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LOCATION AND ACTUATION OF FLIGHT DECK CONTROLS FOR TRANSPORT AIRCRAFT

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1. PURPOSE AND SCOPE:

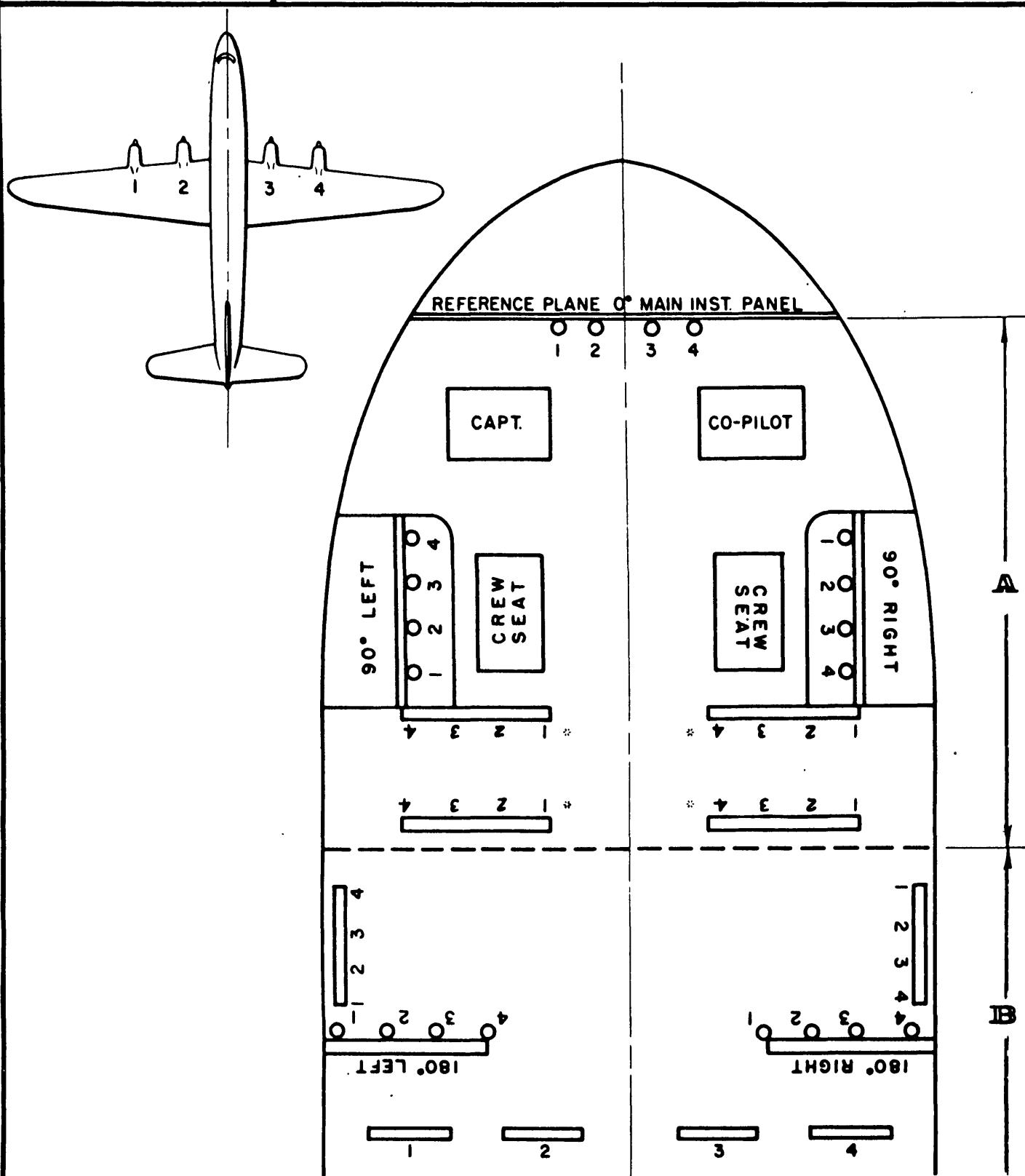
- 1.1 Purpose: The purpose of this document is to set forth the recommendations of SAE Committee S-7 relative to the location and actuation of flight deck controls. These recommendations are intended to minimize confusion and distraction and thereby reduce transition training time, crew errors, fatigue, and other factors detrimental to flight safety and efficiency. In arriving at these recommendations, the committee carefully reviewed the work of the flight deck layout panel of the Aircraft Committee of the Munitions Board, the recommendations and requirements of the Civil Aeronautics Board, the Federal Aviation Agency, the requirements of the airline operators, the aircraft manufacturers, etc. In cases where conflicting opinions existed, suitable compromises were made.
- 1.2 Scope: The recommendations of this document apply to commercial type, multi-engine transport aircraft which utilize reciprocating or turbine type powerplants and which are operated in subsonic, transonic, or supersonic speed regimes. These recommendations are not intended to apply to V/STOL configurations.

2. DEFINITIONS:

- 2.1 Types of Flight Decks: Two types of flight decks are covered herein: two-man flight deck (two pilots) and three-man flight deck (two pilots and flight engineer).
- 2.2 Definition of Functions: In paragraph 5 et seq., each of the controls is assigned a function. The definitions of these functions are as follows:
- 2.2.1 Primary: "Primary" indicates that the operation of the specified control is a primary function of the crew member to whom it is assigned and, hence, must be readily accessible to that crew member while he is seated in his normal position.
- 2.2.1.1 Normal Position: For pilots, "normal position" means that the pilot's seat is adjusted so as to bring the pilot's eye to the design flight eye position illustrated in Fig. 1.
- 2.2.1.2 Accessible: For controls, "accessible" means that the control is within normal reach of, and is capable of manual actuation by, the crew member to whom it is assigned.

For instruments and displays, "accessible" means that the instrument or display is in plain sight of the crew member to whom it is assigned, and that it can be read or interpreted without undue strain or difficulty under normal and emergency night lighting conditions.

- 2.2.2 Secondary: "Secondary" indicates that operation of the specified control is a secondary function of the crew member to whom it is assigned and, hence, some compromise regarding accessibility to this crew member may be tolerated. It is assumed that the crew member's lap belt and/or shoulder harness is in place (shoulder harness is assumed free on the locking reel); however, the flight engineer's seat itself may be moved to the limits of its travel in order to achieve such accessibility. (The pilot's seat may not be moved to achieve such accessibility during normal operation.)
- 2.2.3 Desirable: "Desirable" indicates that, although there is no specific requirement for that control to be accessible to that crew member, it would nevertheless be desirable.
- 2.3 Pilot's Design Flight Eye Position: The Pilot's Design Flight Eye Position is the primary flight deck dimensional reference point.
- 2.4 Visual Reference Plane: The Visual Reference Plane is a plane through the Pilot's Design Flight Eye Position which is horizontal in straight and level, subsonic cruising flight.
- 2.5 Pilot's Heel Rest Plane: The Pilot's Heel Rest Plane establishes the flight deck horizontal and vertical coordinates. It should be parallel to the Visual Reference Plane with a tolerance of 3 deg toward nose down for the heel rest plane.
- 2.5.1 The Pilot's Heel Rest Plane (extended as necessary) should be located 41 in. below the Pilot's Design Flight Eye Position. Ref. Fig. 2.
- 2.5.2 The rearmost position of the aft face of the control wheel or yoke should be located not less than 5 in. forward of the Pilot's Flight Eye Position. Ref. Fig. 2.
3. LAYOUT OF THREE-MAN FLIGHT DECKS: There are several possible arrangements for the flight engineer's station for three-man flight decks. It is not the purpose of this document to prescribe accurately the optimum arrangement for the flight engineer, but rather to set down some general recommendations which will apply towards any flight deck of the three-man category. These general recommendations are as follows: (See Fig. 3)
- 3.1 The flight engineer will not sit facing aft.
- 3.2 It is desirable that means be provided for the engines to be viewed from the flight engineer's station.
- 3.3 Regardless of whether the flight engineer's controls are located ahead of him or to his side, he should normally sit facing his instrument panel. The more important instruments and displays should be grouped at eye level or below, with the associated switches and controls below the instruments. The captain, from his station, should be able to monitor the flight engineer's station at all times.



*Not allowed for location of primary controls. See para. 3.5.3

FIGURE 1

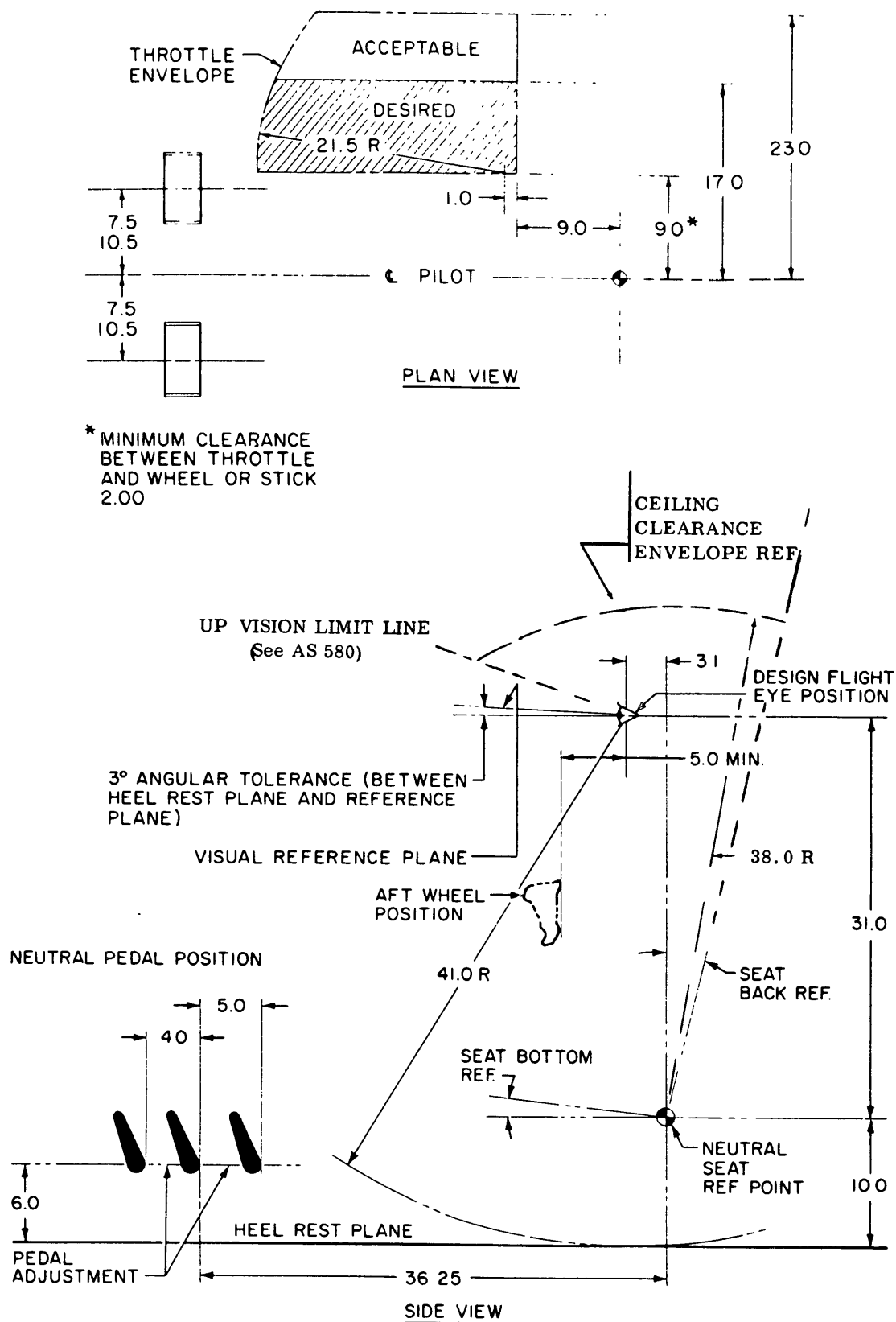


FIGURE 2 - Pilot's Normal Position

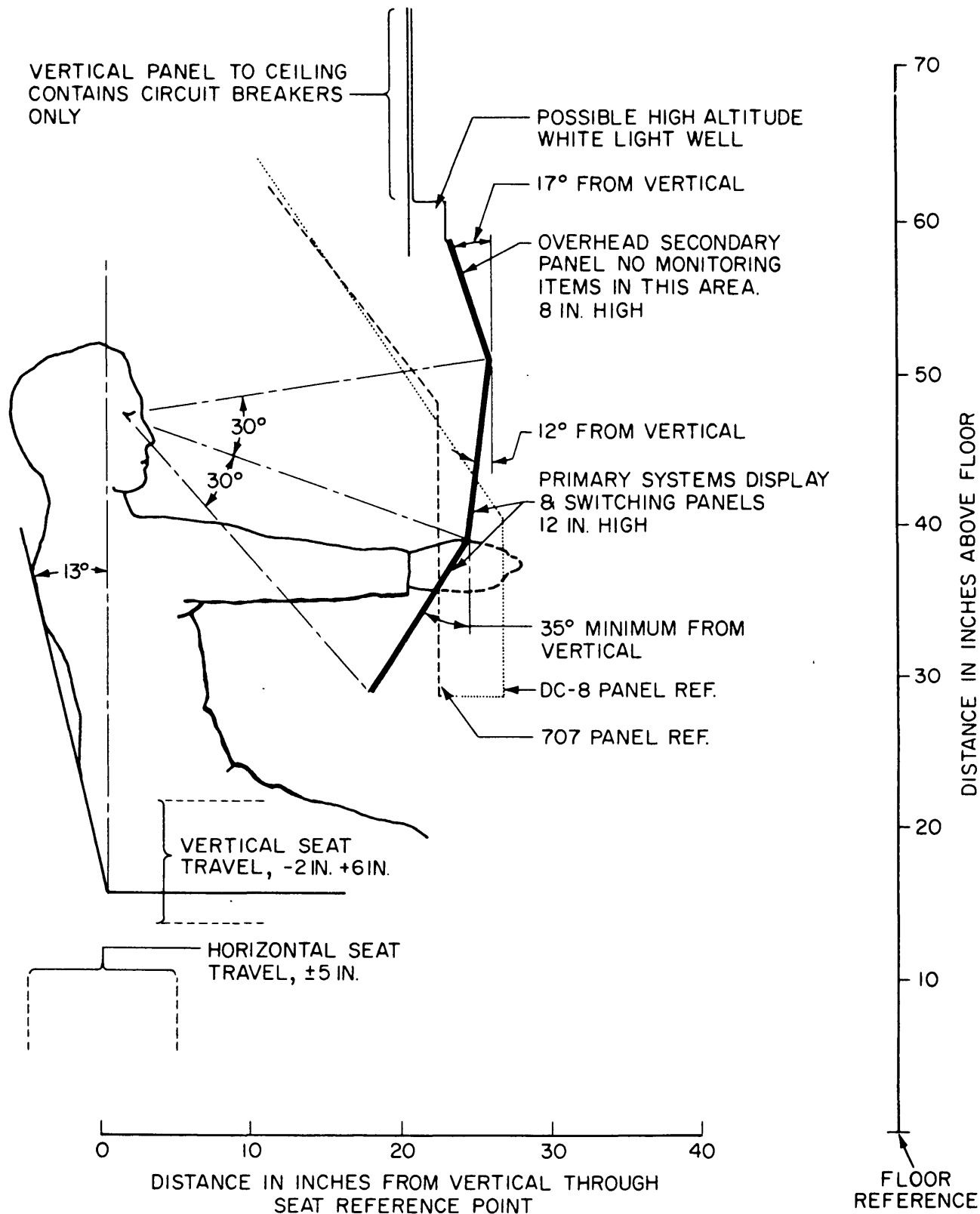


FIGURE 3 - Recommended Flight Engineer Panel Profile

- 3.4 The flight engineer's station should be located so as to permit conversation between crew stations without the use of intercoms.
- 3.5 The following principles govern the orientation of switches and controls in the flight deck area:
- 3.5.1 Powerplants are numbered consecutively from port to starboard.
- 3.5.2 Powerplant controls should be numbered corresponding to the powerplant with which they are associated regardless of their orientation at the particular flight station.
- 3.5.3 Primary or emergency powerplant controls and fuel system controls shall be located in Zone A of Fig. 1. These controls shall be oriented in vertical planes displaced by not more than 90 deg to the left or right from the reference plane (plane of the main flight instrument panel). This applies irrespective of whether the panels on which the controls are located are horizontal or vertical.
- 3.5.4 The controls in Zone A should be oriented from left to right relative to the crew member when he is facing the controls, as numbers 1, 2, 3, 4 . . .
- 3.5.5 The controls in Zone B should be oriented 1, 2, 3, 4 . . . from port to starboard.
- 3.5.6 Zone A includes all areas reached by flight crew members while they are seated at their stations with all required restraint harnesses normally secured, including shoulder harness, if provided, with locking reel free.
- 3.5.7 Zone B includes all other areas in or out of the flight compartment.
- 3.5.8 Secondary controls, if oriented vertically, should be numbered from top to bottom.
4. GENERAL RECOMMENDATIONS: There are many detailed recommendations made in this document concerning location and actuation of controls. Where no specific requirements are indicated, the following general recommendations will apply:

(Whenever the recommended assignment of system controls or displays as "secondary" or "desirable" to either pilot results in an impractical design configuration, consideration should be given to the provision of satisfactory advisory/warning displays for that pilot. Such advisory/warning displays may be included as parts of master advisory/warning displays, as appropriate.)

4.1 Location of Controls:

- 4.1.1 Controls should be located so as to permit their use by the crew member to whom they are assigned while he is seated at his normal station with all required restraint harnesses normally secured, including shoulder harness, if provided, with locking reel free.

4.1.2 All controls of a like function should be grouped together and segregated according to systems. Controls that are similar in configuration and actuation, but which are in different systems, should be physically separated to avoid confusion.

4.1.3 Controls should be located relative to the eye position as established in Fig. 2 and as used in AS 580 (for visibility) and AS 290 (for seats and seat reference point) or superseding documents to insure that optimum control locations coincide with the pilot's location for maximum exterior visibility.

4.2 Actuation of Controls:

4.2.1 Controls should be so designed that the actuation thereof, forward, upward or clockwise, will result in increased performance of the component or the aircraft. Also see paragraph 4.2.4.

4.2.2 Controls should be so designed that the actuation thereof, aft, downward, or counterclockwise, will decrease the performance of the component or the aircraft. Also see paragraph 4.2.4.

4.2.3 All controls of a variable nature actuated by a rotary motion should move clockwise from the "OFF" position through "LOW" or "DIM" to "HIGH" or "BRIGHT."

4.2.4 On control panels located above eye level, every effort should be made to keep these panels as nearly vertical or horizontal as possible to avoid ambiguity in control movement which attends a 45 deg panel installation.

4.2.5 Where momentary contact switches are used, exceptions to the above criteria may be desirable to facilitate operation. This is particularly true where multiple switches are used and where prolonged actuation in flight is necessary (e.g., carburetor alcohol switches). When exceptions are made, the direction of actuation should be such as to provide the greatest ease of operation.

4.3 Crew Member's Reach: Figs. 4 and 5 contain information on the reach of an average crew member in various directions. This should be helpful in initial flight layout, but is not intended to limit flight deck dimensions. Note that these charts show fingertip reach.

4.4 Where damage to the aircraft can result from exceeding a placarded limitation, initial movement of the control (flap, wingsweep, landing gear, etc.) as well as the position of the device being controlled, should be physically prevented or it should excite the appropriate aural or visual warning. (Ref. ARP 450B).

5. SPECIFIC RECOMMENDATIONS: This section sets forth specific recommendations with respect to assignment, location, and actuation of controls.

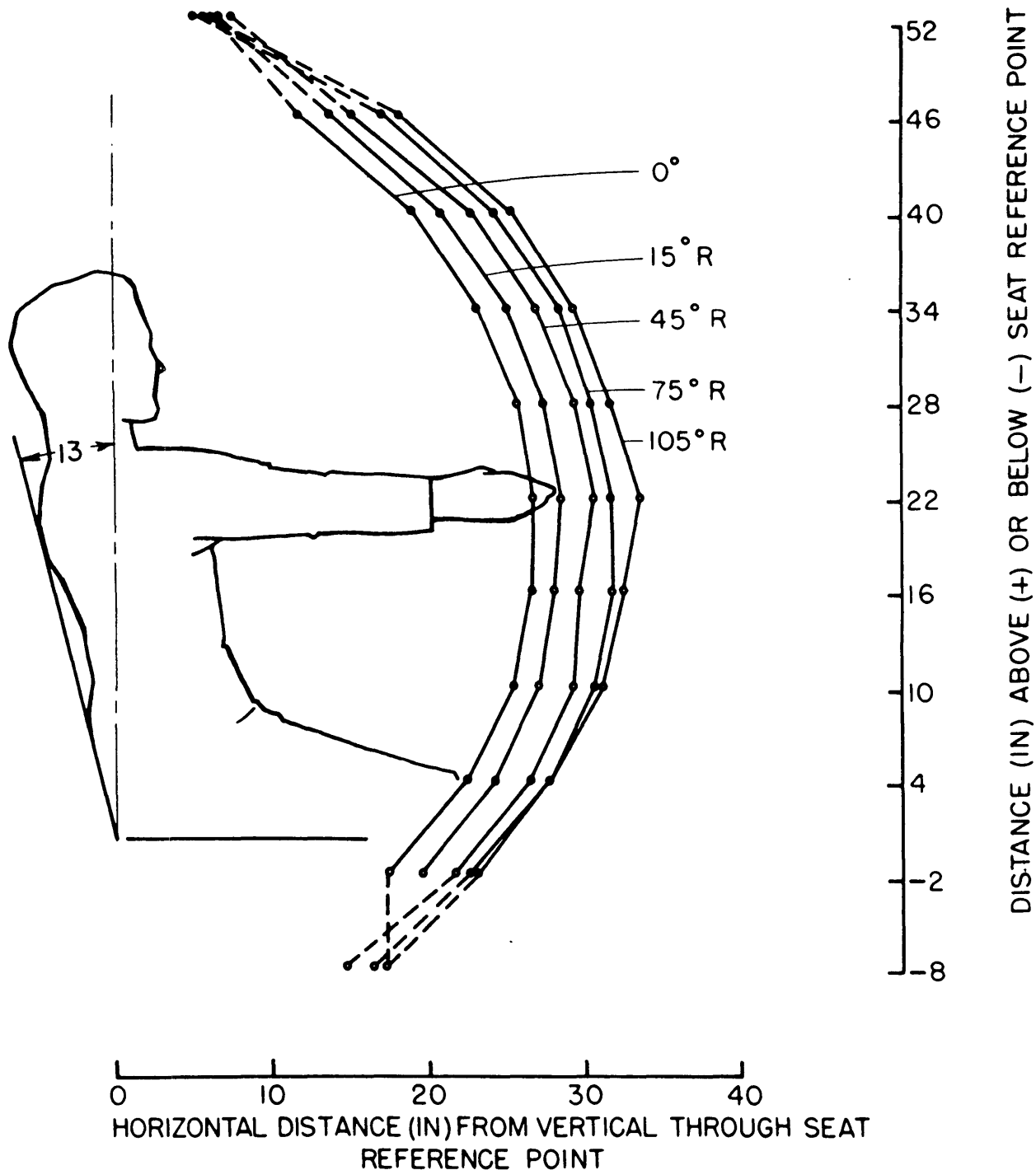


FIGURE 4 - Maximum Distances Which Can Be Reached By 97 Percent Of The Population At Each Position. The Elliptical Arcs Indicate The Maximum Boundaries Of The Working Area For Operation Of Manual Controls (At Angles From 0° To 105° To The Right) For This Group Seat Back Angle 13

NOTE: This Figure Is Reproduced From Report No. 3 Project X-651. Published By Naval Medical Research Institute.

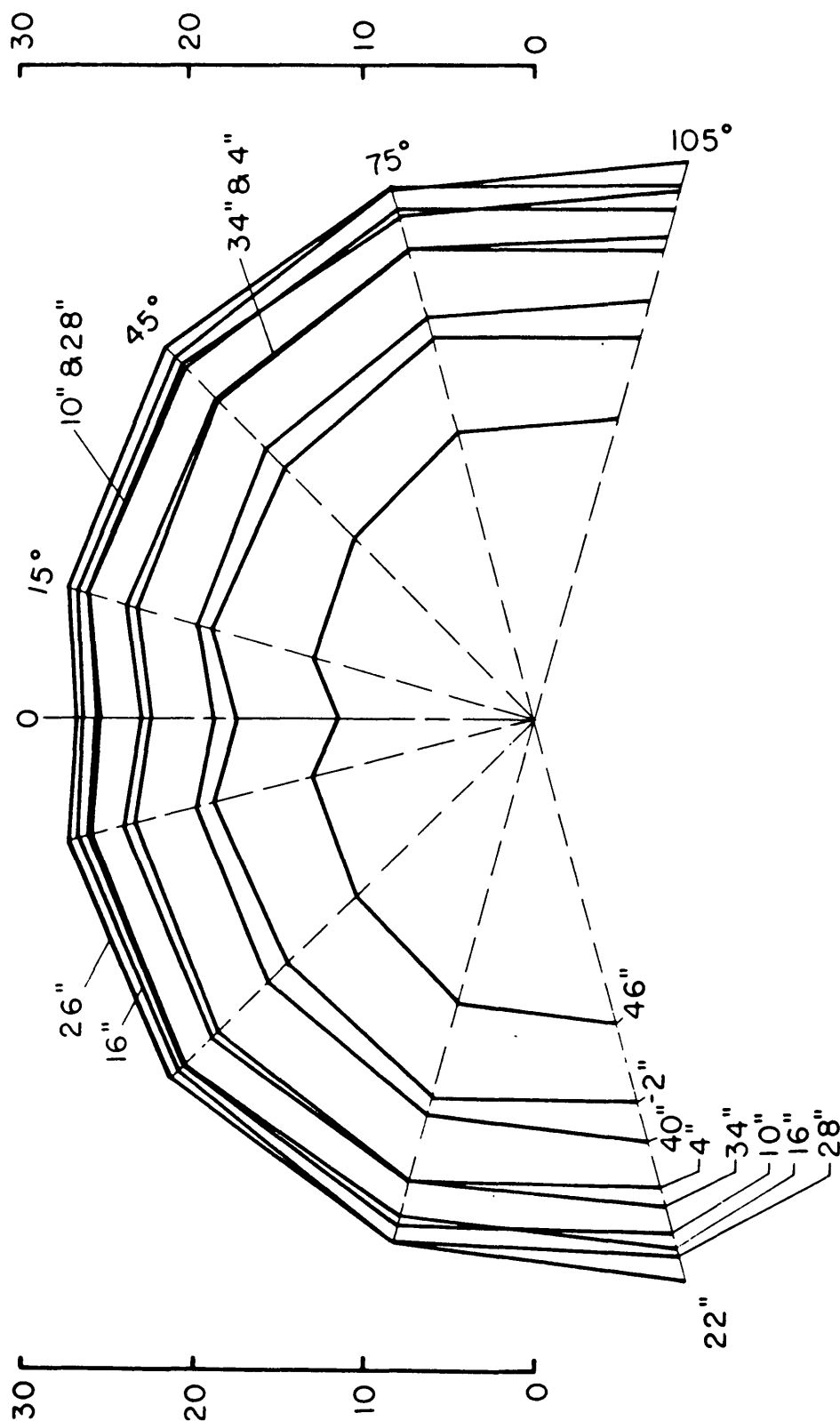


FIGURE 5 - Maximum Distances Which Can Be Reached By 97 Percent Of The Population At Each Position. The Elliptical Arcs Indicate Maximum Boundaries For This Group For Operation Of Manual Controls At Various Horizontal Levels. Seat Back 13 From Vertical.

NOTE: This Figure Is Reproduced From Report No. 3 Project X-651. Published By Naval Medical Research Institute.

5.1 Primary Flight Controls: Fig. 2 shows specific recommendations for the locations, travel, and adjustment of these controls to insure that the pilot's position, so obtained, coincides with his required position for exterior visibility as defined in AS 580. A means should be provided in the aircraft for the pilots to locate their eyes and flight position at the design eye position in order to guarantee that they will have and can use the visibility designed into the aircraft.

5.2 Secondary Flight Controls:

5.2.1 Automatic Pilot:

- a. Assignment: Primary - both pilots.
- b. Location: Mode and function controller and maneuvering control, when used, should be located close to the airplane centerline, below the pilot's eye level, and preferably forward of the pilot's eye position. The maneuvering control may be located separately from the mode and function controller.
- c. Actuation: Conventional.
- d. Comments: A suitable arm rest is desirable if a separate maneuvering control is used. A thumb-operated electrical disconnect button shall be provided on the outboard horn of each control wheel. If a mechanical disconnect is used, it should be accessible to both pilots. Suitable guards should be provided to prevent inadvertent operation of the controller and suitable priority interlocks should be provided where separate maneuvering controls are used.

5.2.2 Stability Augmentation: Stability augmentation controls, where provided, should be incorporated in the autopilot mode and function controller, or adjacent thereto.

- a. Assignment: Primary - both pilots.

5.2.3 Control Surface Boost Control (where provided):

- a. Assignment: Primary - both pilots.
- b. Location: Pilot's overhead panel forward of pilot's normal eye position and within reach of both pilots.
- c. Actuation: Conventional.