U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Airworthiness Approval for Aircraft Weather Radar Systems | **Date**: 6/17/14 | **Initiated by**: AIR-130 | **AC No**: 20-182

1. Purpose.

a. This advisory circular (AC) provides guidance for the initial and follow-on airworthiness approval of aircraft weather radar systems meeting the latest revision of the Technical Standard Order (TSO)-C63, *Airborne Weather Radar Equipment*. This AC covers aircraft weather and ground mapping pulsed radar systems, and airborne Doppler weather radar systems with forward-looking windshear, turbulence detection or weather hazard indication capability. The guidance is applicable to Title 14 of the Code of Federal Regulations, parts 23, 25, 27, and 29 aircraft. This AC does not address forward-looking windshear and/or turbulence detection capability for rotorcraft.

b. This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable means, but not the only means, of accomplishing airworthiness approval for the installation of airborne weather radar equipment. However, if you use the means described in this AC, you must follow it entirely. The term "must" is used to indicate mandatory requirements when following the guidance in this AC. The terms "should" and "recommend" are used when following the guidance is recommended but not required to comply with this AC. A list of related documents can be found in Appendix B of this AC.

c. This AC provides guidance intended for new approvals. This AC is not intended to modify, change, or cancel existing equipment design or airworthiness approvals. Equipment with existing approvals can continue to be installed within the provisions of its original design and airworthiness certification.

2. Audience. This AC is for applicants seeking airworthiness approval of aircraft weather radar systems. The airworthiness approval can be approved under a type certificate (TC), supplemental type certificate (STC), amended type certificate (ATC), or amended supplemental type certificate (ASTC).

3. Background.

a. Airborne Doppler Weather Radar Systems with Forward-Looking Windshear Detection. The FAA previously accepted an interim certification document titled "System Level

Requirements (SLR) 10.2" as a basis for airworthiness certification of forward-looking windshear systems. SLR 10.2 was an interim certification basis for a maturing technology. With the forward-looking windshear technology now mature, the FAA is publishing this AC adopting the appropriate airworthiness guidance from SLR 10.2.

> **Note:** The formal title of SLR 10.2 is "Airborne Short and Long Range Windshear Predictive Systems (Forward-Looking Windshear Systems) Interim Certification Requirements, Revision 10.2."

b. Airborne Doppler Weather Radar Systems with Forward-Looking Turbulence Detection. Prior to February 2012, the FAA used design standards developed by the Airborne Turbulence Detection Systems (ATDS) Working Group and airworthiness requirements documented in issue papers to certify forward looking turbulence detection radars. The FAA published TSO-C63d in February 2012 incorporating the ATDS Working Group design requirements. This AC incorporates the remaining airworthiness guidance from issue papers into formally published FAA guidance.

4. General.

a. The display of weather radar alerts, graphical depictions of weather or other hazards, and the expected pilot response to information provided by the weather radar system (for example, display format, colors, labels, data formats and interaction with other display parameters) should be clear and unambiguous.

b. In general, the progression from green to amber/yellow to red represents an increasing degree of threat, potential hazard, or need of flight crew awareness or response. You should ensure the use of color for display of weather radar system information follows the guidance in the latest revisions of the following ACs for parts 23, 25, 27, and 29 aircraft:

(1) AC 25-11, *Electronic Flight Displays*, Appendix G *Weather Displays.*

(2) AC 25.1302-1, *Installed Systems and Equipment for Use by the Flight Crew*.

(3) AC 25.1322-1, *Flight Crew Alerting.*

(4) AC 23.1311-1, *Installation of Electronic Display in Part 23 Airplanes.*

(5) AC 27-1, *Certification of Normal Category Rotorcraft.*

(6) AC 29-2, *Certification of Transport Category Rotorcraft.*

c. The weather radar system may interface with other systems (for example, ground proximity warning system, and traffic alert and collision avoidance system).

d. You must ensure the weather radar system does not adversely affect the functioning of, and is not adversely affected by, other aircraft systems.

e. You must document any areas where radar emissions could be harmful to people or wildlife. The following three standards provide acceptable guidelines for safe radar operation and determining minimum safe distances:

(1) AC 20-68B, *Recommended Radiation Safety Precautions for Ground Operation of Airborne Weather Radar*.

(2) IEEE standard C95.1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*.

(3) Federal Communications Commission OET Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*.

f. Some system configurations utilize the transponder mode to automatically activate the radar to enable forward-looking windshear alerts during takeoff, even if the flight crew has not manually activated the radar. This configuration was established at a time when the transponder was not turned on until an aircraft taxied onto the runway before takeoff, and was turned off when the aircraft left the runway after landing. However, with the advent of Airport Surface Detection Equipment-Model X (ASDE-X) radars and Automatic Dependent Surveillance-Broadcast (ADS-B), flight crews now routinely keep the transponder ON while taxiing. This could create a hazard for ground crews handling the aircraft, as marshalers and tug operators often operate in extremely close proximity to the nose radome. A hazard assessment should be done for the automatic activation feature of the forward-looking windshear function taking this type of operation or any automatic ground activation feature of the windshear function into account.

5. Airborne Doppler Weather Radar Systems with Forward-Looking Windshear Detection.

a. Forward-Looking Windshear Activation.

(1) To allow timely takeoff abort due to windshear condition, you must ensure the forward-looking windshear function is capable of manual activation prior to the start of the takeoff roll.

(2) You must ensure the forward looking windshear function automatically activates for takeoff so that timely takeoff warnings are provided.

(3) When the forward-looking windshear function is enabled, you must ensure the system will automatically activate without flight crew intervention during descent to approach at

an altitude sufficient to allow visual and aural alerts as specified in paragraph 5.b(2) of this AC.

(4) You must ensure the forward looking windshear detection system is reset to the appropriate mode (landing or takeoff) in the event of a go-around or touch and go.

b. Forward-Looking Windshear Alert Requirements.

(1) You should ensure the alerts and annunciations follow the flight deck alerting philosophy for the aircraft and adhere to both the regulation and the guidance in the latest revision of the following ACs for parts 23, 25, 27, and 29 aircraft:

(a) 14 CFR § 25.1322, *Flight Crew Alerting*.

(b) AC 25.1322-1, *Flight Crew Alerting*.

(c) AC 23.1311-1, *Installation of Electronic Display in Part 23 Airplanes*.

(2) You must ensure the system is capable of detecting windshear alerts from ground level to 1200 feet above ground level (AGL).

(3) You must ensure the integrated system is capable of making all forward-looking windshear Level I, Level II, and Level III annunciations and alerts described in Table 1 of Appendix A.

(4) You must ensure the visual warning alerts are annunciated when any of the following conditions exist:

(a) The aural alert is being annunciated;

(b) The threat exceeds the alert threshold; or

(c) The threat exists within the area defined by the latest revision of the TSO-C63.

(5) You must ensure the annunciation of the failure of the windshear detection capability is readily visible to the flight crews from their normal seated position on the flight deck.

c. Forward-Looking Windshear Alert Inhibit.

(1) During takeoff, the system must be able to inhibit all new aural and visual alerts at a specified aircraft speed prior to rotation and re-enable the alerting capability after liftoff. Set the takeoff alert settings per installation manual instructions and ensure the inhibits coincide

with aircraft type specific takeoff alert inhibit criteria.

(2) During final approach, you must ensure all new system aural and visual caution and warning alerts are inhibited from 50 feet AGL until touchdown.

(3) You must ensure all new aural and visual warning and caution alerts are inhibited above 1200 feet AGL.

d. Forward-Looking Windshear Alert Prioritization.

(1) You must ensure all the aircraft alerts are prioritized. If alerts can be issued simultaneously or issued by separate systems, you must ensure the alerts do not interfere with one another and both are understandable. TSO-C151c, *Terrain Awareness and Warning System*, Appendix 1, Table 4-2 provides an acceptable example of alert prioritization. For part 25 aircraft, AC 25.1322-1, section 8.b provides additional information regarding prioritization of multiple aural alerts.

(2) If you install a forward-looking windshear system on an aircraft which also has a reactive windshear system, you must ensure the reactive windshear systems caution alert is disabled. It is acceptable to issue reactive windshear caution alerts if the forward-looking windshear system is inoperative.

Note: The reactive windshear system warning alert would remain enabled.

e. Display Requirements.

(1) It should be permissible to display the windshear icon at any altitude at which the system is armed in the windshear mode.

(2) The windshear icon consists of alternating red and black bars. The bars should be oriented such that they are circular arcs centered on the apex. The color red is appropriate in order to provide visual discrimination from underlying yellow weather display. Figure 1 in Appendix A depicts several forward-looking windshear icon examples.

(3) You should ensure the depth of each bar makes the windshear icon conspicuous from other displayed information.

(4) If the range selected by the flight crew for the display is greater than 5 nautical miles (nm), and this range selection does not allow the flight crew to differentiate the windshear symbology from other displayed information, you should ensure amber/yellow radial lines extend from the icon to the upper edge of the display to help differentiate the windshear symbology.

(5) If other windshear symbology is used, you should demonstrate that this symbology provides a clear and substantial benefit to the flight crew.

(6) When a windshear threat is detected, the corresponding display may be automatically presented or selected by flight crew action. If only manual selection is provided, you should ensure the flight crew workload necessary for manual presentation of the windshear display is minimized and does not take more than one action by the flight crew when the flight deck is configured using the normal operating procedures.

6. Airborne Doppler Weather Radar Systems with Forward-Looking Turbulence Detection.

a. The latest revision of the TSO-C63 defines three airplane classes. The airplane classes are solely differentiated by wing loading. You should ensure the radar is appropriate for the wing loading of the airplane.

b. Some applicants may wish to provide detection and display of multiple levels of turbulence. You should ensure the displays of those levels are sufficiently distinct from each other.

7. Test and Evaluation. This section provides guidance for testing radar systems on aircraft. Follow the guidance in section 7.a. for weather and ground mapping radar. Follow the guidance in section 7.b. if your radar system includes a forward-looking windshear detection function. Follow the guidance in section 7.c. if your radar system includes turbulence detection or weather hazard indication functions. Testing of all radar systems must ensure:

- The radar antenna and radome combination function correctly;
- The radar display, alerts, alert inhibits, alert prioritization, annunciations, and controls function correctly;
- The fault detection functionality works properly;
- The human factors interface is acceptable;
- The radar does not interfere with other systems; and
- Other systems do not interfere with the radar.

a. Weather Radar. Accomplish flight test of the weather and ground mapping pulsed radar functions in accordance with the latest revision of the following ACs for parts 23, 25, 27, and 29 aircraft:

(1) AC 23-8, *Flight Test Guide for Certification of Part 23 Airplanes*, Chapter 5, paragraph 1.b (10).

(2) AC 25-7, *Flight Test Guide for Certification of Transport Category Airplanes*, Chapter 6, section 1, paragraph 170.c(8).

(3) AC 27-1, Change 3, Chapter 3, AC 27 MG 1, paragraph b (10).

(4) AC 29-2, Change 3, Chapter 3, AC 29 MG 1, paragraph b (10).

b. Forward-Looking Windshear Detection. Follow the TSO installation instructions to verify performance of the forward looking windshear function. Installation testing of the forward looking windshear function often relies on general weather radar functional testing, as described in paragraphs 7 and 7.a. of this AC, and integration testing, versus dedicated forward looking windshear flight testing.

(1) Penetration Flight Evaluation. Penetration flights will typically be accomplished by the radar manufacturer as part of the TSO authorization. If penetration data and analysis is available and you determine it is applicable, you do not need to conduct penetration flight tests. Previously approved test data, generated during the TSO authorization or previous certification effort, is acceptable. If the forward-looking windshear capability has not been previously demonstrated, then the detection capability of the forward-looking windshear system must be verified by flying in areas of convective activity that can be verified by in-situ measurements, appropriate ground based radar systems, or equivalent.

> **Note:** Flying in or near storm cells can be extremely hazardous. Flight crews should exercise good judgment for safe flight based on knowledge of their own abilities and of the capability of the aircraft when considering approaching or penetrating any storm cell or turbulent area.

(2) Clutter Suppression Flight Test. Evaluate the system's ability to reject spurious conditions (for example, clutter suppression, bi/multi-static signal interference, range ambiguous returns, and radome effects). The flight tests may be conducted under visual meteorological conditions. Conduct this evaluation at one or more airports with the following characteristics:

(a) Expressways and high-volume surface streets within approximately 1 nm of the runway;

(b) Nearby taxiing aircraft; and

(c) Concentrated urban clutter. The clutter should occupy a minimum area of approximately 1 nm surrounding the airport.

c. Turbulence Detection or Weather Hazard Indication. Follow the TSO installation

instructions to verify performance of turbulence detection or weather hazard indication functions. Weather hazard indication functions could include, but are not limited to, hail and lightning indication. Installation testing of these functions often relies on general weather radar functional testing, as described in paragraphs 7 and 7.a. of this AC, and integration testing, versus dedicated flight testing. You should attempt to evaluate the performance of these functions against operationally significant weather when weather is reasonably available and you can do so without placing the aircraft in the hazardous weather. This performance evaluation should ensure the depiction of turbulence or weather hazard is consistent with the actual weather phenomenon. Data from the radar manufacturer may be used to supplement or replace additional flight testing if the data is determined to be applicable.

8. Aircraft Flight Manual/Supplement (AFM/S). Follow AC 23-8, Chapter 6, Section 3 for small airplane flight manual/supplement. Follow AC 25.1581-1, *Airplane Flight Manual*, for transport category airplane flight manual/supplement. Follow AC 27-1 and 29-2 as appropriate for rotorcraft flight manual/supplement. You should incorporate the following radar specific information in the AFM/S:

a. Describe the weather and ground mapping, windshear, turbulence detection, and/or weather hazard indication capabilities of the system.

b. Provide any limitations associated with the capabilities of the system.

c. Describe the appropriate actions and recovery procedures for annunciations and alerts.

d. Describe the conditions necessary for automatic activation of the system, if applicable.

e. Describe when alerts are provided, and when they are inhibited.

f. Outline the hazard areas associated with radar operation on the ground.

g. Describe limitations on use of the system.

h. Provide normal and abnormal operating procedures.

9. Instructions for Continued Airworthiness (ICA).

a. Incorporate the following information into the ICA:

(1) Maintenance instructions for the radar system and radome.

(2) Description of the interface between the radar and the aircraft.

(3) Calibration instructions to maintain the radome and antenna performance to a level equal to or better than that demonstrated for the basic system certification.

(4) Inspection intervals for the radar system and radome.

(5) Hazard areas associated with radar operation.

b. High performance radar radomes are precisely constructed. Small changes in their physical characteristics can adversely affect radar system performance. All repairs to radomes, no matter how minor, should return the radome to the minimum performances required for aircraft weather radar system operation. If you are repairing or replacing the radome in conjunction with the radar installation refer to the latest revisions of AC 43-14, *Maintenance of Weather Radar Radomes*, and RTCA/DO-213, *Minimum Operational Performance Standards for Nose-Mounted Radomes*, for additional information.

If you have any suggests for improvements or changes, you may use the template provided at the end of this AC.

Brenn Cable

/s/ James D. Siepel
Acting Manager, Design, Manufacturing, &
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Aircraft Certification Service

Appendix A. Forward-Looking Windshear System Annunciation, Alert, and Display

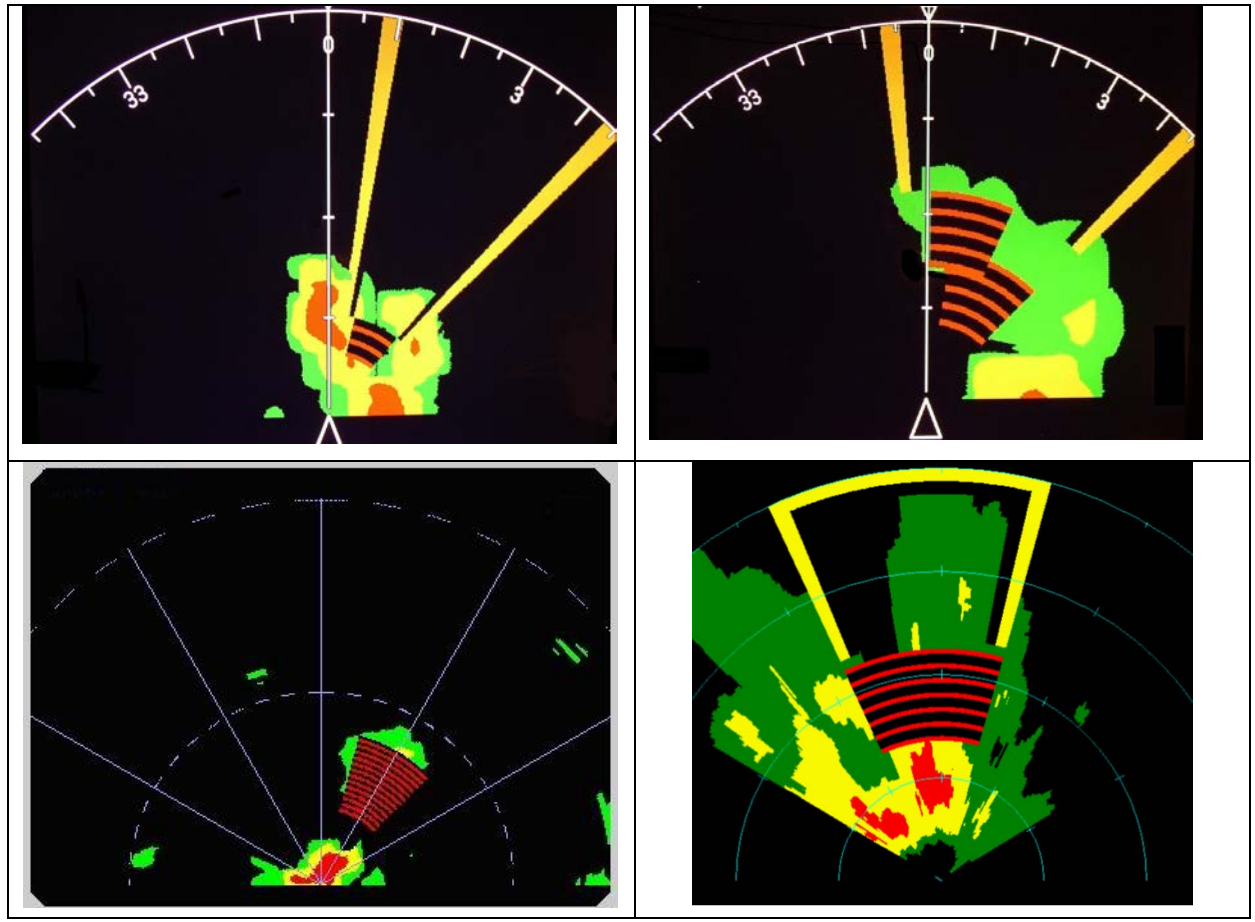
Table 1. Forward-Looking Windshear System Annunciation, Alert, and Display

Alert Level	Advisory (Level I)	Caution (Level II)	Warning (Level III)
Visual Alert	None	Amber/Yellow Visual Annunciation: "Windshear" or "Windshear Ahead" or "W/S Ahead"	Red Visual Annunciation: "Windshear" or "Windshear Ahead" or "W/S Ahead"
Aural Alert	None	Chime or message, not containing the word windshear. Example: Tone "Whoop" or "Monitor Radar Display"	Takeoff: "Windshear Ahead, Windshear Ahead" Approach or Go-around: "Go Around, Windshear Ahead"
Icon	Alternating Red and Black with Amber/Yellow radial lines	Alternating Red and Black with Amber/Yellow radial lines	Alternating Red and Black with Amber/Yellow radial lines
Flight Deck Presentation	A visual indication should be displayed in a location periodically scanned by the flight crew. (For part 25 aircraft, refer to AC 25.1322-1, paragraph 6.e.)	Along with the aural alert indicated above, a visual indication should be displayed within both pilots' primary field of view. (For part 25 aircraft, refer to AC 25.1322-1, paragraph 6.d.)	Along with the aural alert indicated above, a visual indication should be displayed within both pilots' primary field of view. (For part 25 aircraft, refer to AC 25.1322-1, paragraph 6.b.)

Note 1: The forward-looking windshear icon is provided as a weather hazard position indication and not an alert. Its color is not in conflict with the latest revision of AC 25.1322-1, Section 11, or AC 25-11.

Note 2: The forward-looking windshear caution alert may progress to a time-critical windshear warning alert depending on the location of the windshear hazard.

Figure 1. Forward-Looking Windshear System Icon Examples



Note: These images are provided only as examples of possible icon implementations. Other implementations may be used. Refer to manufacturer installation and operations manual for icon implementation.

Appendix B. Related Documents

Note 1: The ACs and TSOs referenced in this document refer to the current revisions.

Note 2: The industry documents referenced in this AC refer to the current revisions and amendments or regulatory authority-accepted revisions and amendments.

1. FAA Documents.

a. AC 20-68, *Recommended Radiation Safety Precautions For Ground Operation of Airborne Weather Radar*.

b. AC 23-8, *Flight Test Guide for Certification of Part 23 Airplanes*.

c. AC 23.1311-1, *Installation of Electronic Display in Part 23 Airplanes*.

d. AC 25-7, *Flight Test Guide for Certification of Transport Category Airplanes*.

e. AC 25-11, *Electronic Flight Displays*.

f. AC 25.1302-1, *Installed Systems and Equipment for Use by the Flight Crew*.

g. AC 25.1322-1, *Flight Crew Alerting*.

h. AC 25.1581-1, *Airplane Flight Manual*.

i. AC 27-1, *Certification of Normal Category Rotorcraft*.

j. AC 29-2, *Certification of Transport Category Rotorcraft*.

k. AC 43-14, *Maintenance of Weather Radar Radomes*.

l. TSO-C63, *Airborne Weather Radar Equipment*.

m. TSO-C151, *Terrain Awareness and Warning System*.

2. RTCA, Inc. Documents (RTCA DO). RTCA/DO-220, *Minimum Operational Performance Standards for Airborne Weather Radar with Forward-Looking Windshear Capability*, and Change 1.

3. How to Get Related Documents.

a. Order copies of 14 CFR parts from the Superintendent of Documents, Government Printing Office (GPO), P.O. Box 979050, St. Louis, MO 63197. For general information,

telephone (202) 512-1800 or fax (202) 512-2250. You can also get copies online at the GPO electronic CFR Internet website at www.gpoaccess.gov/cfr/.

b. You can get copies of ACs and TSOs from our website at from our website at http://www.faa.gov/regulations_policies/advisory_circulars/ or www.airweb.faa.gov/rgl.

c. Order copies of RTCA documents from RTCA Inc., 1150 18th St. NW, Suite 910, Washington, D.C. 20036. For general information, telephone (202) 833-9339 or fax (202) 833-9434. You can also order copies online at http:/www.rtca.org.

Appendix C. Advisory Circular Feedback Information

If you have comments or recommendations for improving this advisory circular (AC), or suggestions for new items or subjects to be added, or if you find an error, you may let us know about by using this page as a template and 1) emailing it to 9-AWA-AVS-AIR500-Coord@faa.gov or 2) faxing it to the attention of the AIR Directives Management Officer at 202-267-3983.

Subject: (insert AC number and title) Date: (insert date)

Comment/Recommendation/Error: (Please fill out all that apply)

An error has been noted:

Paragraph _____

Page _____

Type of error (check all that apply): Editorial----- Procedural-----

Conceptual____

Description/Comments:_____

_____

_____

Recommend paragraph _____ on page _____ be changed as follows:
(attach separate sheets if necessary)

_____

In a future change to this advisory circular, please include coverage on the following subject: (briefly describe what you want added attaching separate sheets if necessary)

_____

Name: _____