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AIRCREW STATION VISION REQUIREMENTS FOR MILITARY AIRCRAFT

FSC 15GP

DEPARTMENT OF DEFENSE
Washington, D. C. 20301

Aircrew Station Vision Requirements for Military Aircraft

MIL-STD-850B

* 1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense.

* 2. Recommended corrections, additions, or deletions should be addressed to the Aeronautical Systems Division (ENZSA), Wright-Patterson Air Force Base, Ohio 45433.

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1. PURPOSE AND SCOPE

1.1 Purpose. The purpose of this document is to establish requirements for providing adequate external vision from within the aircrew stations of military aircraft.

1.2 Scope. The requirements contained herein apply to external vision from aircraft procured by the military departments. The general vision requirements are for the various type seating arrangements and limited aircraft missions.

2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on date of invitation for bids or request for proposal form a part of this standard to the extent specified herein.

STANDARDS

Military

MIL-STD-1333	Aircrew Station Geometry for Military Aircraft
MS33573	Dimensions, Clearance, Cockpit, Fixed Wing Aircraft
MS33574	Dimensions, Basic, Cockpit, Stick Controlled, Fixed Wing Aircraft
MS33575	Dimensions, Basic, Cockpit, Helicopter
MS33576	Dimensions, Basic, Cockpit, Wheel Controlled, Fixed Wing Aircraft

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS

* 3.1 Types of cockpit seating arrangements. The vision criteria set forth in this standard are applicable to the following types of cockpit seating arrangements:

(a) Single pilot

(b) Tandem pilot

(c) Side-by-side pilot.

* 3.2 Types of aircraft. The vision criteria set forth in this standard are applicable to the following types of aircraft:

(a) Fighter/attack

(b) Bomber/transport

(c) ASW/patrol

(d) Helicopter

(e) V/STOL

(f) Trainers.

* 3.3 Design eye position. The design eye position shall be that eye position as defined by MS33573, MS33574, MS33575, and MS33576 or MIL-STD-1333.

* 3.4 Clear vision area. The clear vision area is defined as that area of transparent material through which vision is unobstructed by structure, edge bonding material, or any other material which prohibits clear vision.

4. GENERAL REQUIREMENTS

4.1 Vision requirements. The vision requirements set forth in this standard were based on utilization of monocular vision. The reference plane from which the vision angles are specified shall be the pilot's horizontal vision plane (or line) with respect to the specific aircraft longitudinal fuselage reference line. The zero reference in azimuth shall be straight ahead of the design eye position.

4.1.1 Extent of external vision. The maximum practicable external vision shall be provided for the pilot(s). The vision requirements established herein are minimal and are subject to further definition by the procuring activity. Particular consideration shall be given in each case to the external vision provided in conjunction with the specified mission of the aircraft. For landing approach conditions, downward and forward vision shall be provided to insure effective vision of all ground and shipboard landing aids specified by the procuring activity. For carrier aircraft, the landing area, landing aids, and stern of the carrier (drop lights) must be visible from landing pattern altitude in level flight at glide slope intercept. The landing area, including the contiguous areas port and starboard, must be visible on the glide slope. The pilot's vision of these landing aids shall be provided when the aircraft longitudinal fuselage reference line is pitched at the critical approach conditions Vpa (min). Verification for meeting this requirement shall be accomplished as specified in 4.1.2.2.

* 4.1.2 External vision verification. The vision data derived in accordance with the instructions herein shall be submitted to the procuring activity for review and approval. Vision plots shall be updated on completion of design and at any time a change in the vision envelope is either proposed or completed.

* 4.1.2.1 Total vision envelope plot. The total vision envelope (plus and minus 180° in azimuth and plus and minus 90° in elevation) shall be plotted for each crewmember in the flight compartments where the crewmember's duties require external vision. The plots shall reflect the unobstructed vision as defined in 3.4. The plots shall be presented as specified by the procuring activity on either US Department of Commerce form number 3099 (Aitoff's Equal Area Projection of a Sphere) or on rectilinear plots using the technique described in figures 1 and 2 (reference figures 3 through 7). The scale of the rectilinear plots shall be one-tenth of an inch equal to 1° of azimuth and elevation. The obscuration of external vision caused by accessory equipment, fixed or retractable (such as gunsight framework and air-refueling probes), shall also be shown and identified on the vision plots. The vision plots shall be made using minimum one-fourth scale accurate crew station engineering data; i.e., loft line contours, structural arrangement, and transparency installation.

* 4.1.2.2 Landing approach vision plots. A plot (as illustrated on figures 8, 8A, and 8B) of each pilot station shall be provided. The plot shall be presented on transparent material 8-1/2 by 11 inches in size. Minimum vision evaluations shall include:

* (a) Land-based aircraft - 300- by 11,600-foot runway on a 3° glide slope at distances from runway end of 1 mile, 1/2 mile, and 1/4 mile, as illustrated by figures 9, 10, and 11.

* (b) Carrier-based aircraft - Same as (a) above plus aircraft carrier at distances of 1/2 mile, 1/4 mile, 450 feet, 300 feet, and 150 feet on a 4° glide slope as illustrated by figures 12, 13, 14, 15, and 16. Additional evaluations using varying glide slopes and carrier sizes may be required by the procuring activity. If so, the distances noted above shall be used.

(c) Each vision plot submitted shall include the following information clearly marked on the face:

(1) Specific pilot stations

(2) Fuselage angle with relation to the horizon

(3) Maximum rate of closure in feet per second.

* 4.1.3 Quality of external vision. Radii-of-curvature and angles of incidence of the transparent components of the cockpit shall be consistent with the aerodynamic, structural, and fabricating considerations, which will result in the least possible optical distortions in these parts, and shall minimize reflections of objects both within and without the cockpit from interfering with the pilot's vision. Minimum distortion specifications will be established by the procuring activity. At the intersection of the horizontal vision line and the windshield, the angle of incidence shall not exceed 60°. Every attempt shall

be made to meet the maximum 60° requirement on other areas of the transparency(ies) from the design eye position as closely as possible. The angle of incidence is defined as the angle between the line of sight and the normal (perpendicular) to the surface.

* 4.1.4 The external vision requirements are based on the assumption that the vision areas are symmetrical with respect to the centerline of the aircraft. The minimum vision requirements stated for the pilot's position in the side-by-side piloted aircraft are, therefore, applicable to the copilot's position with the angles of azimuth reversed.

* 4.1.5 The requirements for the extent of external vision for transparent areas between azimuth positions, as specified in sections 5, 6, 7, and 8 shall progressively increase, or decrease, as specified between the azimuthal positions. It is acknowledged that the presence of framing at any of the specified points shall not be considered a nonconformance with the standard requirements.

5. FIGHTER/ATTACK AIRCRAFT

* 5.1 Single pilot/tandem pilot. The vision requirements set forth in this paragraph are applicable to single- and tandem-piloted fighter aircraft (reference figure 3).

* 5.1.1 Forward pilot position. The vision criteria set forth in this paragraph are applicable to the forward pilot station:

(a) The following shall be the minimum angles of unimpaired vision available to the pilot from the design eye position:

(1) At 0° azimuth at least 11° down and 10° up. (Every effort should be made to exceed 11°.)

(2) At 20° azimuth, left and right, 20° down.

(3) At 30° azimuth, left and right, 25° down.

(4) At 90° azimuth, left and right, 40° down.

(5) At 135° azimuth, left and right, 20° down.

(b) The area above the canopy rail from the canopy bow aft, past the pilot's headrest shall be of transparent material.

(c) The windscreen forward of the canopy bow shall be as free of structure as possible consistent with sound engineering practice. No windscreen structure in this area shall exceed 2.0 inches in width when projected onto a plane perpendicular to a line between the structure and the design eye position.

* (d) The blind spot caused by the structure between the top of the windscreen and the canopy shall not exceed 35° horizontally nor 7° vertically. Reference shaded area, figure 3.

(e) Aft vision from 135° to 180° azimuth shall be provided, as specified by the procuring activity.

5.1.2 Aft pilot position. The vision criteria set forth in this paragraph are applicable to the aft pilot station in tandem-piloted aircraft.

(a) At 0° azimuth, a minimum of 5° vision down shall be provided, measured from the aft design eye position with the forward seat in the neutral seat adjustment. The front seat headrest shall be designed to a minimum width, contoured about the upper corners and the forward seat structure; ejection rails and actuator shall be so designed and positioned as to obstruct a minimum of forward vision.

(b) The extent and quality of the aft pilot's external vision shall be as specified in 5.1.1. Various lateral eye positions in a plane through the aft pilot's design eye position may be employed to meet the above requirements. Sufficient canopy width shall be provided to permit eye movement in the frontal plane to obtain the specified external vision.

(c) The vision required by the above criteria may not be sufficient in all respects for all operational uses of an aircraft. Therefore, particular consideration must be given in each case to the vision provided in conjunction with the mission of the aircraft. In aircraft utilized for fighter-bomber missions, reconnaissance missions, search, and night intruder missions, the maximum amount of vision that can be incorporated is desirable.

5.2 Side-by-side pilot fighter/attack aircraft

* 5.2.1 The vision requirements set forth in this paragraph are applicable to side-by-side piloted fighter-type aircraft (reference figure 4).

(a) The following shall be the minimum angles of unimpaired vision available to the pilot and copilot measured from their respective design eye positions:

(1) At 0° azimuth, provide at least 13° down and 12° up.

(2) From 0° through 70° left azimuth for the pilot and 0° through 70° right azimuth for the copilot, vision shall increase from 13° down to 40° down and from 12° up to 40° up. The canopy bow vision obstruction within this area shall be within the limits as specified in 5.1.1 (c).

(3) At all points between 70° and 110° left azimuth for the pilot and between 70° and 110° right azimuth for the copilot, provide 40° down and 90° up.

* (4) At 135° azimuth, provide 20° down.

(b) In the cockpit area inboard of the pilot and copilot centerlines, maximum vision with a minimum of obstruction shall be provided for the pilot and copilot.

(c) Sufficient vision for the pilot(s) to see the engines with his head next to the window shall be provided where practicable.

(d) At 90° left azimuth for the pilot and 90° right azimuth for the copilot, at least 70° downward from a point not more than 14 inches outboard of the pilots' respective design eye positions shall be provided.

(e) In aircraft utilizing inflight refueling, sufficient vision must be provided for the pilot to see the tanker, refueling signal lights, boom, and probe, when in position for refueling.

6. BOMBER/TRANSPORT AIRCRAFT

* 6.1 Side-by-side pilot aircraft. The vision criteria stated in this paragraph are applicable to side-by-side piloted aircraft (reference figure 5).

(a) The following shall be the minimum angles of unimpaired vision available to the pilot and copilot left and right respectively, measured from the respective design eye positions:

(1) At 0° through 30° left azimuth, provide 17° down and 20° up.

(2) The vertical angles of clear vision in the area between 30° and 70° left azimuth shall increase gradually from the smaller to the larger vertical angles.

(3) At all points between 70° and 110° left azimuth, provide 35° down and 40° up.

(b) To the right of the pilot's centerline the angular vision downward and upward may decrease slightly from 17° and 20° specified in (a) (1) above due to the increase in distance from the design eye position to the windshield.

(c) The transparent area shall extend to 135° left azimuth at the eye level but the vertical angles of vision may decrease below those values at 110°. Sufficient vision for the pilot to see the engines with his head next to the window shall be provided where practicable. If sufficient vision is not provided, provisions must be made for another crewmember to view the engines.

(d) At least 70° downward vision from a point not more than 14 inches outboard of the design eye positions shall be provided. Sufficient headroom shall be provided to permit this eye position.

(e) The entire transparent area between 20° right and 30° left shall be free of windscreen structure or posts. No windscreen post or structure shall exceed 2.5 inches in width when projected onto a plane perpendicular to a line between the post or structure and the pilot's design eye position.

(f) Vision throughout the entire overboard area aft to the seat reference point is desirable, though often not practicable due to structure, overhead console, etc. However, transparent material should be utilized to the maximum extent practicable throughout this area.

7. ASW/PATROL AIRCRAFT

7.1 The vision criteria stated in section 6 for bomber/transport aircraft are the minimum applicable to ASW/patrol aircraft. Maximum vision downward consistent with structural integrity shall be provided for pilot and copilot between 30° and 135°, measured from the design eye position. When lookout stations are specified by the procuring activity, vision available at these stations shall be 75° fore and aft or horizontally and 85° downward measured from zero reference.

8. HELICOPTERS

* 8.1 Side-by-side pilot. The vision requirements set forth in this paragraph are applicable to side-by-side piloted helicopters and are given relative to the longitudinal fuselage reference line (reference figure 6).

(a) Controls, consoles, and instrument panels shall be so located as not to restrict vision, with particular emphasis on adequate over-the-nose visibility. Insure that mounting and reinforcing frames or strips which divide transparent areas and form obstructions to vision are not more than 2 inches wide when projected onto a plane perpendicular to a line between the structure and the pilot's eyes at the design eye position. Distribute such obstruction to avoid critical vision areas.

(b) The following minimum angles of unimpaired vision shall be available to the pilot from the design eye position as shown on MS33575:

☆ (1) At 0° azimuth, 25° down and 20° up shall be available.

(2) From 10° left azimuth to 10° right azimuth, downward vision shall increase from 20° to 30°.

(3) In the area between 10° right azimuth and 135° right azimuth, 50° of downward vision shall be available.

(4) From 0° to 80° right azimuth, upward vision shall increase from 20° to 40°.

(5) From 80° right azimuth to 100° right azimuth, upward vision shall be 40°.

(6) From 100° right azimuth to 135° right azimuth, upward vision requirement may decrease gradually from 40° to 20°.

(7) From 10° left azimuth to 100° left azimuth, 20° up and 20° down shall be available.

(c) There shall be no vertical obstruction between 20° right and 20° left of the longitudinal axis relative to the design eye position.

(d) There shall be no horizontal obstructions in the area extending 15° above the horizon from 135° right to 40° left and decreasing to a point 10° above the horizon at 100° left. No horizontal obstructions shall be in the area 15° below the horizon between 135° right and 100° left. If necessary, horizontal obstructions in this area shall be limited to one above the horizon and one below the horizon and shall be restricted to 4 inches in width.

+ 8.2 Single pilot/tandem pilot. The vision requirements set forth in this paragraph are applicable to single- and tandem-piloted helicopters with pilot in either forward or aft position, and are given relative to the longitudinal fuselage reference line (reference figure 7). The forward cockpit position, if occupied by other than the primary pilot (i.e., gunner or observer), also shall comply with these requirements.

(a) The following shall be the minimum angles of unimpaired vision available to the pilot from the design eye position:

(1) At 0° azimuth, at least 25° down and 70° up.

(2) At 20° azimuth, left and right, 25° down and 70° up.

(3) At 30° azimuth, left and right, 30° down and 70° up.

(4) At 90° azimuth, left and right, 50° down and 70° up.

(5) At 135° azimuth, left and right, 34° down and 70° up.

(b) Visibility in elevation (up) above that specified in 8.2(a) of at least 90° shall be provided. Interruptions of vision by horizontal structure of not more than 2 inches of width along or above the elevation boundary of 8.2(a) and vertical structural members of not more than 2 inches in width located in accordance with 8.1(d) are permitted.

9. V/STOL AIRCRAFT

9.1 The minimum vision requirements for V/STOL aircraft shall be those of the helicopter (side-by-side or tandem, as appropriate, for the configuration chosen) and of the fixed-wing-type aircraft which designates the primary mission. The precise requirements shall be specified by the procuring activity and shall consider the aerodynamic characteristics, engineering and power designs, and primary and secondary missions.

10. TRAINER AIRCRAFT

10.1 The extent and quality of external vision in trainer aircraft should be at least that of the aircraft which they are to represent. It is to be noted that the flight proficiency and the nature of the training flight performed will require a considerable increase in external vision. Accordingly, every attempt should be made to provide a higher degree of external vision in these aircraft than in their parent type to insure adequate safety of flight.

11. OTHER CREW STATIONS

11.1 In single-piloted aircraft employing tandem or side-by-side seating arrangements where the second crew station is occupied by a radar operator or bombardier/navigator, the vision requirements in the second crew station shall be as specified by the procuring activity. Insofar as practicable, the design of this crew station will follow the intent of this standard.

12. ADDITIONAL REQUIREMENTS

☆ 12.1 In those aircraft where the external vision need exceeds the minimum requirements specified herein, the maximum external vision that can be incorporated without sacrificing engineering integrity is desirable. When excessive solar heating through the transparent portions of the canopy roof is anticipated, means to reduce or eliminate this problem, such as by incorporation of flight crew operated extendable/retractable shields, may be employed at the discretion of the procuring activity. Methods which affect the transmissive characteristics of the clear transparencies shall be subject to the approval of the procuring activity.

13. RECONNAISSANCE AIRCRAFT

13.1 Those aircraft assigned to reconnaissance and research and night intruder missions require maximum external vision for tactical utilization of the aircraft and for carrier and field landing. Particular means shall be provided to insure adequate visibility for taxiing, takeoff, approach, and landing under all weather conditions.

14. AIRCRAFT UTILIZING INFLIGHT REFUELING

14.1 In aircraft utilizing inflight refueling, sufficient vision shall be provided for the pilot to see the tanker, refueling signal lights, boom, and probe when in position for refueling.

* 15. NOTES

* 15.1 Data requirements. The selected date requirements in support of this standard will be reflected in a Contractor Data Requirements List (DD Form 1423) attached to the request for proposal, invitation for bid, or the contract as appropriate.

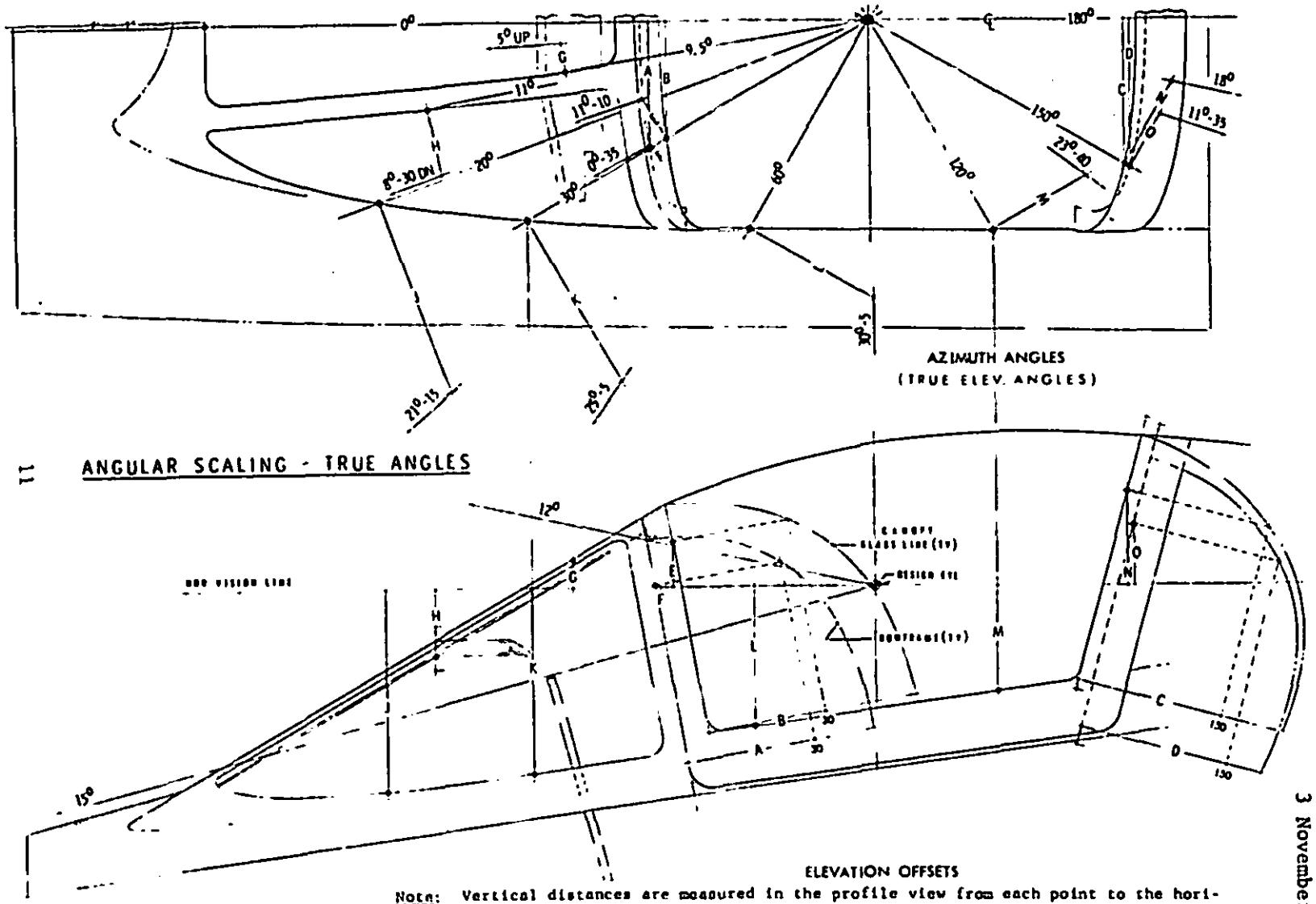
15.2 The margins of this standard are marked with an asterisk to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - AV
Navy - AS
Air Force - 11

Review activities:
Army - AV
Navy - AS
Air Force - 11

Preparing activity:
Air Force - 11

Project No. 1500-0085



Note: Vertical distances are measured in the profile view from each point to the horizontal vision line and layed out perpendicular to the azimuth line in the plan view. The included angle measured in the plan view is the true angle of depression or elevation.

FIGURE 1. METHOD FOR DETERMINING DATA FOR TOTAL VISION PLOTS

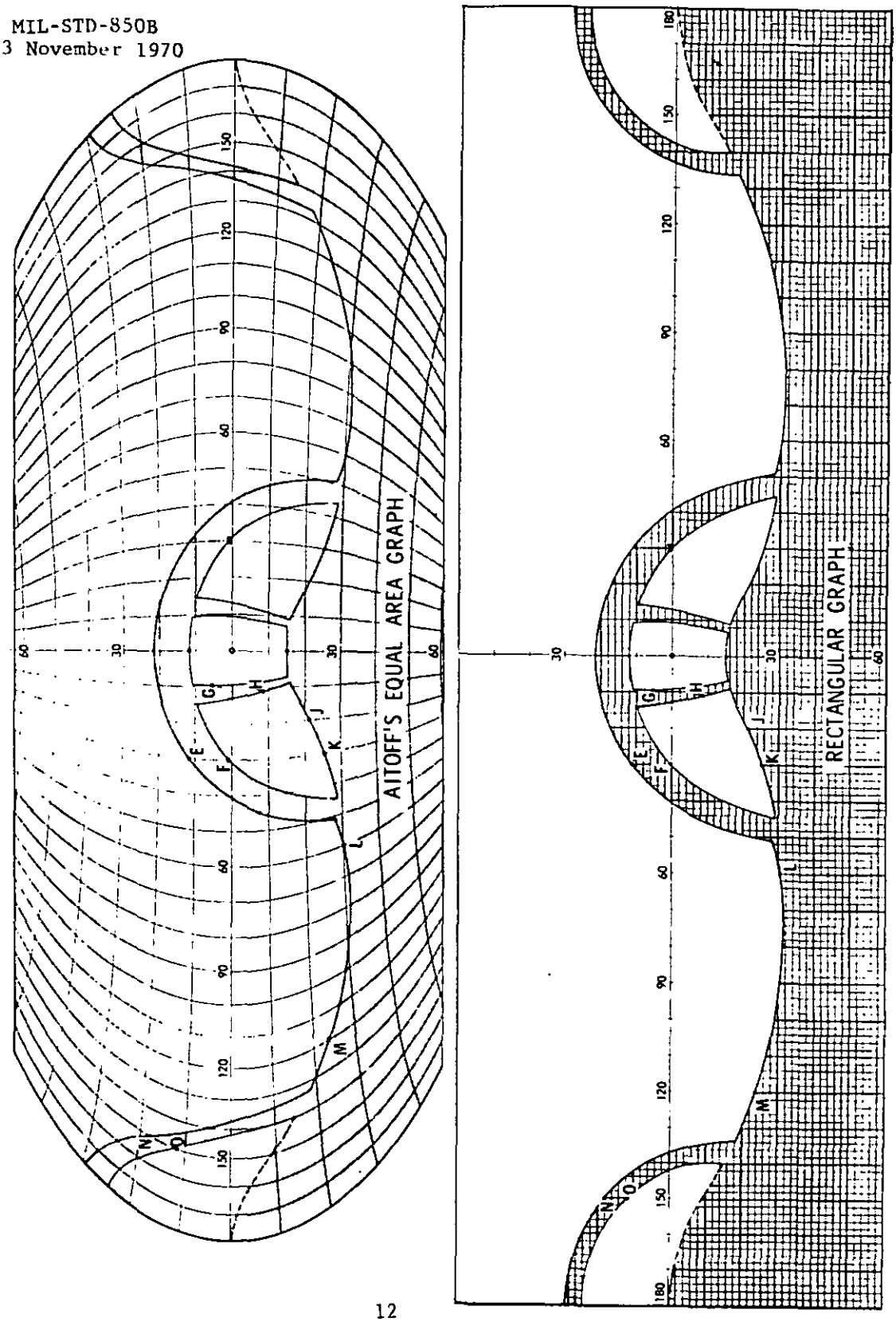


FIGURE 2. SAMPLE OF TOTAL VISION PLOTS

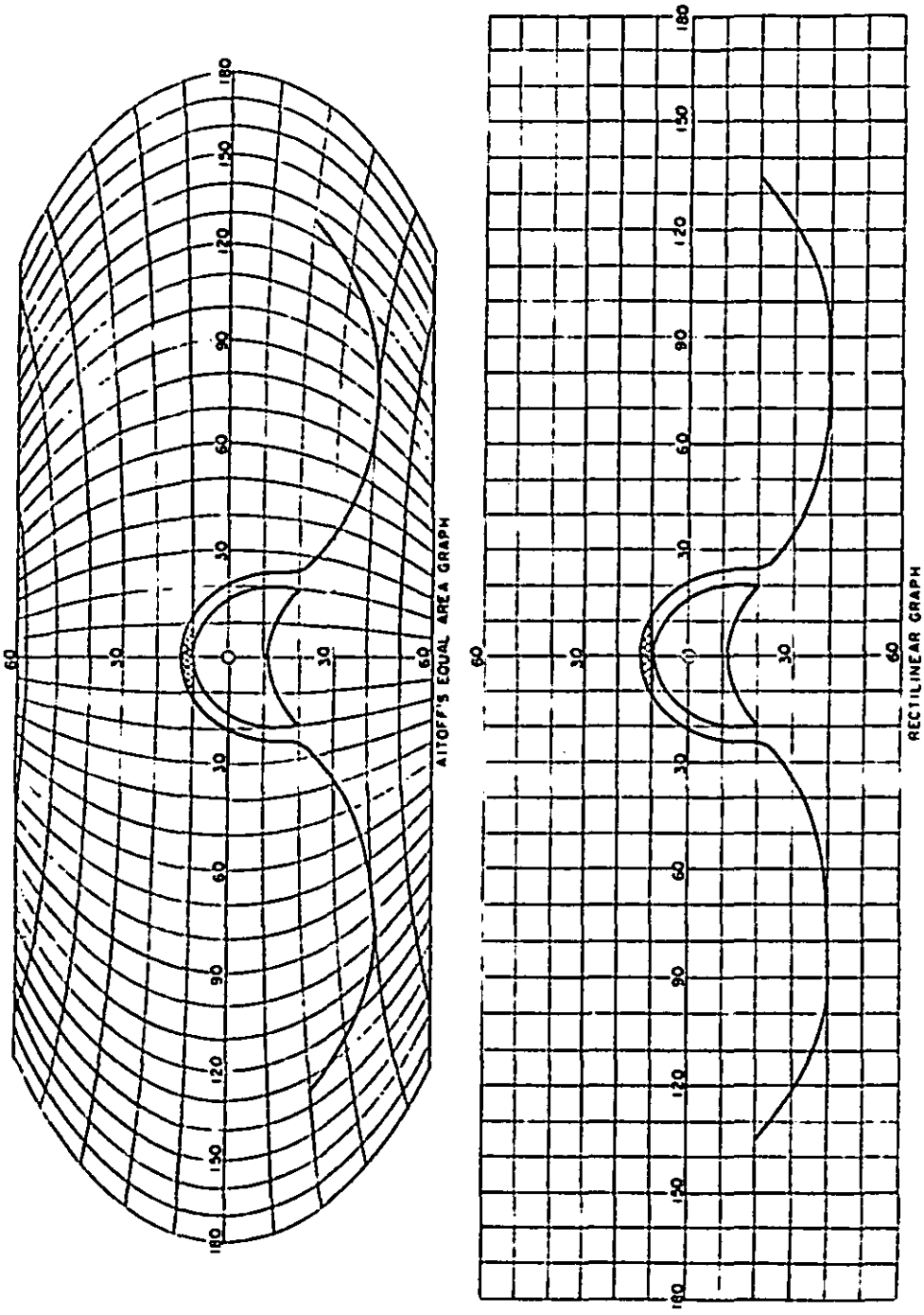


FIGURE 3. SINGLE AND TANDEM PILOT (FIGHTER) VISION PLOT

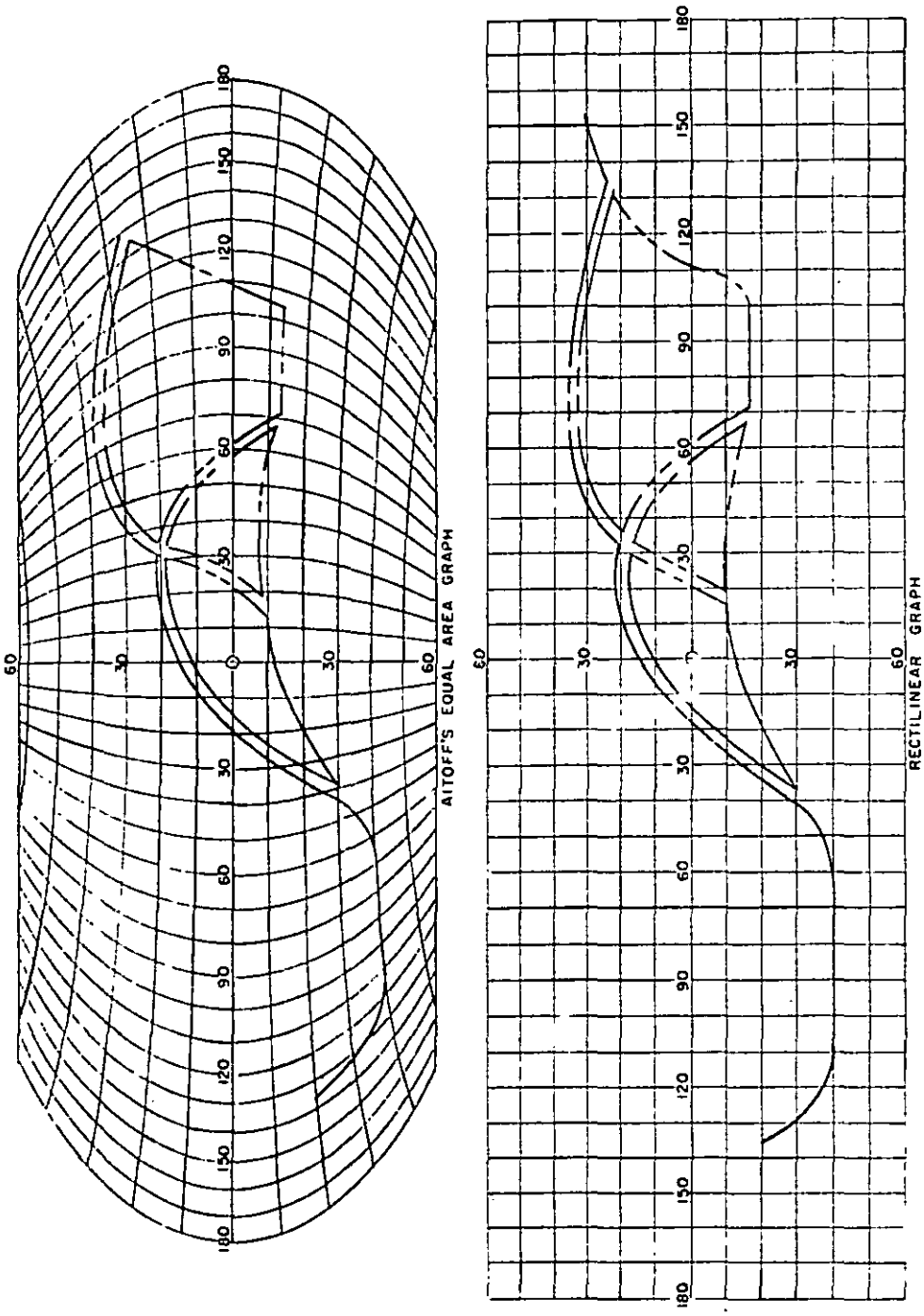


FIGURE 4. SIDE-BY-SIDE PILOT (FIGHTER) VISION PLOT

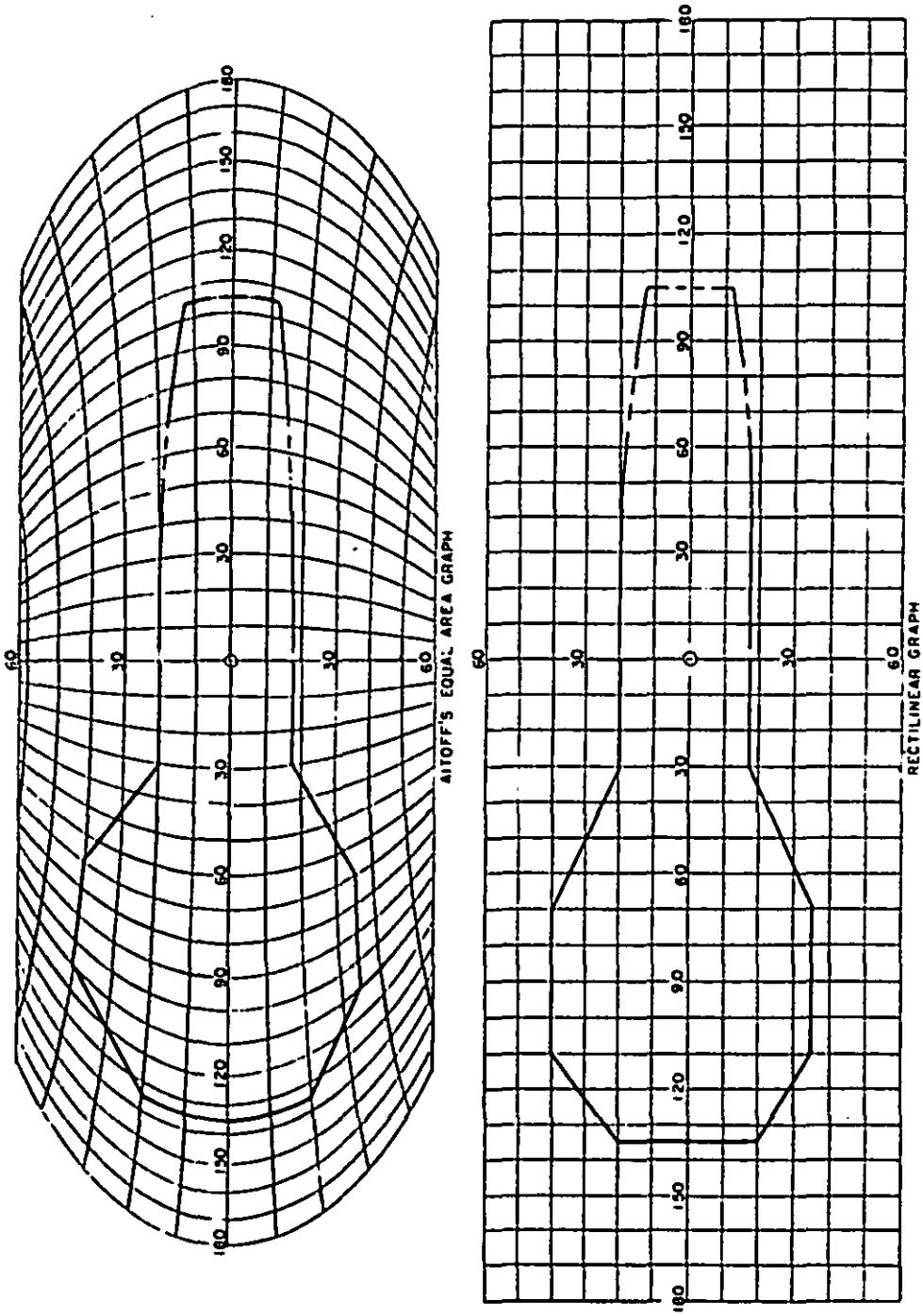


FIGURE 5. SIDE-BY-SIDE PILOT (BOMBER/TRANSPORT) VISION PLOT

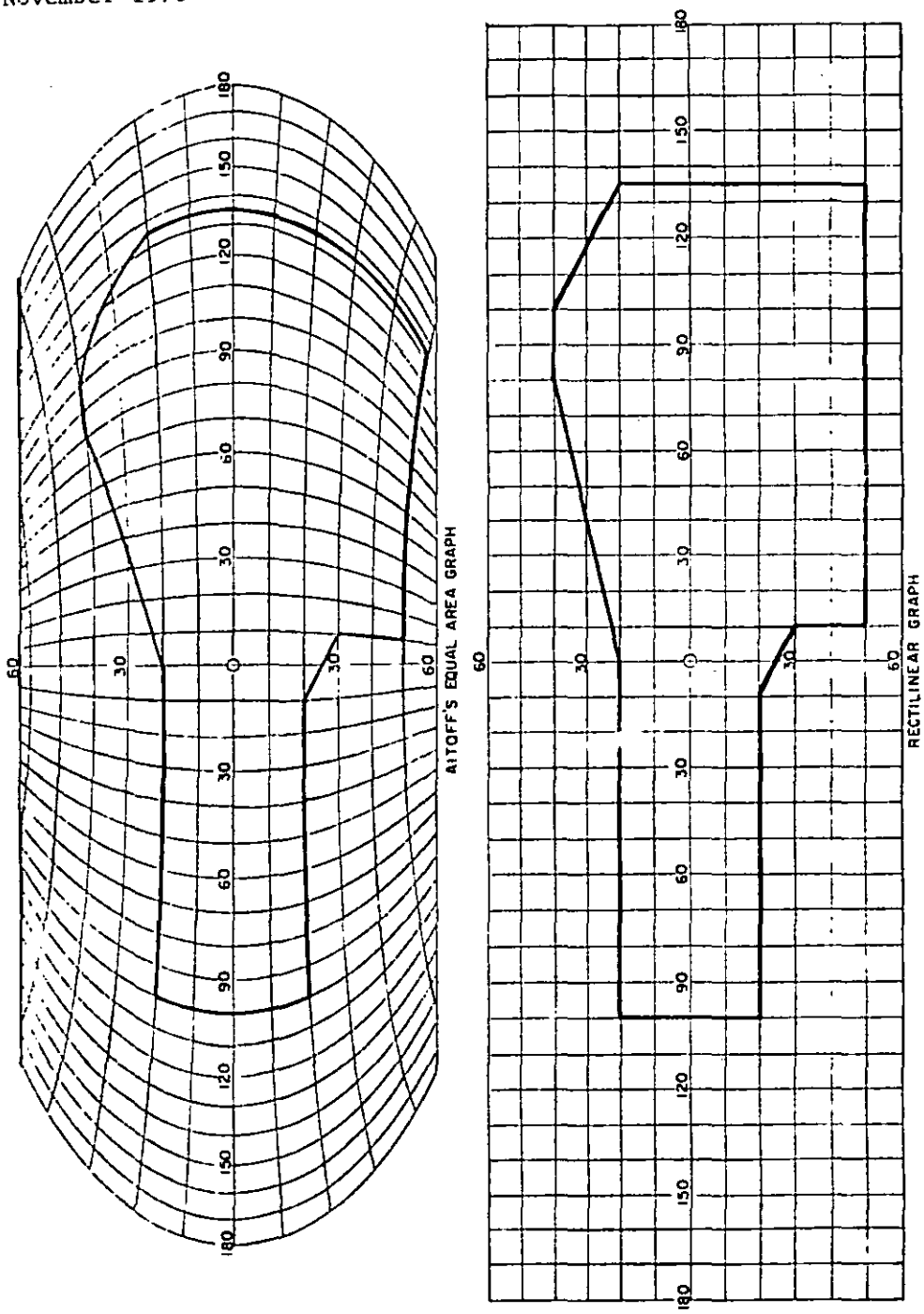


FIGURE 6. SIDE-BY-SIDE PILOT (HELICOPTER) VISION PLOT

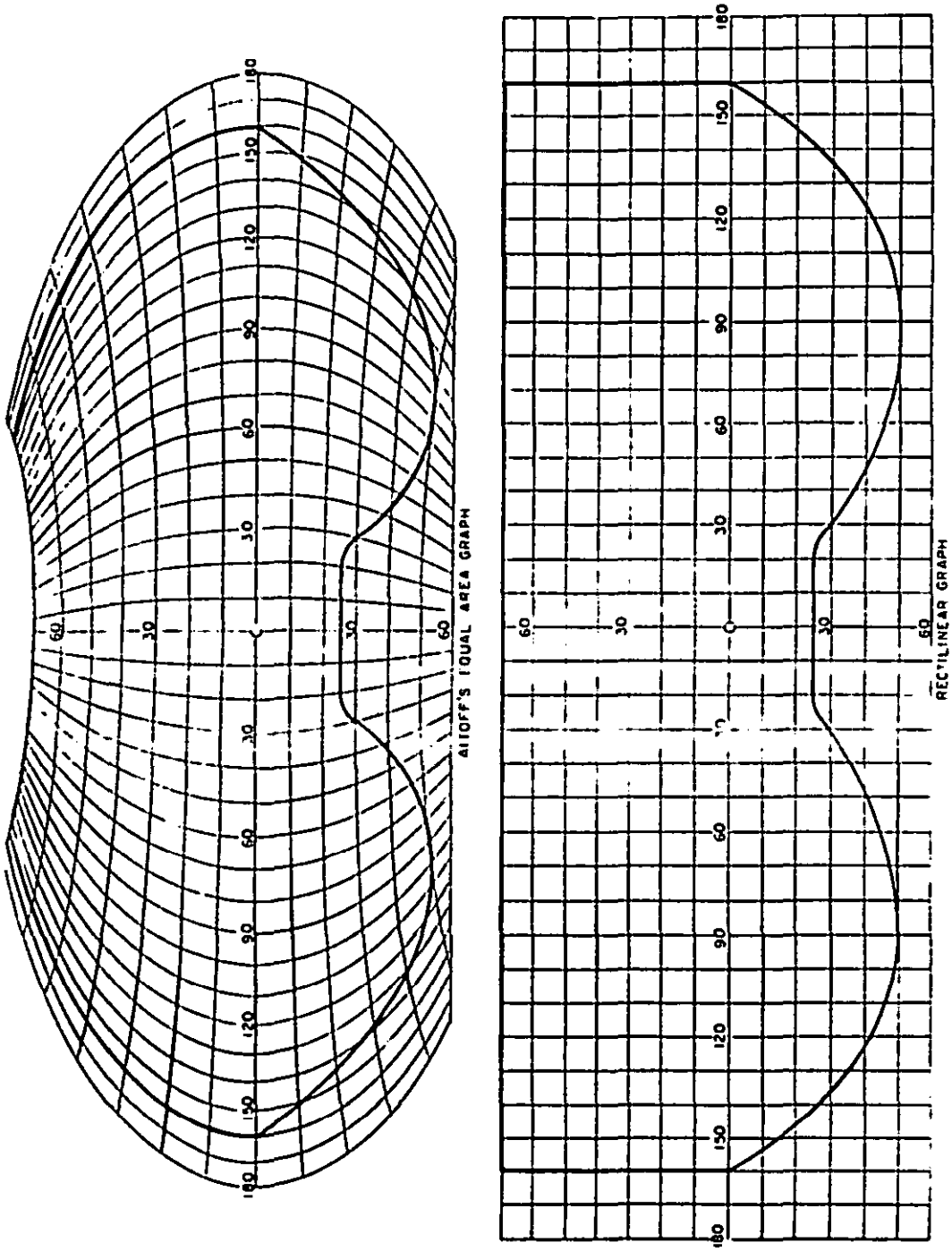


FIGURE 7. SINGLE PILOT/TANDEM PILOT (HELICOPTER) VISION PLOT

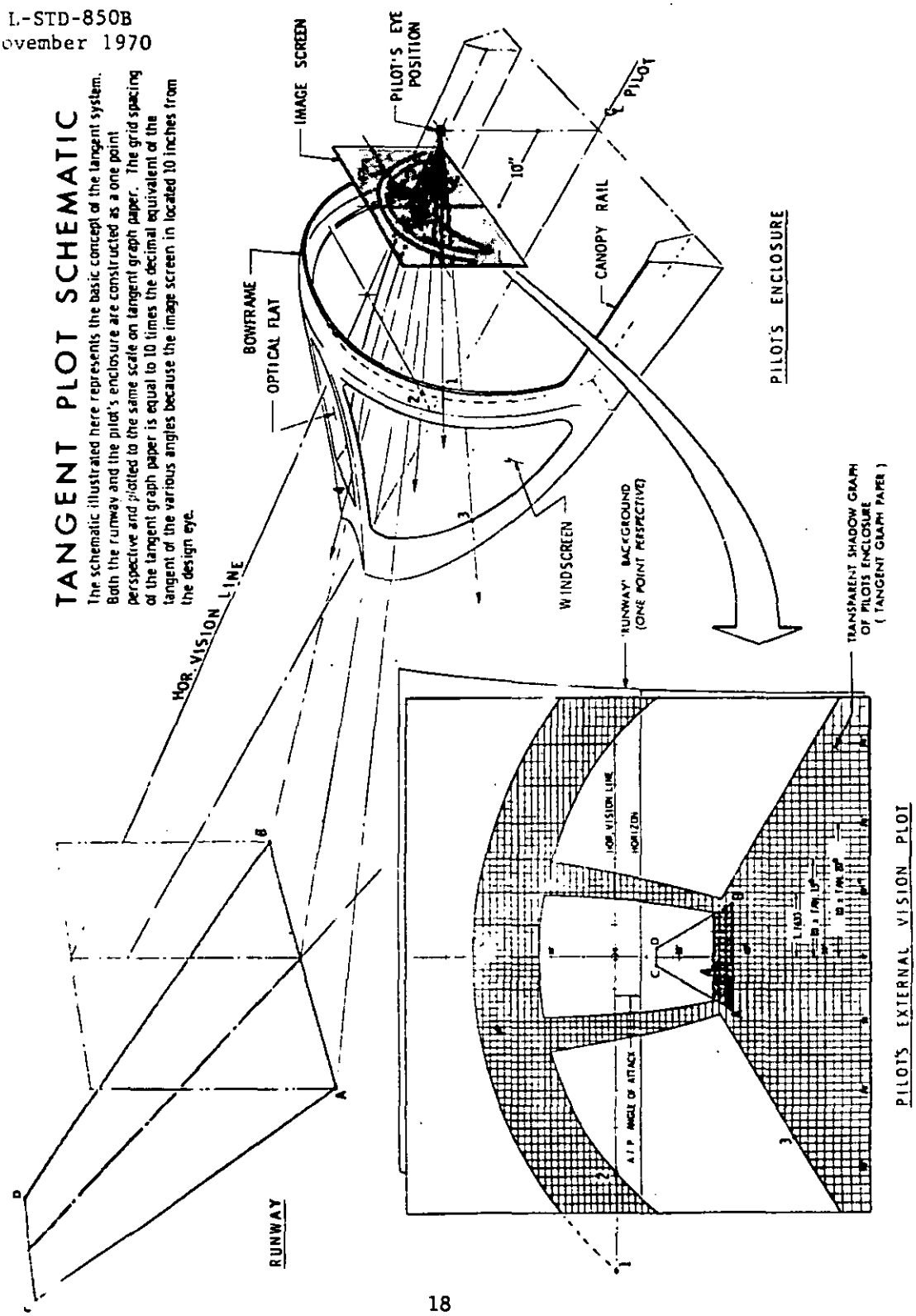


FIGURE 8. SCHEMATIC OF LANDING APPROACH VISION PLOTS

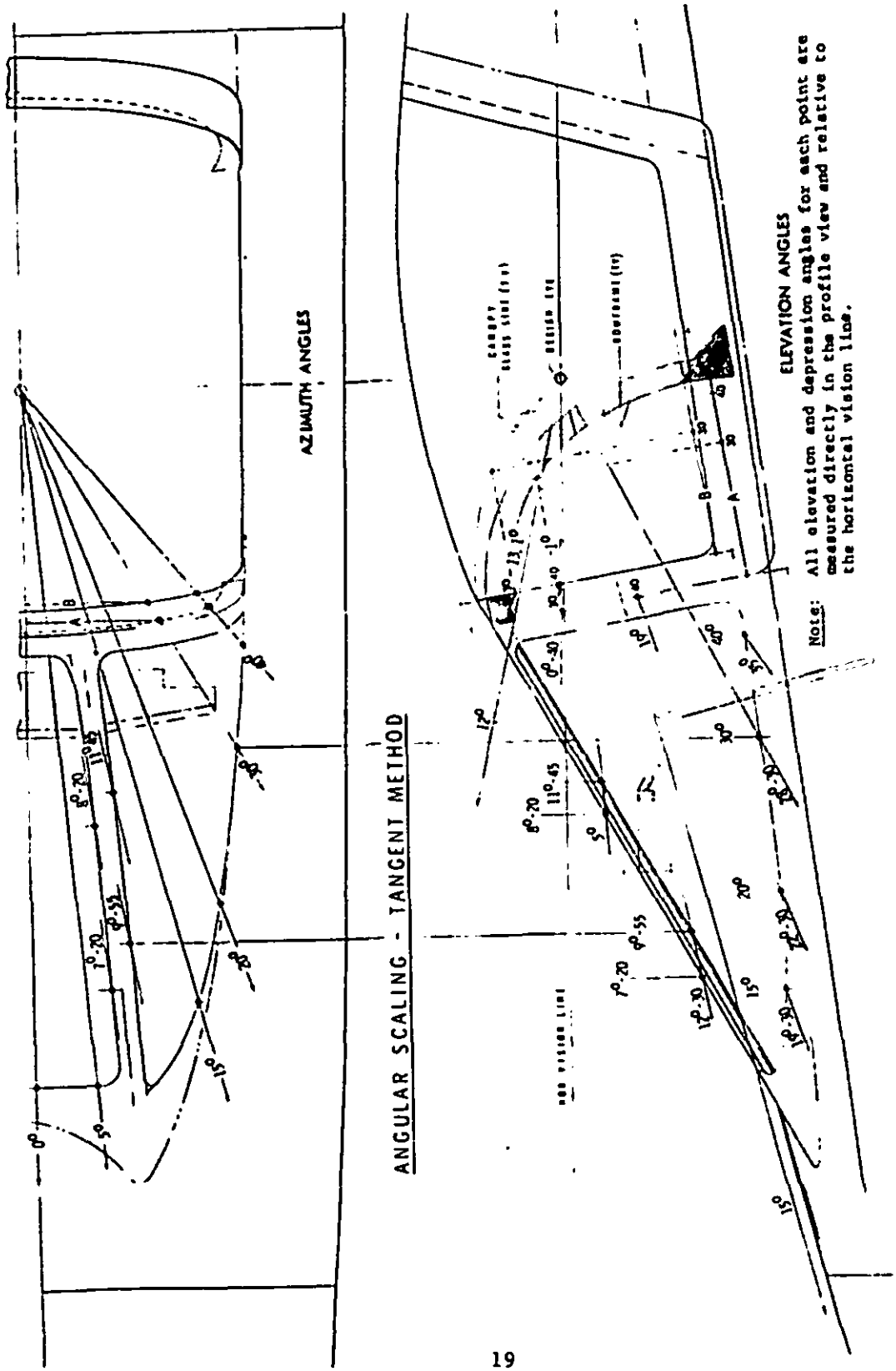


FIGURE 8A. METHOD FOR DETERMINING DATA FOR LANDING APPROACH VISION PLOTS

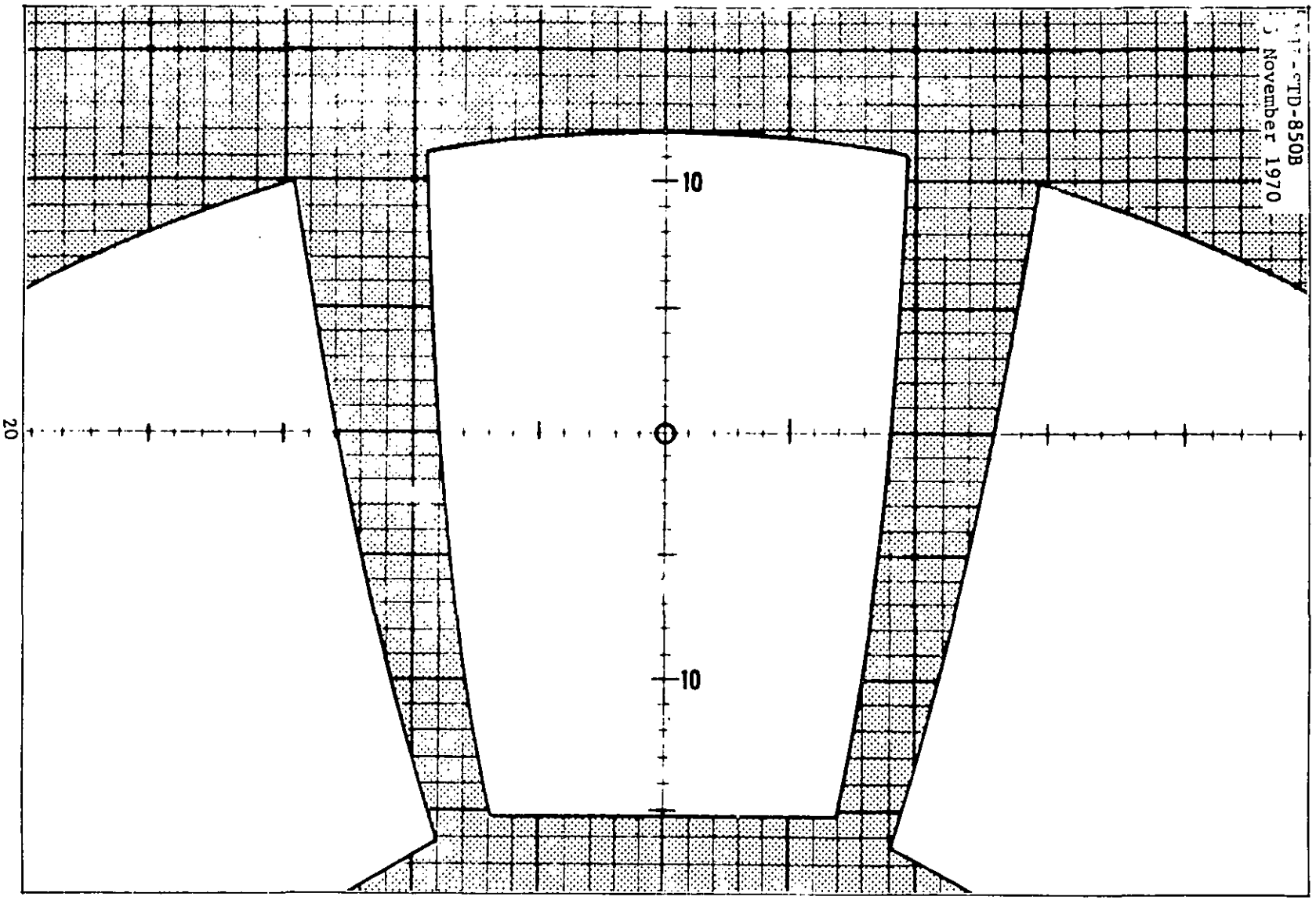


FIGURE 8B. SAMPLE LANDING APPROACH VISION PLOT

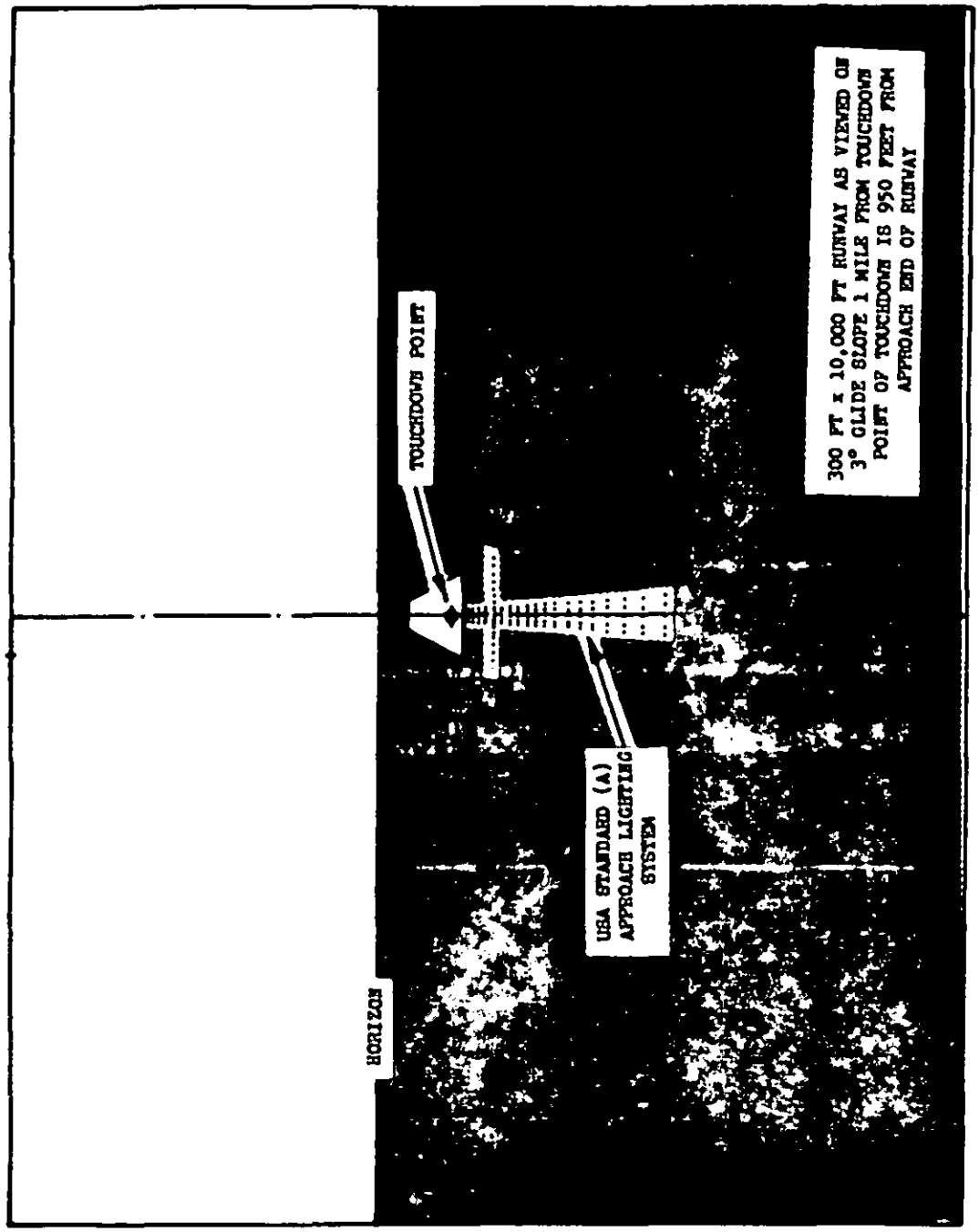


FIGURE 9. FIELD APPROACH AT 1 MILE

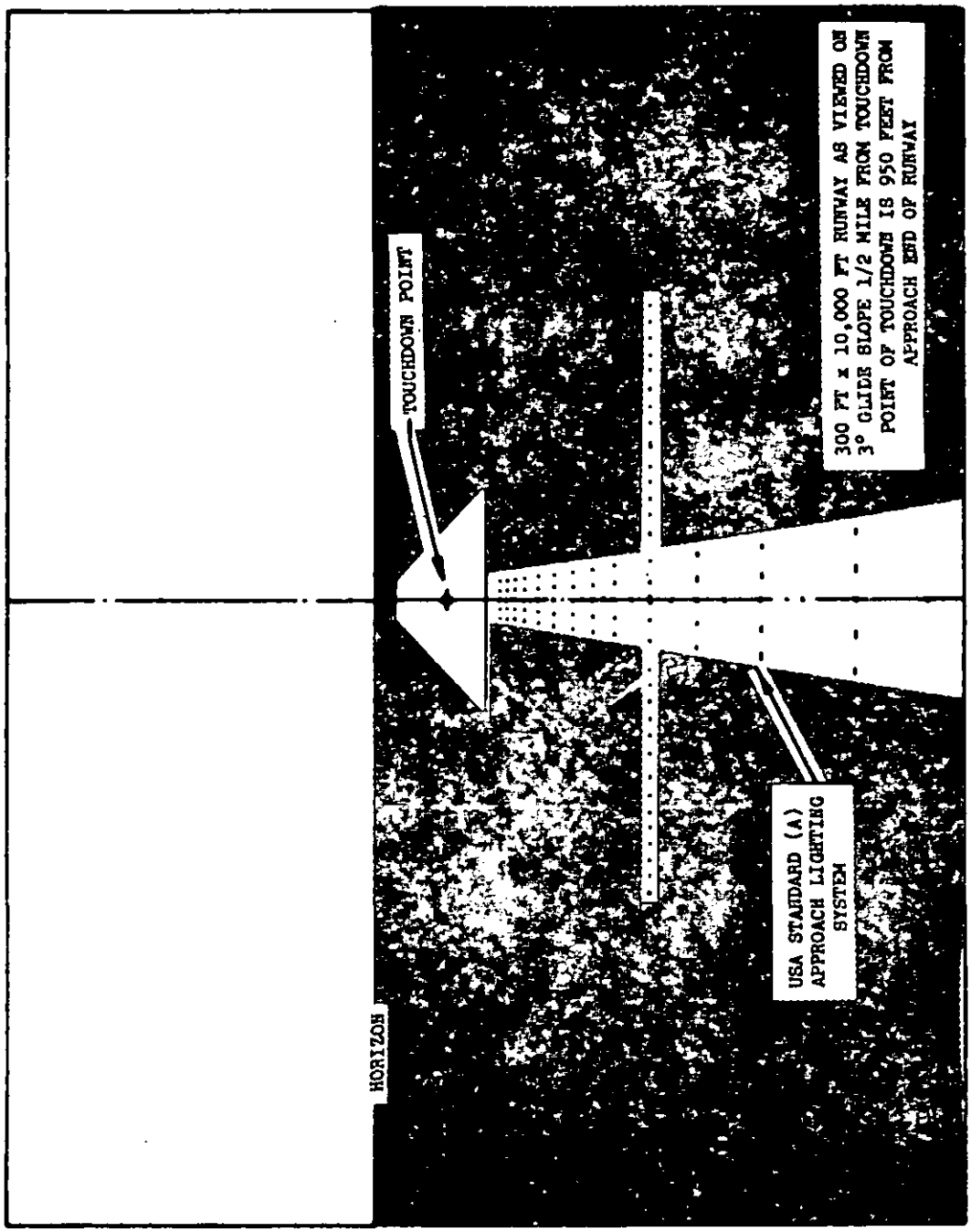


FIGURE 10. FIELD APPROACH AT 1/2 MILE

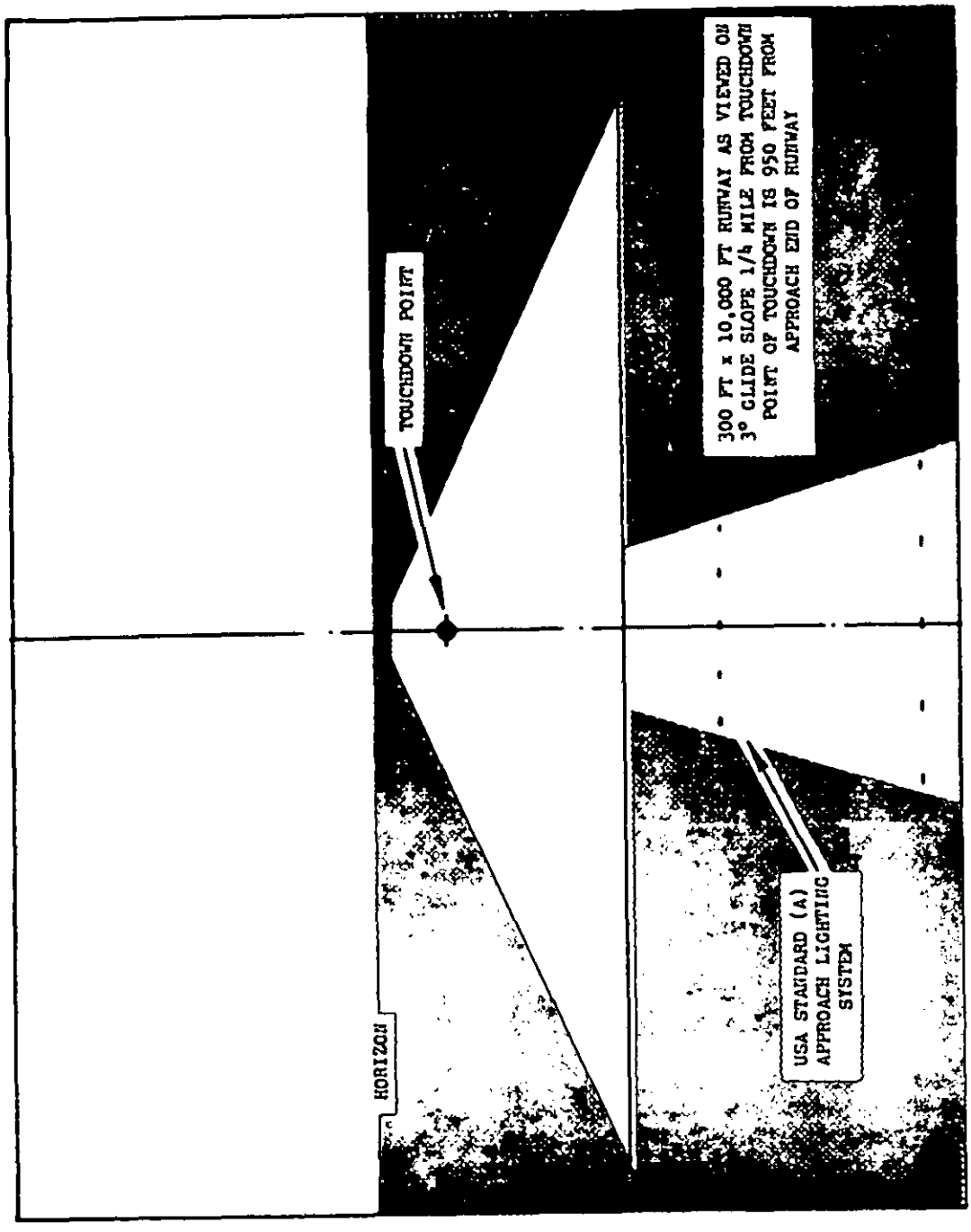


FIGURE 11. FIELD APPROACH AT 1/4 MILE

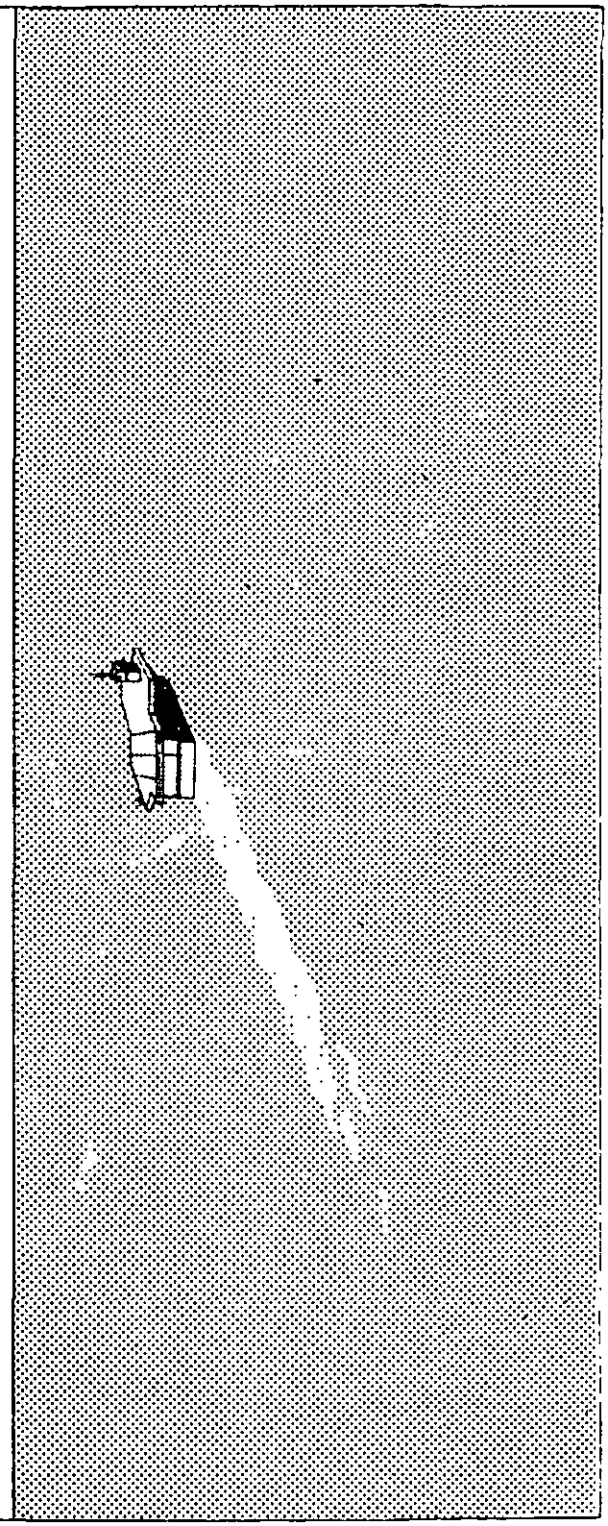


FIGURE 12. APPROACH VIEW - CVA-59 - 4° GLIDE SLOPE - 1/2 MILE ASTERN

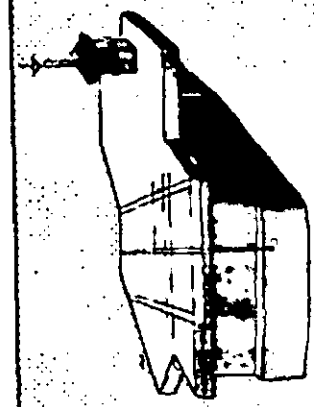


FIGURE 13. APPROACH VIEW - CVA-59 - 4° GLIDE SLOPE - 1/4 MILE ASTERN

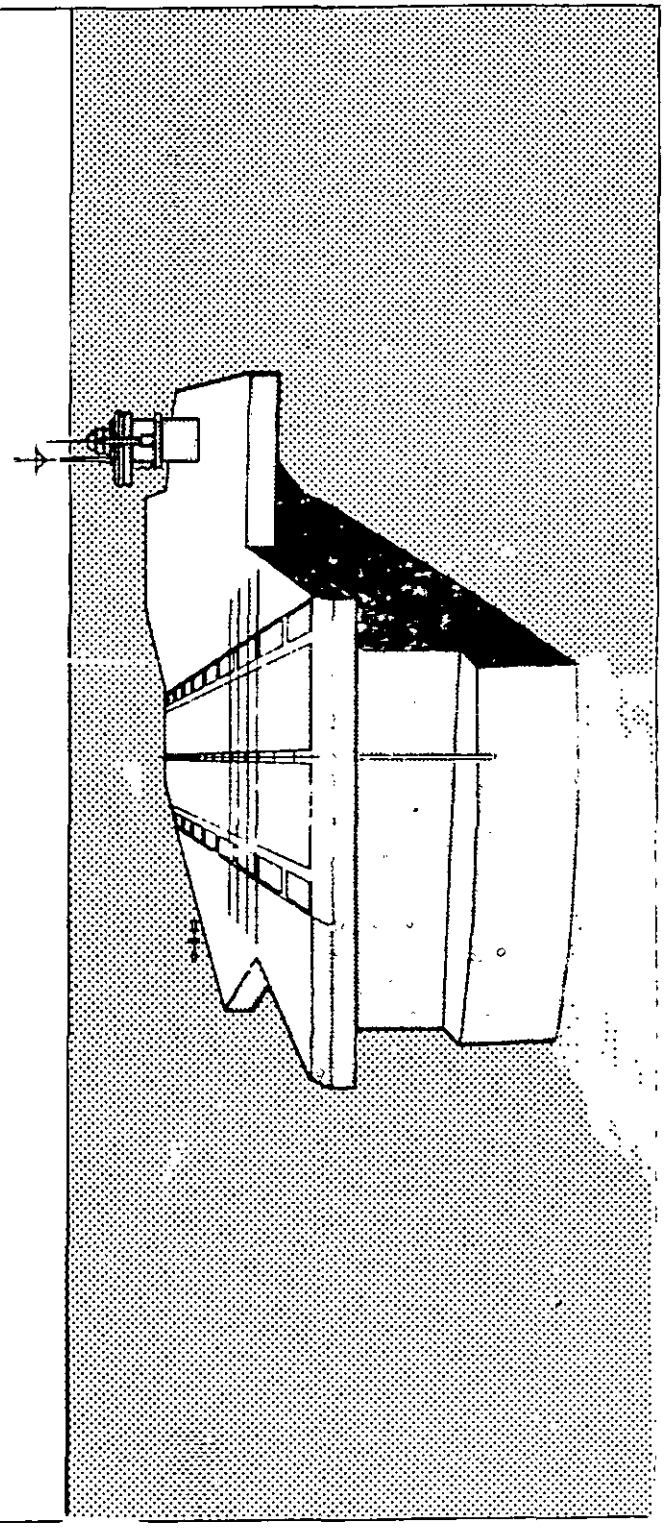


FIGURE 14. APPROACH VIEW - CVA-59 - 4° GLIDE SLOPE - 450 FT ASTERN

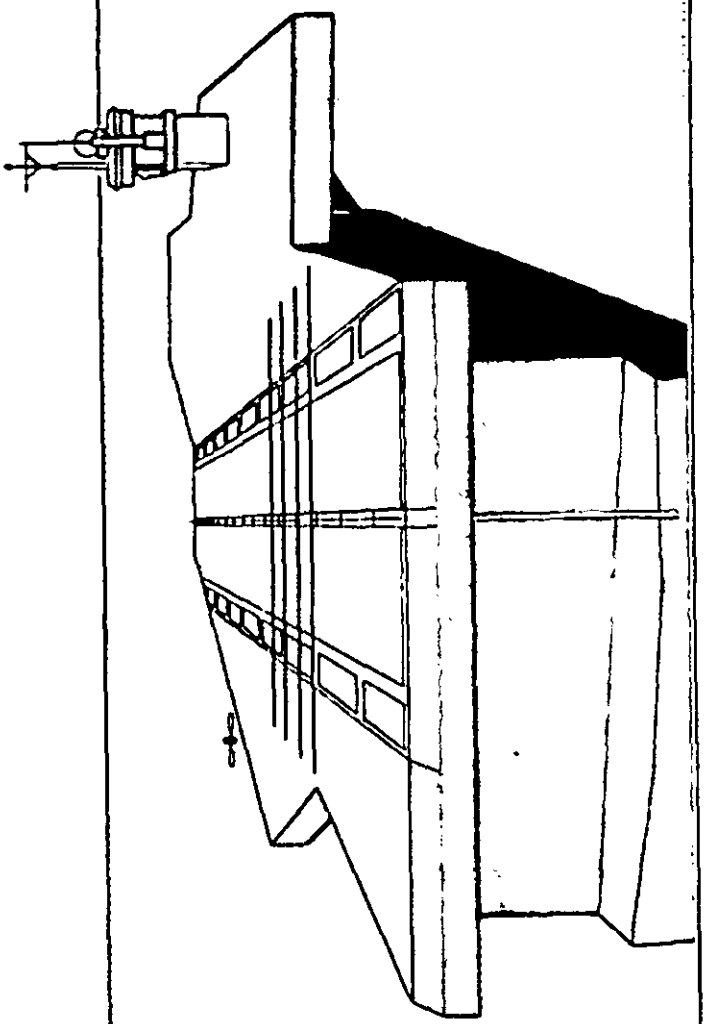


FIGURE 15. APPROACH VIEW - CVA-59 - 4° GLIDE SLOPE - 300 FT ASTERN

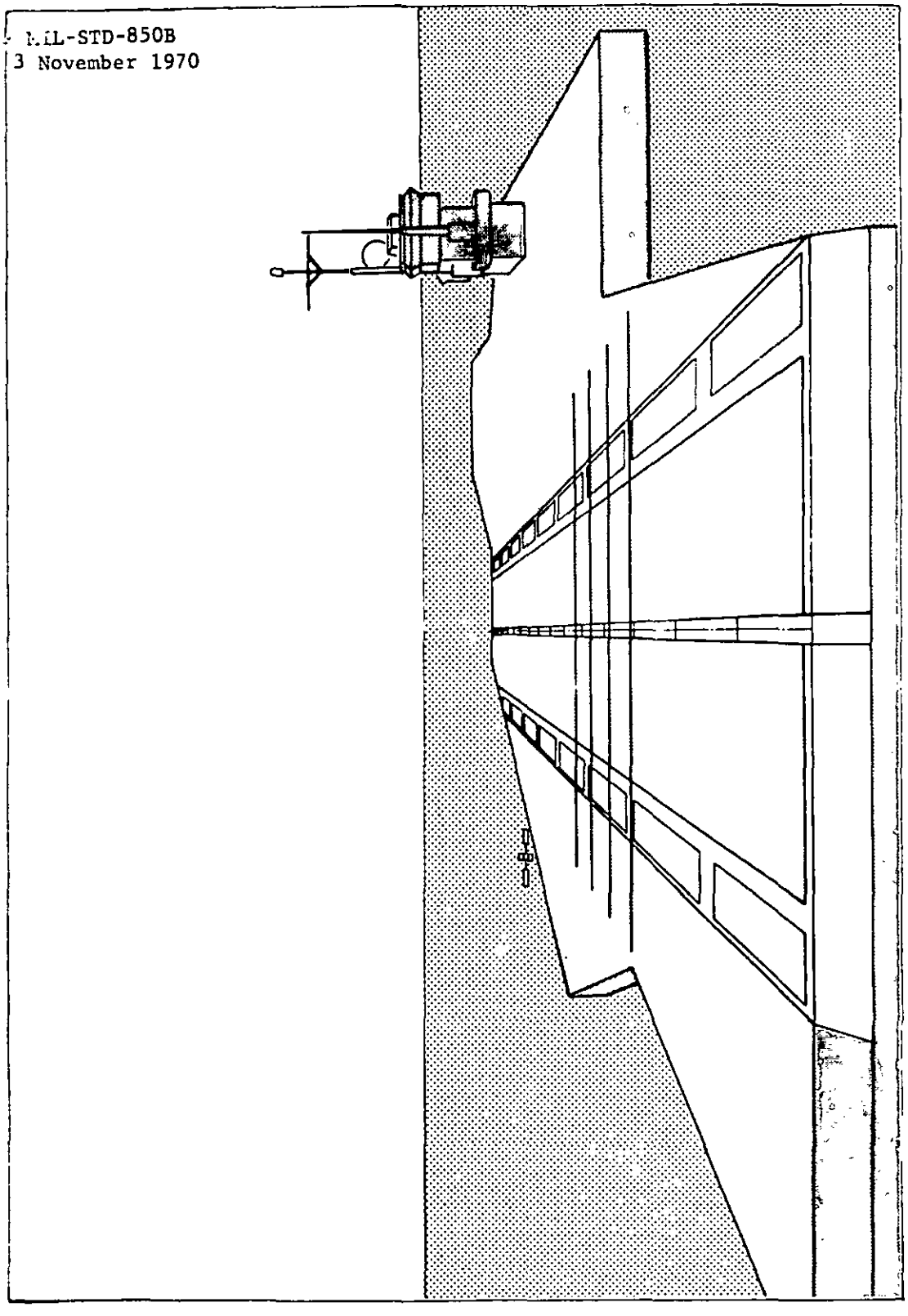


FIGURE 16. APPROACH VIEW - CVA-59 - 4° GLIDE SLOPE - 150 FT ASTERN