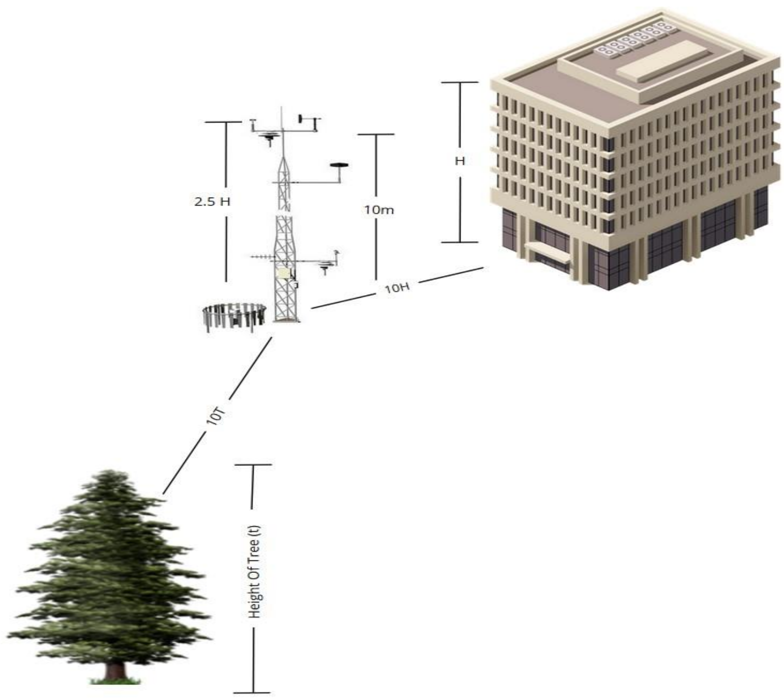
Sales: sales@metone.com | **Service:** service@metone.com | **Website:** www.metone.com

Guidance for Instrument Siting

The primary objective of instrument siting is to place the instrument in a location where it can make precise measurements that are representative of the general state of the atmosphere in that area, consistent with the objectives of the data collection program. Because most atmospheric properties change dramatically with height and surroundings, certain somewhat arbitrary conventions must be observed so that the measurements can be compared. In this section, conventions published by the World Meteorological Organization (WMO, 1971) have been adopted wherever possible. Secondary considerations such as accessibility and security must be taken into account but should not be allowed to compromise data quality.

Wind Speed and Direction

"The standard exposure of wind instruments over level, open terrain is 10m above the ground" (WMO, 1971), however optimum measurement height may very according to data needs. Open terrain is defined as an area where the horizontal distance between the instrument and any obstruction is at least ten (10) times the height of that obstruction. An obstruction may be man-made (such as a building) or natural (such as a tree).



Siting wind instruments; a 10m tower located at least 10 times the height of obstructions away from those obstructions (not to scale).

The wind instrument should be securely mounted on a mast that will not twist, rotate, or sway. If it is necessary to mount the wind instrument on a roof of a building, it should be mounted high enough to be out of the area in which the airflow is disturbed by the building. This is usually 1.5 times the height of the building above the roof so that it is out of the wake of the obstruction. This is not a good practice, however, and should only be done when absolutely necessary. Sensor height and its height above the obstructions, should be documented.

Temperature and Humidity

Temperature and humidity sensors should be mounted over a plot of open level ground at least 9 meters in diameter. The ground surface should be covered with non-irrigated, non-watered short grass or in areas where grass does not grow, natural earth. The surface must not be concrete, asphalt or oil soaked. The standard height for climatological purposes is 1.25m to 2m, but different heights may frequently be required in air quality studies.

The sensors should not be closer to obstructions such as trees and/or buildings than a distance equal to four times their height. They should be at least 30m from large paved areas and not close to steep slopes, ridges or hollows. Areas of standing water should be avoided. Louvered instrument shelters should be oriented with the door opening toward true north, in the northern hemisphere.

Radiation

Solar and whole sky radiation measurements should be taken in a location free from any obstruction to the measurements. This means there should be nothing above the horizontal plane of the sensing element that would cast a shadow on it. Neither should the instrument be near light colored walls or artificial sources of radiation. Usually a tall platform or roof of a building is the most suitable location.

Precipitation

A rain gauge should be mounted on level ground so that the mouth or the opening is horizontal. The gauge should be shielded from the wind but not placed in an area where there will be excessive turbulence caused by the shield. For example, a good opening would be in an orchard or a grove of trees where the wind speed near the ground is reduced due to the canopy effect. A location that is mostly open except for one or two trees would not be a good location because of the strong eddies that could be setup by the trees. This admittedly requires a good deal of subjective judgement, but it cannot be avoided. Obstructions to the wind should not be closer than two to four times the obstruction height from the instrument. In open areas, a windshield such as that used by the U.S. National Weather Service should be used. The ground surface around the rain gauge may be natural vegetation or gravel. It should not be paved, as this may cause splashing into the rain gauge. The Gauge should be mounted a minimum of 30cm above the ground and should be high enough so that it will not be covered by snow.

Meteorological Towers

It is frequently necessary to measure some meteorological variables at more than one height. Towers should be located an open level area representative of the area under study. In terrain with significant topographic features, different level of the tower may be under the influence of different meteorological regimes at the same time. Such conditions should be well documented.

Distance from Tower (m)	Slope Between (%)	Max Obstruction or Vegitation Height (m)
0-15	± 2	0.3
15-30	± 3	0.5-1.0 (most Veg. <0.3)
30-100	± 7	3.0
100-300	± 11	10 x ht. (must be less than distance to obstruction)

Towers should be of the open grid type of construction. Such as what is typical of most television and radio broadcast towers. Enclosed towers, stacks, water storage tanks, grain elevators, cooling towers and similar structures should not be used. Towers must be rugged enough so that they may be safely climbed to install and service the instruments. Folding or collapsible towers that make the instruments available to be serviced or calibrated at the ground are desirable provided they are sufficiently rigid to hold the instruments in the proper orientation and attitude during normal weather conditions.

Wind instruments should be mounted above the top of the tower or on booms projecting horizontally out from the tower. If a boom is used, it should support the sensor at a distance equal to twice the maximum diameter or diagonal of the tower away from the nearest point on the tower. The boom should project into the direction, which provides the least distortion for the most important wind direction. For example, a boom mounted to the east of the tower will provide least distortion for north or south winds. One may wish to consider having two sets of instruments at each level, located on opposite sides of the tower. A simple automatic switch can choose which set of data to use (NASA, 1968). Documentation of the tower should include the orientation of the booms.

Temperature sensors must be mounted on booms to hold them away from the tower, but a boom length equal to the diameter of the tower is sufficient. Temperature sensors should have downward facing aspirated shields. The booms must be strong enough so that they will not sway or vibrate excessively in strong winds. The best vertical location on the tower for the sensors is at a point with a minimum number of diagonal cross members, and away from mayor horizontal cross members. Even with these precautions, data obtained while the wind blows from the sector transected by the tower may not be free from error.

These instrument siting suggestions may seem to preclude the use of many air monitoring sites that otherwise would be desirable, but this need not be the case. In siting air quality monitors that are to be used for long-term trend analysis or large geographic area coverage, it may be perfectly acceptable to have some or all of the meteorological equipment at a different location that better meets the large-scale requirements of the study. As long as both sites in the same area of interest meet their respective siting criteria, this should present no problems. When the air quality data is to be used for short-term diffusion model validation or studies or short-term levels from specific sources, a meteorological station should be located in the vicinity of the air quality sensor.

Station Siting

Besides care in selecting the local environment of a meteorological sensor, it is important that care be taken in selecting station location with respect to major man-made and topographic features such as cities, mountains, large bodies of water, etc. Meteorological variables are obviously affected by large-scale surrounding features. The effect of cities has been studied extensively. Documented effects include a decrease in an average wind speed, decrease in atmospheric stability, increase in turbulence, increase in temperature and changes in precipitation patterns. These changes will obviously have an effect on the evaluation and interpretation of meteorological and air quality data in an urban area.

Even more pronounced are the effects of large natural features. Besides their obvious effect on humidity, oceans and large bodies of water are usually at a different temperature than the nearby land. This generates the well known land and sea-breezes which, in many coastal areas, dominate the wind patterns. There are also often simultaneous differences in cloud cover between the oceans and nearby land surfaces. This difference in thermal lag, isolation and changes in surface roughness and vertical temperature structure can have a profound effect on atmospheric stability.

The effects of mountains and valleys on meteorological variables and atmospheric dispersion continue to be studied. Well-known effects include the channeling of flow up or down a valley, the creation of drainage flow, the establishment of lee-waves and an increase in mechanically generated turbulence. All of these effects and others can play a major role in the transport and dispersion of pollutants.

The important point is that almost any physical object has an effect upon atmospheric motion. In fact, it is probably impossible to find a site that is completely free of obstruction. This being the case, it is the responsibility of the person choosing a monitoring site to have in mind the various forces at work and to choose a site that will be the most representative of the area of interest. If the area is a valley or a seas coast, then the meteorological instrument should be in that valley or near the coast; not on a nearby hilltop or inland 30km at a more convenient site. Winds are measured at the bottom of a 10m valley will not represent the winds at the top of a 200m stack whose base happens to be in that valley. The choice of a station for meteorological data collection must be made with a complete understanding of the large-scale geographic area, the sources being investigated and the potential use of the data. Then rational, informed, choices can be made.

Once they are made, the site should be completely documented. This should include both small and large-scale site descriptions, local and topographic maps (1:24,000 scale), photographs of the site (if possible), and a written description of the area that is adequately represented by this site. This last point is the most important as it will allow for a more rational interpretation of the data. It might state, for example, that a site adequately represents a certain section of a particular valley, the suburban part of a given city or several rural counties. Whatever it is, the nature of the site should be clearly described in a way that will be clear to those who will be using the data in the future.