



ASOS

Automated Surface Observing System

A little background

Back in the 1980s, the National Weather Service (NWS), in cooperation with the Federal Aviation Administration and the Department of Defense, decided to make some major changes in the way surface weather observations would be made in the future. These observations were to be automated, produced by sensors that would do much of the work previously done by human weather observers. These systems are called the Automated Surface Observing System, or ASOS for short. ASOS sensors sample the sky for cloud coverage; take temperature, dewpoint, and wind readings; determine visibility; and even detect the present weather—if it is raining or snowing. ASOS is installed at more than 900 airports across the United States, where they make observations intended for use by pilots and airport-based weather personnel.

Pilots receive ASOS reports during preflight briefings in the form of METARs and SPECIs, in flight during contacts with Flight Watch, and when approaching airports in the form of automated terminal information service (ATIS) broadcasts or automated messages on dedicated ground-to-air ASOS radio frequencies.

Designing automated equipment to exactly match human observations is impossible, but after years of development, ASOS correlates quite closely with human observations most of the time.

A change in the observations

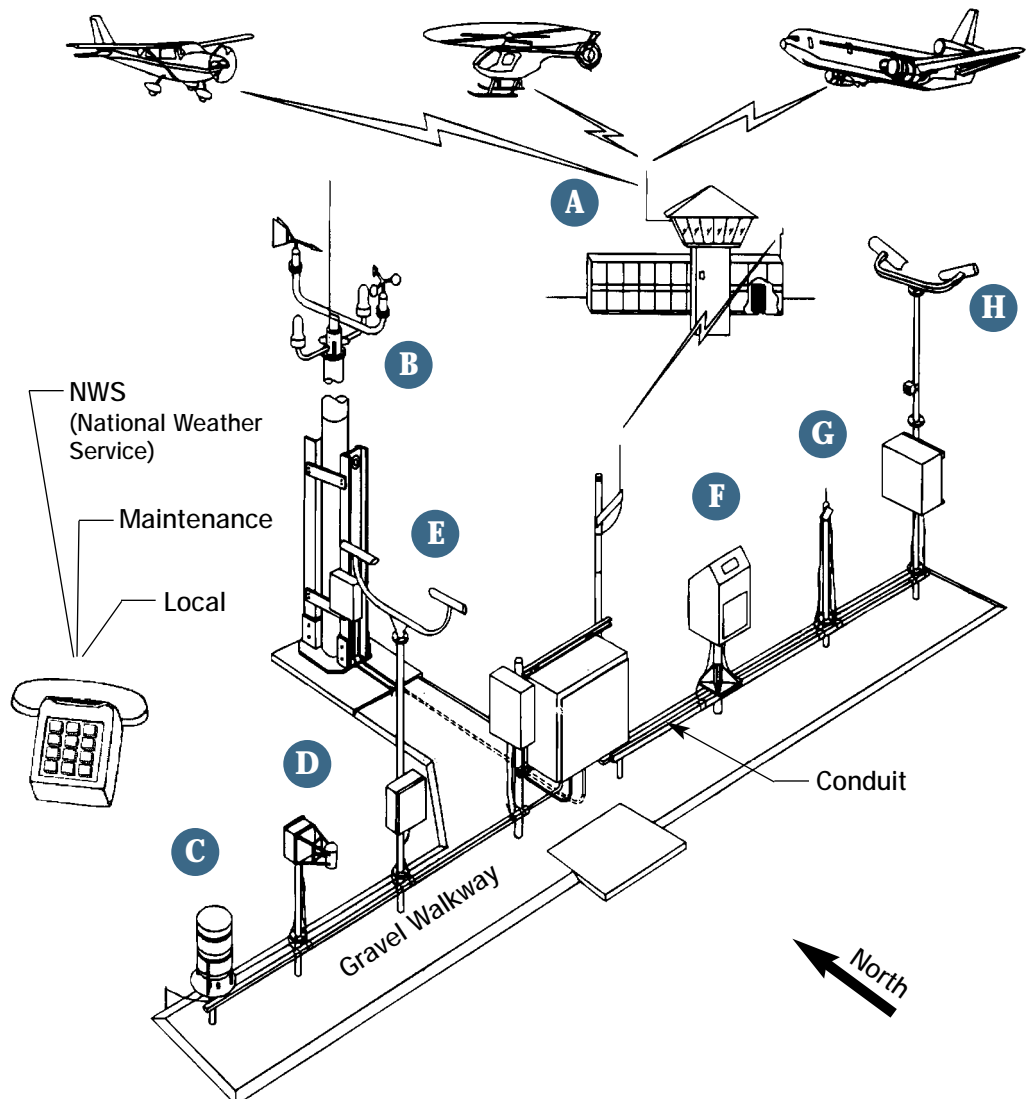
It's only human to be suspicious of new technology, especially if it replaces a familiar and trusted service. ASOS combines the new and the familiar. Human observations are made from horizon to horizon. ASOS is designed to represent conditions in a 5-mile radius of the installation. The major change in observations has to do with computer processing of all ASOS data and the automation of sky condition, visibility, and present weather—observations that were made by humans in the past. Human observers evaluate these elements based partly on their perception. Everyone sees differently and so it's not unusual for reports of identical conditions to vary significantly from observer to observer. Designing automated equipment to exactly match human observations is impossible, but after years of development, ASOS correlates quite closely with human observations most of the time.

Automated systems provide consistency in observations. Under identical conditions, all ASOSs will report the same weather so pilots can expect to see the same information from the same data at any location. ASOS is superior to human observation in many ways, but it can be quite different from what we have learned to expect. In order to fly safely, pilots need to learn as much as they can about weather, and that includes an understanding of automated weather systems.

In the following pages, we'll provide a brief explanation of ASOS, its capabilities, and limitations. At the end of this process, you'll know how to include ASOS observations in your vital pilot-in-command responsibility of assessing aviation weather.

ASOS Features

- A. FAA Ground-to-Air Radio
- B. Wind Tower (Tilting)
- C. Rain Sensor
- D. Temp./Dewpoint Sensor
- E. Precipitation Identification Sensor
- F. Ceilometer
- G. Freezing Rain Sensor
- H. Visibility Sensor



ASOS components

ASOS's sensors each detect a different weather element and issue updated data to a central processing computer at the airport. Algorithms—defined computer processing steps—are used to process observation data and in self-test routines that keep track of the availability and accuracy of ASOS sensors. Whenever a sensor fails to meet internal data quality checks or fails altogether, it is taken off-line, and a report is automatically forwarded to a national ASOS Operations and Monitoring Center (AOMC). This full-time facility will assign a technician to correct the problem. How long any ASOS element is unavailable is determined by the nature of the problem and the air traffic at the facility. Higher traffic installations will receive repair priority.

ASOS sensors include the following:

- **Wind speed and direction.** This consists of the familiar wind vane and rotating anemometer cups. These sensors are very accurate, with wind speed reported to an accuracy of within 2 knots or 5 percent of wind speed, whichever is greater, and wind direction reported to tolerances of no more than 5 degrees of error. When ASOS reports the wind conditions, it biases its observations toward those reported in the past 10 minutes.



ASOS also looks for gusts. ASOS continually looks for wind values that exceed the current average speed by 5 knots and holds those values for 10 minutes (the time required to evaluate wind gusts). If, at the end of the 10-minute period, the value exceeds the current average wind by 3 knots, a gust is reported.

All wind sensors can freeze in certain snow/icing conditions. Frozen sensors will report zero wind speed and possibly a false wind direction. An ultrasonic wind sensor is currently available and can be added to the existing ASOS wind tower with minor modification. This sensor has heated probes to prevent freeze-ups and contains no moving parts. It detects precise wind speed and direction and is the same



sensor that will be used in the low-level wind shear alert system (LLWAS).

Because ASOS makes many more wind observations than a human observer, pilots will benefit from more timely wind information than in the past.

- **A laser beam ceilometer (LBC).** This is used to measure cloud height, vertical visibility, and sky coverage. A laser beam pointed vertically reflects off any cloud bases directly overhead, and the time for the beam to return to the sensor is measured. This is converted into a cloud base measurement, reported to tolerances of 100 feet. The sampling rate is once every 30 seconds, but a single sample is insufficient to create a report; 30 minutes of data are required to create a new observation every minute. The observation is weighted toward the most recent 10 minutes of data. This enables ASOS to report rapidly changing sky conditions.



The ceilometer is able to report no more than three different cloud height levels at a time. Current ceilometers measure up to 12,000 feet agl, so any clouds above that height won't be reported. A new generation of LBCs will take readings as high as 25,000 feet agl.

LBCs are very accurate, but the biggest drawback is their narrow beams. If a single cloud “parks” over the LBC for long enough, a false cloud coverage report could be generated. Moreover, LBCs cannot detect the presence of any nearby hazardous cloud conditions such as cumulonimbus, funnel clouds, rotor clouds, or virga. Similarly, they cannot describe the nature of the clouds being sensed. To an LBC, a cloud base is a cloud base, whether it's caused by fair-weather cumulus or a Level 6 thunderstorm.

Under certain conditions, LBCs may report a lower than actual cloud height or ceiling. This is most likely to occur when obscurations or precipitation is present. When the beam bounces back from the falling precipitation,

such as snow, sleet, fog, or rain, instead of cloud bases, ASOS can report cloud bases lower than they really are.

When visibility measurements drop to 1 mile or lower and, at the same time, the ceilometer detects a smearing of the beam returns (presumably by moisture) and reports cloud heights of 2,000 feet agl or less, another formula kicks in that may cause ASOS to issue **vertical visibility** reports. Because the new METAR format does not acknowledge the term “obscurations,” vertical visibility—abbreviated “VV”—is now used. ASOS reports vertical visibilities in 100-foot increments but does not identify the obscuring phenomena that reduce vertical visibility.

The ceilometer lens can sometimes be affected by dirt, dust, spider webs, bird droppings, and other kinds of contamination. Then the ceilometer report on an ASOS broadcast will be “sky condition missing.”

Finally, the ASOS algorithm or formula used for the ceilometer is predicated upon various assumptions about the natural motions of the atmosphere. The 30-minute sample reflects the NWS’s belief that accurate, time-averaged LBC readings—over the long run—are as representative of true sky conditions as the large spatial samplings made hourly by human weather observers.

Small numbers of cloud-base detections generate reports of cloud covers labeled “few” or “scattered.” “Broken” and “overcast” skies are reported if more numerous cloud base readings are made. ASOS sky-cover reports are weighted to favor an average of the past 10 minutes’ worth of observations. In general, this has resulted in accurate observations, but *in frontal or convective weather, when cloud layers and breaks in clouds move rapidly and cloud heights quickly rise and fall, ASOS may differ from human observations until conditions stabilize.*

How responsive is the ASOS ceilometer to rapidly changing conditions? If an overcast suddenly moves over an LBC, a report of FEW

clouds will be generated in two minutes and BKN will appear in 10 minutes. At airports near bodies of water or where unique weather frequently impacts airport operations, a secondary sensor may be installed to provide an early alert to changing conditions.

An improved laser beam ceilometer capable of detecting cloud cover to 25,000 feet is currently in testing at Sterling, VA, by the NWS and at Charleston, SC, by the U.S. Navy. These sensors would be angled units that could provide wide area coverage and/or slant visual range.



- **Visibility.** ASOS determines visibility with a scatter meter, a device that measures the amount of radiation scattered from a beam of light by particles in the air such as fog, rain, snow, or other airborne particulates. This yields a measurement of air clarity. The measurement is processed through algorithms designed to correlate the readings with familiar visibility values. ASOS visibility is reported in varying increments from less than 1/2 to 1 statute mile. ASOS reports the visibility to 10 miles.

The visibility algorithms are designed to respond quickly to decreases in visibility and more slowly to increases. For example, if a sudden fog bank moves over an airfield dropping the visibility to near zero, ASOS will drop below VFR (3 miles) to 2 miles in one minute, 1 mile in two minutes, and to less than 1/2 mile in three minutes. If conditions rapidly improve to above 3 miles, ASOS will go from less than 1/2 mile to 2 miles in nine minutes and over 3 miles in 10 minutes.

Tests have shown that the ASOS scatter meter’s accuracy correlates well with the transmissometers used to report runway visual ranges (RVRs), agreeing 80 percent of the time to within plus or minus 1/2 mile, with RVR readings up to 1 1/2 miles. This is good news for pilots who rely on RVR readings for approaches in instrument conditions.

Under certain conditions, the scatter meter can give erroneous readings, though. A localized

patch of ground fog around the sensor can cause ASOS to report low visibility when in fact the sky is clear, or there could be situations where a low layer of ground fog might exist, but visibility above the scatter meter is unlimited. For this reason, great care is taken to site ASOS in a representative location on the airport.

Bright sunlight can also affect the representativeness of visibility reports in certain reduced-visibility situations. One NWS publication says that if it's bright enough to wear sunglasses and there's haze or thin fog with a clear sky above, halve the ASOS visibility report. In dense fog, ASOS reports correlate well with human observations.

Multiple sensors are being used in some areas with varying weather conditions—such as on the coast—to increase the accuracy of observations. For example, where fog typically affects an airport that is located at a coastal site, an additional sensor group would enable comparison of the weather on one side of the airport with weather on the other side to determine if fog was rolling in. The difference would then be reported in the remarks section of the weather report.

- **Barometric pressure/altimeter setting.** ASOS contains either two or three pressure transducers for providing barometric pressure. At all sites, at least two sensors must agree within at least 0.04 inch of mercury to report pressure. The lowest pressure reported by all the working sensors is transmitted. ASOS reports ambient pressure, altimeter, density altitude, station pressure, pressure altitude, and pressure falling or rising rapidly. A new pressure value is computed every minute.
- **Temperature.** Temperature readings are made by a thermistor, a type of electronic thermometer. Readings are generally very accurate, and the update cycle is once per minute.
- **Dew point.** Dewpoint measurements are made by a hygrothermometer. A fan draws ambient air into its housing and over a mirror electronically cooled to a lower than ambient

temperature. The cooling process continues until the dewpoint temperature is reached, at which time a layer of dew forms on the mirror. A laser beam and detector are used to detect dew formation. At that time, the mirror temperature is read and recorded as the dewpoint temperature.

Contamination of the mirror by dirt, dust, sand, corrosion, spider webs, and other foreign material will cause erroneous readings. If conditions are right, the sensor may also “ice up” when dew points are around freezing and the cooling and heating of the mirror cannot completely remove the ice from the mirror. Newer, capacitance-type hygrothermometers are now being tested and may be phased into ASOS sites in the future.

- **Precipitation identifier.** Also known as a light-emitting-diode weather identifier, or LEDWI, this device measures the passage of particles through a sensor beam. Much of this instrument's logic is tied into calculations relating to fall velocity patterns. Snow falls slowly and makes one type of pattern. Rain falls at a faster rate, creating another signature.



The LEDWI was designed only to report the occurrence of rain or snow at precipitation fall rates of .01 inch per hour or greater. *Light rain, light snow, and blowing snow are frequently unreported because their fall rates are usually below the threshold*—although blowing snow has been reported as rain or snow. Pilots should suspect snow or freezing rain when precipitation is reported and the temperature is at or near freezing.

What happens when other phenomena pass through the beam? Sleet may be reported as rain, hail may be reported as rain, and blowing snow may be reported as snow or rain, depending on the wind speed and flake size. Insects or even spider webs bobbing in the wind can sometimes trigger a light rain report. The development of new algorithms should allow further refinement of the reported elements.

The algorithms for reporting blowing snow and ice pellets have been integrated into an ASOS software modification that is currently being installed in all of the commissioned ASOSs. An enhanced LEDWI sensor underwent testing in winter, 1998. Modification to the existing LEDWI sensor includes an acoustic channel to detect ice pellets and a reduced aperture for infrared signals that will allow detection of drizzle size droplets. Further development of this sensor is expected to enable the reporting of hail. Additional software modification will relate the LEDWI and freezing rain sensors to determine freezing drizzle. This enhanced sensor is expected to complete testing by 2000. It is anticipated that the NWS will implement this modification by 2005.



- **Freezing rain.** ASOS detects freezing rain by means of a small vibrating probe. Nearly identical to the ice detectors found on many newer, larger general aviation and airline airplanes, this probe measures a change in its resonant frequency when an additional mass adheres to it.

The freezing rain sensor updates its information at one-minute intervals. After the probe has accumulated one-tenth inch of ice, a signal is sent that heats the probe and melts the ice. Then the probe is ready to sound the alarm once again, should icing conditions persist or recur.

Once ASOS's freezing rain probe freezes up, it continues to report freezing rain until the layer of ice melts. The accuracy of subsequent readings depends on the rate of the probe's cooling. Once the probe's temperature drops to ambient, a new sensing cycle begins.

- **Lightning.** Lightning detection technology is being added to ASOS. There are currently 24 airports that have "fourth generation" Single Point Lightning Sensors installed, tested and certified by the National Weather Service. These are now an integral part of the ASOS reporting process. These Single Point Sensors utilize



electric and magnetic field detection along with an optical channel. This type of sensor is capable of detecting cloud-to-cloud and intra-cloud lightning, which comprise half of all lightning activity. At the present time, the Single Point Sensors report lightning strikes detected within 5-10 miles. Modification is expected late 1999 to add azimuth reporting. Until it is modified to report azimuth of the lightning strike, it will not report any strikes beyond 10 miles.

A second source of lightning detection for ASOS is currently being tested. Automatic Lightning Detection and Reporting System (ALDARS) is anticipated to be employed at the FAA in the near future. This system gathers data from a commercially available lightning detection network of more than 140 sites around the country known as the National Lightning Data Network (NLDN). The ASOS sites currently need computer software upgrades to enable collection of the NLDN. The FAA has indicated that the first ASOS unit to be modified to accept ALDARS will be sometime in 1999.

ASOS's strengths

ASOS sensors—when all is well—are extremely precise, and the system's deficiencies are well known and being addressed. At the largest, busiest airports—and some of the less congested ones—human observers augment ASOS observations. Augmentation consists of oversight of ASOS general operation, as well as editing of any unrepresentative observations.

ASOS works 24 hours a day, seven days a week (it does, however, call in sick once in a while). ASOS also provides a more constant stream of data at more locations than human observers. This benefits the forecast and research communities and promotes more accurate forecasts of all kinds—not just those applying to aviation weather. ASOS sensors also perform well at night, a difficult time for human observers to make accurate observations.

Spreading the word

Each ASOS is equipped to transmit weather information via voice or computer through telephone or on VHF radio frequencies. The official hourly and special weather reports for the field are automatically transmitted to NWS and FAA communication systems. These are the ASOS METARs and SPECIs pilots receive from flight service or DUATS. Pilots can also dial the ASOS phone number to hear a current weather observation, or they can tune the ASOS radio frequency to hear the latest ASOS weather.

FAA towers or other facilities on the field can have a direct computer line from ASOS to a Visual Display Unit (VDU). The VDU will display current weather and the most recent hourly METAR or SPECI. That's the official weather for the field, and that's what will be used to record the ATIS. Controllers or flight service personnel use a combination of ASOS and other sensors when reporting weather conditions to pilots.

If the weather is changing but not changing enough to force a SPECI report, the ATIS information you hear, although derived from ASOS, could be up to an hour old, and that can cause pilots to doubt ASOS's veracity. At fields with no ATIS or FAA facility, you'll hear the up-to-the-minute ASOS report.



Human observation

Weather observers make their observations according to rules and methods, some of which were established long ago. Observations are ordinarily made every hour, with the observation process beginning at 45 to 50 minutes after the hour. Ten minutes is the usual time needed to make the weather observations, record them, and pass them along to the NWS for distribution throughout the rest of the weather-reporting network—including the FAA. Special observations—SPECIs—are made and reported whenever certain weather conditions (e.g., an abrupt drop in visibility or ceiling) change rapidly enough to warrant special mention.

Observers use their trained eyes, ears, and other senses to ascertain the prevailing weather. They scan the sky and make a judgment about the nature of the sky cover: Is it scattered, broken, or overcast? They look for any menacing clouds, such as a thunderstorm's cumulonimbus or rotor clouds. They listen for thunder to confirm a thunderstorm's presence. They look at objects situated at a known distance from the observation site to determine visibility. They look at the sky and ground to determine the type and nature of any precipitation. In short, they and ASOS follow the weather observer's bible—*Federal Meteorological Handbook Number 1*, or FMH-1—to make their reports to government-issue standards.



Human vs. ASOS observations

Unlike ASOS's time-based sampling, human observers make judgments on a larger, spatial scale that take in more variables and are open to the subjective inclinations of each individual observer. Still, humans do share common experiences as they are trained as observers, then refine their skills by working as apprentices with more-experienced observers. However, because each human observation is a judgment call, an element of error can creep in. There are limitations to human observation—just as there are limitations to ASOS. Studies have shown that visibility disagreements between human observers occur as much as 40 percent of the time; with sky cover, the disagreement is somewhat less, at 15 percent. Often, there's never complete agreement between human observers.

What ASOS doesn't measure

ASOS makes pinpoint weather observations and uses complicated mathematical algorithms to extrapolate conditions around the ASOS location. The ceilometer only "sees" the sky directly above its beam. If the sky's only cloud is parked above the LBC for 10 minutes or more, it will likely report a broken or overcast sky. Because it can't see the sky all around it, the ceilometer cannot make judgments of sky cover.

The scatter meter measures a parcel of air about .75 cubic feet in volume, and it senses the diffusion of the light striking the particulates in that parcel. It cannot make judgments about prevailing, sector, tower, or flight visibility, and it can't make RVR measurements.

At this writing, ASOS will not report blowing dust, blowing sand, tornadoes, funnel clouds, hail, ice crystals, drizzle, freezing drizzle, thunderstorms, smoke, amount of snowfall, snow depth, hourly snow increase, or clouds above 12,000 feet. Many of these capabilities may be added over the next several years as the system matures.

What ASOS does measure

ASOS does directly measure wind speed and direction, barometric pressure, temperature, and

dew point. In sites equipped for lightning detection, ASOS will tell if lightning is nearby but will not issue bearing and distance information.

What veteran observers say

Experienced weather observers familiar with ASOS say that it can, depending on the nature of the weather phenomenon, issue unrepresentative reports when IFR and low IFR conditions prevail. Whenever this happens, observers at ASOS sites must monitor the ASOS's Operator Interface Device (OID), compare the ASOS report there with their own observation, edit unrepresentative readings, and then enter the corrections on the OID using a keyboard.

When weather conditions are changing rapidly, as is so often the case with frontal or convective weather, the need to augment/correct ASOS readings rises.

Pilots and weather observers agree that ASOS is most accurate when stable, non-frontal weather prevails. The more stable the cloud cover, the better. When it comes to visibility measurements, isolated fog conditions cause the most problems. Fog that extends above the visibility sensor can yield low visibility reports, while fog confined to the runway will go undetected by ASOS.

Experienced weather observers who have spent months and years augmenting ASOS observations say disagreement is most likely when moisture-laden fronts move quickly by an airport. They say ASOS can report confusing up-and-down cloud heights as layers of clouds at different altitudes pass overhead and the ceilometer reads the height of each passing cloud.

One reason for this disagreement may simply be ASOS's ability to make many more observations than human observers. Observers can make no more than one observation each 10 minutes or a maximum of six observations in one hour. In that hour, ASOS will make up to 12 observations. When the weather is changing, ASOS will report those changes more frequently than a human observer would, and that can be confusing for pilots who are used to hearing only one or two observations per hour. *The trick is for pilots to*

monitor ASOS prior to arrival at the airport. That way, you can get a general picture of what the weather is doing, and if it's changing rapidly, you'll likely see some trends, as well.

Observers also say that the precipitation reports can be misleading when rain or snowshowers begin. If showers are very local, it can be raining at the runway and dry at the ASOS. Convective weather poses similar difficulties. Couple this with the fact that ASOS can't issue tactical thunderstorm information, and it becomes clear that *pilots must supplement ASOS observations when thunderstorms are in the picture.* Because ATC radar is not designed to detect weather, controllers can't be much help in finding ways between closely packed thunderstorms. ATC can tell you, workload permitting, if there is significant precipitation near the airport, how far away it is, and what direction it's moving. They can also forward relevant pilot reports.

Levels of ASOS service

The FAA, NWS, and the aviation industry have established four levels of ASOS service: A, B, C, and D.

Service Level D is provided by stand-alone ASOS units located at more than 450 smaller, usually nontowered airports with lower traffic counts. There is no human augmentation or backup of missing ASOS reports at Level D sites. Only the basic weather elements of wind, visibility, precipitation, obscurations, sky conditions, temperature, dewpoint temperature, altimeter, and freezing rain are reported at these sites.



Service Level C is located at approximately 270 full- and part-time towered airports. These ASOSs will offer basic Level D service, but when human observers are available (i.e., when the tower is open), they will provide additional weather reports as part of the ASOS transmission. These include

- Thunderstorms,
- Tornadoes,
- Hail,
- Virga,
- Volcanic ash, and
- Tower visibility.

In the case of part-time towers, ASOS augmentation stops when the controllers go home, then the airport reverts to Level D service.

Service Level B ASOSs are installed at approximately 60 towered airports where contract weather observers are available 24 hours a day to provide augmentation and backup. Tower personnel will provide tower visibility. Level B sites have all the features of levels C and D, plus the following additional observer-provided augmentations:

- RVR (runway visual range),
- Freezing drizzle versus freezing rain,
- Ice pellets,
- Snow depth and "snow increasing rapidly" remarks,
- Thunderstorm and lightning location remarks, and
- Any observed significant weather not at the station.

Service Level A ASOSs are installed at 81 major airports, some of them in or near Class B airspace. In addition to Level B service, these installations have human observers who may report the following phenomena:

- 10-minute RVR reports, or if no RVR is available, additional visibility increments of 1/8 mile, 1/16 mile, and 0 miles,
- Sector visibility,
- Variable sky conditions,
- Cloud layers above 12,000 feet and cloud types,
- Widespread dust, sand, and other obscurations; and
- Volcanic eruptions.

Ranking of ASOS service levels

The decision regarding which airports receive which level of service is based on a ranking process. The airports chosen to receive higher service levels are those that routinely experience significant weather and higher traffic counts, are farther from suitable alternate airports, and have certain airport characteristics. Factors such as a busy tower or that an airport is a hub or that it is located in mountainous terrain, for example, can bias an airport toward a higher service level.

Scores are assigned to each of these variables, and composite scores are developed. Those that come out higher on the list receive higher service levels. For this reason, some airports with service levels A or B might not always be large airports in busy terminal areas. Instead, they might be relatively remote but known for their high number of days with thunderstorms or freezing precipitation.

ASOS is not AWOS

The acronyms may sound the same, and they might perform some of the same functions, but AWOS (Automated Weather Observation System) is not the same as ASOS. ASOS is a more sophisticated observing system with a higher level of computer processing and more quality control checks. ASOS is totally federally funded. AWOS is primarily funded at the state or municipal level, although there are a handful of federally funded AWOSs.

AWOS comes in four levels of service:

- **AWOS-A** only reports altimeter setting.
- **AWOS-1** usually reports altimeter, wind data, temperature, dew point, and density altitude.
- **AWOS-2** adds visibility reporting to the AWOS-1 reporting features.
- **AWOS-3** reports everything AWOS-2 does, plus cloud and ceiling data.

How to use ASOS

Pilots today face more challenges in obtaining and interpreting weather information than ever before. The widespread availability and use of aviation weather data from private vendors means that mountains of reports and images are there for the asking—all for just a few keystrokes on a computer keyboard. Similarly, the FAA-endorsed Direct User Access Terminal System (DUATS) lets pilots download reams of weather information, as well as file flight plans and perform other route-planning chores via a number of computer programs.

This is a double-edged sword. We have more information, but we also have the responsibility and need to interpret more raw data. In short, pilots have to train themselves to become more like meteorologists in interpreting weather reports and forecasts. Although the flight service station (FSS) network, with its telephone briefers, will probably always be there to perform some interpretive tasks for pilots, it's no secret that the number of FSSs has been cut back. Consequently, it can be difficult to reach FSS briefers in a timely manner when the weather is changeable and more pilots want longer telephone briefings.



ASOS strategies and considerations

Obtain a complete preflight weather briefing prior to departure. This goes without saying but is particularly important when planning a trip to an airport with ASOS Service levels C and D. For example, if you are concerned about elements such as freezing drizzle, you must realize that this element won't be reported at D and some C level sites. By keeping close tabs on the forecast weather, you can compare ASOS reports as you near the destination airport and tune in the ASOS frequency. If you don't know whether the ASOS at your destination or alternate is augmented by human observers, then it's certainly worth finding out during the preflight briefing.

A good synoptic weather brief is essential. Know the big picture before takeoff. Then compare this information with enroute weather reports to verify accuracy of both forecasts and METARs.

Look for an AUTO prefix to a METAR. This means that the observation is fully automated and has no augmentation by either weather observers or ATC personnel. Level D sites will always show the AUTO prefix. When part-time towers are staffed at Level C sites, the AUTO prefix is removed when a controller signs on for duty.

Is IFR or MVFR weather forecast? If so, be wary of unaugmented ASOS reports, and be prepared—as always—for a missed approach and trip to an alternate.

Contact Flight Watch (122.0 MHz) and obtain pireps en route. These are excellent tactics for updating conditions all along the route of flight. By comparing near-real-time pilot and briefer reports with forecast weather and ASOS reports, you'll be better able to judge whether a forecast was botched, or if ASOS reports might be misleading. Pireps may also fill in those missing areas of information along a route where weather information is sparse.

Don't depend too much on pireps, though. Pireps are most useful when weather is bad,

and that's just the time when pilots and controllers are at their busiest. Many, if not most, pilots flying IFR at the lower altitudes are flying without copilots. You may be too busy to forward a pirep when it's most needed, but you should try—as long as safety will permit—to do so.

Check the latest METARs for missing or unavailable elements from ASOS sites.

Especially at D level sites where observers are not available to back up the ASOS, it's wise to determine if all weather elements needed are available. Contact Flight Watch for the latest observation and listen for missing information. If a sensor is out of service, information will be omitted from the observation. For some sensors, you'll hear or see remarks such as:

- RVRNO The RVR sensor is not operating.
- PWINO Present weather sensor is not operating.
- FZRANO The freezing rain sensor is not operating.
- TSNO Thunderstorm information is not available (sensor may be broken or observer unavailable)
- VISNO Second site visibility sensor is not operating. (VISNO RY12 indicates the runway location of the failed sensor).
- CHINO Second site cloud height indicator is not operating. (CHINO RY24L indicates the runway location of the failed sensor).

The missing sensor may be just the one you need to provide the information for a safe landing. You wouldn't want to fly into a site with missing sky conditions if you expect low ceilings and precipitation.

Know what observation you're using. All the ASOS observations you get through DUATS, flight service, ATC, private vendors, or from Flight Watch are the latest "transmitted" METAR or SPECI. METARs are usually transmitted about 5 minutes *before* the hour. A SPECI is transmitted every time a major change occurs in weather conditions that could impact the level of service at an airport.

The *only* time you'll receive the one-minute observation, updated minute-by-minute, is when you're accessing Service D sites or at Service Level C sites when the tower is closed and no observer is available. At towered sites, the latest observation will be the last transmitted METAR or SPECI, not the latest one-minute observation. Therefore, it's important to note the time of the observation. Even in the era of automated weather, you may still be using data nearly an hour old.

Contact ATC radar facilities for thunderstorm information. Although ATC radar is intended for detecting aircraft, controllers, especially in approach control facilities, can see some rain. They are also talking to pilots of radar-equipped airplanes who may be deviating around convective weather. Air traffic controllers can, work load permitting, be very helpful in weather-avoidance tactics. They are understandably reluctant to assist with weather penetration. That is best left for fully equipped airplanes flown by proficient instrument pilots.

Tune in early and often. Punch in the ASOS frequency as far from the airport as the signal's strength permits, then listen for several minutes. This is especially important when MVFR or IFR conditions are expected or forecast. Update the ASOS report at least twice en route and make notes on the weather. This way, you can compare observations and develop valuable trend information.

Tune other ASOS frequencies in the area. Because ASOS is available in many places where there was previously no weather information, there will usually be one or two in the neighborhood. Comparing their observations with those of the ASOS at your destination will give you a more complete weather picture. You'll also be able to spot any inconsistencies in the observations that may indicate a sensor problem.

Count on accurate wind, altimeter, and temperature information. The instruments providing this information have proven very

accurate and reliable. At Level D airports with instrument approaches, this information alone may let you descend to lower minimums—and might make the difference between successfully completing an approach or having to perform a missed approach. The wind speed and direction information lets you make a logical runway choice—always a critical decision, but even more so when flying a circling approach in instrument weather conditions. The value of this information can be, well, invaluable.

Ask ATC if missed approaches are being performed. If the ASOS reports above minimums but pilots are missing approaches, it's a fair bet that ceilings and visibilities are lower than the ASOS readings. Conversely, if ASOS reports below minimums but pilots are landing without difficulty, the observation may be conservative.

Look for SPECI observations. A SPECI observation is an unscheduled METAR, issued when weather worsens or improves beyond various thresholds in specified periods of time. ASOS tends to transmit more SPECI observations than human observers and often leads human observers in reporting critical conditions—especially at night.

Finally, learn METARs and TAFs if you haven't already. ASOS broadcasts are made in the METAR format, with wind direction first, followed by visibility, present weather type, sky condition, temperature/dew point, and altimeter.

Report anomalies. Consistent unrepresentative ASOS reports can indicate siting problems and should be reported to flight service or ATC. Self-testing equipment is supposed to report hardware problems automatically, but it doesn't hurt to report these, as well. The ASOS Operations and Monitoring Center (AOMC), which monitors outages and component failures, can be reached at 800/242-8194, 24 hours a day.

ASOS Upgrades

Upgrade	Added Capability	Benefits
<i>Lightning sensors</i>	Augments cloud-to-ground strikes with cloud-to-cloud and in-cloud lightning reports.	Reduces workload of controllers at Level C airports; reduces need for contract weather observers (CWOs) at Level B airports.
<i>Replace dew cell sensor</i>	Provides direct measurement of relative humidity that can be converted to dew point reports.	Replaces sensor that is responsible for a large percentage of maintenance calls.
<i>Ultrasonic wind sensor</i>	Provides ice-free wind speed/direction sensor with no moving parts.	Eliminates freeze-ups and preventive maintenance calls.
<i>Additional ceiling and visibility sensors</i>	Improves representativeness of ceiling/visibility observations.	Reduces workload of controllers at Level C airports and reduces need for CWOs at Level B airports.
<i>Enhanced LEDWI</i>	Provides reports of hail, drizzle, and ice pellets.	Enhances safety; reduces workload of controllers at Level C airports and reduces need for CWOs at Level B airports.
<i>25,000-foot ceilometer</i>	Allows reports of cloud cover to 25,000 feet.	Improves aviation community acceptance. Reduces work load of controllers at Level C sites and reduces need for CWOs at Level B airports.



KEY TO ASOS (Automated Surface Observing System) WEATHER OBSERVATIONS

TYPE OF REPORT	STATION IDENTIFIER	DATE AND TIME OF REPORT	REPORT MODIFIER	WIND DIRECTION AND SPEED	VISIBILITY	RUNWAY VISUAL RANGE	WEATHER PHENOMENA	SKY CONDITION	TEMPERATURE /DEW POINT	ALTIMETER SETTING	REMARKS IDENTIFIER
METAR	KHTM	231351Z	AUTO	34009G14KT	3/4SM	R32/5000FT	- RA FG	OVC005	23/22	A2992	RMK A02 TSN0 TWR VIS 1SLP132

TYPE OF REPORT:

METAR: Hourly (scheduled) report.
SPECI: Special (unscheduled) report.

STATION IDENTIFIER:

ICAO (International Civil Aviation Organization) location identifier (using four alphabetic characters).

DATE AND TIME OF REPORT:

All dates and times in Coordinated Universal Time (UTC) using a 24-hour clock; two-digit date and four-digit time; letter Z appended to indicate UTC.

REPORT MODIFIER:

AUTO: Fully automated report. No human intervention.
COR: Correction to a previously disseminated report.

WIND DIRECTION AND SPEED:

Wind direction in tens of degrees from true north (three digits); Speed in whole knots (two digits); Gusts (G) followed by maximum observed speed; followed by KT to indicate knots; 0000KT for calm. Variable wind reported when direction varies by 60 degrees or more when the average wind speed is greater than 6 knots. Variable winds less than or equal to 6 knots are shown without degrees: VRB05KT.
Example: 21016G24KT 180V240 = Winds from 210 degrees at 16 knots with gusts to 24 knots. Wind direction varies from 180 to 240 degrees.

Note: Wind direction is reported from magnetic north in ground-to-air broadcast and telephone dial-in messages.

VISIBILITY:

Visibility in statute miles and fractions (space between whole miles and fractions); always followed by SM to indicate statute miles; values less than 1/4 reported as M1/4SM. Maximum reported visibility is 10SM.

RUNWAY VISUAL RANGE (RVR):

Identified runway ten-minute RVR value (in hundreds of feet) is reported if visibility one mile or less or RVR 6000 feet or less, followed by FT to indicate feet. Value prefixed with M or P to indicate value is lower or higher than reportable RVR value.
Examples: P6000FT = greater than 6000 feet
M1000FT = less than 1000 feet.

WEATHER PHENOMENA:

ASOS reports:
Rain (RA): liquid precipitation that does not freeze
Snow (SN): frozen precipitation other than hail
Precipitation of unknown type (UP)
Precipitation intensity indicated by a prefix:
light (-), moderate (no sign), heavy (+)
Fog (FG) Mist (BR) Haze (HZ)
Freezing Rain (FZRA) Squall (SQ)
Freezing fog (FRFG): temperature below 0=C
When **augmented** by observer ASOS may report:
Funnel Cloud/Tornado/Waterspout (FC) Thunderstorm (TS) VA (volcanic ash)
Hail (GR) Small hail (GS): hail <1/4 inch
Note: Additional weather phenomena may be added using plain language or abbreviations.

SKY CONDITION:

ASOS will not report clouds above 12,000 feet AGL unless augmented (added) by a weather observer.
Cloud amount (in eighths of coverage) and height:
CLR no clouds detected below 12,000 feet
FEW few: <1/8 - 2/8 sky coverage
SCT scattered: 3/8 - 4/8 sky coverage
BKN broken: 5/8 - 7/8 sky coverage
OVC overcast: 8/8 sky coverage
followed by 3-digit height in hundreds of feet. Indefinite sky condition is expressed as vertical visibility (VV), followed by 3-digit height in hundreds of feet.

TEMPERATURE/DEW POINT:

Each is reported in whole degrees Celsius using two digits. Values are separated by a slash (/). Sub-zero values are prefixed with an M (minus).
Example: 04/M02: Temperature + 4 degrees C
Dew Point - 2 degrees Celsius

ALTIMETER SETTING:

Altimeter setting always prefixed with A indicating inches of mercury - reported in hundredths of an inch and using four digits.
Example: A2992 = 29.92 inches
REMARKS IDENTIFIER: RMK

REMARKS: Additional information may be added to the weather observation. **Automated** remarks are generated by the system. **Augmented** remarks are added by a human observer.

Remarks may include (but are not limited to): TORNADO, FUNNEL CLOUD, WATERSPOUT: (Tornadoic Activity); AO1: (Automated station without precipitation sensor); AO2: (Automated station with precipitation sensor); PK WND: (Peak Wind); WSHFT: (Wind Shift); FROPA: (Frontal Passage); TWR VIS: (Tower visibility); SFC VIS: (Surface visibility); VIS [min V max]: (Variable visibility); VIS [location]: (Visibility at a second location); LTG [type] [location]: (Lightning); TSB [minutes] E [minutes]: (time past the hour Thunderstorm Began, Ended); RAB [minutes] E [minutes]: (time past the hour Rain Began, Ended); VIRGA: (Precipitation not reaching the ground); CIG [min V max]: (Variable ceiling); CIG [location]: (Ceiling height at second location); PRESRR: (pressure rising rapidly); PRESFR: (pressure falling rapidly); SLP: (Sea-level pressure).

SYSTEM STATUS:

Sensors not operating (NO) are indicated:
TSNO: Thunderstorm Information; RVRNO: Runway Visual Range; PWINO: Present Weather Identifier; SLPNO: Sea Level Pressure; PNO: Precipitation Amount; FZRANO: Freezing Rain
ASOS voice messages contain the basic weather observation and selected remarks such as Density Altitude and NOTAMs.

DECODED OBSERVATION:

Aviation Routine Weather Report for Hometown Municipal Airport. Weather observed on the 23rd day of the month at 1351 UTC (Z). Automatic observation (no human observer).
Wind 340 degrees (true) at 9 gusting to 14 knots. Visibility 3/4 statute mile. RVR for runway 32 is 5000 feet. Light rain. Fog. Ceiling 500 feet overcast. Temperature 23 degrees Celsius.
Dew point 22 degrees Celsius. Altimeter 29.92 inches.
Remarks: Automated station with precipitation sensor. Thun derstorm information not available. Tower visibility 1 statute mile. Sea level pressure is 1013.2 Hectopascals.

NOTE: Refer to the ASOS Guide for Pilots and the Aeronautical Information Manual for more information. Refer to the Air port/Facility Directory, aeronautical charts, and related publications for broadcast, telephone, and location data. Check Notices to Airmen for ASOS system status.



Safe Pilots. Safe Skies.

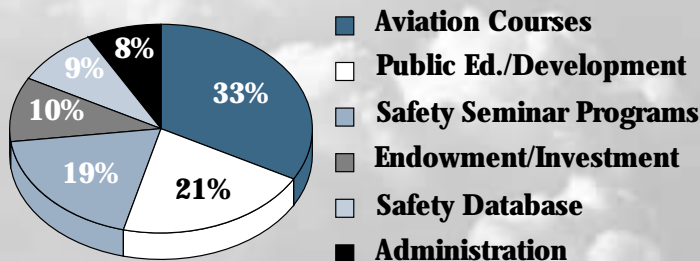
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