U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: PILOT COMPARTMENT VIEW DESIGN CONSIDERATIONS

Date: 1/8/93 **Initiated by:** ANM-110

AC No: 25.773-1 **Change:**

1. PURPOSE. This advisory circular (AC) sets forth a method for demonstrating compliance with the airworthiness standards for transport category airplanes pertaining to pilot compartment view. As with all AC material, it is not mandatory and does not constitute a regulation. It is for guidance purposes only.

2. RELATED DOCUMENTS.

a. Federal Aviation Regulations (FAR). The related sections of Part 25 include:

§ 25.237 Wind velocities
§ 25.773 Pilot compartment view
§ 25.775 Windshields and windows
§ 25.777 Cockpit controls (seat for pilots from 5'2" to 6'3" in height, in consideration of the design eye position).

b. Industry Documents. The following documents are available from the Society of Automotive Engineers, Inc. (SAE), 400 Commonwealth Drive, Warrendale, PA 15096:

ARP 268G	Location and Actuation of Flight Deck Controls for Transport Airplanes.
ARP 4101/1	Seats and Restraint Systems for the Flight Deck.
ARP 4101/2	Pilot Visibility from the Flight Deck.

3. BACKGROUND.

a. On January 19, 1971, the FAA issued Notice of Proposed Rulemaking No. 71-2, Cockpit Vision and Cockpit Controls. This notice proposed amendments to the airworthiness standards for transport category airplanes that introduced comprehensive cockpit vision standards and changed the range of pilot heights used for the location and arrangement of cockpit controls. A majority of the commenters responding to Notice 71-2 objected to the proposed amendments. In general, the airplane manufacturers believed the proposed requirements were too stringent and exceeded the state-of-the-art, particularly with respect to the size of transparent panels, considering weight and structural strength necessary to provide clear vision in the specified areas. The manufacturing industry, represented by the Transport Airworthiness Requirements Committee

(TARC) of the Aerospace Industries Association, maintained that the proposed size of the clear vision field was in excess of that required to meet the most important objective of the proposed standards. That objective was to provide optimum vision for avoidance of midair collisions in "see and be seen" conditions of flight. The committee carried out a computerized study program that considered 10,000,000 hypothetical cases of pairs of airplanes on collision courses considering reasonable airplane mixes of type, speed, flight path angles, bank angles, etc. In addition, all known available data from actual midair collisions, reported near misses, and USAF Hazardous Air Traffic Reports (HATR) were used.

b. The pilot compartment view that evolved from the TARC study was somewhat smaller and its area redistributed in comparison with existing CAM 4b.350 recommendations and those proposed in Notice 71-2. The FAA withdrew the proposed rulemaking based on the information presented. Subsequent to that withdrawal, the Society of Automotive Engineers Inc. (SAE), Committee S-7, adopted the TARC recommendation as Aerospace Standard AS 580B. The FAA has adopted the TARC/SAE pilot compartment view for this advisory circular. Some of the SAE criteria have been modified and adopted as guidance for validating the pilot compartment view. Users of this circular should bear in mind that the pilot compartment view described herein is that which the TARC study showed to be minimum for collision avoidance. Designers are urged to provide the maximum practicable capability in excess of this field of view.

c. It is the responsibility of the applicant to show by acceptable means that the proposed arrangement meets the requirements of accessibility and non-interference set forth by § 25.777. Designers and certification authorities are encouraged to refer to guidance in current Aerospace Recommended Practice ARP 268G and ARP 4101/1 (replaces AS 290B) for these considerations. These documents were also prepared by the SAE for use in conjunction with ARP 4101/2 (replaces AS 580B).

4. CRITERIA FOR PILOT COMPARTMENT VISIBILITY.

a. The flight deck windshield must provide sufficient external vision to permit the pilot to safely perform any maneuvers within the operating limits of the aircraft and, at the same time, afford an unobstructed view of the flight instruments and other critical components and displays from the same eye position. The following subparagraphs describe the minimum criteria for pilot compartment view. Aircraft designers and manufacturers should make every effort to build windshields that offer the pilot more external vision.

b. Design Eye Position. The design eye position is a single point selected by the applicant that meets the requirements of §§ 25.773(d) and 25.777(c) for each pilot station. Figure 1 depicts a design eye position and pilot compartment view for optimum collision avoidance potential for the left pilot seat. For the right pilot seat, all left/right dimensions are reversed.

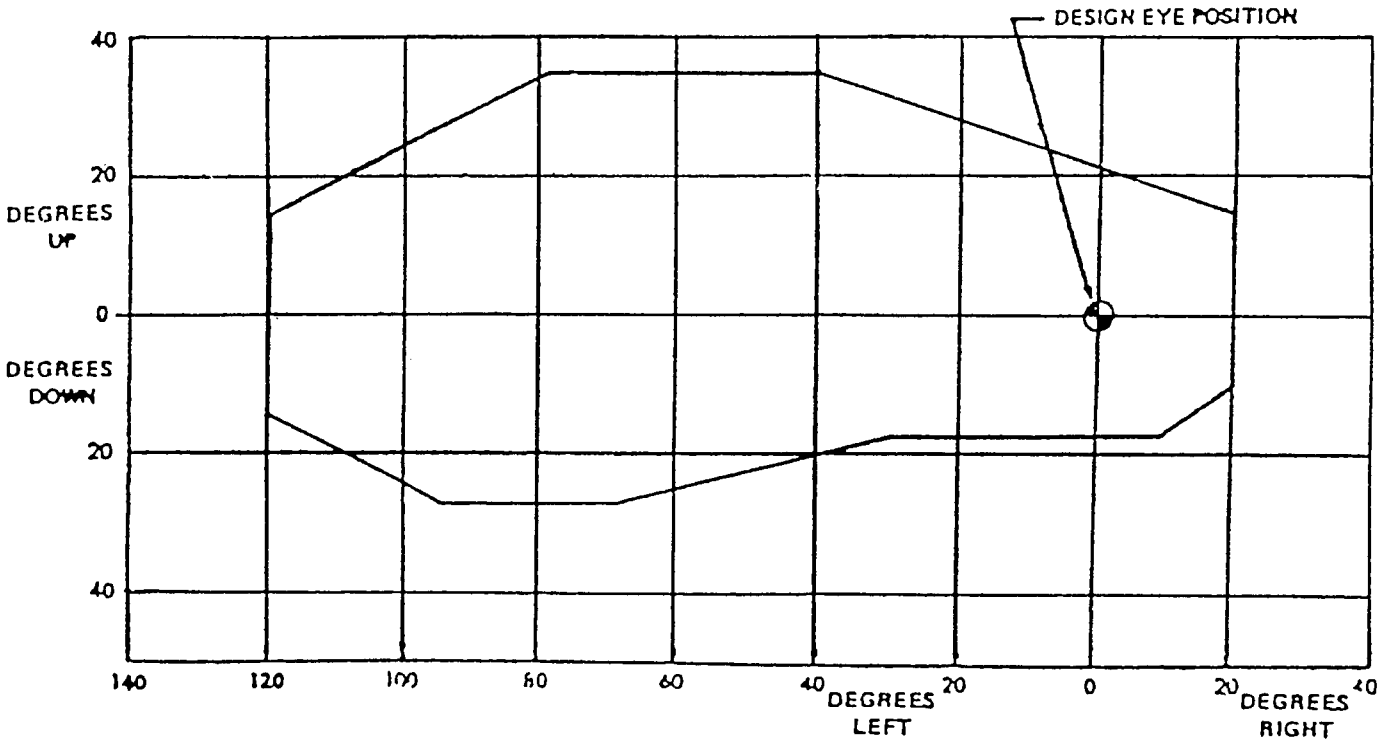

Figure 1. Pilot Compartment View

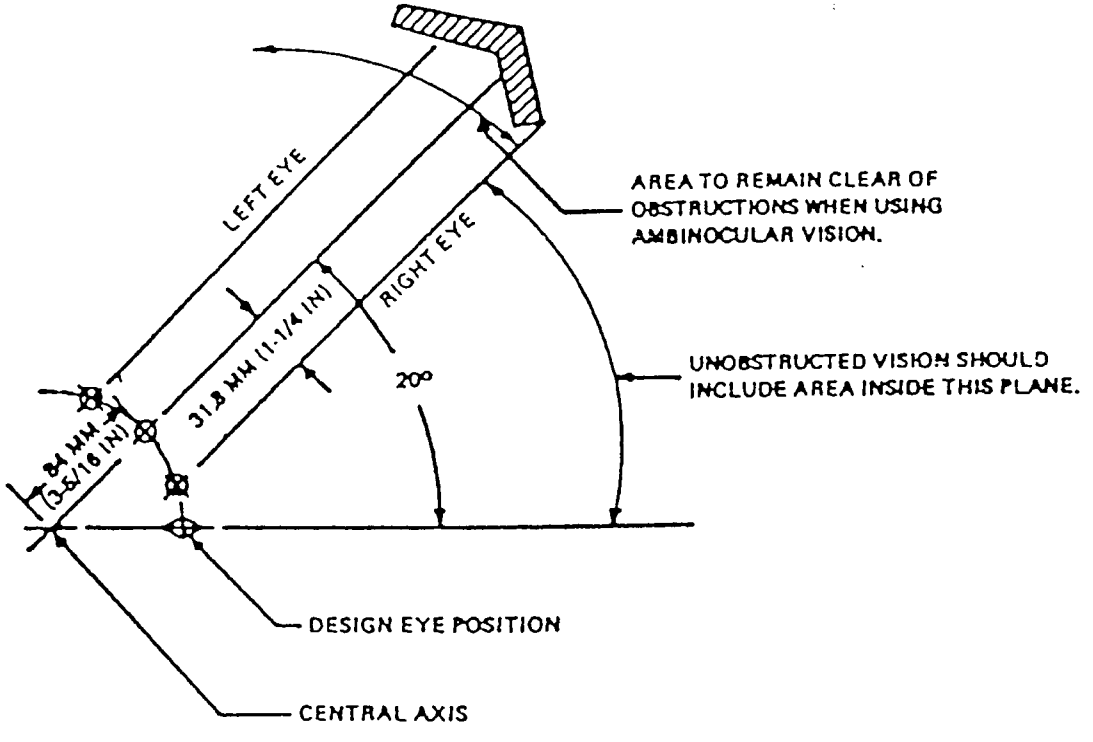

Figure 2. Measurement of Angles

c. Clear Areas of Vision. The clear areas of vision should be determined by measurement of angles from the design eye position utilizing ambinocular vision. Ambinocular vision is the total area that can be seen by both eyes. It is not limited to the binocular field but includes, in addition, monocular regions visible to the right eye, but not to the left, and vice versa. Measurements are made as depicted in figure 2 with an intraocular distance of 63.6 mm (2 1/2 inches) and utilizing rotational motion in a horizontal plane about a central axis 84 mm (3 5/16 inches) aft of the design eye position. These dimensions correspond to average cranial dimensions for humans. The horizontal and vertical vision angles should be measured from: (1) a vertical datum plane running fore and aft through the design eye point and central axis; and (2) a horizontal datum plane perpendicular to the vertical plane that also passes through the design eye point and central axis. The vertical and horizontal datum planes are fixed relative to the airplane and should be parallel to those corresponding to zero pitch and yaw angles for the airplane. With the design eye position located per paragraph 4b, the vision through the transparent areas should provide the following pilot compartment view:

(1) Forward and up 35 degrees from the horizontal datum plane at 40 degrees left of the vertical datum plane, diminishing linearly to 15 degrees up at 20 degrees right.

(2) Forward and down 17 degrees from the horizontal datum plane between 30 degrees left and 10 degrees right of the vertical datum plane, diminishing linearly to 10 degrees down at 20 degrees right.

(3) Forward and up 35 degrees from the horizontal datum plane between 40 degrees left and 80 degrees left of the vertical datum plane, diminishing linearly to 15 degrees up at 120 degrees left.

(4) Forward and down 17 degrees from the horizontal datum plane at 30 degrees left of the vertical datum plane, diminishing linearly to 27 degrees down at 70 degrees left.

(5) Forward and down 27 degrees from the horizontal datum plane between 70 degrees left and 95 degrees left of the vertical datum plane, diminishing linearly to 15 degrees down at 120 degrees left.

d. Landing Vision. In addition to the requirements of paragraph 4c, the view angle forward and down should be sufficient to allow the pilot to see a length of approach and/or touch-down zone lights that would be covered in three seconds at landing approach speed when the aircraft is:

(1) On a 2 1/2 degree glideslope.

(2) At a decision height that places the lowest part of the aircraft at 30.5 m (100 feet) above the touch-down zone extended horizontally.

(3) Yawing to the left to compensate for ten knots crosswind.

(4) Loaded to the most critical weight and center of gravity.

(5) Making the approach with 366 m (1200 feet) runway visual range (RVR).

e. Obstructions to Vision.

(1) There should be no obstructions to vision between 20 degrees right and 20 degrees left in the vision polar depicted by figure 1. Obstructions outside this 40 degree area should be kept to a minimum; ideally not more than three (i.e., center post, forward post, and side post). Using ambinocular vision, it should be possible for a pilot to have vision of any given bearing that is blocked to the other pilot from 80 degrees right to 80 degrees left of the design eye position. In addition, it is desirable that obstructions be eliminated by using ambinocular vision with the average human intraocular dimensions of 63.6 mm (2 1/2 inches). This would require that the projected width of the obstruction be no greater than the intraocular dimension. It should be possible for the pilot to eliminate any obstruction to vision using ambinocular vision with head movement of 13 mm (1/2 inch) left and right. In the example depicted in figure 2, head movement to the left would eliminate the obstacle. Use of sun visors that reduce light transmissivity are acceptable; however, totally opaque visors that impinge upon the field of view of figure 1 should not be used.

(2) Windows and windshields that have become deteriorated in service are considered to be airworthy only if the pilot compartment view is not impaired below the criteria set forth in paragraph e(1).

f. Optical Properties. The windshield should exhibit optical properties equivalent to those specified in MIL-P-25374B for plastic windows, and MIL-G-25871B for glass or glass-plastic windows. These documents contain information on laminate construction, optical uniformity, luminous transmittance, physical properties, environmental exposure, etc.

g. Precipitation. Precipitation clearing should be provided for the windshield panels directly forward of each pilot and should be effective at all thrust settings up to at least 1.6 Vs (clean) or 230 knots, whichever is less. The minimum area to be cleared should be 15 degrees left to 15 degrees right of the design eye position, upward to the horizon during the steepest approach path expected in operation, and downward to the limits recommended in paragraph 4c. If windshield wipers are used, wiper speeds of approximately two sweeps per second have been found to be satisfactory in maintaining a cleared area.

h. Compliance Considerations. A method traditionally used for showing compliance with the viewing requirements has been a somewhat exotic camera system. Other methods are also allowed, including 3-D graphics systems and

simple surveying equipment. The formation of the vision boundaries described in this advisory circular is based on flight at subsonic speeds. Any aircraft featuring variable nose geometry, or those capable of making STOL/VSTOL steep approaches, should be subject to special compliance considerations.

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