U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: AUTOMATED WEATHER OBSERVING SYSTEMS (AWOS) FOR NON-FEDERAL APPLICATIONS

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1. PURPOSE. This advisory circular (AC) contains the Federal Aviation Administration (FAA) standard for non-Federal Automated Weather Observing Systems. This circular is intended to provide interim guidance until issuance of Subpart K of Federal Aviation Regulation (FAR) Part 171, Non-Federal Navigation Facilities.

2. APPLICATION. The standards in this circular are applicable to all new AWOS facilities. Existing AWOS facilities have 3 years to come into compliance with the standards in this circular. AWOS's which are manufactured, installed, and maintained according to the criteria in this circular constitute a National Weather Service (NWS) approved source for weather information. AWOS's must meet the criteria contained in this circular to satisfy FAR requirements for aviation weather information, to receive a broadcast frequency assignment, to be connected to the national weather network, and to be eligible for funding under Federal grant programs.

3. REQUESTS FOR INFORMATION. Further information concerning AWOS standards and the FAA type approval process may be obtained from the Federal Aviation Administration, Attention: Program Engineering and Maintenance Service, APM-650, Washington, D.C. 20591, telephone (202) 426-8714.

4. METRIC UNITS. To promote an orderly transition to metric (SI) units, this AC includes both English and metric dimensions. The metric conversions may not be exact, and until there is an official changeover to the metric system, the English dimensions will govern.

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AUTOMATED WEATHER OBSERVING SYSTEMS (AWOS) FOR NON-FEDERAL APPLICATIONS

CHAPTER 1. INTRODUCTION

1. FUNCTIONAL DESCRIPTION. AWOS's automatically measure meterological parameters, reduce and analyze the data via computer, and broadcast weather reports which can be received on aircraft radios. Pilots may use weather information provided by the AWOS to fulfill the requirements of various FAR's. For example, at airports with instrument approaches, an AWOS weather report eliminates the remote altimeter penalty and thereby allows use of the published minimum descent altitude.

2. WEATHER SENSORS. The AWOS is a modular system utilizing a central processor which may receive input from several sensors. Three standard groups of sensors are defined below; however, the AWOS owner may select a different assortment of sensors based on operational requirements. Depending on the system design, additional sensors may be added to the AWOS at any time.

a. AWOS I. The AWOS I system contains sensors to measure altimeter setting, wind data (speed, direction, and gusts), temperature, dewpoint, and density altitude.

b. AWOS II. The AWOS II system contains the AWOS I sensors plus a visibility sensor.

c. AWOS III. The AWOS III system contains all the AWOS II sensors plus a cloud-height sensor.

d. Additional Sensors. A runway surface condition sensor has been developed and may be used with the AWOS. Additional sensors are being developed to detect precipitation occurrence, lightning, freezing rain, and the type of precipitation.

3. OUTPUT MEDIA FOR AWOS WEATHER INFORMATION. The output of the AWOS is reported by a computer-generated voice, which is transmitted to pilots over the voice output of a navigational aid or via a discrete very high frequency (VHF) transmitter. The transmission may be continuous or a 3-minute broadcast activated by air-to-ground radio control and triggered by three clicks of a pilot's microphone on the AWOS broadcast frequency. AWOS messages may be offered via other formats which the owner chooses to provide, including a telephone dial-up service. Another option allows the AWOS to be linked to the national weather network which makes the weather information available nationally for forecasting and flight planning purposes. To contribute to this network the AWOS must have an interface module which puts the data into a format which is compatible with

a centrally located AWOS Data Acquisition System (ADAS). The ADAS, located in each Air Route Traffic Control Center (ARTCC), collects and consolidates AWOS reports for input to the national network. The data communications protocol and other details of the interface between the AWOS and the ADAS are described in the AWOS/ADAS Interface Control Document. A copy of this document may be obtained from the office listed on the front of this AC. The ADAS also performs other services, such as archiving (storing) AWOS reports. For certain installations which meet a cost/benefit criteria, the FAA will provide a communications link between the AWOS and the ADAS. At other installations, the line will be provided by the owner.

CHAPTER 2. CERTIFICATION AND COMMISSIONING PROCESS

4. PROCESS OVERVIEW. To provide confidence in the quality of the meteorological data which the AWOS provides to users in the aviation community, the FAA has initiated a three-part certification and commissioning process. The manufacturer will provide the FAA with test data and documentation to demonstrate that the AWOS system meets the criteria of this circular (type approval). After the AWOS is installed on site, the FAA will conduct an inspection to verify that the system is installed and operating correctly, and the owner has the resources to maintain the system in proper operating condition (facility commissioning). This process must be successfully completed for the AWOS to receive FAA authorization to operate the system as part of the National Airspace System (NAS). Finally, there may be visits to the operating AWOS by the FAA and other technical representatives to verify that the system is still operating correctly (periodic revalidation).

5. SUBMITTALS BY MANUFACTURER FOR TYPE APPROVAL. The FAA will grant type approval to an AWOS design after review and approval of three submittals from the manufacturer. The first submittal consists of test procedures and data sheets which demonstrate that the proposed AWOS configuration meets the hardware and software criteria of this circular. The second submittal consists of warranty, training, and maintenance documents intended to support the AWOS system owner. The third submittal consists of a configuration control plan which identifies the components and options approved for use with the system. Requests for type approval should be sent to the AWOS Program Office at the address listed on the front of this circular. Product approval may be revoked if:

a. The equipment has an unacceptable failure rate.

b. Changes are made in the equipment without FAA approval.

c. This advisory circular is revised and the manufacturer fails to requalify.

d. The manufacturer fails to honor the guarantee.

6. UNACCEPTABLE FAILURE RATE. Since reliable equipment is of prime importance to safety of aircraft operations, equipment which proves unreliable in use must be removed from the approval listing. The determination of unreliability must be based on judgment and experience with equipment of a like nature. Where any such equipment is deemed to have an unsatisfactory failure rate or is deficient in workmanship or materials, the manufacturer will be notified in writing as to the basis for this determination. The manufacturer shall then notify the FAA in writing as to its plan of action for correcting the problem. If the manufacturer does not resolve the problem within a reasonable time (the time frame will, of necessity, be based on safety considerations and/or the nature of the problem), the equipment will be removed from the approval listing. The FAA reserves the right to require the equipment to be resubjected to any or all qualification tests when the equipment has been deemed unreliable or deficient in materials or workmanship. Owners of similar AWOS's will be notified of any systematic problems uncovered during this retesting through the configuration control procedure discussed in paragraphs 9 and 14c.

7. TEST PROGRAM. Chapter 3 contains the performance and testing standards for each component of the AWOS. The manufacturer demonstrates compliance with these standards through performance testing (where a test is specified) or by analysis and inspection. The manufacturer provides all necessary equipment and bears all testing costs. It is recommended that the manufacturer propose a test plan to the FAA containing detailed procedures for conducting the tests as well as the name and location of the facility where the tests will be conducted. Prior FAA review of the test plan will minimize the likelihood of improper test procedures which will result in rejection of the data. The FAA reserves the right to witness testing. After completion of the tests, the manufacturer must reduce the data to demonstrate compliance with the specification. The FAA reserves the right to examine raw data. If the manufacturer has previously performed testing, the test procedures and data sheets from these tests may be submitted for FAA approval.

8. SYSTEM DOCUMENTATION. The documentation described in this paragraph must be submitted by the manufacturer for FAA review and approval. It is intended to assist the AWOS owner in installing, operating, and maintaining the system. The documentation listed below may be provided as separate manuals or combined and consolidated. The items may be cross-referenced to avoid duplication, but the elements of each portion of the plan should be clear (for example, the maintenance procedures which are performed during the annual system revalidation should be explicitly referenced.) If the manufacturer wishes to modify the initially approved configuration, then the supporting documentation must be revised to reflect the approved change before the system is offered for sale.

a. System Description. The System Description identifies and catalogs the hardware components to the level of the smallest field-replaceable module and describes computer software. The principles of system operation are described using schematics, block diagrams, and flow diagrams. For peripheral devices, the performance parameters are included along with the name and address of the original manufacturer.

b. Maintenance Manual. The Maintenance Manual contains a comprehensive maintenance program to be implemented by the owner which will ensure reliable and accurate performance over the life of the system. As a minimum, the program must discuss all maintenance activities which might be required within a period of 5 years and a recommended frequency for each operation. The following topics are addressed in the maintenance manual.

(1) Maintenance Procedures. The manual contains a step-by-step procedure for each maintenance operation and discusses calibration methods, troubleshooting procedures, suggested spare parts, and identifies any test equipment required.

(2) System Performance Parameters. The manual contains a complete listing of the test points, sensor outputs, waveforms, and other parameters which indicate system performance and may be measured in the field. If these quantities are field-adjustable, then an initial value and an operating tolerance are given. The key system parameters are also identified, i.e., those values which best indicate system performance and should be checked most frequently.

(3) Data Recording Forms. The manual contains two forms designed to aid the system owner in recording the system performance data described above. The Comprehensive Facility Performance and Adjustment Data form is completed at system commissioning, after major repair work, and during the annual system revalidation. The form contains space to record all significant system parameters with additional space to detail any repair work completed. The Technical Performance Record contains space for the key parameters only and is intended for use after a scheduled maintenance visit to the facility. Both forms contain the date of the action, the facility name and location, and other identifying data.

c. Installation, Checkout, and Operation Instructions. This document thoroughly describes the installation and checkout procedures to be followed by the technician at the intended installation site. Detailed instructions on operation of the system are also provided.

d. Training Program. The training program consists of a summary of the knowledge and skills which a technician must possess to operate and maintain an AWOS. This document also proposes a program to familiarize technicians with the maintenance and operation of the AWOS system. The instruction program may be conducted on-site, at the factory, via home study, or by other means suggested by the manufacturer. The training program also contain standards for establishing the proficiency of potential maintenance technicians.

e. Annual System Revalidation Plan. This plan contains the manufacturer's recommended procedure for an annual inspection of the facility to verify that it is operating within tolerance.

f. Warranty. The manufacturer will submit a statement certifying that the following minimum warranty will be provided for the equipment:

> "This equipment has been manufactured and will perform in accordance with the requirements of FAA Advisory Circular 150/5220-16. Any defect in design, materials, or workmanship which may occur during proper and normal use during a period of 1 year from date of installation or a maximum of 2 years from shipment will be corrected by repair or replacement by the manufacturer f.o.b. factory."

9. CONFIGURATION CONTROL PLAN. Due to the modular nature of the AWOS, many system components such as sensors and peripheral devices may be interchangeable. Since type approval is given only to specific combinations of components, the manufacturer must establish a configuration control mechanism which will uniquely identify FAA-approved systems and the components which comprise them. The manufacturer's configuration control system is explained in the AWOS documentation, and the identifying information for each system is permanently inscribed on a system nameplate. Minor product improvement changes may be incorporated at the manufacturer's discretion. Major changes to the approved configuration are submitted for FAA approval to the AWOS Program Office at the address listed on the front of this circular. Significant changes, such as a sensor or major software changes, must be fully supported by documentation and appropriate test data. Before Type Approval will be granted, the manufacturer must submit a configuration control plan which addresses the following subjects:

a. Explanation of the manufacturer's system for identifying which system components are included in a particular system.

b. Procedures for notifying system owners of changes in the approved configuration.

c. Procedures for identifying and recording the configuration of operational systems.

10. PLANNING THE AWOS INSTALLATION. Airport owners or other parties contemplating purchase of an AWOS should coordinate with the FAA in the planning stages of the project before the equipment is ordered. Airport sponsors obtaining a grant under the Airport Improvement Program (AIP) should coordinate with the Airports District or Field Office that has jurisdiction over their specific geographical area. Other sponsors should contact the FAA regional Airway Facilities (AF) Division. The FAA point of contact will coordinate the proposal with regional Flight Standards Division, Air Traffic Division, and the regional Frequency Management Officer. The selection of a voice outlet frequency for the AWOS is a critical issue which must be coordinated with the regional Frequency Management Officer in the early planning stages of the facility, since there are a limited number of frequencies available for this purpose. FAA policy is to use an existing navigational aid (VHF omnidirectional range (VOR) or nondirectional radio beacon (NDB)) voice outlet for the AWOS whenever practical. If there is no navigational aid facility that satisfies the coverage requirement, or if the facility is being used for an Automated Traffic Information System (ATIS), Transcribed Weather Broadcast (TWEB), or Hazardous In-Flight Weather Advisory Service, the regional Frequency Management Officer will recommend the use of a dedicated transmitter operating on a discrete frequency. If the AWOS system proposed for installation does not meet the requirements of this circular, the FAA will not assign the system a broadcast frequency.

11. FACILITY COMMISSIONING. The AWOS facility must be formally commissioned by the FAA before it becomes part of the National Airspace System. After receiving project approval as described above, the owner may procure and install the AWOS facility. At least 120 days prior to the anticipated commissioning date, the owner should notify the FAA regional Flights Standards Division so that routine revisions may be made to the instrument approach procedures. When the system is ready for operation, the owner requests a commissioning ground inspection, which will be conducted by regional Airway Facilities (AF) personnel. This inspection requires participation of the owner or owner's maintenance representative. The commissioning inspection consists of the tests and checks listed below, a review of the operations and maintenance documents on file at the facility, and recording of facility performance data which will be retained as commissioning documentation.

a. Siting and Installation. The FAA AF representative will verify that the AWOS equipment was installed in accordance with the siting criteria contained in Chapter 4. The AWOS is a permanent facility and is located, constructed, and installed in accordance with applicable code requirements. Any discrepancies found during this inspection must be rectified before the facility will be commissioned.

b. Performance Test. The AWOS owner or maintenance representative operates the system and measures all System Performance Parameters described in the maintenance manual. These parameters are recorded on a Facility Equipment Data and Adjustment Form and retained at the facility as commissioning documentation.

12. ON-SITE DOCUMENTATION. The following documentation is to be permanently on file at the facility and will be reviewed at the commissioning inspection:

a. Type Approval. A copy of the FAA Type Approval for the AWOS system design. The subsystems will be inspected to verify that the installed AWOS is exactly the configuration for which the Type Approval was given.

b. Frequency Allocation Approval. The documentation from the Federal Communications Commission (FCC) assigning the approved operating frequencies (if appropriate).

c. Manufacturer's Documentation. Copies of the AWOS operating instructions, maintenance manual, and system description.

d. Operational Procedures. Site-specific operational procedures which set forth mandatory site procedures for both routine and nonscheduled situations. These procedures may incorporate appropriate sections of the manufacturer's manuals and will be available for inspection at the time of the commissioning inspection. The following items must be covered.

(1) Physical security of the facility

(2) Maintenance and operations by authorized persons.

(3) Posting of licenses and signs.

(4) Notice to the FAA of any suspension of service.

(5) Reference to technical data in maintenance manual.

(6) Keeping of station logs and other technical reports.

(7) Names, addresses, and telephone numbers of persons to be notified in the event of system failure.

(8) Procedures for shutdown for periodic scheduled maintenance, including the office to be notified to generate a Notice to Airmen (NOTAM) for routine or nonscheduled shutdowns. Also, an explanation of the kinds of activities (such as construction or grading) in the vicinity of the AWOS facility that may require shutdown or reverification of the AWOS.

(9) Procedures for amending or revising the instructions.

(10) Procedures for suspending the updates of the archived data and for retrieving archived data.

(11) AWOS component locations with respect to airport layout, including sensor locations. This includes the result of the survey to establish the elevation of the barometric pressure sensors (see paragraph 35).

(12) A Memorandum of Understanding signed by the owner and the FAA regional Airway Facilities Division Manager. This memorandum will state that the owner agrees to maintain, repair, and modify the AWOS in accordance with the requirements, standards, or criteria governing AWOS, particularly those contained in the operation instructions and maintenance manuals. The owner understands that noncompliance with the above requirements may result in removal from service or decommissioning of the AWOS.

13. MAINTENANCE PROGRAM. At the time of facility commissioning, the owner must show that a maintenance program has been established. The maintenance program shall cover a minimum period of 5 years and shall consist of properly trained personnel, adequate test equipment, and resources to fulfill the manufacturer's recommended maintenance and calibration procedures. The maintenance program may be implemented by the owner, the manufacturer, or a qualified third party.

a. Maintenance Personnel. The owner must show that qualified personnel are available to maintain the AWOS system. Each AWOS maintenance technician must have the special knowledge and skills needed to maintain the AWOS facility, including proficiency in maintenance procedures and the use of specialized test equipment.

b. Test Equipment. The owner will have available at the facility at the time of commissioning all test equipment required by the approved maintenance plan for maintenance and calibration of the facility. The owner will also have provisions for calibration of the test equipment. After commissioning, the test equipment will be available when required for scheduled maintenance and calibration, or for repairs after system failure.

c. Performance/Configuration Revalidation. The owner shall show provisions for complying with the manufacturer's recommended procedure for system revalidation. The plan includes a list of the procedures to be followed during the revalidation and the source of the qualified person who will conduct the inspection.

14. ON-GOING SYSTEM VALIDATION. To verify that the system is being properly maintained and that the system retains an approved configuration, the following ongoing validation program will be conducted. Failure to meet the criteria of this program will result in withdrawal of the facility's certification.

a. Performance/Configuration Revalidation. Each AWOS will be inspected by a qualified technical representative in accordance with the manufacturer's approved Annual System Revalidation Plan. This inspection will include the items below, and the results are recorded on a Facility Performance and Adjustment Data form and retained on file at the facility.

(1) Verify that the maintenance program is being followed and properly documented.

(2) Verify that system performance is within the limits specified by the manufacturer's documentation.

(3) Verify that the AWOS configuration is the same as approved at the time of commissioning. Additionally, it shall be determined that all mandatory configuration changes approved by the FAA have been accomplished and documented.

(4) A summary of all maintenance (hardware and software) performed since the last report is on file at the facility.

b. FAA Site Visits. The FAA will visit certificated nonfederal AWOS facilities to verify that the system operates within tolerance, that the maintenance is performed and documented according to the approved maintenance plan, and that the configuration is controlled and in accordance with the manufacturer's documentation previously provided to the FAA. The owner will provide the FAA representative with access to the sites in order to perform this inspection.

c. Mandatory Configuration Changes. If the FAA determines that an AWOS system, or any element of the system, is providing data which could be in error, the FAA may direct the system manufacturer to issue a mandatory configuration change order to the owners of similar systems. The system owner will disable the appropriate part of the system and will issue a NOTAM describing the missing parameter and giving an estimate of the time for which it will be disabled.

CHAPTER 3. PERFORMANCE AND TESTING SPECIFICATIONS FOR AWOS

15. GENERAL. This chapter contains the performance standards and testing specifications for components of the AWOS. Equipment must comply with these standards in order to constitute a source of weather information approved by the National Weather Service and the FAA.

16. DEFINITIONS.

a. Root Mean Square Error (RMSE). Root mean square error is determined by comparing the output value with the true value of a parameter according to the following equation:

$$RMSE = \left[\frac{1}{N} \sum_{N=1}^{N} (T - M)^2 \right]^{\frac{1}{2}}$$

Where

N = Number of independent comparisons

M = Measured value

T = True value

b. Time Constant. After a step change in the value of a parameter measured by a sensor, the time constant is the length of time it takes the sensor to register a given percentage (63 percent unless otherwise specified) of the change.

c. Resolution. The resolution of a sensor is the value of the least significant digit which is given as sensor output.

d. Variance. For the purposes of this document, variance is defined as the difference between the value of the reference sensor and the sensor under test.

17. GENERAL PERFORMANCE STANDARDS. This paragraph addresses aspects of performance which are applicable to the AWOS as a whole. The electromagnetic interference, transient, and lighting protection standards are also applicable to the entire system, and are addressed in paragraphs 30 and 31.

a. Input Power. AWOS equipment operates from a 120/240 V (± 10%) 60 Hz ac (± 5 Hz) 3-wire single phase service.

b. Loss of Power. The AWOS system will return to normal operation without human intervention after a power outage. When power is restored, the system will not output erroneous data.

c. Obstruction Lighting. If a separate tower is used for the wind sensor, it is lighted with a dual L-810 fixture placed within 5 feet (1.5 m) of the top of the tower. The two lamps on the L-810 are wired in parallel. The standards for L-810 fixtures may be found in Advisory Circular (AC) 150/5345-43, Specification for Obstruction Lighting Equipment, which may be ordered from the Department of Transportation, Subsequent Distribution Unit, M-494.3, Washington, D. C. 20590.

d. VHF Transmitter. It is FAA policy that the output of the AWOS will be transmitted on an existing navigational aid voice outlet whenever practical. If there is no navigational aid available, then the output will be broadcast via a separate VHF transmitter. The transmitter operates in the 118-136 MHz band. The upper limit of this band is planned to be extended to 137 MHz in the near future. The transmitter must have an FCC type acceptance, and have the following operational parameters:

Channel Spacing: 25 KHz

RF Power Output: 10 watts maximum

Frequency Stability: ±0.001% (-30 to +60° C)

Emission Type: 6A3

Spurious and harmonic emissions: 80 db minimum up to 90% modulation

18. OPERATING ENVIRONMENT. AWOS equipment will operate under the environmental conditions listed below. Equipment which cannot satisfy the full range of conditions may be waivered for operation in locales where those conditions do not occur.

a. Site Elevation. From 100 feet (30 m) below sea level to 10,000 feet (3000 m) above sea level.

b. Equipment Installed Indoors in a Conditioned Space.

(1) Temperature. From +40 to +105° F (+5 to +40° C)

(2) Relative Humidity. 5% to 90%

c. Equipment Installed Outdoors.

(1) Temperature.

Class 1 - -30 to +130° F (-35 to +55° C)
Class 2 - -65 to +130° F (-55 to +55° C)

(2) Relative Humidity. 5% to 100%

(3) Wind. Up to 85 knots (98 miles per hour)

(4) Hail. Up to 1/2 inch (12.5 mm) in diameter

(5) Ice Build-up. Freezing rain rate equivalent to a buildup of 1/2 inch (12.5 mm) per hour, lasting for a period of one hour. The accuracy of the wind sensors is permitted to deteriorate during icing conditions.

(6) Rain. Up to 3 inches (75 mm) per hour with 40 knot wind.

19. WIND SPEED AND DIRECTION SENSOR.

a. Performance Standard.

(1) Wind Speed Sensor.

(i) Range. The sensor shall respond to a threshold of 2 knots and a maximum of at least 85 knots.

(ii) Accuracy. The wind speed sensor shall provide an accuracy of 2 knots or 10% RMSE, whichever is greater, with a maximum error of 15% at any speed.

(iii) Resolution. The resolution shall be one knot.

(iv) Distance Constant. The distance constant shall be less than 10 meters. The method for calculation is given in paragraph b(1)(ii) below.

(v) Threshold. Two knots.

(2) Wind Direction Sensor. This sensor shall be aligned to true north and withstand a wind speed of 85 knots without damage.

(i) Range. 1° to 360° in azimuth

(ii) Threshold. 2 knots

(iii) Accuracy. Within 5° (RMSE), with a maximum error of 10° in any direction.

(iv) Resolution. To nearest 1° , dead band not to exceed 10°.

(v) Time constant. Less than 2 seconds

b. Performance Testing. Testing shall be conducted in a calibrated wind tunnel, except for the wind direction accuracy test which is conducted on a bench test fixture. The wind speed sensor shall be compared against a calibrated pitot static tube or transfer reference standard traceable to the National Bureau of Standards. The following test procedure shall be used.

(1) Wind Speed.

(i) Accuracy and Resolution. The test is conducted under "no rain" conditions. Four full test cycles (2 - 85 knots) shall be conducted in increments of 2 knots between 2 and 10 knots, in increments of 10 knots between 10 and 80 knots, and at 85 knots. During these test runs, data shall be gathered to demonstrate compliance with the requirements for accuracy and resolution.

(ii) Distance Constant. The distance constant shall be computed according to the following formula.

$$D = T \times W$$

Where:

D = Distance constant (in meters).
T = Time constant.
W = Wind speed (meters per second) in the wind tunnel.

The distant constant will be determined from an average of 10 runs (5 runs each with the tunnel wind speed at 10 knots (5 meter/sec.) and at 20 knots (10 meter/sec) with the sensor propellor speed at the zero at time zero). The distance constant must be less than 10 meters for the sensor to pass this test. If the sensor is of a type with no moving parts (i.e., no propeller), the manufacturer shall develop a test for FAA approval to demonstrate the distance constant.

(2) Wind Direction.

(i) Accuracy. This test will be conducted on a bench test fixture under "no rain" conditions. The accuracy of the sensor shall be checked at each 15° increment. The accuracy shall be checked in 2° increments between 350° and 010° (a dead band of up to 10° is permissible). Two complete test cycles shall be conducted, and the RMSE accuracy shall be within specified limits.

(ii) Time Constant. The time constant will be determined from an average of 10 runs (5 runs each with the tunnel speed at 10 knots and at 20 knots). The vane shall be displaced 10° from the indicated wind direction and released. The time constant shall be less than 2 seconds to reach within 5° of the indicated wind direction.

20. AMBIENT TEMPERATURE SENSOR.

a. Performance Standards. The sensor shall be thermally isolated to accurately measure the environments below.

(1) Range. From -35° to +55° C (-30° to +130° F) for Class 1 systems.
From -55° to +55° C (-65° to +130° F) for Class 2 systems.

(2) Accuracy. 1° F RMSE for the entire range of the sensor, with a maximum error 2° F.

(3) Resolution. Not greater than 1° F.

(4) Time Constant. Not greater than 2 minutes.

b. Performance Testing.

(1) Accuracy. Temperature accuracy shall be verified using a calibrated reference instrument traceable to the National Bureau of Standards. The temperature sensor shall be exercised through the full range of the device in 20° F increments. This 20° F change in chamber temperature must be accomplished within 5 minutes, and the sensor reading will be taken 5 minutes after the chamber temperature is stable. This test cycle shall be performed a total of eight times (or four times with two sensors in the chamber). These cycles shall include two increasing and two decreasing temperature cycles without radiation heating; and two increasing and two decreasing temperature cycles with radiation heating on the aspirated enclosure of 1.6 gram-calories per square centimeter per minute. The accuracy of the sensor shall be within 1° F (RMSE) for each test cycle (a total of 9 data points for each Class 1 system cycle; 11 data points for each Class II system cycle.)

(2) Time constant. The sensor shall be placed in a chamber and stabilized at 85° F. The temperature shall be rapidly raised (within one minute) 5° (to 90° F); the time constant shall be 2 minutes or less. The same test shall be repeated with a 5° decrease in temperature within one minute. The time constant shall be 2 minutes or less.

21. DEW POINT SENSOR. A single thermal shield and aspirator unit may include both the dewpoint and temperature sensors.

a. Performance Standards.

(1) Operating Range. From -30° to +90° F

(2) Dewcell Protection. If the dewpoint sensor is a dewcell, it shall not be damaged if the sensor becomes excessively wet (e.g. from precipitation or a loss of power). The dewcell probe will return to normal operation, without damage, within 30 minutes after the abnormal, excessively wet condition is alleviated or after restoration of power.

(3) Resolution. Not greater than 1° F

(4) Time constant. Less than 2 minutes.

(5) Accuracy. The accuracy shall be as shown below. All errors are RMSE.

(i) 2° F dewpoint for dry bulb temperatures of +30° to +90° F (80% to 100% relative humidity), with a maximum error of 3° F at any dry bulb temperature.

(ii) 3° F dewpoint for dry bulb temperature of +30° to +90° F (15% to 75% relative humidity) with a maximum error of 4° F at any dry bulb temperature.

(iii) 4° F dewpoint for dry bulb temperatures of -20° to +20° F (25% to 95% relative humidity) with a maximum error of 5° F at any dry bulb temperature. The minimum dewpoint required is -30° F.

b. Performance Testing.

(1) Accuracy. All tests shall be performed with the sensor in the aspirated enclosure supplied with the sensor. Temperature and dewpoint accuracy will be verified using calibrated reference instruments traceable to the National Bureau of Standards. The data points given below will be taken during four test runs (two with increasing humidity and two with decreasing humidity.) This may be reduced to two test runs if two sensors are placed in the chamber. During the test run, the change in temperature and/or relative humidity will be accomplished within 5 minutes, and the sensor reading will be taken 5 minutes after the temperature and humidity have stabilized. The following data points must be demonstrated and the RMSE calculated to demonstrate the error in each category.

a. With an error not to exceed 2° F (RMSE) dewpoint,
30° F temperature; 80, 90, 100 % relative humidity
60° F temperature; 80, 90, 100 % relative humidity
90° F temperature; 80, 90, 100 % relative humidity

b. With an error not to exceed 3° F (RMSE) dewpoint,
30° F temperature; 15, 45, 75 % relative humidity
60° F temperature; 15, 45, 75 % relative humidity
90° F temperature; 15, 45, 75 % relative humidity
120° F temperature; 15, 40 % relative humidity

c. With an error not to exceed 4° F (RMSE) dewpoint,
-20° F temperature; Between 65 and 95 % relative humidity
0° F temperature; 25, 60, 95 % relative humidity
+20° F temperature; 25, 60, 95 % relative humidity

(2) Time Constant. At ambient temperature and 50% relative humidity, change the dewpoint +5° F (within one minute), and then -5° F (within one minute.) In each case, the time constant shall be less than 2 minutes.

(3) Power Interruption. At ambient temperature and 90% relative humidity with the sensor operating normally, disconnect the power from the sensor for a period of one hour. Power shall then be reapplied, and the sensor shall return to normal operation and accuracy within 30 minutes.

22. PRESSURE SENSOR.

a. Design. Two pressure sensors shall be provided for each AWOS system. The pressure sensors shall have provisions for venting to the outside of the building where required. Pressure variations due to airflow over the venting interface shall be avoided. The venting interface shall be designed to avoid and damp pressure variation and oscillation due to "pumping" or "breathing" of the pressure sensor, venting, and porting equipment. Each sensor shall have an independent venting interface (from separate outside vents through dedicated piping) to the sensors.

b. Performance Standards.

(1) Altitude Ranges. High pressure shall be standard atmospheric pressure at -100 feet plus 1.5 inHg (30.065 + 1.5 = 31.565 inHg). Low pressure shall be standard atmospheric pressure at +10,000 feet minus 3.0 inHg (20.58 - 3.00 = 17.58 inHg).

(2) Pressure Range. The sensor shall be capable of measuring a pressure range at any fixed location (station) of +1.5 to -3.0 inHg from the standard atmospheric pressure at that location. Pressure sensors shall have a provision for setting the sensor to the station elevation to the nearest 1 foot over the range of -100 feet (-30 m) to +10,000 feet (+3000 m).

(3) Accuracy. The accuracy shall be 0.01 inHg RMSE at all altitudes from -100 to +10,000 feet (-30 to +3000 m) MSL; maximum error 0.02 inHg at any one pressure.

(4) Resolution. The resolution shall not be greater than 0.005 inHg.

(5) Differential Accuracy. The sensor shall exhibit a maximum differential accuracy of 0.01 inHg or less between any two pressure measurements taken from the same sensor 3 hours apart. Ambient temperature over this 3-hour period shall not change more than 5° F; ambient pressure shall not vary more than 0.1 inHg (RMSE) over the 3 hour period.

(6) Maximum Drift With Time. Each sensor shall be stable and continuously accurate within 0.01 inHg RMSE for a period of not less than 6 months. The maximum error shall be 0.02 inHg.

c. Performance Tests.

(1) Accuracy. Both pressure sensors shall successfully complete the following accuracy test. A calibrated barometer or transfer standard with an accuracy of 0.003 inHg that is traceable to the National Bureau of Standards shall be used as a standard during testing. Two test cycles shall be performed on each pressure sensor. One test cycle consists of running the sensor through the full pressure range at each of the three ambient temperatures. Before taking measurements, allow sufficient time for the sensor to achieve steady state at each data point (not to exceed 5 minutes). The RMSE shall be within the specified limits.

(i) Pressure Range. The pressure sensors shall be tested through the full range of performance (normally 17.5 to 32.0 inHg) in 1 inHg increments of both increasing and decreasing pressure. Partial range (4.5 inHg) pressure sensors shall be tested by setting the sensor to a pressure altitude from zero to 10,000 feet in 500 foot increments. The sensors will be tested from minus 3.0 inHg to +1.5 inHg at 0.5 inHg increments at each pressure altitude.

(ii) Temperature Range. The sensor shall be tested at ambient (+85° F) and at the hot and cold extremes called for in the environmental requirements.

(2) Differential Accuracy. Differential accuracy (change in accuracy) of the pressure sensor shall be tested at ambient temperature (85° F) and ambient barometric pressure.

(i) Take 14 measurements of pressure on the pressure sensor under test and 14 measurements of pressure on the reference barometer. These measurements should be taken about 5 seconds apart, and all 14 measurements shall be completed within 90 seconds. This time shall be called t=0.

(ii) Repeat the 14 measurements on the pressure sensor under test and 14 measurements of pressure on the reference barometer after an elapsed time of 3 hours and with an ambient temperature change of less than 5° F, and an ambient pressure change of not more than 0.1 inHg. This time shall be called t=3.

(iii) Compute the average reading of the reference barometer at t=0. Compute the average reading of the reference barometer at t=3. Determine the difference in the two averages. If the difference is greater than 0.1 inHg, repeat steps (a) and (b).

(iv) Compute the 14 errors in reading between the sensor and reference barometer at t=0.

(v) Compute the 14 errors in reading between the sensor and reference barometer at t=3.

(vi) Subtract the 14 t=0 errors from the 14 t=3 errors determined in steps (iv) and (v). These differences are the changes in accuracy (the differential accuracy).

(vii) Compute the average and standard deviation of the 14 changes in accuracy determined in step (vi). The average differential accuracy shall be not greater than 0.010 inHg. The standard deviation shall be less than 0.003 inHg.

(3) Resolution. The manufacturer shall demonstrate that the resolution is not greater than ± 0.005 inHg.

(4) Drift Over Time. Testing shall be done to determine maximum drift over a 6 month period.

23. CLOUD HEIGHT SENSOR

a. Performance Standards.

(1) Range. The cloud height sensor must detect clouds up to at least 5,500 feet. If the manufacturer claims a greater sensor defined limit, the sensor shall be tested to the greater value. Specifically, the sensor shall detect clouds to the following ranges under the conditions specified.

(i) 5,500 feet (or the sensor defined limit) with daytime equivalent visibility greater than 3 miles under conditions of no precipitation, or light precipitation (equal to or less than 0.1 in/hr).

(ii) 3,000-foot range, with daytime equivalent visibility greater than 2 miles, but equal to or less than 3 miles, under conditions of no precipitation or light precipitation (equal to or less than 0.1 in/hr).

(iii) 1,500-foot range, with daytime equivalent visibility equal to or greater than 1 mile, but equal to or less than 2 miles, under conditions of no precipitation or light precipitation (equal to or less than 0.1 in/hr).

(iv) 1,000-foot range, with daytime equivalent visibility equal to or greater than 2 miles under conditions of moderate precipitation (0.11 to 0.3 in/hr).

(2) Accuracy. The accuracy shall be at least 100 feet, surface to 5,500 feet (or the sensor defined limit).

(3) Resolution. The resolution shall be not more than 50 feet, surface to 5,500 feet.

(4) Sampling. The sensor shall provide an output of cloud height at least once every 30 seconds when clouds are present. To extend sensor life, the sampling rate may be reduced to at least one sample every 3 minutes when no hits are detected for the preceding 15 minutes.

(5) Detection Performance Accuracy. The sensor shall be accurate within the limits specified in paragraphs 23b(4) and 23b(5) below.

(6) Maximum Range Detection Capability. The sensor shall be capable of measuring the maximum height at which the attenuation of the output signal is such that detection of clouds at greater heights is not possible.

(7) Eye Safety. The cloud height indicator sensor shall be designed to conform to ANSI-Z 136.1, Accessible Emission Limits for Laser Radiation, with Class 3b maximum accessible emission level applied to direct viewing without optical instruments (excluding ordinary eye glasses). This document may be obtained from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018. An interlock device in the laser power circuit shall be provided to disable the laser during maintenance thereby preventing inadvertent exposure of the laser emission to the eyes of the technician or others.

(8) Optics Contamination. An air blower or other device shall be used to reduce the contamination of sensor optics. A signal shall be generated to indicate the amount of optics contamination, thereby indicating the need for optics cleaning.

(i) Snow. The ceilometer window shall demonstrate an ability to remain clear of snow under the conditions of snow accumulating at a rate of 2 inches per hour for one hour at a temperature of 20° F.

(ii) Ice. The window shall remain clear of ice for 60 minutes under conditions of freezing rain equivalent to a buildup of 1/2 inch per hour radial thickness of clear ice.

b. Performance Testing.

(1) Test Procedure.

(i) The signal shall be projected horizontally to a uniform diffuse target (whose reflectivity approximates a cloud) at known distances (100-foot increments from 100 to 500 feet, and 500 foot increments from 500 to 3000 feet). All range points shall be accurate to within 100 feet. This test is conducted at full-rated power output.

(ii) The return signal level shall be measured at each range, and the ratio of the return signal level to the hit threshold shall be computed at each range. Any variation in this ratio of more than 3 db is unacceptable.

(iii) A calibrated rotating beam ceilometer (RBC) or an FAA approved cloud height indicator whose accuracy is traceable to a National Weather Service approved and calibrated RBC shall be the standard for determining cloud height.

(iv) An FAA-approved visibility sensor whose accuracy is traceable to an FAA transmissometer standard shall be the standard for determining visibilities.

(v) Precipitation measurements shall be made using an FAA-approved and calibrated 0.01 inch per tip tipping bucket precipitation gauge. Light precipitation is defined as one but not more than two bucket tips in a 10-minute period. Moderate precipitation is defined as more than two, but not more than five tips in a 10-minute period.

(2) Cloud Height Sensor Detection Testing Conditions.

(i) Group A Conditions. Visibility greater than 3 miles, with a minimum of 20% of the data in each subgroup collected under conditions of light precipitation.

Table 1. Group A test conditions.

Subgroup	Cloud Height (feet)
1	100 - 700
2	800 - 1500
3	1600 - 3000
4	3100 - 5500 (or sensor design limit)

(ii) Group B Conditions. Visibility equal to or less than 3 miles, but greater than 2 miles, with minimum of 20% of the data in each subgroup collected under conditions of light precipitation.

Table 2. Group B test conditions.

Subgroup	Cloud Height (feet)
1	100 - 700
2	800 - 1500
3	1600 - 3000

(iii) Group C Conditions. Visibility equal to or less than 2 miles, but greater than 1 mile, with a minimum of 20% of the data in each subgroup collected under conditions of light precipitation.

Table 3. Group C test conditions.

Subgroup	Cloud Height (feet)
1	100 - 700
2	800 - 1500

(iv) Group D Conditions. Visibility equal to or greater than 2 miles, under conditions of moderate precipitation.

Table 4. Group D test conditions.

Subgroup	Cloud Height (feet)
1	100 - 500
2	600 - 1000

(v) Group E Conditions. Not more than 30% total sky coverage with the lowest cloud layer at 10,000 feet or above under the following visibility conditions with a minimum of 20% of the data in each subgroup collected under nighttime conditions.

Table 5. Group E test conditions.

Subgroup	Visibility (miles)
1	Equal to or greater than 1, but less than 3
2	Equal to or greater than 3, but less than 7
3	Equal to or greater than 7

(3) Collection of Test Data.

(i) A minimum of 25 data sets shall be collected for each subgroup in Groups A through D (e.g., a minimum of 100 data sets shall be collected under Group A conditions). One data set is defined as the second 10-minute interval of any consecutive 30-minute period during which a uniform cloud layer is detected by the RBC used as a standard. In order to be classified a uniform cloud layer, the RBC must continuously measure a cloud layer (for a 30-minute period) that does not vary from its mean height more than the variances given in table 6 more than 5% of the time. "Missed-Hits" by the candidate sensor shall be included as a data point in each data set.

Table 6. Criteria for determining uniform cloud layers.

Mean Cloud Height (as measured by RBC)	Variance (Feet)
Equal to or less than 1000 ft.	200
Greater than 1000 ft, but equal to or less than 2000 ft.	300
Greater than 2000 ft, but equal to or less than 3000 ft.	400
Greater than 3000 ft, but equal to or less than 5000 ft.	500

(ii) A minimum of 25 data sets shall be collected for each subgroup under Group E. One data set is defined as the second 10 minutes of any consecutive 30-minute period during which the cloud/sky coverage/visibility conditions specified for Group E are met.

(4) Criteria for Acceptance of the Candidate Sensor Under Uniform Cloud Layer Conditions.

(i) Group A Conditions. The mean cloud height as measured by the RBC shall be determined for each data set. The variance for each "cloud hit" in each data set shall be computed. Eighty-eight percent of the data sets within a subgroup (e.g. 22 out of 25 minimum) shall satisfy the following condition: 95% of the cloud hits (measured by the candidate sensor) in each data set shall agree with the mean cloud height measured by the RBC within the variance limits given for the RBC in paragraph (3) above. The candidate sensor must perform successfully in each subgroup to pass this test. Failure of any subgroup constitutes failure of the test.

(ii) Group B Conditions. The same criteria shall be satisfied as detailed for Group A conditions, except that 90% of the hits in each data set shall agree with the cloud height measured by the RBC within the appropriate variance levels.

(iii) Group C Conditions. The same criteria shall be satisfied as detailed for Group A conditions, except that 85% of the hits in each data set shall agree with the cloud height measured by the RBC within the appropriate variance levels.

(iv) Group D Conditions. The same criteria shall be satisfied as detailed for Group A conditions, except that 80% of the hits in each data set shall agree with the cloud height measured by the RBC within the appropriate variance level.

(v) Group E Conditions. Not more than one false hit per data set in each subgroup. More than one false hit per data set shall constitute failure of the test.

(5) Detection Test Under Ragged Overcast Conditions. Cloud hits detected by the candidate sensor shall be compared with hits detected by the RBC during ragged overcast conditions. Valid data shall be that collected during overcast cloud conditions below 5000 feet as verified by a minimum of 95% hits by the RBC during a 20 minute period. Calculate the percentage of hits by the candidate sensor falling within the RBC hit ranges in table 7 under each of the conditions specified in table 8. A minimum of 80% weighted average of the hits by the candidate sensor shall fall within the range of the RBC hits.

Table 7. RBC hit classification under ragged overcast conditions.

Group	RBC Hit Ranges
1	100 - 700 feet
2	800 - 1500 feet
3	1600 - 3000 feet
4	3100 - 5000 feet

Table 8. Weather conditions for testing of ragged overcast performance.

Group	Weather conditions
1	No precipitation
2	Light or moderate precipitation
3	Visibility equal to or greater than 1 mile, and equal to or less than 3 miles
4	Visibility greater than 3 miles.

(6) Optics Contamination Testing.

(i) Simulated Optics Contamination Test for Laser Devices. The unit shall be operated with the return signal level reduced by 5 db with an overcast ceiling (measured by an RBC) between 3000 and 5,500 feet. Return laser signal level may be reduced by an adjustment of laser emmission power, receiver gain, or through the use of appropriate optical filters. The cloud hit response relative to the RBC shall be at least 75% during a 2-hour sample.

(ii) Operational Contamination Testing. The unit shall be operated over a 90-day period without any routine (periodic) maintenance. The test procedure outlined above shall be repeated at full power at the end of this 90-day period.

(iii) Snow and Ice Contamination Testing. The manufacturer shall demonstrate by test or calculation that the sensor meets the requirements of paragraph 23a(8)(i) and (ii) above.

24. VISIBILITY SENSOR.

a. Performance Standards.

(1) Range. The visibility sensor shall be capable of determining visibilities from less than 1/4 mile to 10 miles. A method of calibration traceable to an FAA-approved transmissometer shall be provided.

(2) Resolution. In terms of equivalent visibility, the sensor shall provide data to report visibility values as follows (in statute miles): less than 1/4, 1/4, 1/2, 3/4, 1, 1-1/4, 1-1/2, 1-3/4, 2, 2-1/2, 3, 3-1/2, 4, 5, 7, and 10 miles.

(3) Time Constant. The time constant shall not exceed 3 minutes.

(4) Accuracy. The sensor shall agree with a transmissometer standard as follows:

Table 9. Visibility sensor accuracy requirements.
(All values in statute miles)

Reference Transmissometer Reading	Acceptable sensor variance
1/4 through 1-1/4	± 1/4
1-1/2 through 1-3/4	+1/4, -1/2
2 through 2-1/2	± 1/2
3 through 3-1/2	+1/2, -1
greater than 4	± 1

(5) Ambient Light Sensor. The visibility sensor shall contain an ambient light sensor (i.e., a photocell) to measure the ambient luminance within its field of view, and to generate a signal to the visibility sensor to indicate whether the ambient light level is day or night. It shall indicate day for increasing illumination between 0.5 and 3 footcandles (FC), and night for decreasing illumination between 3 and 0.5 FC. This sensor may be exposed to ambient light levels as high as 50 FC.

b. Performance Tests. The visibility sensor shall be tested using an FAA approved transmissometer as a reference standard.

(1) Accuracy Testing.

(i) At least 2 months of accuracy test data shall be accumulated, assuring that a representative number of valid test points are experienced at each of the reporting increments (paragraph 24a(2)) and under the conditions listed below (i.e., with and without precipitation). All data collected during the test shall be included in the test report. Any samples not included in determining the candidate sensor's accuracy shall be fully explained. The test data shall consist of a number of independent samples of 10 minutes each, with at least 5 minutes between each sample. Samples shall consist of visibilities from less than 1/4 mile to greater than 10 miles, and shall be weighted in the following ratio:

70% without precipitation (i.e. with fog, haze, or clear conditions.)

30% with precipitation (e.g. 15% with rain, 15% with snow).

(ii) Eighty percent of the sensor test data points in each of the above categories (e.g., with, without precipitation) shall agree with the transmissometer standard within the allowed variances from less than 1/4 through 5 miles.

(iii) Eighty percent of the sensor test samples in each of the above categories that are obtained when the transmissometer reads greater than 5 miles shall be 5 or greater.

(2) Time Constant Demonstration. Under conditions of 10-mile visibility, a technique shall be used to reduce the sensor detector output to one mile or less. After the restriction is applied, the time constant shall be measured to reflect the reduction of visibility. After a period of 10 minutes, the artificial restriction to visibility shall be removed, and the sensor time constant shall be measured to reflect the increase in visibility. The time constant shall be equal to or less than 3 minutes.

(3) Ambient Light Sensor Testing. The manufacturer shall demonstrate that the ambient light sensor complies with paragraph 24a(5).

25. PRECIPITATION OCCURRENCE AND ACCUMULATION SENSOR(S). The term "precipitation" is defined as including all forms, i.e., liquid, freezing, frozen, or combinations thereof. The term "precipitation amount" is the liquid or liquid equivalent amount. The precipitation sensor provides an indication of precipitation occurrence and measures the precipitation amount. The sensor(s) may be designed as a single or separate units.

a. Performance Standards.

(1) Precipitation Occurrence Sensor. The sensor shall detect the occurrence of precipitation as specified below. It shall not "false alarm" on other moisture sources such as dew and frost.

(i) Precipitation Onset. The sensor shall detect the onset of precipitation 95% of the time as follows:

(A) With the precipitation rate of 0.11 inches per hour or more, the sensor shall detect the onset of precipitation within one minute.

(B) With precipitation rates of 0.05 to 0.10 inches per hour, the sensor shall detect the onset of precipitation within 2 minutes.

(C) With precipitation rates of 0.01 to 0.04 inches per hour, the sensor shall detect the onset of precipitation within 5 minutes.

(D) With a precipitation rate of less than 0.01, but equal to or greater than 0.005 inches per hour, the goal shall be the detection of the onset of precipitation within 10 minutes.

(ii) Precipitation Cessation. The sensor shall detect the cessation of precipitation within 5 minutes 95% of the time.

(2) Precipitation (Liquid Equivalent) Accumulation. The sensor shall be capable of measuring the precipitation amount within a range of 0.01 to 5 inches per hour, with a resolution of 0.01 inches and an accuracy of 0.02 inches per hour (RMSE) or 4% of actual (whichever is greater).

b. Performance Testing. The manufacturer shall conduct a test program to demonstrate that the precipitation occurrence and accumulation sensor(s) meet the performance requirements under the environmental conditions found in paragraph 18.

26. RUNWAY SURFACE CONDITION SENSOR. This sensor provides real-time information on runway conditions to alert the pilot if the runway is wet or if there are possible icing conditions.

a. Performance Standards. The sensor shall meet the requirements found in Chapter 2, Paragraph 8a of AC 150/5220-13, Runway Surface Condition Sensor Specification Guide. This AC may be ordered from the Department of Transportation, Subsequent Distribution Unit, M494.3, Washington, DC 20591. The sensor shall be capable of detecting three runway conditions: dry runway (no perceptible moisture), wet runway (visible moisture on the surface), and possible freezing conditions (pavement temperature below freezing and moisture present on the surface).

b. Performance Testing.

(1) The testing shall be performed on a sensor installed in a runway or other suitable pavement section which is free from chemicals, rubber build-up, or other contamination. The pavement temperature shall be measured with an infra-red thermometer or other approved method. The sensor shall be accurate within $\pm 1^{\circ}$ F within the temperature band of 25 to 35° F. At least ten observations shall be made under the conditions below.

(i) Dry Runway. No visible moisture is present on the sensor.

(ii) Wet Runway. The sensor is damp, wet, or flooded, and the temperature is above 32° F.

(iii) Possible Freezing Conditions. The sensor is damp, wet, flooded, covered with ice, or packed snow, while the surface temperature is at or below 32° F.

(2) The sensor shall be operationally tested during an entire winter season. The sensor reports shall be visually verified (with consideration of the effects of wind and any chemicals on the surface), and shall be accurate at least 80% of the time in each of the three conditions (i.e., dry, wet, and possible freezing).

27. AWOS DATA PROCESSOR. The four principal functions of the processor are data acceptance, data reduction, data processing, and product dissemination (digital and voice). The processor typically accepts data inputs, performs various data reduction functions, implements the AWOS algorithms, and prepares weather observation reports. The processor shall have the ability to provide a computer-generated voice weather observation to a ground-to-air radio (VOR, NDB, VHF discrete, etc.) for transmission to pilots. As an option, this voice message may also be provided to users via an integral automatic telephone answering device.

a. Performance Standards.

(1) Number of Sensors. The processor will typically be able to receive inputs from up to eight sensors.

(2) Data Reduction. The data reduction function consists of the preprocessing of information prior to the actual algorithm processing. The AWOS data reduction software shall include quality control checks to ensure that the data received is accurate and complete, and that the associated equipment is working properly before the weather algorithms are performed. If data from any sensor is erroneous or missing (e.g., the sensor loses power, etc.), that parameter shall be reported "missing" in the weather observation. The processor shall continue to sample the data, and if the error condition is corrected, the weather parameter shall be reinserted in the AWOS report. As an optional feature, an error indication light may be provided which will be located in an attended location and will be energized when a parameter is reported "missing" by the AWOS. If the examples of data reduction checks given below are not applicable to a sensor's output, the manufacturer shall propose suitable criteria.

(i) The processor shall periodically check reference or calibration points within the system (e.g., reference voltage; aspirator airflow; sensor heater current, etc.) to monitor system operation.

(ii) The processor may set upper and lower limits on the sensor output which correspond to the normal operating limits of the sensor or to the real-world limits of the site. This is a gross error check that will prevent reporting clouds below ground level, negative wind speeds, etc.

(iii) The processor may set rate-of-change limits on the sensor's output. For example, the temperature sensor may have upper and lower limits of +130° F and -60° F. A rate-of-change limit might be set by determining the maximum acceptable change in temperature or signal characteristics allowable over a given period of time.

(iv) The processor may examine the history of the sensor output to detect sensor problems. As an example, the mean and standard deviation of a sensor measurement may be calculated every hour and compared to established upper and lower limits. If the wind speed sensor has a mean greater than 3 knots but a standard deviation less than 0.5 knot, the sensor has probably malfunctioned. Likewise, the wind direction sensor is probably inoperative if the wind speed is above 5 knots and the standard deviation is less than 1 degree. Other examples of data checks include consistently low wind speeds, unvarying wind speed or direction, lack of visibility of more than 5 miles for long periods, a consistent cloud layer or a lack of clouds for long periods, and so forth.

(v) The processor shall recognize continued static data output, which usually indicates a malfunction. If the sensor output is static for a sustained period of time, the parameter shall be reported as missing. For example, if the anemometer output does not vary for 15 minutes, it would be assumed frozen or otherwise inoperative and wind "missing" would be reported.

(3) Weather Algorithms. The system processor shall implement algorithms provided by the FAA to generate the elements of the weather observation. If the output is to be supplied to the National Weather Network, it shall be in accordance with the appropriate Interface Control Document (ICD) (e.g., AWOS/ADAS ICD). Copies of the ICD's may be obtained from the AWOS Program Office at the address given in the front of the circular. An observation shall be generated each minute containing the current weather information for all the valid parameters observed by the AWOS.

(4) System Output. The system shall generate the first output listed below with the other output formats being provided at the manufacturer's option.

(i) Computer generated voice transmitted to pilots over radio (VOR, NDB, discrete frequency, etc.);

(ii) Optional telephone port for dial-up service;

(iii) Optional output port for a video display

(iv) Optional input/output port for an operator terminal;

(v) Optional output port to the national weather network.

(5) Real Time Clock. The Universal Time Constant (UTC) Time shall be a product of the processor. Typically, days, hours, minutes, and seconds are provided as a system output for use in system displays, computer generated voice output, etc. The day shall be expressed in the Gregorian Calendar. Hours and minutes shall be indicated numerically from 0000 to 2359. The clock function shall be accurate within 15 seconds a month.

(6) Power Outage. The system shall return to normal operation without human intervention after a power outage. The system shall not output erroneous data when power is restored.

(7) Data Archiving. The processor shall retain a representative sample of the weather reports for use by accident investigators. The interval between archived reports shall not be more than 20 minutes, and the report shall be retained for at least 96 hours (4 days). A method shall be provided for the retrieval of archived reports, and the operator shall be able to suspend the updates of the archived weather reports to freeze the data until retrieval may be accomplished.

(8) System Constants. The following system constants shall be either permanently installed in the processor at the factory or placed in a tamper-proof enclosure so that they may not be changed after initial adjustment at the site.

(i) Elevation of the pressure sensors at the installation site (MSL).

(ii) Magnetic variation of the intended installation site to the nearest degree.

(iii) AWOS facility identification.

(iv) Algorithm constants to include the pressure reduction ratio or pressure reduction constant.

(v) Alert criteria, including site unique criteria.

b. Performance Testing. System processing validation tests shall be performed in three stages.

(1) A listing of digital data sets will be supplied by the FAA. This data shall be inputted into the system processor to verify proper operation of the algorithms. Fixed and variable data sets will be provided to exercise the processor over the full range of possible sensor inputs and will include various overrange and abruptly changing data to check the data reduction quality control routines. Smaller data subsets shall be run with the processing unit operating in extreme environmental conditions.

(2) Analog data sets (or digital data sets, if sensor output is digital) corresponding to the digital data above shall be inputted at the sensor input ports to verify accurate and correct operation of the data acquisition process.

(3) Finally, a full complement of actual sensor devices shall be connected to the processor (through the data collection unit if part of the design) and driven by actual or simulated weather conditions to verify accurate and correct operation of the entire AWOS unit. The sensors shall have passed their individual performance/acceptance tests. Data outputs from the processor shall meet the same standards of accuracy as have been established for the sensors in their individual parts of this document.

28. OPERATOR TERMINAL (OT). The OT is an optional component of the AWOS. It is normally a part of an AWOS installed at a facility with a qualified weather observer. It includes a video display terminal and keyboard as well as a microphone that will permit the manual addition of a voice message to the end of the computer generated voice message.

a. Performance Standards.

(1) Product Editing. The product editing function allows an authorized observer to initiate or change any observation product. A specific "editing" password shall control access to this function. Manual entries of weather phenomena not automatically observed shall be placed in the remarks section of the observation. In the case of a sensor failure or an incorrect AWOS output, an operator shall have the capability to replace the incorrect parameter value with a missing symbol. An authorized observer shall have the capability to:

(i) Prepare a current observation using the latest updated parameters.

(ii) Prepare corrected observation products, either from scratch or by editing a previously disseminated product still accessible in memory.

(iii) Edit any observation product (before release for dissemination) by override of AWOS parameters, cancellation of AWOS parameters, addition of new data, or cancellation of the entire product.

(iv) Add to the voice message. Typically, the OT should have the capability to manually input a voice message (30 seconds maximum) to the end of the computer-generated voice message.

(2) Security. If an OT is a part of the AWOS system, it shall be designed to prevent unauthorized persons from entering data into the system. The system shall require the operator to enter a successive series of codes in response to system queries prior to allowing him to proceed with the entry of data.

(3) Periodic Data Validation. Where an OT is used to modify the report, all manually entered data shall be automatically time tagged by the system. The data shall be valid until the next hourly or manually inputted observation. In order to retain the manually entered data in the system, the operator shall be required to revalidate his entries hourly. The data shall be retained in the observation until the "on-the-hour" observation, when it must be revalidated. If no data is to be changed, the operator shall be able to accomplish the revalidation using a simple procedure. The data shall then be tagged with a new one-hour limit.

b. Performance Testing. The AWOS manufacturer shall test the OT to demonstrate that the unit performs as follows:

(1) Displays the most current AWOS observation.

(2) When called for in the system design, retrieves archived data.

(3) Editing capability, to include rejection of erroneous inputs.

(4) When called for in the system design, provide maintenance diagnostics data and perform maintenance diagnostics.

(5) Adequate AWOS/OT communications security.

(6) Manual voice entry capability.

29. VOICE SUBSYSTEM. The voice subsystem shall provide high quality computer-generated speech for output of the AWOS observation. A high level error-checking scheme shall be incorporated to prevent erroneous outputs. The voice subsystem will also provide the speech for the local ground-air radio broadcast and for telephone dial-up users. An optional feature is the capability for the addition of a manually input (analog) voice message from the OT (a maximum of 30 seconds duration) at the end of the computer-generated voice message.

a. Performance Standards. The voice subsystem shall have the following features:

(1) The voice output shall be a balanced, low-impedance driver providing a minimum of 1 milliwatt of power into a 600-ohm line. The output amplitude shall be adjustable with a nominal 0 db output.

(2) The voice message shall be output continuously with approximately a 5-second delay between the completion of one message and the beginning of the next.

(3) If the voice message is in process of output when the new AWOS observation is received, the output message will be completed without interruption; voice transmission of the new AWOS observation will begin upon completion of the next delay time.

(4) The quality (clarity and phrasing) of the automated speech shall provide high intelligibility from telephone and ground-air radio transmitters. As a guideline, the FAA Voice Response System (VRS) provides the quality of synthesized voice acceptable for the AWOS. Information on the VRS may be found in Notices to Airmen (Class II), and the Airman's Information Manual, Basic Flight Information and ATC Procedures. These documents may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Information may also be obtained by telephoning the IVRS Project Office at (202) 426-9393.

(5) The format and sequence of the voice message shall be in accordance with FAA Order 7110.10, Flight Services Handbook. This document may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. When any weather parameter is reported "MSG" (missing) due to a disabled or inoperative sensor, as determined by internal AWOS checks, the voice report shall be "(parameter) MISSING", e.g., "WIND SPEED MISSING," "CLOUD HEIGHT MISSING," etc. The UTC time of the observation will be given after the location identification.

(6) If a valid data update is not received prior to the start of the next voice transmission, the last valid data set received shall be used to compose the voice message. Failure to receive a data update for more than five minutes shall result in the termination of the voice output and generation of a failure message. In this event, the AWOS shall output the message "(station identification) automated weather observing system temporarily inoperative."

(7) As an option, the voice system may contain an automatic telephone answering device that will permit user access to the voice message via the public telephone system. The incoming call shall be answered prior to completion of the second ring, and the audio signal in progress at the time the call is received shall be placed online. The voice subsystem shall automatically disconnect when the weather observation has been completely transmitted twice. Typically, the telephone answering device should have the capability to answer five calls at a time with no loss of audio signal strength or intelligibility. The minimum requirement is that the system answers a single call.

(8) The voice system shall contain a headset/speaker jack for monitoring the voice output.

(9) The voice quality shall not be degraded when output on a VOR, NDB, or other navigational aid.

b. Performance Testing. As a minimum, the manufacturer shall demonstrate the following voice unit capabilities:

(1) Capability to generate all combinations of words corresponding to possible AWOS output reports.

(2) Detection of communication transmission errors, data loss, and cessation of voice transmission after loss of updates.

(3) Response to dial-up requests for voice data.

(4) If the Operator Terminal is offered as an option, demonstrate the transmission of the manually input voice messages at the end of the AWOS observation.

(5) The frequency response of the computer generated speech (i.e., voice quality) is compatible with the frequency of the intended transmission medium (i.e., VOR, NDB, VHF radio, or telephone.)

(6) Tests shall be performed to demonstrate that the quality of the AWOS computer-generated voice is equal to or greater than the VRS.

30. ELECTROMAGNETIC INTERFERENCE (EMI) PROTECTION. The AWOS is to be designed to minimize susceptibility to EMI and to operate sucessfully in the complex electromagnetic environment of an airport.

31. TRANSIENT AND LIGHTNING PROTECTION. AWOS equipment shall be protected against damage or operational upset due to lightning-induced surges on all sensor input lines, sensor supply lines, and incoming power and data communications lines. Equipment (including electrical circuits of fiber optics modems) and personnel shall be protected from lightning currents and voltages, from power line transients and surges, and from other electromagnetic fields and charges. Lightning protection systems shall be designed and installed in accordance with the Lightning Protection Code, NFPA 78, for all equipment and structures. This publication may be obtained from the National Fire Protection Association, Inc., 470 Atlantic Avenue, Boston, MA 02210.

a. General.

(1) Cone of Protection. All equipments, including antennas, sensors, and obstruction lights that are tower mounted, shall be within a maximum 45 degree cone of protection provided by an air terminal. The air terminal shall be connected to the earth electrode grounding system. The structure of steel towers may serve the function of down conductors, provided that air terminal and grounding cable connections are made as defined herein.

(2) Materials. All materials shall be UL approved for the purpose used except where specific requirements or exceptions given herein apply. Down conductor shall be a soft-drawn, stranded, bare copper cable weighing approximately 215 pounds per 1,000 feet. Down conductors shall always be routed in a downward direction and bends shall have an 8 inch or greater radius. Down conductors shall be attached to the tower at approximately 3-foot intervals. Substantial electrical and mechanical connections are required between air terminals and down conductors, and between down conductors and the below grade earth electrode grounding system.

b. Earth Electrode Grounding System. New earth grounding systems shall be provided and installed, or existing earth grounding systems shall be upgraded as necessary. These grounding systems shall consist of driven ground rods or buried plates, and buried interconnecting cables. All site grounding conductors shall terminate or directly connect to the earth ground system. Adjacent earth grounding systems within 30 feet of each other shall be interconnected by buried cables. The earth electrode grounding system configurations shall depend upon the geological conditions at the site, with very extensive systems justifiable in areas with high soil resistivity and frequent lightning damage. Ground rods shall be copper clad steel, UL approved, 10-foot minimum length, 3/4-inch minimum diameter, pointed end or coupling type, as necessary. Tops of driven rods shall be at least 18 inches below grade level. Separation between rods at a site shall be at least equal to their driven depth and preferably at twice their depth where space permits. Grounding plates shall be 20-gauge minimum sheet copper and at least 2 feet by 2 feet in size. Grounding cables used to interconnect ground rods or plates shall be bare copper of the same size as the largest down conductor required for the site. Grounding cables shall be installed a minimum of 18 inches below grade level. All steel materials used to anchor guy wires shall be interconnected using split bolt connectors and No. 6 AWG bare copper grounding wire. Similar bonding jumpers shall be connected around guy wire couplings and fittings. Where driven poles or foundation piers are required to support towers, earth grounding cables shall be installed.

c. Grounding. Grounding shall be provided to conduct lightning charges, power faults, and unbalanced currents; to eliminate static and electromagnetic charges; and to provide an equal potential reference for the operation of equipments. All metallic structures, enclosures, conduit, cable armor, and conductor shielding shall have a direct, identified path to the earth electrode grounding system. The grounding path shall be provided by a separate grounding conductor or by bonding metallic structures or enclosures with a separate conductor to the earth electrode grounding system. All grounding conductors shall be routed as directly as possible without loops, excess length, or sharp (less than 8 inch radius) bends. All equipment enclosures, housings, cases, cabinets, cases, cabinets, and racks shall be grounded by an equipment grounding conductor provided and installed in accordance with the National Electric Code (NFPA-70), except that conduit and other power circuit enclosures shall not be used to serve the purpose. A separate equipment grounding conductor shall be provided and installed with each power circuit. The neutral conductors for power circuits shall not be grounded in or by any equipment or at any point in the system except at service entrances as defined by the NEC. At service entrances and at main disconnect circuit breaker boxes, the power neutral conductor and the equipment grounding conductor shall be balanced 2-wire signal lines to serve as ground return or reference. The outer conductors for all coaxial, twinaxial, and triaxial cable shall be grounded at equipments, antennas, and bulkheads, and not isolated at any point.

d. Bonding. Bonding is the mechanical and electrical connection of metal materials, wires, and cables for the low impedance conduction of currents and electromagnetic energy. The effectiveness of lightning portection, transient protection, grounding and shielding depends upon the quality of bonding connections. Therefore, high quality bonding shall be designed and implemented into the AWOS and its installations.

e. Shielding. Shielding shall be provided to protect equipment and interface lines (all signal data, control, monitoring, power lines, and cables) from lightning currents and discharges. Shielding shall also provide for the containment of interference and signals produced by equipments and to protect susceptible equipments from related environmental signals and interference.

f. Conductor Segregation, Separation, and Routing. The segregation, separation, and routing of all lines, cables, and conductors shall be designed by the installer to minimize the coupling of lightning currents, transients, surges, and interference. AC power lines, signal lines, and grounding cables shall be segregated and routed separately and not installed in the same trench or conduit. The parallel routing of these types of cables shall be avoided, and, where necessary, shall conform to NFPA-78 code. To the extent feasible, all crosses shall be at right angles.

g. Transient and Surge Suppression. All transients and surge arrestors, suppressors, circuits, and components required for the system and equipments shall be furnished and installed by the installer except for the suppressors required at service entrances to existing buildings and shelters. These service entrance suppressors shall be supplied by the manufacturer and installed by the installer.

CHAPTER 4. SITING CRITERIA FOR AWOS

32. GENERÀL. This chapter contains the siting criteria for the Automated Weather Observing System (AWOS). These criteria are specifically adapted for AWOS installations at airports and heliports from the Federal Standard for Siting Meteorological Sensors of Automated Weather Observing Systems at Airports and Heliports (Draft). These criteria apply to AWOS installations at airports with visual, nonprecision, and Category I instrument runways, with 95% or more of their forecast traffic in Airplane Design Groups I, II, or III. Airplane Design Groups are defined in AC 150/5300-4, Utility Airports--Air Access to National Transportation, current edition, which may be obtained from the Department of Transportation, Subsequent Distribution Unit, M-494.3, Washington, D.C. 20590. At airports with Category II or III instrument runways, or whose forecast traffic includes more than 5% in Airplane Design Groups IV, V, or VI, there are more restrictions on placing hardware in the vicinity of the runway. On these airports AWOS siting must be determined on a site-by-site basis, using the criteria in this chapter as a guide. When planning AWOS siting, the designer should consider future plans for the airport/heliport (e.g., installation of an ILS/MLS, runway construction, etc.) that could impact the AWOS siting.

33. DEVIATIONS. All deviations from the siting criteria contained in this chapter must be approved by the FAA regional office. It is important to adhere to the siting criteria in this Appendix whenever possible, since the ability of the weather sensors to provide reliable and representative data depends to a large extent on the exposure of the sensors to the prevalent weather conditions. In cases where it is impossible or impractical to strictly adhere to these siting criteria, the FAA will approve a deviation only after a thorough analysis of the impact on sensor and system performance.

34. ENVIRONMENTAL IMPACT. An environmental impact statement is not required.

35. PRESSURE SENSORS.

a. Siting. The pressure sensors are typically installed in a weatherproof facility (building, shelter, enclosure, etc.) located on the airfield. FAA regional office approval is necessary before locating the data processing unit (DPU) and pressure sensors off the airport. Before requesting approval of an off-airport location, a study must be conducted which considers precipitous terrain, the distance between the sensor and the airport, and weather history. In order to establish reference values for the altimeter, a qualified surveyor must determine the mean sea level (MSL) elevation for both the sensor and the airport within one foot. The difference between the pressure sensor elevation and the airport elevation shall not exceed 100 feet (30m).

b. Venting. In most cases, internal venting of the pressure sensors is satisfactory. However, if it is determined that internal venting will affect the altimeter setting value by ±0.02 inHg or more, then outside venting must be used. Outside venting is accomplished by use of a vent header. A portable transfer standard is used to resolve any questions regarding the need for external venting.

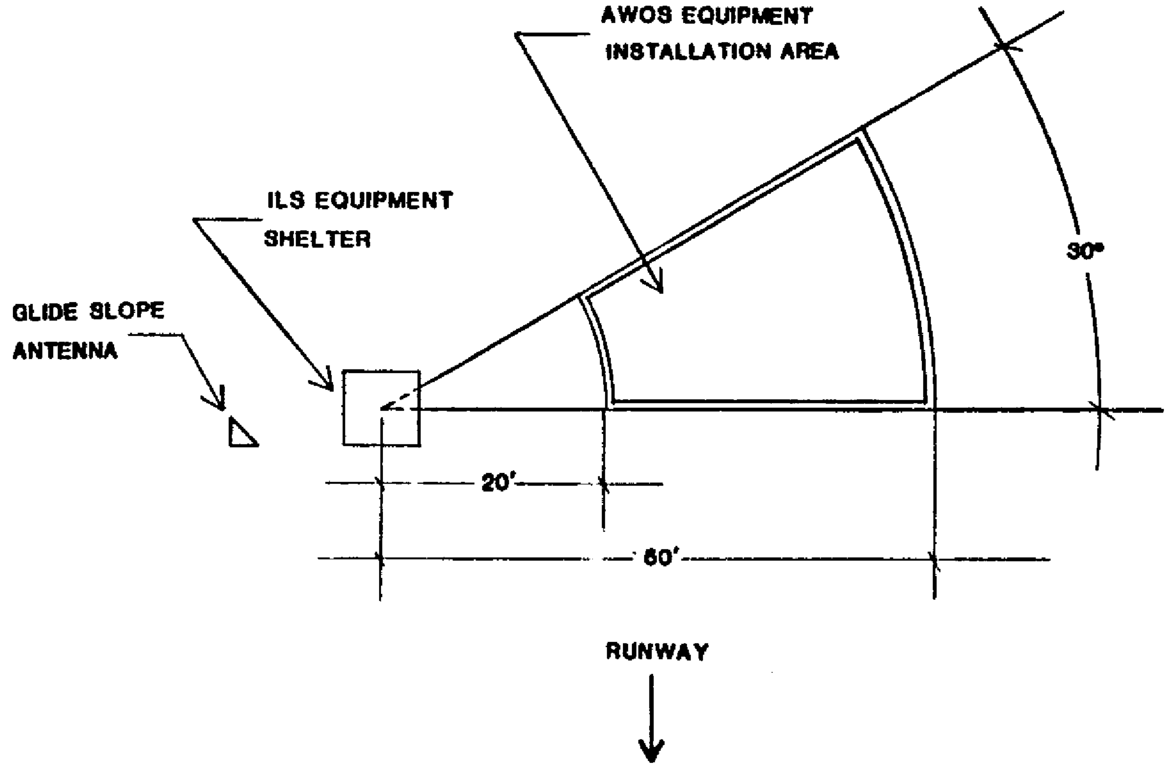
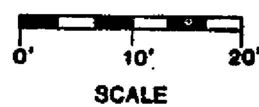


FIGURE 1. PRECISION INSTRUMENT RUNWAY AWOS SITING



(iii) If an obstruction lies between 500 and 1000 feet from the wind sensor, but does not block more than 10 degrees of azimuth, then the height computed in step (ii) may be reduced by 5 feet for every 100 feet in excess of 500 feet the obstruction is distant from the sensor. The height of the sensor may not be reduced to less than 30 feet.

(4) Temperature and Dewpoint Sensors. These sensors are mounted approximately 5 to 8 feet (2 ±0.5 m) above the ground level with an unobstructed flow of air. The sensors are sited to provide temperature representative of the area around the airport and must be protected from reflective surfaces or other temperature influencing sources (e.g., air conditioners, roofs, etc.). The sensors are shielded from direct solar radiation and long-wave radiation from the earth or man-made structures without preventing the flow of ambient air over the sensing elements.

(5) Precipitation Occurrence (Yes/No) Sensor. The precipitation occurrence sensor is mounted in accordance with the manufacturer's specifications at a convenient height but not less than 6 feet (2 m) above ground level. Care must be taken to avoid shielding of the sensor by structures, buildings, and obstacles.

(6) Precipitation Accumulation (Liquid or Liquid Equivalent) Sensor. This sensor is mounted so that the orifice is horizontal and in an area where the terrain is relatively flat. The height of the orifice should be as close to ground level as practicable. In determining the height of the orifice, consideration is given to keeping the orifice above accumulated/drifting snow and the potential for splashing into the orifice. Except for lightning rods and similar objects, objects extending above the height of the sensor orifice should be no closer to the sensor than 4 times the difference in height between the sensor orifice and the object. For example, if the sensor orifice is 6 feet above the ground and a building is 20 feet high, the sensor should be at least 56 feet from the building (4 X (20 - 6) = 56 feet). A wind tower is not considered an obstruction but should be at least 15 feet (4.5 m) away from the precipitation accumulation sensor. In order to reduce losses due to wind, an alter-type wind shield may be used.

(7) Combined Visibility / Precipitation Occurrence / Precipitation Accumulation Sensor. The siting requirements for the visibility sensor apply to this combined sensor or any other combinations of the precipitation parameters and visibility.

37. RUNWAY SURFACE CONDITION SENSORS. In general, the guidance in the manufacturer's instructions apply to the siting of these sensors. However, above-ground components (e.g., remote field unit) must not violate runway safety area, obstacle free zone, or instrument flight procedure surfaces as defined in the documents referenced in paragraph 36a.

38. HELIPORT SITING CRITERIA.

a. Non-airport Heliport Siting Criteria. For AWOS installations at heliports which are not located on airports, the sensors (except the pressure sensor) are sited within 700 feet (210 m) of the edge of the takeoff and landing area. Within this area, the sensors should be sited as far as possible from the approach and departure obstacle identification surfaces defined in TERPS (see paragraph 36a).

At heliport installations, it is very important to locate the sensors so that they are exposed to representative weather, while preventing them from being influenced by rotor downwash and other transient conditions. When choosing a sensor location, consideration must be given to all contemplated operations: IFR and VFR, approaches and departures, and hovering and taxiing. Tests have shown that sensors are not significantly affected when located about 100 feet from a medium weight helicopter. Conversely, the sensors must not be sheltered so that they provide unrepresentative weather conditions. This may be a particular problem for heliports located in urban areas and on rooftops. In the ideal installation, the sensors are clustered together for ease of installation and maintenance. However, optimum siting of the individual sensors may require that they be separated.

The pressure sensor is not constrained to be at any specific location on the heliport. Specific guidance on the siting of individual sensors follows, with siting at airports referring to paragraphs 35 and 36.

(1) Pressure Sensors. Pressure sensors are sited the same as for airports, except the height above or below mean sea level is determined for the heliport takeoff and landing area.

(2) Sensors in Vicinity of Takeoff and Landing Area (Cloud Height, Visibility, Wind, Temperature/Dewpoint, Precipitation). These sensors are sited as indicated below. In areas subject to large amounts of snow, the heights specified are adjusted upward by an amount equal to the normal predicted snow depth for the area.

(i) Cloud Height Sensor. Same as for airports.

(ii) Visibility Sensor. Same as for airports, except the height is with respect to the takeoff and landing area. To reduce the influence of dust due to rotorwash on the reported visibility, the visibility to sensor should not be sited in a location which is downwind (considering the prevailing wind direction) from the takeoff and landing area.

(iii) Wind Sensor. This sensor is oriented with respect to true north, and is mounted 20 to 33 feet (6 to 10 m) above the heliport takeoff and landing area. If side mounting on a tower is necessary, a boom is used to permit installation of the sensor a minimum of 3 feet (1 m) laterally from the tower.

(A) Ground Level Heliports. The wind sensor should be located to the side of the preferred approach and departure track. The sensor should be removed from the sheltering influence of buildings or large trees.

(B) Rooftop Heliports. The wind sensor on a building or other elevated landing structure should be located at least 20 feet (6 m) above the highest structure to minimize the Bernoulli effect. Rooftop size may require siting the wind sensor elsewhere to preclude penetration of an obstacle identification surface(s). In these situations, siting on an adjacent building may be a viable or even preferred option.

(iv) Temperature and Dewpoint Sensors. Same as for airports, except the height is with respect to the takeoff and landing area.

36. CLOUD HEIGHT, VISIBILITY, WIND, TEMPERATURE, DEWPOINT, AND PRECIPITATION SENSORS.

a. General. The sensor siting must not violate runway safety area, obstacle free zone, or instrument flight procedure surfaces as defined in AC 150/5300-4 (Utility Airports--Air Access to National Transportation), AC 150/5300-12 (Airport Design Standards--Transport Airports) or FAA Handbook 8260.3 (Terminal Instrument Procedures (TERPS)). The AC's may be obtained from the Department of Transportation, Subsequent Distribution Section, M-494.3, Washington, D.C. 20590. The FAA Handbook may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. These sensors (cloud height, visibility, wind, temperature, dewpoint, and precipitation) should be located together near available power and communications. However, the temperature, dewpoint, and precipitation sensors are not site-critical and can be placed at any convenient location on the airport that meets the specific sensor siting criteria outlined below. This alternate siting will be particularly advantageous for simplified systems (such as AWOS-I). FAA sector managers must approve the use of any FAA facilities such as power, communications, shelters, towers, etc. In areas subject to large amounts of snow, the sensor heights specified below are adjusted upward by an amount equal to the normal snow depth for the area.

b. Airports With Precision Instrument Runways. If there is no violation of the obstacle surfaces described above, the cloud height and visibility sensors and associated data collection package (DCP) are located behind the glide slope shelter/MLS elevation station used for the primary precision instrument runway, as shown in figure 1. At locations with an ILS, the wind sensor is installed on the ILS glide slope antenna tower. Exceptions: (1) If this sensor location would result in a violation of an obstacle surface, an alternative location is selected that does not violate the surface and is as close as possible to the siting depicted in figure 1. (2) If a convenient location other than the ILS glide slope antenna tower is available for the wind sensor, and this location would provide wind data representative of conditions in the touchdown area of the primary instrument runway, the wind sensor may be sited at this location.

c. Airports With Only Nonprecision and/or Visual Runways. The cloud height, visibility, and wind sensors are located adjacent to the primary runway. Options 1 and 2 below describe location of the sensors in relation to the runway centerline and threshold. Option 1 is preferred and is used unless such siting would result in a significant increase in installation costs or less than optimum exposure of the sensors. Option 2 is to be considered as the first alternative to Option 1. However, if both of these options would result in an off-airport sensor location, require installation of an additional DCP, or result in poor quality weather observations, a deviation can be requested in accordance with paragraph 33.

(1) Option 1. The cloud height, visibility, and wind sensors and associated DCP are located 1000 feet (300 m) to 3000 feet (1000 m) down the runway from the threshold. The minimum distance from runway centerline is 500 feet (150 m); the maximum distance is 700 feet (210 m).

(2) Option 2. The cloud height and visibility sensors and associated DCP are located 1000 feet (300 m) to 3000 feet (900 m) down the runway from the threshold. The minimum distance from runway centerline is 320 feet (100 m) for a visibility sensor mounted at the preferred height of 10 feet (3 m); the maximum distance is 700 feet (210 m). The wind sensor is located 1000 to 4000 feet (300 to 1220 m) down the runway from the threshold, and between 500 and 700 feet (150 to 210 m) from the runway centerline.

d. Specific Sensor Siting Criteria.

(1) Cloud Height Sensor. This sensor is mounted on a platform/pedestal high enough to be clear of typical snow accumulation or drifting snow. The sensor is located as far as possible from strobe lights and other modulated light sources.

(2) Visibility Sensor. This sensor is mounted on a platform/pedestal as free as possible from jarring vibration, with the receiver pointed in a northerly direction. The sensor is located as far as possible from strobe lights and other modulated light sources. The sensor should not be located in an area that is subject to localized obstructions to vision (e.g., smoke, fog, etc.) nor in an area that is usually free of obstructions to vision when they are present in the surrounding area. The sensor is mounted so that the optics are 10 ±4 feet (3 ±1.2 m) above the ground with 10 feet the preferred height. Any heights above 10 feet may violate the surfaces described in subparagraph a above and require moving the sensor further from the runway centerline. The sensor is placed in a circular area of between 150 and 300 feet (45 to 90 m) radius clear of trees or high brush. Sensors which require a larger clear area will be identified during the FAA type approval, and this fact will be highlighted in the manufacturer's installation instructions. The clear line of sight requirement for the sensor optics will also be specified in the installation instructions.

(3) Wind Sensor. This sensor (wind speed and wind direction) must be oriented with respect to true north. If an ILS glide slope antenna tower is used to mount the wind sensor, all parts of the installation shall not project beyond the front "face" of the antenna system. Also, if side mounting (i.e., perpendicular to the tower) is necessary, a boom must be used to permit installation of the sensor a minimum of 3 feet laterally from the tower. The wind sensor is mounted 30 to 33 feet (9 to 10 m) above the average ground height within a radius of 500 feet (150 m). The sensor height should not exceed 33 feet except under the following circumstances.

(i) The sensor must be at least 15 feet above vegetation, buildings, or other obstructions within a 500-foot radius of the sensor.

(ii) If an obstruction lies between 500 and 1000 feet from the wind sensor, and the obstruction blocks 10 degrees of azimuth when viewed from the wind sensor (i.e., the included lateral angle from the sensor to the ends of the obstruction is 10 degrees or more), then the sensor height must be 10 feet higher than the obstruction.

(v) Precipitation Sensors. Same as for airports, except the height is with respect to the takeoff and landing area.

b. Airport Heliport Siting Criteria. When AWOS is sited at an airport which has or is contemplating a heliport, a site should be chosen which will provide service to both runway and heliport users. The AWOS should be sited in accordance with one of the following options, which are listed in order of decreasing desirability.

(1) Option 1. The AWOS should be sited in accordance with the applicable airport siting criteria (paragraph 35 through 37) if this siting would also satisfy the nonairport heliport siting criteria of this paragraph.

(2) Option 2. If AWOS siting complying with Option 1 is not appropriate, an alternate location should be selected which enhances the quality of the data at the heliport without degrading the data at the primary airport runway. If such an alternate site is selected, a deviation shall be processed in accordance with paragraph 33.

(3) Option 3. If siting in compliance with Option 1 or 2 is not possible, the AWOS is sited in accordance with either paragraphs 35 through 37 or subparagraph a of this paragraph, taking into consideration such factors as volume of fixed-wing/helicopter traffic. If siting according to this paragraph is more appropriate, a deviation to use the nonairport siting shall be processed in accordance with paragraph 33.

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