



Automatic Weather Station:

Sensor Siting Classification

- 1) Air Temperature
- 2) Air Humidity
- 3) Precipitation (AWG)
- 4) Surface Wind (10MW)
- 5) Rainfall Intensity (TBRG)
- 6) Precipitation Wind (2MW)
- 7) Snow Depth - Single Configuration (SR50)
- 8) Solar Radiation (RF-1)



Draft Version - September 2012

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Sensor Siting Classification System

For Automatic Surface Observing Weather Stations – Land

Last Update: September 11, 2012

Overview:

There are three primary factors that directly affect the quality or accuracy of raw meteorological data. That is:

1. the affects from the sensor's siting or exposure.
2. the intrinsic specifications and accuracy of the sensor.
3. how well the sensor is maintained, verified and calibrated.

The WMO (World Meteorological Organization) and CIMO (Commission for Instruments and Methods of Observation) support the initiative to classify sensors and hence apply this classification metadata to the raw data output. Ultimately, the intent is to develop a system classification standard that would be approved and used internationally and sanctioned by ISO. This initiative, which originated with Meteo-France, has been in progress for many years and several countries, including Canada, have agreed to implement the basics of this system. The system attempts to utilize already established standards of the WMO where they exist.

The overall intent is that this classification system must be made as simple as possible to help unsure that it is easily understood. It cannot be too complex such that it does not get used or is applied incorrectly. There is no classification for a station itself – this system applies to each sensor individually and will result in a code that can be applied to help categorize the raw sensor data quality over specific time periods. If and when any of the exposure or siting criteria changes over time to meet a different classification level, the metadata will be updated to reflect this. Although the primary intent is for the user of the data to utilize and/or categorize data by classification codes rather than have to rely on anecdotal metadata text, there are many additional benefits for the utilization of this system. management tool to help categorize the quality of the data product and where deficiencies may exist.

Classification System:

Two classification digits will be used to summarize a sensor's raw data quality. The first element, the '**Siting Classification**', will use class levels from '**1 to 5**' where a 1 fully meets the best WMO standards generally available such that its data would be representative of a large, meso or synoptic scale area. A Class 5 would be a sensor that is significantly influenced or biased by its surroundings such that it would only be representative of a small scale or micro-climatological area. The second classification element is the '**Maintained Performance**' of the sensor. It combines the accuracy specifications of the sensor and how well it is maintained, calibrated and its data output verified. It will use class levels from '**A to E**' where 'A' would represent the

best accuracy and maintenance typically available and 'E' would represent either unacceptable or unknown standards and procedures.

The 'Maintained Performance' category has not yet been established or approved by the WMO. It is felt best to not develop an independent Environment Canada MSC version of this. For intercomparison purposes, it is quite important that this category be internationally consistent. Hence at this time, the implementation of the Sensor Classification System will concentrate only on the 'Siting Classification' portion. The Maintained Performance classification can be added at a later date once the specific criteria levels have been developed and approved.

The basic layout of the system originated with Meteo-France in 1996. The Siting Classification portion of the system was initially utilized to survey for a new, large (400+ stations) network of a specific type of automatic weather station. Hence, its requirement was to quickly and efficiently categorize a very high number of undeveloped or green field potential sites based on each of the meteorological elements or parameters. By using a '1 to 5' classification based only on existing 'obstacles and surface heating/humidity' influences, this was a simple method to categorize multiple sites quickly.

For the purpose of assessing a 'green field' site, the Meteo-France version worked very well. However, to implement and apply this system as it exists to pre-established and highly variable sites and sensor systems across Canada, much more criteria is needed to be considered to make the system useful. A station's own surrounding infrastructure can often bias the data. As well, the Meteo-France version concentrated on a specific type of sensor suite that may not be very well comparable to typical variable Canadian sensor suites that may include multiple types of manned sensors for a single parameter (ie, Type B Rain Gauge and Nipher Snow Gauge combine to give yearly site precipitation but may have different siting classes). Although eventually the plan is to apply the Sensor Classification to all MSC maintained systems and hopefully other agency systems as well, the concentration at this time will be on the MSC standard of autostation – automated RCS and SWX datalogger sensor suites. It is anticipated that additional Siting and Maintained Performance classification listings will be developed that concentrate on other network/sensor configurations so that cross comparison of raw data based on quality assessment code can be done in a homogenous and consistent manner.

Sensor Siting Classification

The following sensor siting criteria is intended for use at automatic weather stations with a concentration of application on MSC datalogger AUTO8 type systems (RCS and SWX). Although the class level criteria is intended for the assessment of established automatic weather stations, it can also be applied to 'green field' or potential new sites and re-assessed once the systems have been installed.

Sensor Siting Classification System

For Automatic Surface Observing Weather Stations – Land

Classification Criteria

Air Temperature

- Assessment is considered to take place in mid-summer with regards to shading from trees in full foliage. Minor, very narrow shading is not a consideration (ie. overhead lines, sparse branches, etc).
- ‘Local geographic horizon’ for sun angle is at the top of surrounding topography. This includes mountains/ridges/hills if general of the area. Shading from this is not a consideration unless alongside an ‘isolated’ topographic feature.
- An obstacle is an object (ie. tree, building, etc.) with a horizontal angle of 10 deg. and wider that can shade the sensor enclosure.
- Degrees of shading is along the general route of the sun (any time of year).
- 10 degrees of ‘sun route’ = 40 minutes.
- For the purpose of this classification, all temperature siting classes require that the sensor utilize an acceptable ventilated radiation shield. The ‘type’ of shielding and aspiration will be assessed within the “Maintained Performance” classification.
- The Sensor Siting Classification class levels refer primarily to the extent or size of the intended area of representation.
- If sensors are installed as ‘Triple Configuration’, it is considered as a single point of measurement.

Class 1

- **T1)** Ground within a **10m radius** ‘mostly’ covered with lawn or natural and low vegetation (generally less than **10cm**) representative of the region.
 - Open patches of bare ground acceptable if natural and representative of the region.
- **T2)** Generally flat area within **10m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.

- **T3)** No irrigation or routine lawn watering system operational within **30m** radius.
- **T4)** Sensor located at more than **100m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
 - Open water can be excluded if representative of the region such as open coastal or large scale inland water/swamp/muskeg (ie. 25% of 100km radius, approximately equal in most directions).

A '**significant**' source of heat (or expanse of water) is defined to have an impact if it comprises more than **10%** of the horizontal surface within a **100m** radius surrounding the sensor, comprises more than **5%** of the horizontal surface within **30m** radius or comprises **1%** of the horizontal surface within a **10m** radius.

- *10% of 100m radius circle = 3142 sq.m (32,212 sf)*
- *5% of 30m radius circle = 141 sq.m (1368 sf)*
- *1% of 10m radius circle = 3 sq.m (33 sf)*

- **T5)** Sensor away from any subjectively determined heat source such as nearby infrastructure (ie. electronics boxes, metal mounting structures, etc.) that will have any affect on sensor. Minimum distance from sensor to nearby other objects at least **2x** the height of the object away (2:1).
- **T6)** Site not subjected to any jet blast, prop wash or helicopter downwash. No routine significant aircraft ground movement/parking or significant paved public highways within **100m**.
- **T7)** Sensor in a ventilated solar radiation shield or enclosure.
- **T8)** Sensor mounted between **1.2m** and **2.0m** above ground level.
- **T9)** The maximum anticipated (subjective and non-extreme) snowdepth will remain at least **1m** below the bottom surface of sensor shield or enclosure.
- **T10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **5 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **10 deg.** anytime of year.

Class 2

- **T1)** Ground within a **5m radius** 'mostly' covered with lawn or natural and low vegetation (generally less than **15cm**) representative of the region.

- Open patches of bare ground acceptable if natural and representative of the region.
- **T2)** Generally flat area within **5m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area..
- **T3)** No irrigation or routine lawn watering system operational within **10m** radius.
- **T4)** Sensor located at more than **30m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
 - Open water can be excluded if representative of the region such as coastal or large scale inland water/swamp/muskeg (ie. 25% of 100km radius, approximately equal in most directions).

A '**significant**' source of heat (or expanse of water) is defined to have an impact if it comprises more than **10%** of the horizontal surface within a **30m** radius surrounding the sensor, comprises more than **5%** of the horizontal surface within **10m** radius or comprises **1%** of the horizontal surface within a **5m** radius.

- *10% of 30m radius circle = 283 sq.m (3000 sf)*
- *5% of 10m radius circle = 16 sq.m (174 sf)*
- *1% of 5m radius circle = 0.8 sq.m (9 sf)*

- **T5)** Sensor away from any subjectively determined heat source such as nearby infrastructure (ie. electronics boxes, metal mounting structures, etc.) that will have any affect on sensor. Minimum distance from sensor to nearby other objects at least **2x** the height of the object away (2:1).
- **T6)** Site not subjected to any jet blast, prop wash or helicopter downwash. No significant routine aircraft ground movement/parking or significant paved public highways within **50m**.
- **T7)** Sensor in a ventilated solar radiation shield or enclosure.
- **T8)** Sensor between **1.2m** and **2.5m** above ground level.
- **T9)** The maximum anticipated snowdepth (subjective and non-extreme) will remain at least **0.5m** below the bottom surface of sensor shield or enclosure.
- **T10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **7 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **20 deg.** anytime of year.

Class 3

- **T1)** Ground within a **5m radius** 'mostly' covered with lawn or natural and low vegetation (generally less than **25cm**) representative of the region.
 - Open patches of bare ground acceptable if natural and representative of the region.
- **T2)** n/a
- **T3)** No irrigation or routine lawn watering system operational within **5m** radius.
- **T4)** Sensor located at more than **10m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
 - Open water can be excluded if representative of the region such as coastal or large scale inland water/swamp/muskeg (ie. 25% of 100km radius, approximately equal in most directions).

A '**significant**' source of heat (or expanse of water) is defined to have an impact if it comprises more than **10%** of the horizontal surface within a **10m** radius surrounding the sensor or comprises more than **5%** of the horizontal surface within **5m** radius.

- *10% of 10m radius circle = 31 sq.m (342 sf)*
- *5% of 5m radius circle = 4 sq.m (43 sf)*

- **T5)** Sensor away from any subjectively determined heat source such as nearby infrastructure (ie. electronics boxes, metal mounting structures, etc.) that will have any affect on sensor. Minimum distance from sensor to nearby objects at least **1x** the height of the object away (1:1).
- **T6)** Site not subjected to any jet blast, prop wash or helicopter downwash. No significant routine aircraft ground movement/parking or significant paved public highways within **30m**.
- **T7)** Sensor in a ventilated solar radiation shield or enclosure.
- **T8)** Sensor between **1.2m** and **3.0m** above ground level.
- **T9)** Sensor in an enclosure where the maximum anticipated snowdepth (subjective and non-extreme) will remain below the bottom surface of the sensor shield or enclosure.
- **T10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **10 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **30 deg.** anytime of year.

Class 4

- **T1)** Ground under sensor covered 'mostly' with grass or natural vegetation (generally less than **50cm**) representative of the region.
 - Open patches of bare ground acceptable if natural and representative of the region.
- **T2)** n/a
- **T3)** No irrigation or routine lawn watering system that can affect the immediate sensor area.
- **T4)** Sensor located at more than **10m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
 - Open water can be excluded if representative of the region such as coastal or large scale inland water/swamp/muskeg (ie. 25% of 100km radius, approximately equal in most directions).

A '**significant**' source of heat (or expanse of water) is defined to have an impact if it comprises more than **50%** of the horizontal surface within a **10m** radius surrounding the sensor or comprises more than **30%** of the horizontal surface within **5m** radius.

- *50% of 10m radius circle = 157 sq.m (1710 sf)*
- *30% of 5m radius circle = 23.6 sq.m (256 sf)*

- **T5)** Sensor away from any subjectively determined heat source such as nearby infrastructure (ie. electronics boxes, metal mounting structures, etc.) that will have any affect on sensor.
- **T6)** n/a
- **T7)** Sensor in a ventilated solar radiation shield or enclosure.
- **T8)** Sensor between **1.0m** and **3.5m** above ground level.
- **T9)** The maximum anticipated snowdepth (subjective and non-extreme) will not obstruct the ventilation.
- **T10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **20 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **45 deg.** anytime of year.

Class 5

- Sensor not meeting the requirements of class 4.

Air Humidity

- Assessment is considered to take place in mid-summer with regards to shading from trees in full foliage. Minor, very narrow shading is not a consideration (ie. overhead lines, sparse branches, etc).
- 'Local geographic horizon' for sun angle is at the top of surrounding topography. This includes mountains/ridges/hills if general of the area. Shading from this is not a consideration unless alongside an 'isolated' topographic feature.
- An obstacle is an object (ie. tree, building, etc.) with a horizontal angle of 10 deg. and wider that can shade the sensor enclosure.
- Degrees of shading is along the general route of the sun (any time of year).
- 10 degrees of 'sun route' = 40 minutes.
- For the purpose of this classification, all humidity siting classes require that the sensor utilize an acceptable ventilated radiation shield. The 'type' of shielding and aspiration will be assessed within the "Maintained Performance" classification.
- The Sensor Siting Classification class levels refer primarily to the extent or size of the intended area of representation.

Class 1

- **H1)** Ground within a **10m radius** 'mostly' covered with lawn or natural and low vegetation (generally less than **10cm**) representative of the region.
 - Open patches of bare ground acceptable if natural and representative of the region.
- **H2)** Generally flat area within **10m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.
- **H3)** No irrigation or routine lawn watering system operational within **30m** radius.
- **H4)** Sensor located at more than **100m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.

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- **H6)** Site not subjected to any jet blast, prop wash or helicopter downwash. No routine significant aircraft ground movement/parking or significant paved public highways within **100m**.
- **H7)** Sensor in a ventilated solar radiation shield or enclosure.
- **H8)** Sensor mounted between **1.2m** and **2.0m** above ground level.
- **H9)** The maximum anticipated (subjective and non-extreme) snowdepth will remain at least **1m** below the bottom surface of sensor shield or enclosure.
- **H10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **5 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **10 deg.** anytime of year.

Class 2

- **H1)** Ground within a **5m radius** 'mostly' covered with lawn or natural and low vegetation (generally less than **15cm**) representative of the region.
 - Open patches of bare ground acceptable if natural and representative of the region.
- **H2)** Generally flat area within **5m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area..

- **H3)** No irrigation or routine lawn watering system operational within **10m** radius.
- **H4)** Sensor located at more than **30m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
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- **H6)** Site not subjected to any jet blast, prop wash or helicopter downwash. No significant routine aircraft ground movement/parking or significant paved public highways within **50m**.
- **H7)** Sensor in a ventilated solar radiation shield or enclosure.
- **H8)** Sensor between **1.2m** and **2.5m** above ground level.
- **H9)** The maximum anticipated snowdepth (subjective and non-extreme) will remain at least **0.5m** below the bottom surface of sensor shield or enclosure.
- **H10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **7 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **20 deg.** anytime of year.

Class 3

- **H1)** Ground within a **5m radius** 'mostly' covered with lawn or natural and low vegetation (generally less than **25cm**) representative of the region.
 - Open patches of bare ground acceptable if natural and representative of the region.

- **H2)** n/a
- **H3)** No irrigation or routine lawn watering system operational within **5m** radius.
- **H4)** Sensor located at more than **10m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
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- **H6)** Site not subjected to any jet blast, prop wash or helicopter downwash. No significant routine aircraft ground movement/parking or significant paved public highways within **30m**.
- **H7)** Sensor in a ventilated solar radiation shield or enclosure.
- **H8)** Sensor between **1.2m** and **3.0m** above ground level.
- **H9)** Sensor in an enclosure where the maximum anticipated snowdepth (subjective and non-extreme) will remain below the bottom surface of the sensor shield or enclosure.
- **H10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **10 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **30 deg.** anytime of year.

Class 4

- **H1)** Ground under sensor covered 'mostly' with grass or natural vegetation (generally less than **50cm**) representative of the region.

- Open patches of bare ground acceptable if natural and representative of the region.
- **H2)** n/a
- **H3)** No irrigation or routine lawn watering system that can affect the immediate sensor area.
- **H4)** Sensor located at more than **10m** from **significant** heat sources or reflective surfaces (buildings, roads, concrete surfaces, car parks, unnatural exposed ground areas, etc.). This also includes expanses of water even if only seasonal.
 - Open water can be excluded if representative of the region such as coastal or large scale inland water/swamp/muskeg (ie. 25% of 100km radius, approximately equal in most directions).

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- *50% of 10m radius circle = 157 sq.m (1710 sf)*
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- **H5)** Sensor away from any subjectively determined heat source such as nearby infrastructure (ie. electronics boxes, metal mounting structures, etc.) that will have any affect on sensor.
- **H6)** n/a
- **H7)** Sensor in a ventilated solar radiation shield or enclosure.
- **H8)** Sensor between **1.0m** and **3.5m** above ground level.
- **H9)** The maximum anticipated snowdepth (subjective and non-extreme) will not obstruct the ventilation.
- **T10)** Sensor radiation shield away from all **significant** shade when the Sun is higher than **20 deg.** above local geographic horizon.

It is considered '**significant**' shade when it is from objects along the sun route with a combined measureable width of greater than **45 deg.** anytime of year.

Class 5

- Sensor not meeting the requirements of class 4.

Precipitation (AWG)

- Angles, distances and obstruction heights are measured from the top, centre of the Precipitation gauge.
- 'Effective' height of an obstacle is its height difference from the top level of the gauge.
- A Tipping Bucket Rain Gauge (TBRG) is not considered in this classification.
- To be classified as a precipitation 'obstacle', its width must be 10 deg. or wider as viewed from the gauge and equal to or closer than 4 times its height away (14 deg. vertically).
- If dual or multiple objects less than 10 deg. wide each are separated by less than 10 deg. and hamper the wind flow, consider them as 1 obstacle to be assessed.
- If an object decreases to less than 10 deg. wide (obstacle) vertically, the top portion (below 10 deg. wide) does not need consideration as part of the obstacle. (ie. tapering trees, peaked roofline, Air Traffic Control cab, etc.).
- Assessment is considered to take place in mid-summer with regards to obstructions (trees and shrubs in full foliage). Tree must be considered as generally opaque to wind flow to be considered as an 'obstacle'.
- If site is subjected to a 'predominant' wind direction such as in a valley, obstacles in all directions are equal considerations for classification.
- Surrounding terrain (hills, mountains, ridges, etc.), if typical of the large area, is not considered an 'obstruction'.
- The sensor wind shield type (Alter, Nipher, Tretyakov, etc.) shall be considered as part of a system with the sensor itself. Hence, the 'type' is to be a consideration of the 'Maintained Performance Classification' and not the siting classification.

Class 1

- **P1)** Generally flat area within **10m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.

Either...

- **P2)** Precipitation Gauge surrounded by trees/obstacles of generally uniform height, seen at a distance of **2 to 4** times their effective height away from the gauge.

- Trees are considered as generally opaque to the wind flow and are functioning as a 'natural' wind shield.
- To 'surround' a gauge with generally uniform height, total horizontal coverage must comprise at least **300 deg**.
- 'Uniform' height means generally that the ratio between the tallest and shortest obstacles is lower than 2.
 - *(Vertical measurement for 2x from top of sensor is just less than 27 deg.)*
 - *(Vertical measurement for 4x from top of sensor is 14 deg.)*
- No obstacles closer than **2 times** (27 deg.) their effective height from the gauge.
- Sensor to be protected by a Wind Shield (ie. Single Alter, Tretyakov, Nipher, etc.) as well if surrounded by natural wind shield.

Or..

- **Optional - P2.1)** Precipitation Gauge artificially protected by **DFIR** (Double Fenced Intercomparison Reference), **SDFIR** (Small Double Fenced Intercomparison Reference) or **Double Alter Shield** against the wind.
- **P3)** Sensor orifice and wind shield height appropriate for Double Shielded specifications above ground level and based on anticipated maximum snowdepth. Wind flow must be unimpeded under the shields.
 - If non-Double Shielded, sensor orifice **1.5m – 2.5m** above ground level.
- **P4)** The maximum anticipated snow depth (subjective and non-extreme) will remain at least **1m** from the top of the gauge.
- **P5)** All obstacles must be no closer than **4 times** their effective height away from the gauge. If meets 'tree surround' criteria P2, all obstacles **2x – 4x**.
 - *(Vertical measurement for 4x from top of sensor is 14 deg.)*

Class 2

- **P1)** Generally flat area within **5m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.
- **P2)** Sensor to be protected by a Wind Shield (ie. Single Alter, Tretyakov, Nipher, DFIR, Double Alter, etc.)
- **P3)** Sensor orifice height between **1.5m** and **3m** above ground.
- **P4)** The maximum anticipated snow depth (subjective and non-extreme) will remain at least **1m** from the top of the gauge.
- **P5)** All obstacles must be at least **2 times** their effective height away from the gauge.

- *(Vertical measurement for 2x from top of sensor is just less than 27 deg.)*

Class 3

- **P1)** The area is surrounded by generally open space with a slope of less than **1:2 (30°)** that is considered to be representative of the large scale area.
- **P2)** Sensor to be protected by a Wind Shield (ie. Single Alter, Tretyakov, Nipher, DFIR, Double Alter, etc.).
- **P3)** Sensor orifice height between **1.5m** and **4m** above ground.
- **P4)** The maximum anticipated snow depth snowdepth (subjective and non-extreme) will remain at least **1m** from the top of the gauge.
- **P5)** All obstacles must be at least their **effective** height (**1x**) away from the gauge.
 - *(Vertical measurement for 1x from top of sensor is 45 deg.)*

Class 4

- **P1)** n/a.
- **P2)** Sensor to be protected by a Wind Shield (ie. Single Alter, Tretyakov, Nipher, DFIR, Double Alter, etc.).
- **P3)** Sensor orifice height over **1.0m** above ground.
- **P4)** Sensor orifice to be a minimum of **0.5m** above maximum anticipated snowdepth (subjective and non-extreme).
- **P5)** All obstacles must be at least **1/2** of their effective height away from the gauge.
 - *(Vertical measurement for 1/2x from top of sensor is just over 63 deg.)*

Class 5

- Sensor not meeting the requirements of class 4.

Surface Wind (10M)

- **To be classified as an 'obstacle', its width must be 10 deg. or wider as viewed from the base of the tower. An object must be above 4, 5 or 6m high (depending on Class Level) to be an 'obstacle'.**

- Angles, distances and obstruction heights are measured from the base of the tower at approximately 1.5m above ground level (eye height).
- If site is subjected to a 'predominant' wind direction(s) (ie. in a valley) such that specific obstacles might not seem to affect local wind, they are still a consideration in any direction for classification purposes.
- For 'narrow objects' (ie. narrow trees, other towers, etc. less than 10 deg. wide) at specific heights, they are assessed on their actual width.
- Significant (isolated) changes in surrounding terrain elevation, if not representative of the general large scale area, are considered as obstacles (ie. cliff, excessive steep slope, building wall from roof mount tower, etc.) even if their apparent horizontal width cannot be measured from the tower base. If sensor is subjected to 'doming' affect, criteria would result in Class 5.
- For 'Ground Roughness Index', consider predominant ground cover conditions within a 300m radius from the tower base with a bias toward the closer items. When assessing this index, the definition of 'obstacle' means anything that would cause wind friction within that radius. Utilize mid-summer conditions.
- Obstacle "d:h" is a ratio of approximate "distance" to predominant obstacles to the average "height" of obstacles within a 300m radius.

Ground Roughness (Friction) Index:

Index #	General Terrain Description	Obstacle d:h
1	Open water all directions, minimum open fetch 3km	n/a
2	Mud flats, water, no significant veg., no obstacles	n/a
3	Open flat terrain, short grass, rocky, generally < 15cm, isolated obstacles	n/a
4	Low crops/grass, generally < 1m, few obstacles	Greater than 20:1
5	High crops, shrubs, brush, generally < 2m, several scattered obstacles	Greater than 15:1
6	Low trees, orchard, bushland, generally < 6m, numerous obstacles	Greater than 8:1
7	Dense, large obstacles, forest, suburb, generally < 15m	n/a
8	City centre, numerous high and low rise buildings	n/a

Class 1

- **W1)** The sensors are mounted on a tower at **10m (+/- 1m)** above ground level.
- **W2)** Site is not subjected to routine aircraft movement (jet blast, prop or helicopter wash) within **100m** radius and vertically.
- **W3)** Surrounding obstacles must be at least **30 times** their height away from the wind tower.
 - *(Vertical measurement for 30x from tower base is just less than 2 deg.)*
- **W4)** Individual obstacles (ie. shed, fence, short trees, etc.) lower than **4m** above ground can be ignored regardless of distance from tower.
- **W5)** 'Narrow' objects higher than **8m** above ground must be at least **15 times** their width away from the wind tower.
- **W6)** Sensor not subjected to 'wind doming' (ie. steep hill, nearby cliff, building roof mount or lighthouse mounted).
- **W7)** Ground Roughness Index:
 - **Index 4 or less.** (= maximum of low crops or tall grass generally less than 1m tall with occasional small obstacles but not closer than 20 times their height away from tower).

Class 2

- **W1)** The sensors are mounted on a tower at **10m (+/- 1m)** above ground level.
- **W2)** Site is not subjected to routine aircraft movement (jet blast, prop or helicopter wash) within **50m** radius and vertically.
- **W3)** Surrounding obstacles must be at least **10 times** their height away from the wind tower.
 - *(Vertical measurement for 10x from tower base is just less than 6 deg.)*
- **W4)** Individual obstacles (ie. shed, fence, short trees, etc.) lower than **4m** above ground can be ignored regardless of distance from the wind tower.
- **W5)** Narrow objects higher than **8m** above ground must be at least **15 times** their width away from the wind tower.
- **W6)** Sensor not subjected to 'wind doming' (ie. steep hill, nearby cliff, building roof mount or lighthouse mounted).
- **W7)** Ground Roughness Index:
 - **Index 5 or less.** (= maximum of high crops, low brush generally less than 2m tall, scattered obstacles but not closer than 15 times their height away)

Class 3

- **W1)** The sensors are mounted on a tower at **10m (+/- 1m)** above ground level.
- **W2)** n/a
- **W3)** Surrounding obstacles must be at least **5 times** their height away from the wind tower.
 - *(Vertical measurement for 5x from tower base is just over 11 deg).*
- **W4)** Individual obstacles (ie. shed, fence, short trees, etc.) lower than **5m** above ground can be ignored.
- **W5)** Narrow objects higher than **8m** above ground must be at least **10 times** their width away from the wind tower.
- **W6)** Sensor not subjected to 'wind doming' (ie. steep hill, nearby cliff, building roof mount or lighthouse mounted).
- **W7)** Ground Roughness Index:
 - **Index 6 or less** (= low trees generally less than 6m tall, numerous obstacles but not closer than 8 times their height away).

Class 4

- **W1)** n/a
- **W2)** n/a
- **W3)** Surrounding obstacles must be at least **2.5 times** their height away from the wind tower.
 - *(Vertical measurement for 2.5x from tower base is just less than 22 deg.)*
- **W4)** Individual obstacles (ie. shed, fence, short trees, etc.) lower than **6m** can be ignored if sensors mounted at **10m** above ground level.
- **W5)** No obstacle with an angular width larger than **60 deg.** and a height greater than **10m** within **40m** from the tower base.
- **W6)** Sensor not subjected to 'wind doming' (ie. steep hill, nearby cliff, building roof mount or lighthouse mounted).
- **W7)** Ground Roughness Index:
 - **Index 7 or less** (forest, suburb, numerous buildings generally less than 15m tall)

Class 5

- Sensor not meeting the requirements of class 4.
- Sensor may be subjected to 'doming' (ie., roof top mounted, edge of cliff, small steep island, on lighthouse structure or building, etc.)

Rainfall Intensity (Tipping Bucket Rain gauge):

- The primary purpose of the Tipping Bucket Rain Gauge (TBRG) is for rainfall intensity. Some AWS may utilize the TBRG as the only sensor for precipitation totalizing. This Siting Classification is to be used for either TBRG primary purpose.
- Angles, distances and obstruction heights are measured from the top of the TBRG.
- To be classified as an 'obstacle', its width must be 10 deg. or wider as viewed from the gauge.
- If dual or multiple objects less than 10 deg. wide each, if separated by less than 5 deg., consider them as 1 object (or obstacle) to be assessed.
- If an object decreases in width with height, only assess that portion of the object that is 10 deg. or wider to be an obstacle. Ignore the top portion less than 10 deg. wide. (ie. pyramidal as in tapering trees, peaked roofline, church peak, etc.).
- 'Effective' height of an obstacle is its height above the top level of the gauge.
- If site is subjected to a 'predominant' wind direction(s) (ie. in a valley) such that specific obstacles might not seem important, they are still a consideration for classification.
- Surrounding terrain (hills, mountains, ridges, etc.), if typical of the large area, is not considered an 'obstruction'.

Class 1

- **R1)** Generally flat area within **10m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.
- **R2)** No infrastructure or junction boxes within **2m** radius with a height higher than **0.5m** below the TBRG orifice height that can cause rainfall 'splash-in'.
- **R3)** No irrigation that could affect sensor.
- **R4)** TBRG orifice height between **0.5m** and **1.0m** above ground.
- **R5)** All obstacles must be at least **4 times** their effective height away from the gauge.
 - If obstacles meet the 'Surround' criteria of the Precipitation AWG (all obstacles between 2x and 4x), sensor will meet Class 1 for 'R5'.

- If sensor is within appropriate research 'ground pit', sensor will meet Class 1 for 'R5'.
 - *(Vertical measurement for 4x from top of sensor is 14 deg.)*

Class 2

- **R1)** Generally flat area within **5m** of sensor. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.
- **R2)** No infrastructure or junction boxes within **1m** radius with a height higher than **0.4m** below the TBRG orifice height that can cause rainfall 'splash-in'.
- **R3)** No irrigation that could affect sensor.
- **R4)** TBRG orifice height between **0.4m** and **1.5m** above ground.
- **R5)** All obstacles must be at least **2 times** their effective height away from the gauge.
 - *(Vertical measurement for 2x from top of sensor is just less than 27 deg.)*

Class 3

- **R1)** Site is surrounded by an open area, slope less than **1:2 (30°)**.
- **R2)** No infrastructure or junction boxes within **0.5m** radius with a height higher than **0.3m** below the TBRG orifice height that can cause rainfall 'splash-in'.
- **R3)** No irrigation that could affect sensor.
- **R4)** TBRG orifice height between **0.4m** and **2.0m** above ground.
- **R5)** All obstacles must be at least their effective **height** away from the gauge.
 - *(Vertical measurement for 1x from top of sensor is 45 deg.)*

Class 4

- **R1)** n/a
- **R2)** n/a
- **R3)** No irrigation that could affect sensor.
- **R4)** TBRG orifice height between **0.3m** and **3.0m** above ground.
- **R5)** All obstacles must be at least **1/2** of their effective height away from the gauge.
 - *(Vertical measurement for 1/2x from top of sensor is just over 63 deg.)*

Class 5

- Sensor not meeting the requirements of class 4.
-

Precipitation Wind (2 Metre Wind):

- The purpose of the Precipitation Wind Sensor is to capture the wind speed equivalent to that experienced over the orifice of the Precipitation Sensor. It is not intended to capture large or synoptic scale wind speeds.
- Although the standard height for the orifice of the Precipitation Sensor is generally 2 metres above ground level, it may often be significantly higher based on local conditions such as anticipated deep snowdepth. The desired reference height of the Precipitation Wind Sensor is to match that of the precipitation sensor orifice.
- Vertical measurement reference is from the centre of the speed pickup (ie. cupwheel, propeller). Horizontal measurement reference is from the centre of the sensor mounting mast (rotational axis).
- Reference measurements from the Precipitation Sensor are from the centre of its catchment orifice or rim.
- In the classification criteria, reference to 'both' or 'the two' sensors refers to Precipitation Wind Sensor and the Precipitation Sensor (All Weather Gauge).
- 'Same ground cover' implies similar ground friction affects on the wind.

Class 1

- **PW1)** Generally flat, horizontal land at the site, surrounded by an open area, with a general slope of less than **1:3 (19 deg.)**.
- **PW2)** No significant objects or infrastructure between the two sensor mounts.
- **PW3)** The same general ground cover exists between and within a **10m** radius from each sensor.
- **PW4)** Wind sensor within **0.1m** of the height above ground of the precipitation sensor rim.
- **PW5)** Wind sensor within a distance of **3m – 15m** from the precipitation sensor.

- **PW6)** The wind sensor is mounted on a mast less than **0.1m** wide.
- **PW7)** Wind sensor at least **3 times** the width of the precipitation wind shield away from the centre of the shield.
- **PW8)** Surrounding obstacles, as defined in the Precipitation AWG Sensor Classification, meet the same class for the wind sensor. No notable differences regarding distance:height (ie. 2:1, 4:1) slopes to surrounding obstacles.

Class 2

- **PW1)** Generally flat, horizontal land at the site, surrounded by an open area, with a general slope of less than **1:3 (19 deg.)**.
- **PW2)** No significant objects or infrastructure between the two sensor mounts.
- **PW3)** The same general ground cover exists between and within a **5m** radius from each sensor.
- **PW4)** Wind sensor within **0.2m** of the height above ground of the precipitation sensor rim.
- **PW5)** Wind sensor within a distance of **2m – 20m** from the precipitation sensor.
- **PW6)** The wind sensor is mounted on a mast less than **0.1m** wide.
- **PW7)** Wind sensor at least **2 times** the width of the precipitation wind shield away from the centre of the shield.
- **PW8)** Surrounding obstacles, as defined in the Precipitation Sensor Classification, meet the same class for the wind sensor. No notable differences regarding height:distance (ie. 2:1, 4:1) slopes to surrounding obstacles.

Class 3

- **PW1)** Site is surrounded by an open area, slope less than **1:2 ($\leq 30^\circ$)**.
- **PW2)** n/a
- **PW3)** n/a
- **PW4)** Wind sensor within **0.5m** below and **1m** above the height of the precipitation sensor rim.
- **PW5)** Wind sensor within a distance of **1m – 30m** from the precipitation sensor.
- **PW6)** n/a
- **PW7)** Wind sensor at least **1 times** the width of the precipitation wind shield away from the centre of the shield.
- **PW8)** Surrounding obstacles, as defined in the Precipitation AWG Sensor Classification, may result in up to **1 class** level difference.

Class 4

- **PW1)** n/a
- **PW2)** n/a
- **PW3)** n/a
- **PW4)** Wind sensor within **0.5m** below and **2m** above the height of the precipitation sensor rim.
- **PW5)** Wind sensor within a distance of **0.5m – 50m** from the precipitation sensor.
- **PW6)** n/a
- **PW7)** n/a
- **PW8)** Surrounding obstacles, as defined in the Precipitation Sensor Classification, may result in up to a **2 class** level differences.

Class 5

- Wind sensor not meeting the requirements of class 4.
-

Snow Depth – Single Configuration (SR50):

- Due to significant differences in setup, operation and configuration for snow depth sensors from different manufacturers, this classification is for the Campbell Scientific “SR50 Sonic Ranging Sensor”.
- All height measurements are referenced from the bottom, centre of the sensor screen.
- The type of ‘pad’ or ‘prepared’ area directly below the sensor is not, at this time, a proven standard. The intent is that it is an installed or maintained area that meets certain requirements. It may be natural ground or a custom pad. It must:
 - provide an acceptable level of surface friction.
 - be flat and level.
 - if natural, vegetation must be seasonably kept below 1 cm.
 - if custom pad, be light coloured and the top of it within 2 cm. of the ground.

- Since a sensor's height must be based on anticipated maximum snow depth and maintain significantly more than a 0.5m separation. Excessive height can decrease the sensor's sensitivity for measuring shallow snow depths. This is reflected in the classification levels.
- (Table A) To measure that the sensor support base is at least '30 deg. off vertical' from directly below sensor, measure the horizontal ground distance from the centre of the 'prepared pad' to the near edge of the support mast footing.
 - 1.5m height, minimum 1.0m distance
 - 2.0m height, minimum 1.3m distance
 - 2.5m height, minimum 1.5m distance
 - 3.0m height, minimum 1.8m distance
 - 3.5m height, minimum 2.2m distance

For at least '20 deg. off vertical' ...

- 1.5m height, minimum 0.6m distance
 - 2.0m height, minimum 0.8m distance
 - 2.5m height, minimum 1.0m distance
 - 3.0m height, minimum 1.2m distance
 - 3.5m height, minimum 1.3m distance
- (Table B) The sensor's vertical measurement cone is 22 deg. wide. The 'minimum' prepared ground area size (and allowance for error) is based on sensor height to meet classification level:
 - 1.5m height = 0.8m x 0.8m
 - 2.0m height = 1.0m x 1.0m
 - 2.5m height = 1.2m x 1.2m
 - 3.0m height = 1.5m x 1.5m
 - 3.5m height = 2.0m x 2.0m

Class 1

- **SD1)** Generally flat area within **10m** of sensor and not on a knoll or ground depression. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.
- **SD2)** Sensor height **1.5m – 2.5m** above ground level.
- **SD3)** Bottom of sensor a minimum of **1.0m** above maximum (subjective and non-extreme) anticipated snow depth.
- **SD4)** Prepared measurement area or pad size at least equal to or greater than above **(Table B)** listed sensor heights. Natural measurement area acceptable if flat and foliage generally less than 1cm.
- **SD5)** Measurement area not affected by any nearby snow removal processes (ie, snow shovelling, snow blowing, airport operations, etc.). None within **50m**.
- **SD6)** Sensor vertical and supported by non-flexible (from wind) horizontal mast section less than **0.1m** width.
- **SD7)** Sensor vertical line to ground **(Table A)** a minimum of **30 deg.** off vertical to nearest edge of sensor mast/tower footing.
 - Sensor mast/tower footing does not significantly affect drifting snow below sensor.
- **SD8)** Minimum of **5m** from other objects, fencing or instrument bases that could possibly affect drifting or falling snow at measurement pad. Measurement is horizontal from ground directly below sensor.
- **SD9)** Meets the **same** obstruction classification criteria as the Precipitation AWG at this site (as measured from equivalent height at the snow depth sensor).
- **SD10)** Meets the **same** shade obstruction classification criteria as temperature sensor enclosure at this site (as measured from equivalent height at the snow depth sensor).

Class 2

- **SD1)** Generally flat area within **5m** of sensor and not on a knoll or ground depression. This area surrounded by generally open space with a slope of less than **1:3 (19°)** that is considered to be representative of the large scale area.
- **SD2)** Sensor height **1.5m – 3.5m** above ground level
- **SD3)** Bottom of sensor a minimum of **1.0m** above maximum (subjective and non-extreme) anticipated snow depth.
- **SD4)** Prepared measurement area or pad size at least equal to or greater than above **(Table B)** listed sensor heights. Natural measurement area acceptable if flat and foliage generally less than 2cm
- **SD5)** Measurement area not affected by any nearby snow removal processes (ie, snow shovelling, snow blowing, airport operations, etc.). None within **25m**.

- **SD6)** Sensor vertical and supported by non-flexible (from wind) horizontal mast section less than **0.2m** width.
- **SD7)** Sensor vertical line to ground (**Table A**) a minimum of **20 deg.** off vertical to nearest edge of sensor mast/tower footing.
 - Sensor mast/tower footing does not significantly affect drifting snow below sensor.
- **SD8)** Minimum of **4m** from other objects, fencing or instrument bases that could possibly affect drifting or falling snow at measurement pad. Measurement is horizontal from ground directly below sensor.
- **SD9)** Within **1** classification level regarding obstructions as the Precipitation AWG at this site (as measured from equivalent height at the snow depth sensor).
- **SD10)** Within **1** classification level regarding shade obstruction as the temperature sensor enclosure at this site (as measured from equivalent height at the snow depth sensor).

Class 3

- **SD1)** Sensor mounted over generally level measurement area. This area surrounded by generally open space with a slope of less than **1:2 (30°)** that is considered to be representative of the large scale area.
- **SD2)** Sensor height **1.5m – 4.5m** above ground level.
- **SD3)** Bottom of sensor a minimum of **0.5m** above maximum (subjective and non-extreme) anticipated snow depth.
- **SD4)** Prepared measurement area size of at least **0.5m x 0.5m**.
- **SD5)** n/a
- **SD6)** n/a
- **SD7)** Sensor mast/tower footing does not significantly affect drifting snow below sensor.
- **SD8)** Minimum of **3m** from other objects, fencing or instrument bases. Measurement is horizontal from ground directly below sensor.
- **SD9)** Within **2** classification levels regarding obstructions as the Precipitation AWG at this site (as measured from equivalent height at the snow depth sensor).
- **SD10)** Within **2** classification levels regarding shade obstruction as the temperature sensor enclosure at this site (as measured from equivalent height at the snow depth sensor).

Class 4

- **SD1)** Sensor mounted over generally level measurement area below sensor.
- **SD2)** Sensor height **1.5m – 6m** above ground level.
- **SD3)** Bottom of sensor above maximum (subjective and non-extreme) anticipated snow depth.

- **SD4)** Designated and maintained measurement area.
- **SD5)** n/a
- **SD6)** n/a
- **SD7)** n/a
- **SD8)** Minimum of **2m** from other objects, fencing or instrument bases. Measurement is horizontal from ground directly below sensor.
- **SD9)** n/a
- **SD10)** n/a

Class 5

- Not meeting the requirements of Class 4.

Solar Radiation (RF-1):

- **The 'local horizon' is the natural relief (hill and mountain tops and their associated tree lines) surrounding the location of the sensor. Shade from this, if general to the geographic area, is not considered.**
- **Sun angles are measured up from the local horizon and apply for any day of the year.**

Class 1

- **SR1)** No shade is projected onto the sensor when the sun is at an angular height of over **3 degrees** above the local horizon.

Class 2

- **SR1)** No shade is projected onto the sensor when the sun is at an angular height of over **5 degrees** above the local horizon.

Class 3

- **SR1)** No shade is projected onto the sensor when the sun is at an angular height of over **7 degrees** above the local horizon.

Class 4

- **SR1)** Shade may be projected onto the sensor for **up to 30%** of the daytime when the sun is above the local horizon on any day of the year.

Class 5

- **SR1)** Shade projected onto the sensor for **more than 30%** of the daytime when the sun is above the local horizon on any day of the year.

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