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USAARL REPORT NO. 70-3

VISIBILITY FROM THE REAR SEAT OF THE U. S. ARMY O-1A (BIRD DOG) AIRCRAFT

By

John K. Crosley, MAJ., MSC

and

Robert W. Bailey, COL., MSC

AUGUST 1969

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY
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John K. Crosley

JOHN K. CROSLEY, MAJ, MSC
Chief, Physiological Optics Branch
US Army Aeromedical Research Laboratory

ABSTRACT

The dynamic visual field of view was measured from the rear seat of the U. S. Army O-1A (Bird Dog) aircraft. Subjects from the 5 and 95 percentile level sitting eye heights were used to determine the changes in field of view when the short man occupied the front seat and the tall man the rear, and vice versa. Changes occurring as a result of using a cushion, sitting in a fixed position, or moving the extent of the seat harness were also measured. Recommendations are made concerning seat adjustment characteristics, rear window design, the availability of instruments to the Instructor Pilot in the rear seat, and the weather standards for dual VFR flight.

APPROVED: Robert W. Bailey

ROBERT W. BAILEY
COL, MSC
Commanding

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VISIBILITY FROM THE REAR SEAT OF THE U. S. ARMY O-1A (BIRD DOG) AIRCRAFT.

INTRODUCTION

The O-1A (Bird Dog) tandem-seated fixed wing aircraft is manufactured by the Cessna Aircraft Company and was designed for use as a combat observation aircraft. The original concept was for the pilot to fly from the front seat, and the observer to sit in the rear. With the excellent forward visibility from the front seat, pilots flying from this position are not unduly hindered in the operation of this aircraft. On the other hand, pilots have expressed dissatisfaction at the lack of visibility when flying from the aft seat.

At Fort Rucker, Alabama, home of both the U. S. Army Aviation Center and the U. S. Army Aviation School, the O-1A is presently being utilized in the tactical fixed wing training program. To prepare instructor pilots for their role in the training mission, the O-1A instructor pilot trainee completes a formal Method of Instruction course designed to teach him to fly the aircraft from the rear seat. Upon successful completion of the course, he is designated as an O-1A instructor pilot. The student pilots assigned to an O-1A instructor for tactical training fly the aircraft from the front seat. During these in-flight instruction periods, it is the instructor pilot's responsibility to ensure that the student is performing properly at all times. Further, he must be prepared to take over the controls of the aircraft immediately, should circumstances so warrant.

Due to the fixed construction of the trainer rear seat, there is no way to adjust or modify the forward-facing seating position. This not only affects the visibility outside the aircraft, but the cockpit geometry of the rear seat severely limits the ability of many pilots to safely maneuver the rudder pedals.

To improve outside visibility, increase comfort, and improve pedal reach, many pilots add a cushion to the rear seat. This custom of using a cushion is frequently practiced both in training areas and combat areas. From a safety standpoint, the U. S. Army Aviation Materiel Laboratories' Report No. 67-22 recommends that a cushion designed for comfort should not exceed 1.5 inches in thickness. Thicker cushions especially designed as load-limiting (crushable) energy absorbers are recommended to be 5.0 to 7.5 inches. Thus, the present policy of using thick cushions simply as a means of increasing sitting height should be discontinued, and a more positive approach taken.

Due to the fact that the side rear windows open inward and fasten overhead, there is also a loss of approximately one and one-half to two inches of valuable head space for the rear occupant during those periods when the aircraft is flown with the windows open. Due to the climatic conditions in southern Alabama, and RVN, the rear windows are often required to be open much of the time.

The O-1A aircraft used for training do not ordinarily have instrumentation available in a separate panel display for rear seat flight. As a result, the instructor pilot is unable to properly monitor the forward-mounted instrument panel during normal student instruction. This problem may become more severe during adverse weather conditions and inadvertent IFR flight. Should an in-flight emergency require a take-over of the controls by the instructor pilot, this inability to see certain instruments could be critical, especially should the emergency arise during an unusual attitude or other critical control phase.

The overall problem of visibility from within the aircraft cannot be over-emphasized. During normal flight, the lack of proper forward field of vision is serious when the problem of mid-air collision prevention is considered. However, during the landing phase, this visibility loss becomes a critical problem, especially for the new instructor pilot.

The addition of a copilot or observer provides a statistical advantage in the military observation role. The Visual Flight Rules (VFR) minimums consider the presence of an instructor pilot/observer to significantly improve the visibility outside the aircraft, and this has contributed to the adoption of the following U. S. Army Aviation School, Department of Training visibility minimums for student training in the O-1A:

<u>Dual</u>	day	700 feet and 1 mile
	night	1000 feet and 3 miles

<u>Solo</u>	day	1000 feet and 3 miles
(front only)	night (not leaving sight of the field)	1000 feet and 3 miles
	cross country	2000 feet and 6 miles

A request directed to this Laboratory for data describing visibility from this aircraft revealed that such information was not readily available. This project was initiated to measure the dynamic or operational visual field of view from the rear seat of the O-1A aircraft. This method of evaluation takes into consideration the actual movements of the aviator in the act of flying the aircraft, as opposed to the usual static method of taking photographs or plotting the visual field from a fixed eye position. In addition, anthropometric measurements of the sitting eye level position of aviators in the 5 and 95 percentile level were used, rather than basing all data on an unrealistic 50 percentile level.

Equipment

1. Circular eight inch target painted red-orange fluorescent and mounted on the end of a three foot stick.
2. Measuring tape.
3. Chalk.
4. Camera.
5. O-1A aircraft fixed in level flight position.
6. Two standard issue aviator helmets (APH-5).
7. Seat cushion measuring 5.5 inches uncompressed.

Personnel

The Aviation Medicine branch of this Laboratory provided current anthropometric data concerning aviator sitting heights and sitting eye heights. One individual in the five percentile (shortest) and one in the ninety-five percentile (tallest) sitting eye heights classification were selected to participate as subjects. Two Laboratory research assistants performed the actual target positioning and measurements.

METHODOLOGY

An O-1A fixed wing aircraft (Figure 1) was placed on an airfield and positioned as if in straight and level flight by placing a jack under the tail portion. A point directly below the center of the rear seat was marked on the asphalt paving. Using this point, a half-circle was drawn in chalk encompassing the forward 180 degree field of view. The radius of this half-circle was ten feet. On the circle, marks were placed at five degree intervals with the straight ahead being the 90 degree position.

The object of the study was to place the two subjects in the aircraft and plot the visual field of the "pilot" in the rear. One research assistant held a marker stick on the degree position that was being measured at that time. A second research assistant walked either toward or away from the aircraft (depending upon whether the "pilot" could or could not see it) in a straight line formed by the marker stick and the center of the circle. He moved the painted target along the ground and recorded (in feet) that point at which the "pilot" could just see all of it. This sequence was repeated at 5 degree increments for the full 180 degrees.

Visual fields of the rear seat occupant were plotted for each of the following situations:

1. Short subject in rear sitting in a fixed position with only head movement allowed - tall subject in front seat.

2. Short subject in rear and allowed to change position to the limit of the seat belt restraint - tall subject in front seat.

3. Tall subject in rear sitting in a fixed position with only head movement allowed - short subject in front seat.

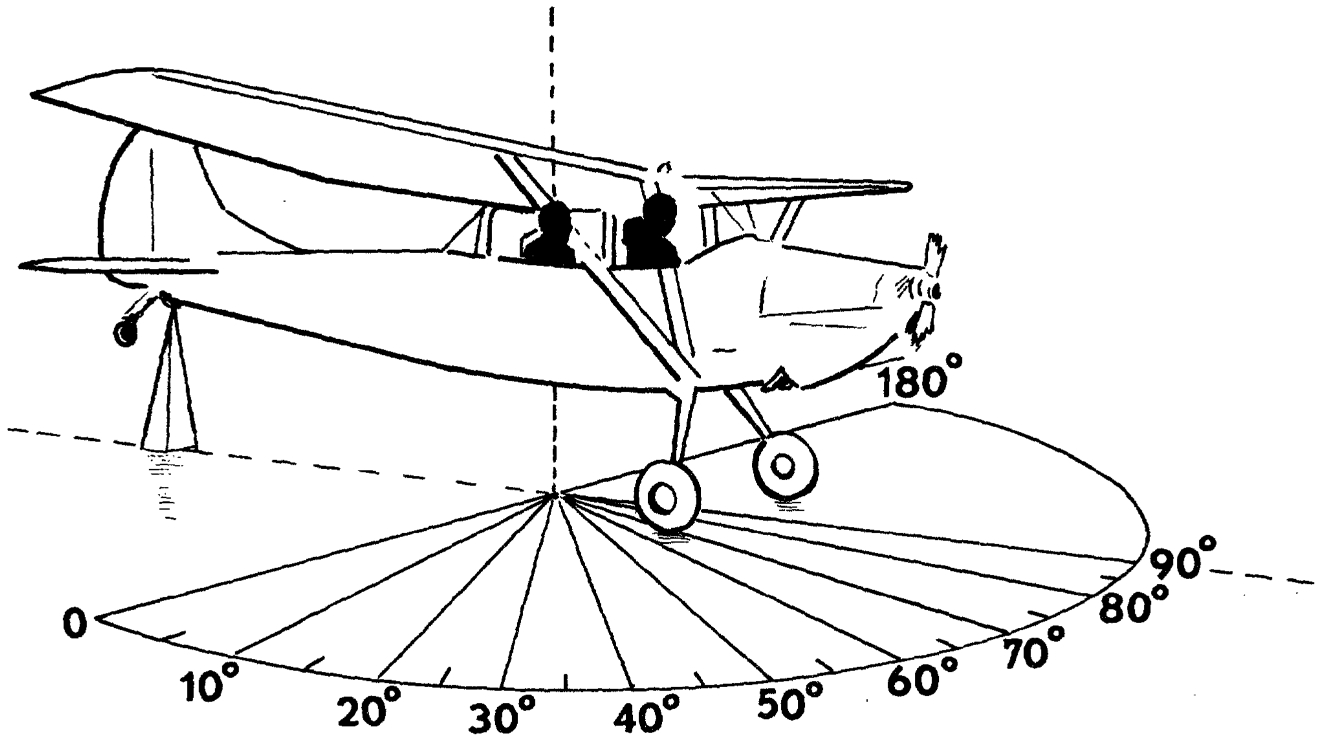


Figure 1

Title: Diagram Showing Method Used to Measure the O-1A Rear Seat Field of View.

4. Tall subject in rear and allowed to change position to the limit of the seat belt restraint - short subject in front seat.

5. Short subject in rear seated on a cushion in a fixed position with only head movement allowed - tall subject seated in front.

6. Short subject in rear seated on a cushion and allowed to change position to the limit of the seat belt restraint - tall subject in front seat.

The decision to evaluate the visual field of the short subject seated in the rear on a cushion was made after learning that it is a common practice for shorter instructor pilots to use such cushions. There is no seat cushion or back cushion provided in either seat of the O-1A aircraft. The seat cushion used for this project was from a UH-1 helicopter.

DISCUSSION AND RESULTS

As is photographically shown in Figures 2 and 3, and illustrated in Figures 4 through 10a, there is often a rather dramatic difference in the field of vision afforded various individuals as they fly the O-1A aircraft from the rear seat.

Although there are no data available which would establish the visual criteria for flying this aircraft, it is readily apparent that the field of vision afforded the rear seat occupant is frequently less than desirable.

There is also sufficient reason to question the one mile visibility limit for dual flight. The rear and side visibility increase resulting from the addition of a rear seat occupant is quite good. However, the forward visibility gained is of little benefit, especially if the individual has a short sitting eye height.

One problem area encountered in this study was not a function of visibility but rather a cockpit geometry problem of major importance. It was noted that not only was it difficult, but virtually impossible for the short pilots to reach the rudder pedals while seated in the rear. Only by stretching himself forward with maximum effort was he able to exert the required control over the rudder pedals of the aircraft.

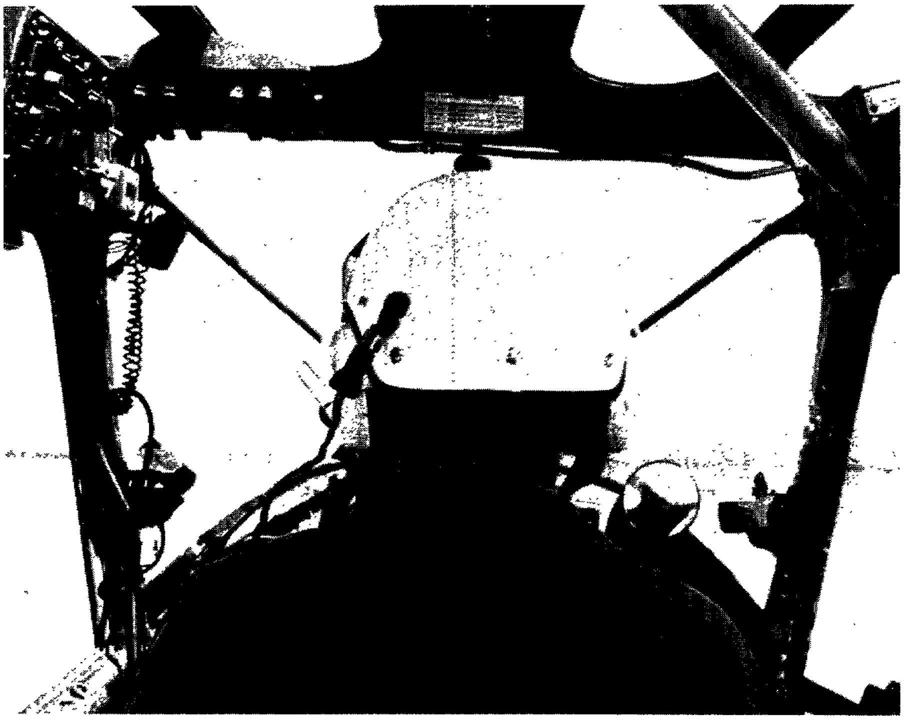
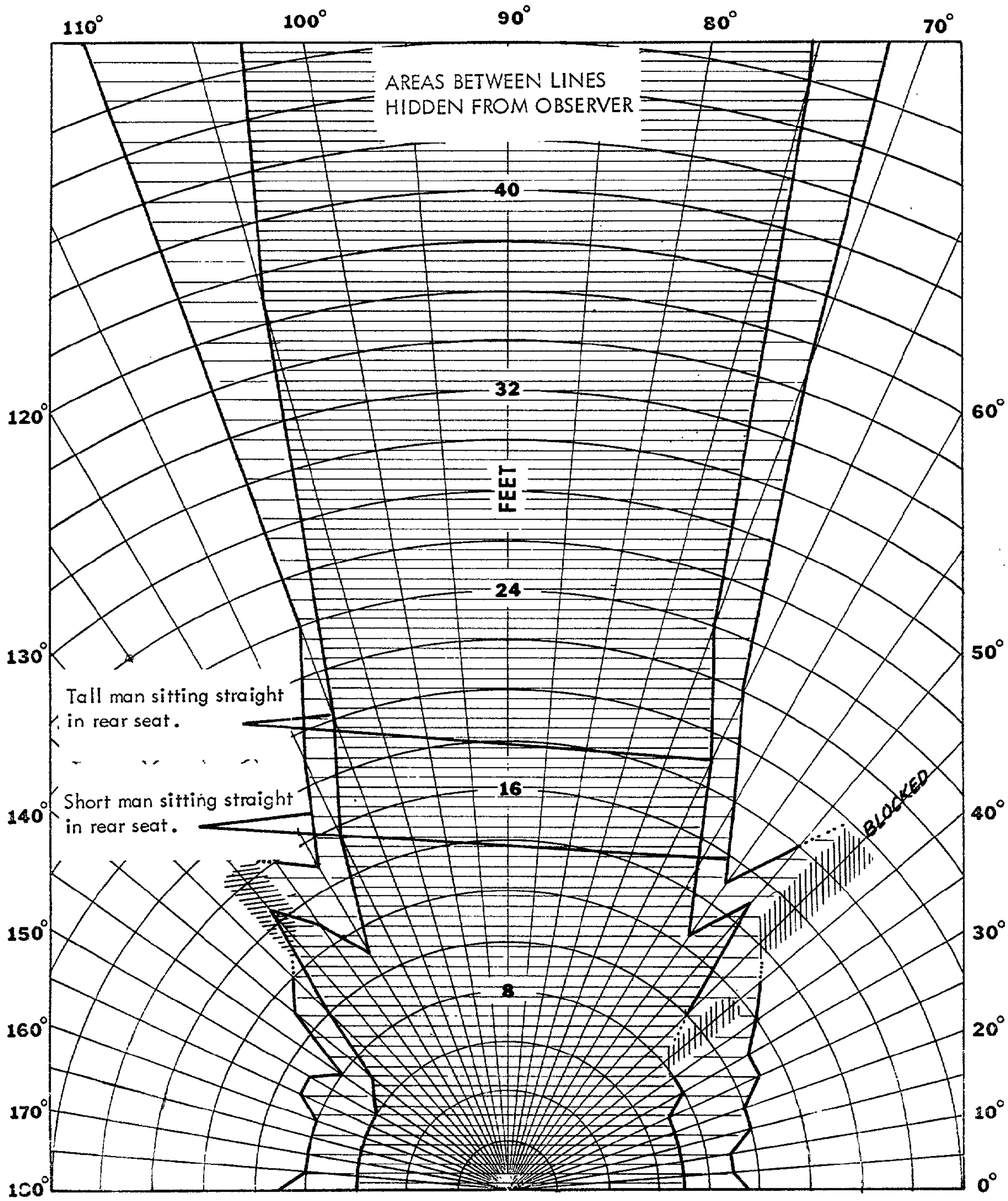


Figure 2.

View from Rear Seat by 95 Percentile Subject
with 5 Percentile Subject in Front Seat.

Figure 3.

View from Rear Seat by 5 Percentile Subject
with 95 Percentile Subject in Front Seat.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Tall man sitting straight in rear seat.
Short man sitting straight in rear seat.
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Figure 4.

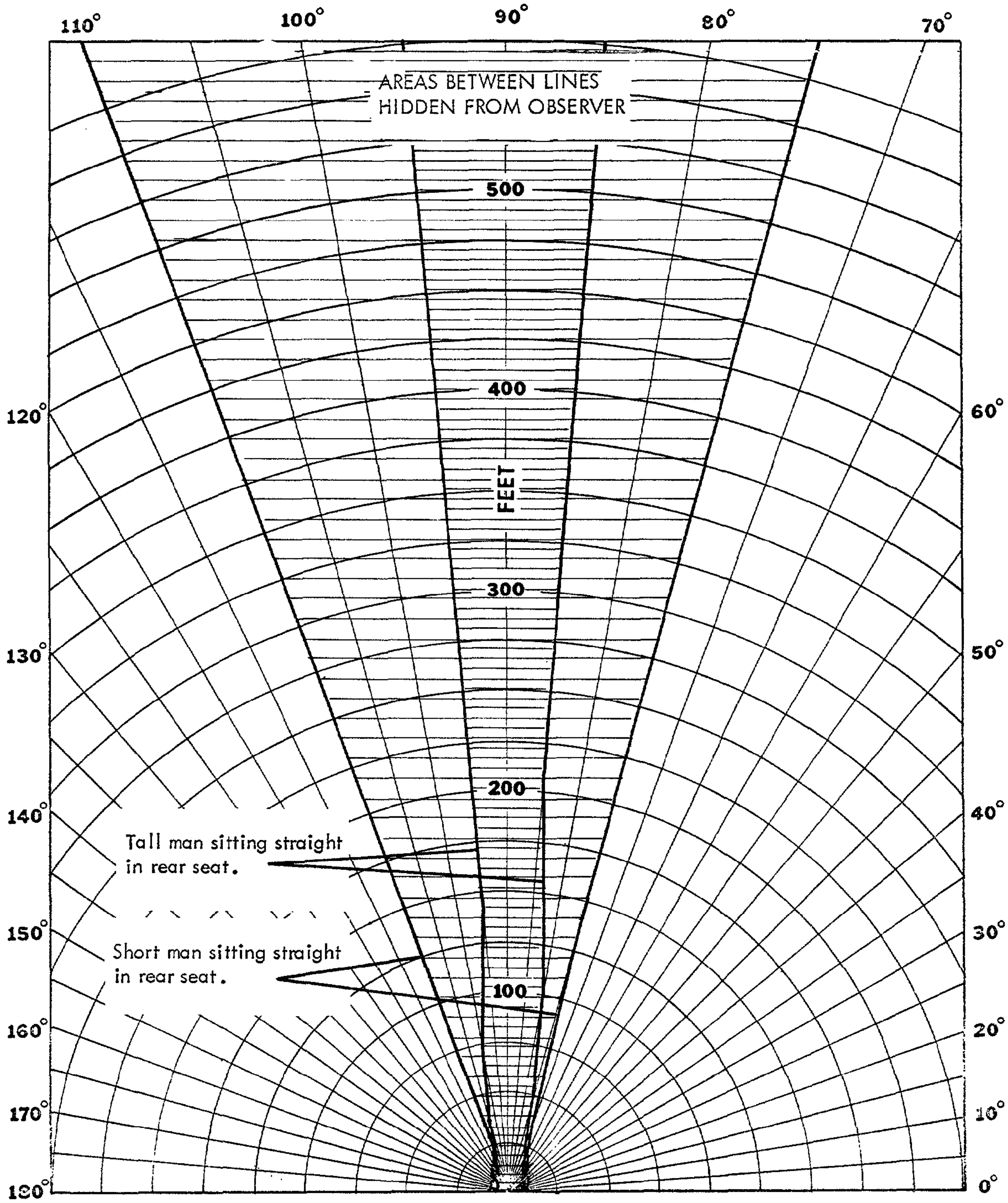
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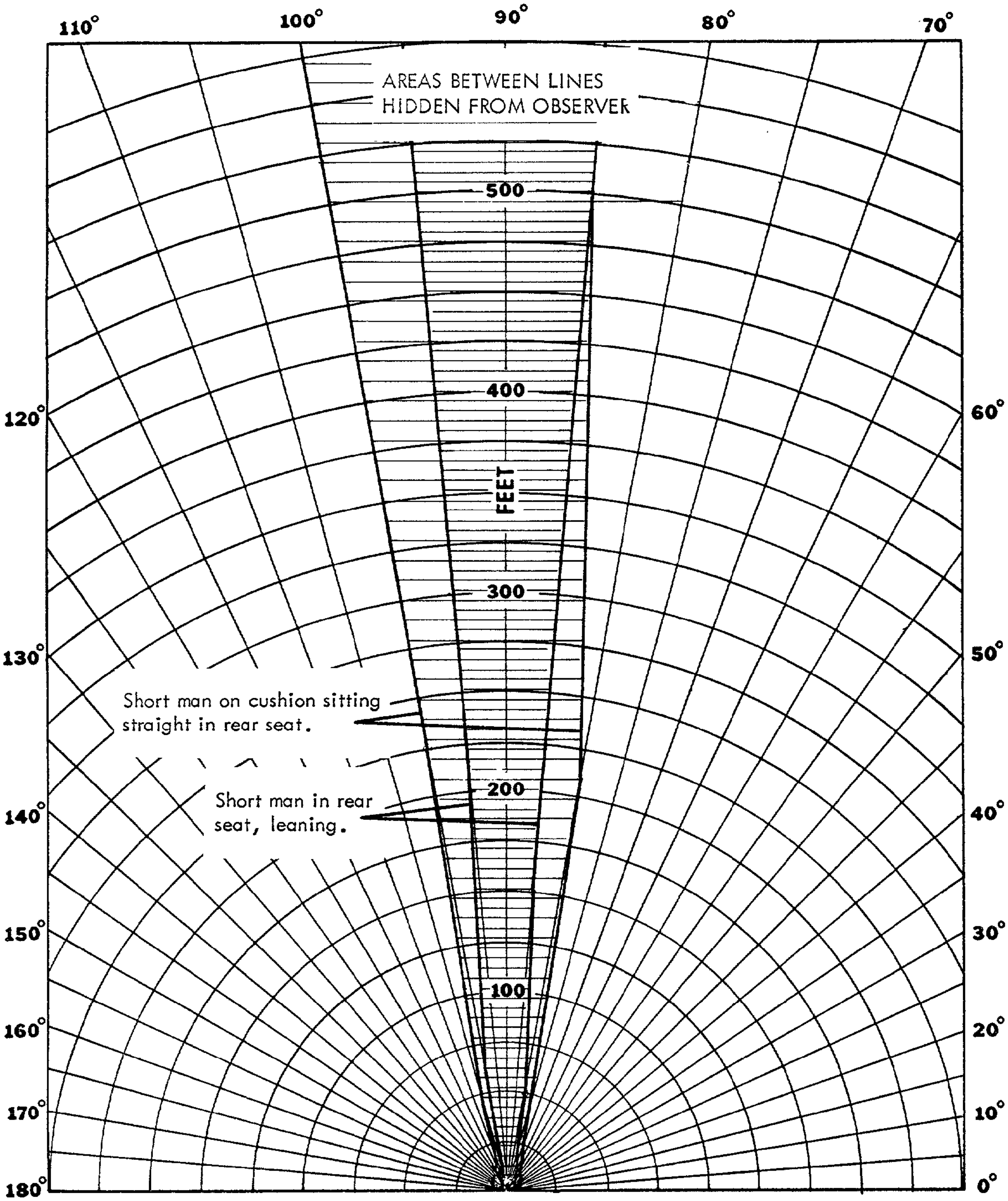
Figure 4a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Short man on cushion sitting straight in rear seat.
Short man in rear seat, leaning.

Figure 5

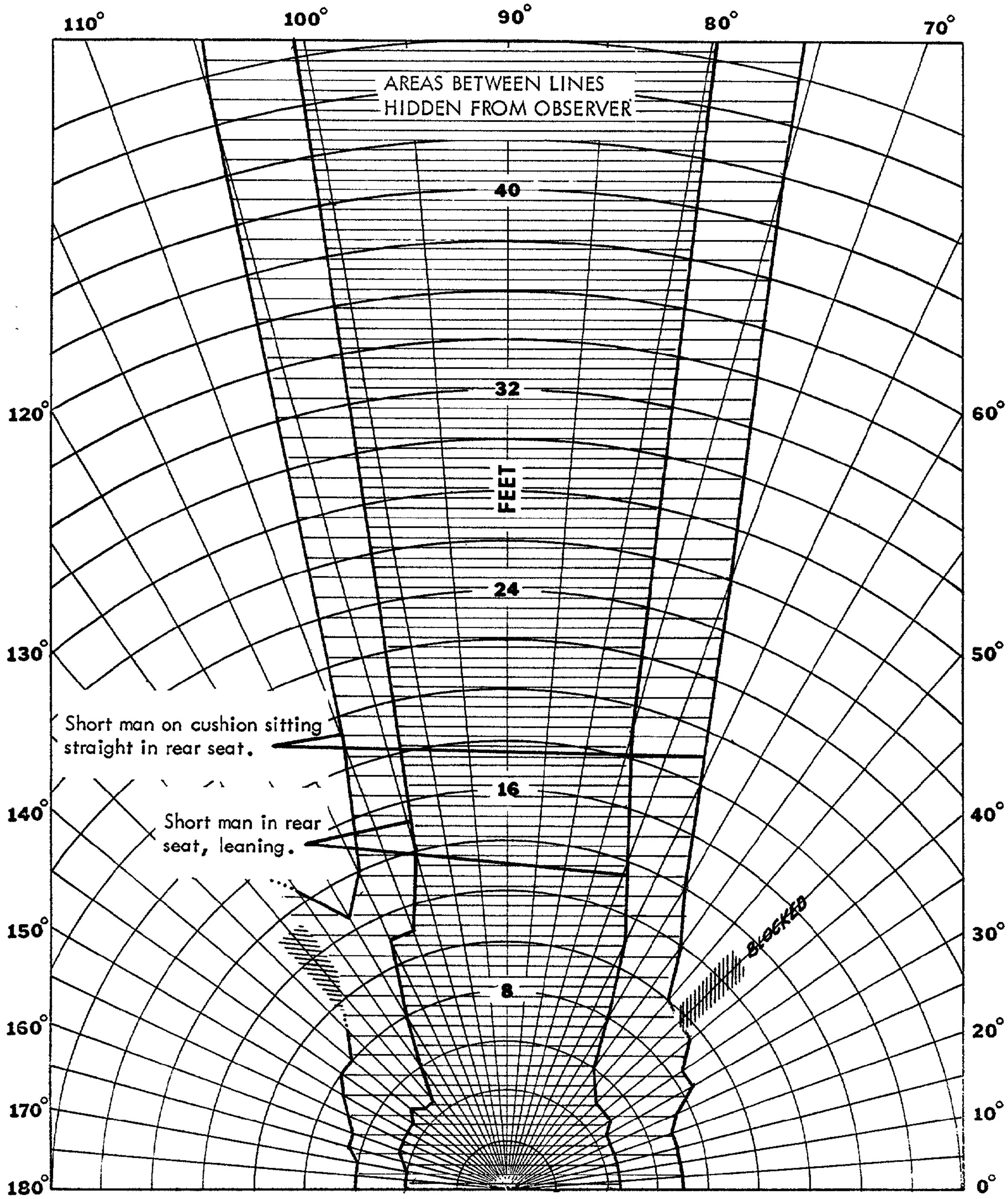
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Figure 5a

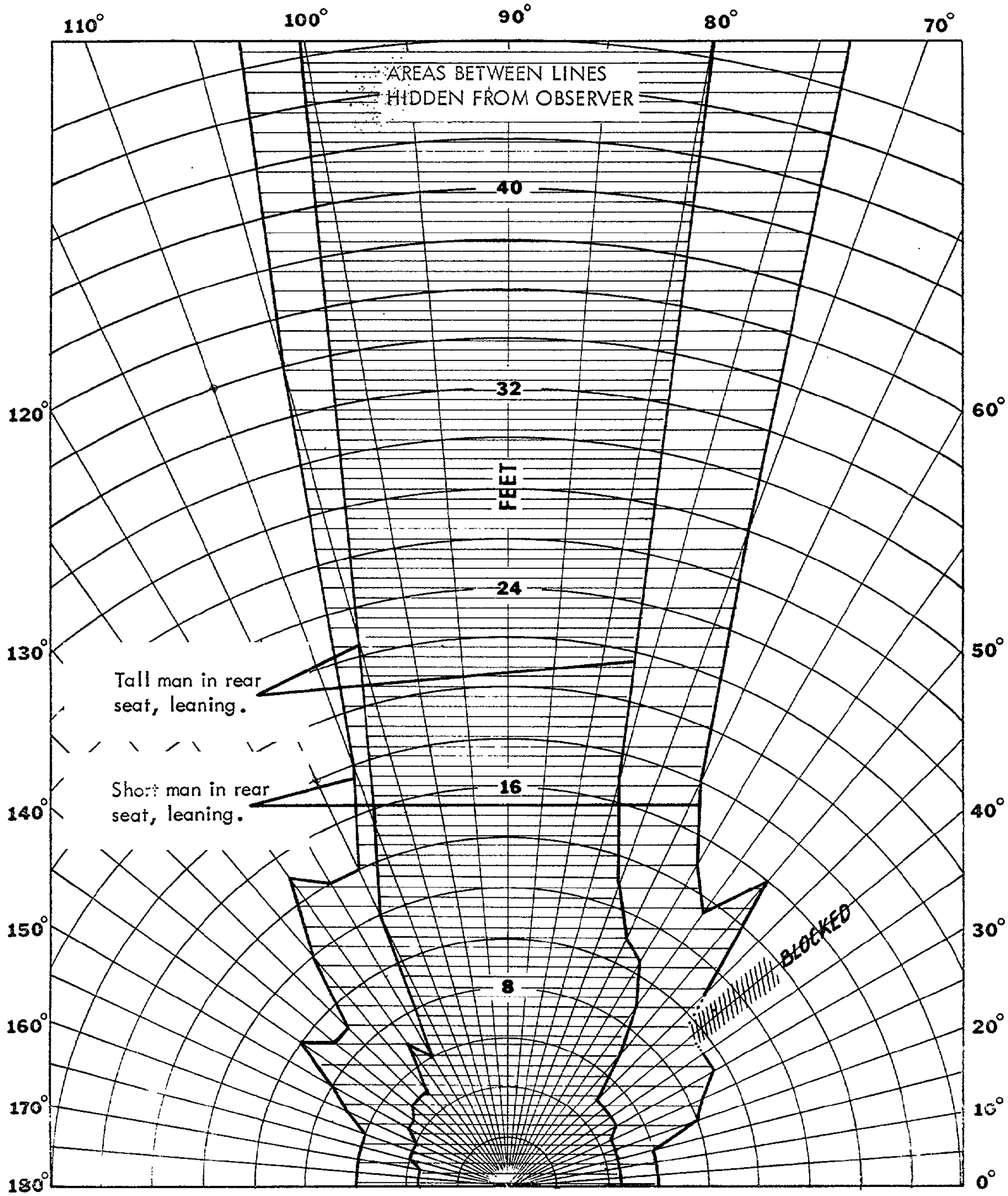
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Figure 6

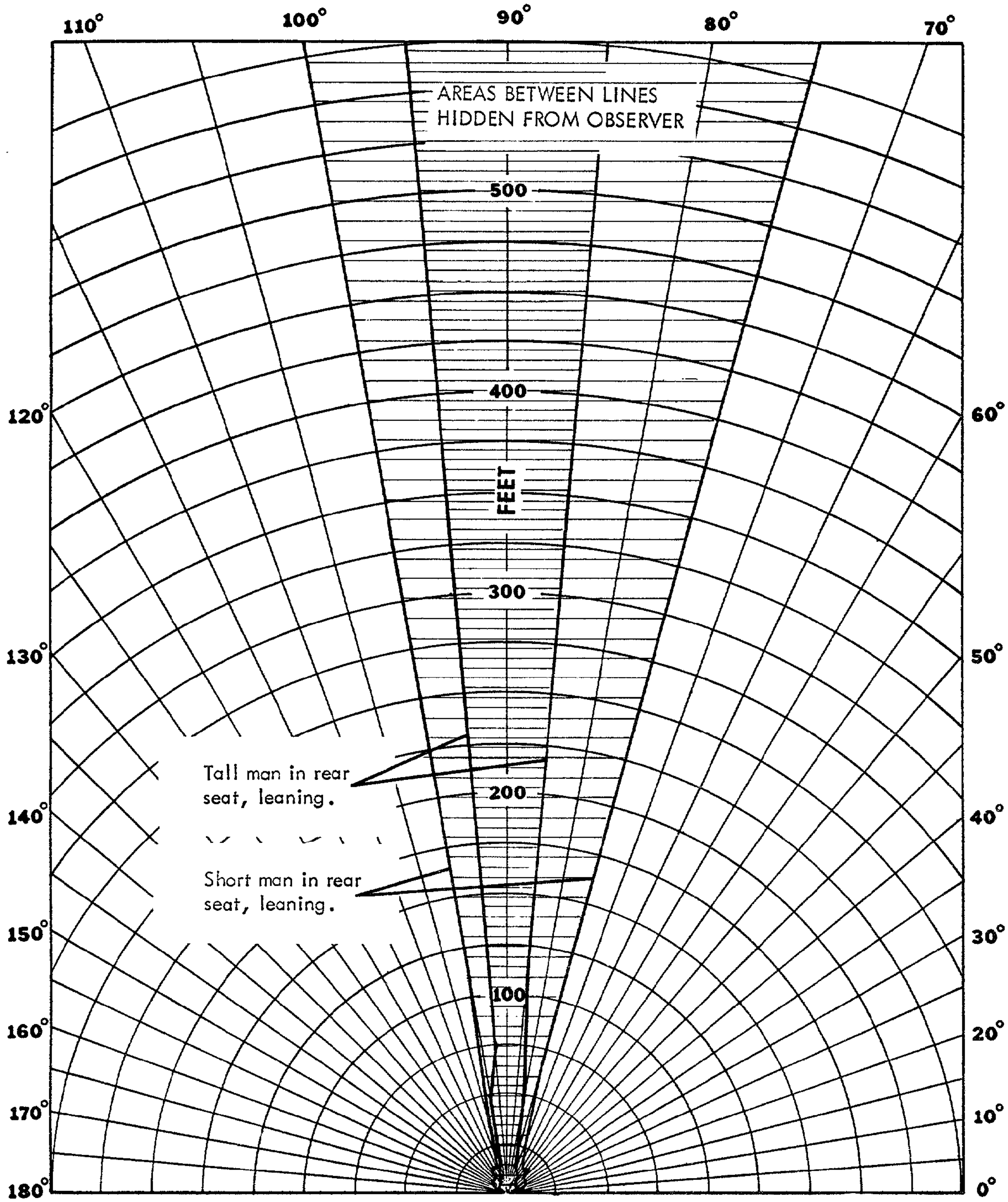
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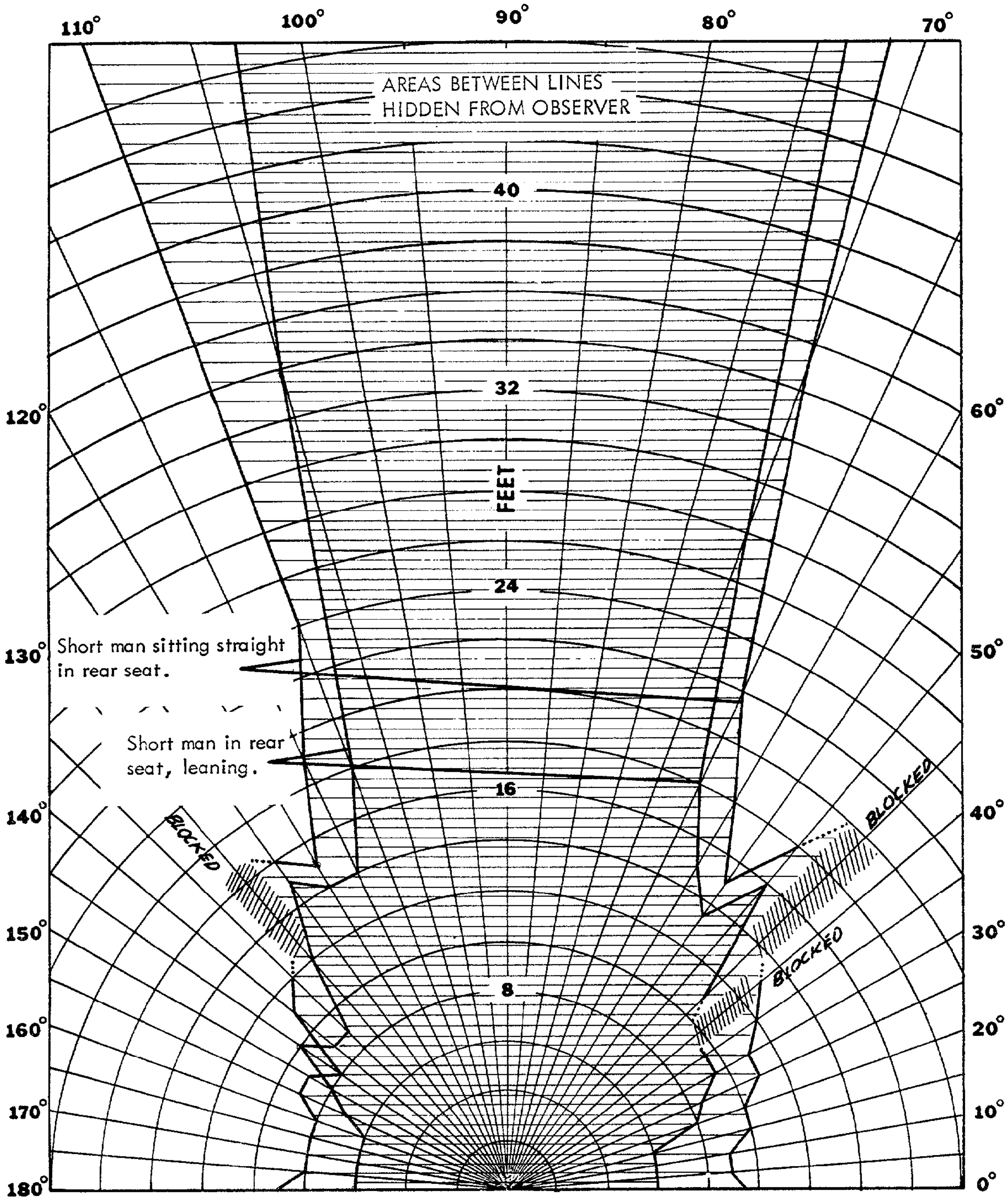
Figure 6a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Short man in rear seat, leaning.
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Figure 7

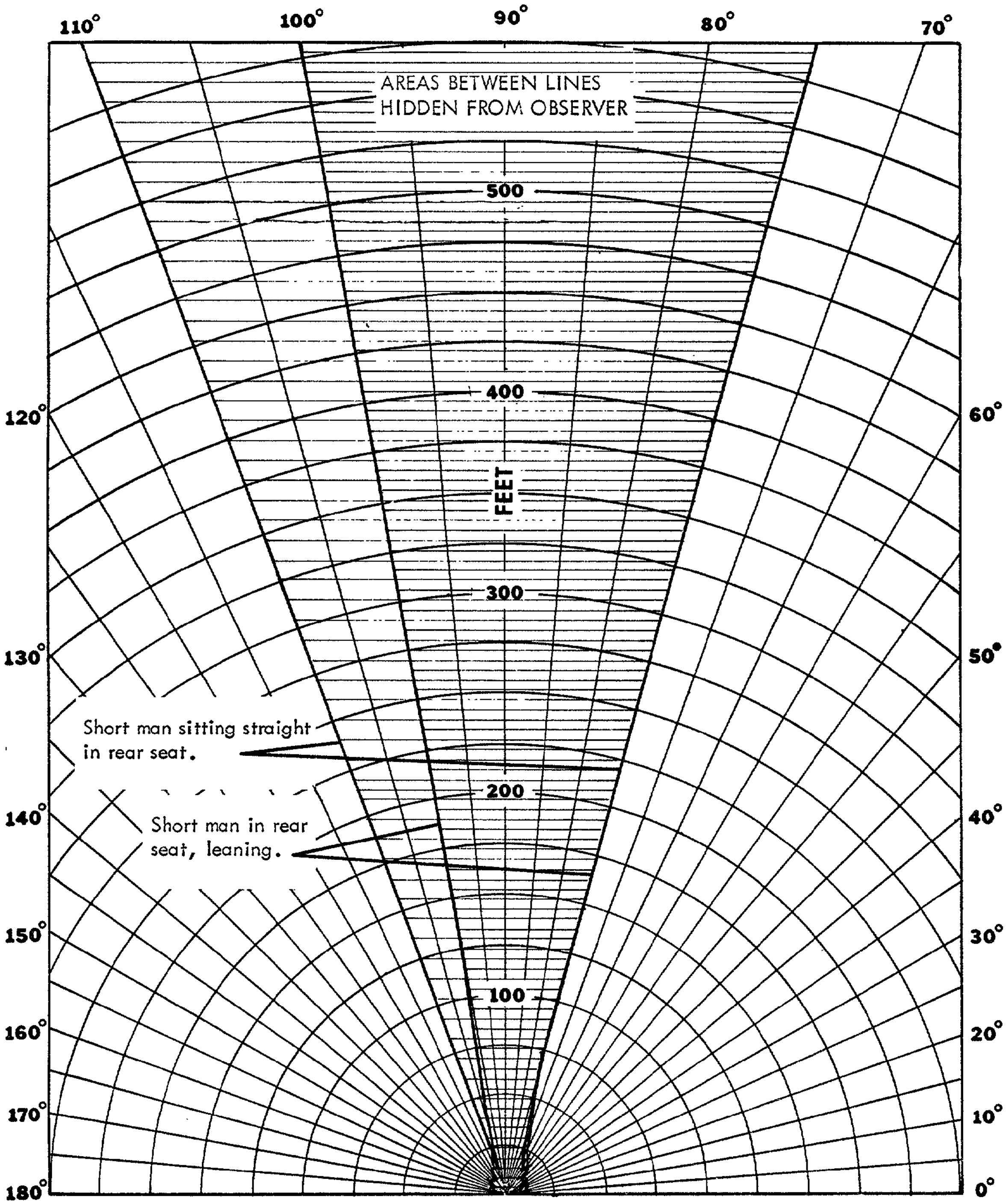

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Figure 7a

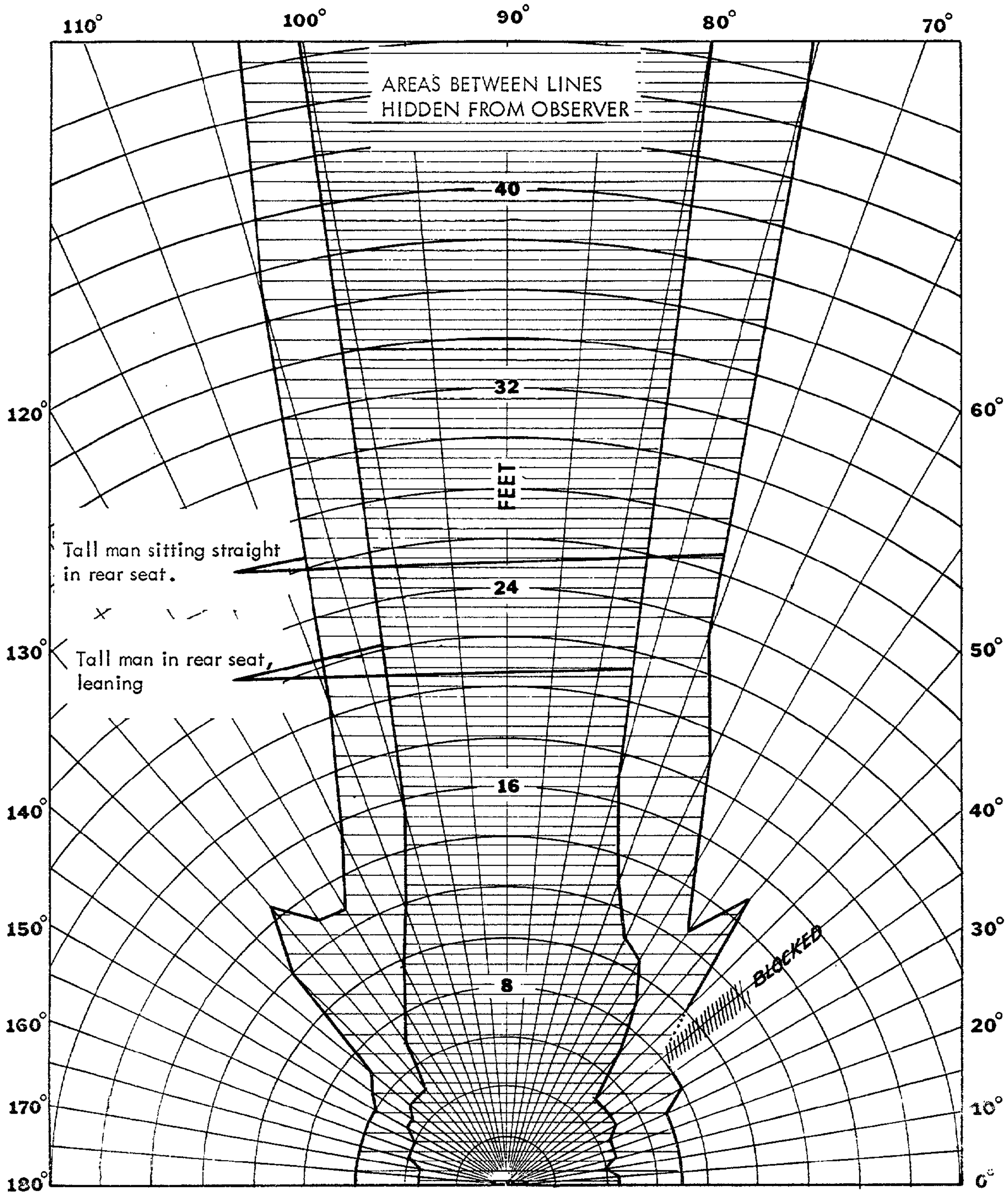
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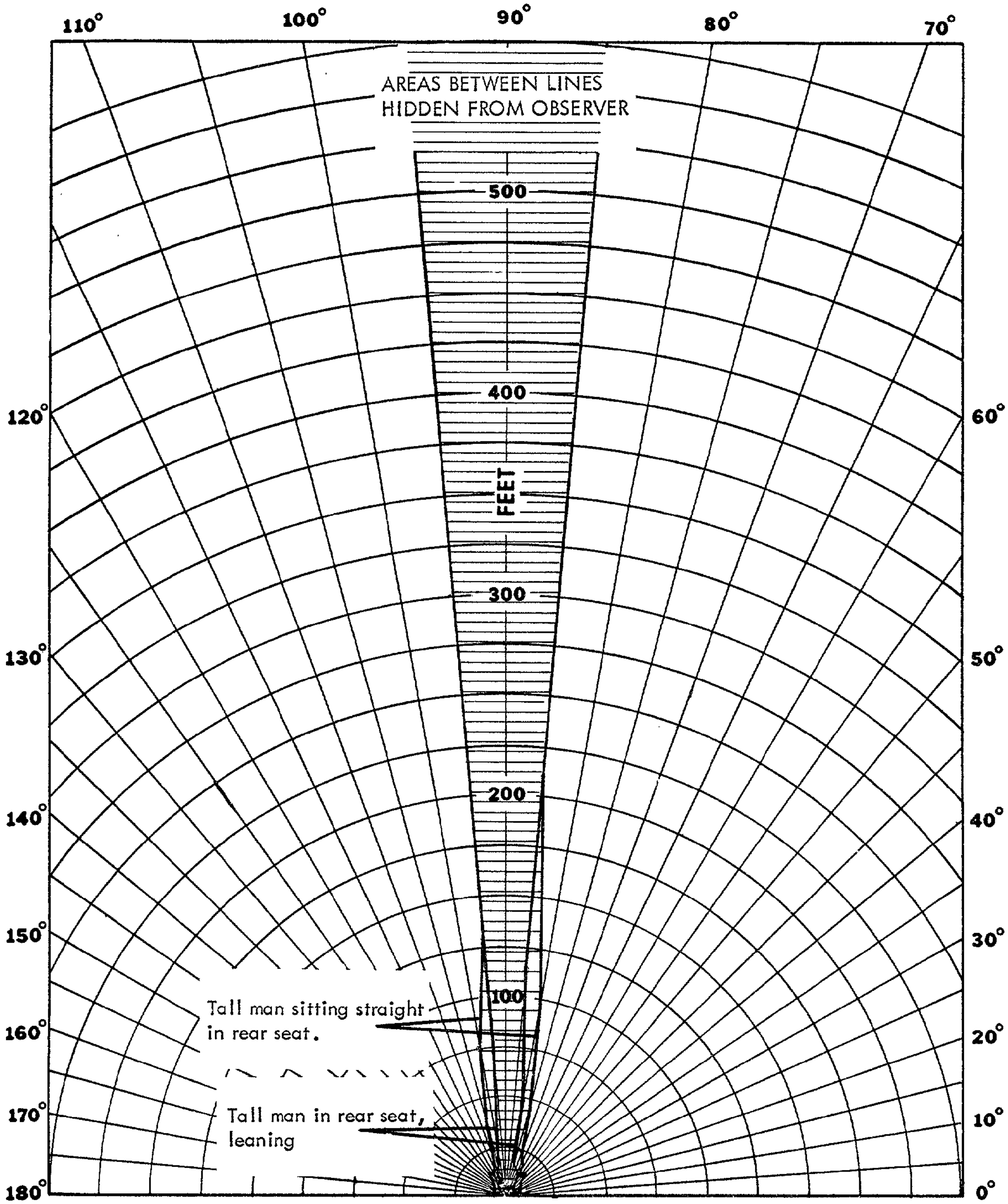
Figure 8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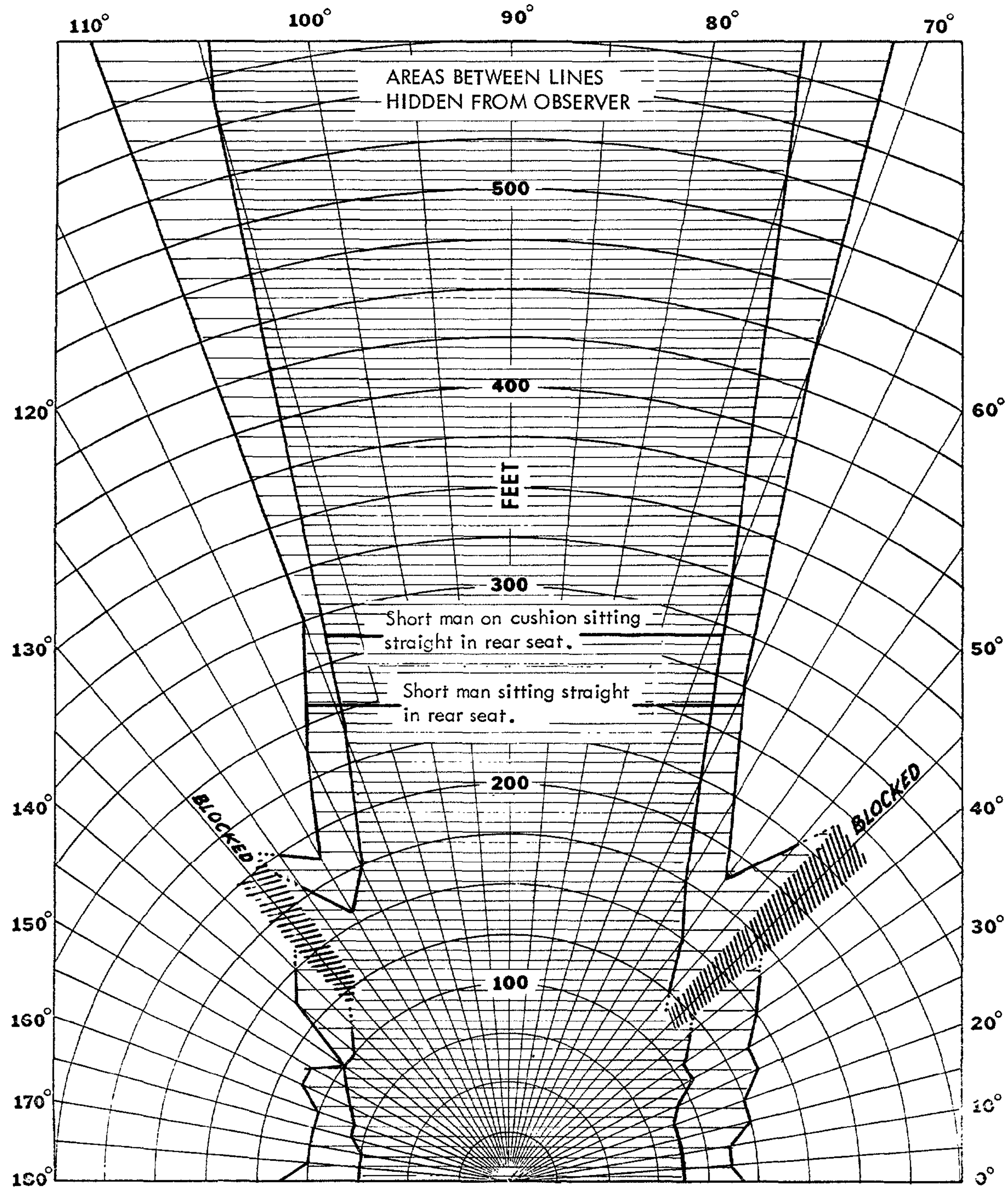
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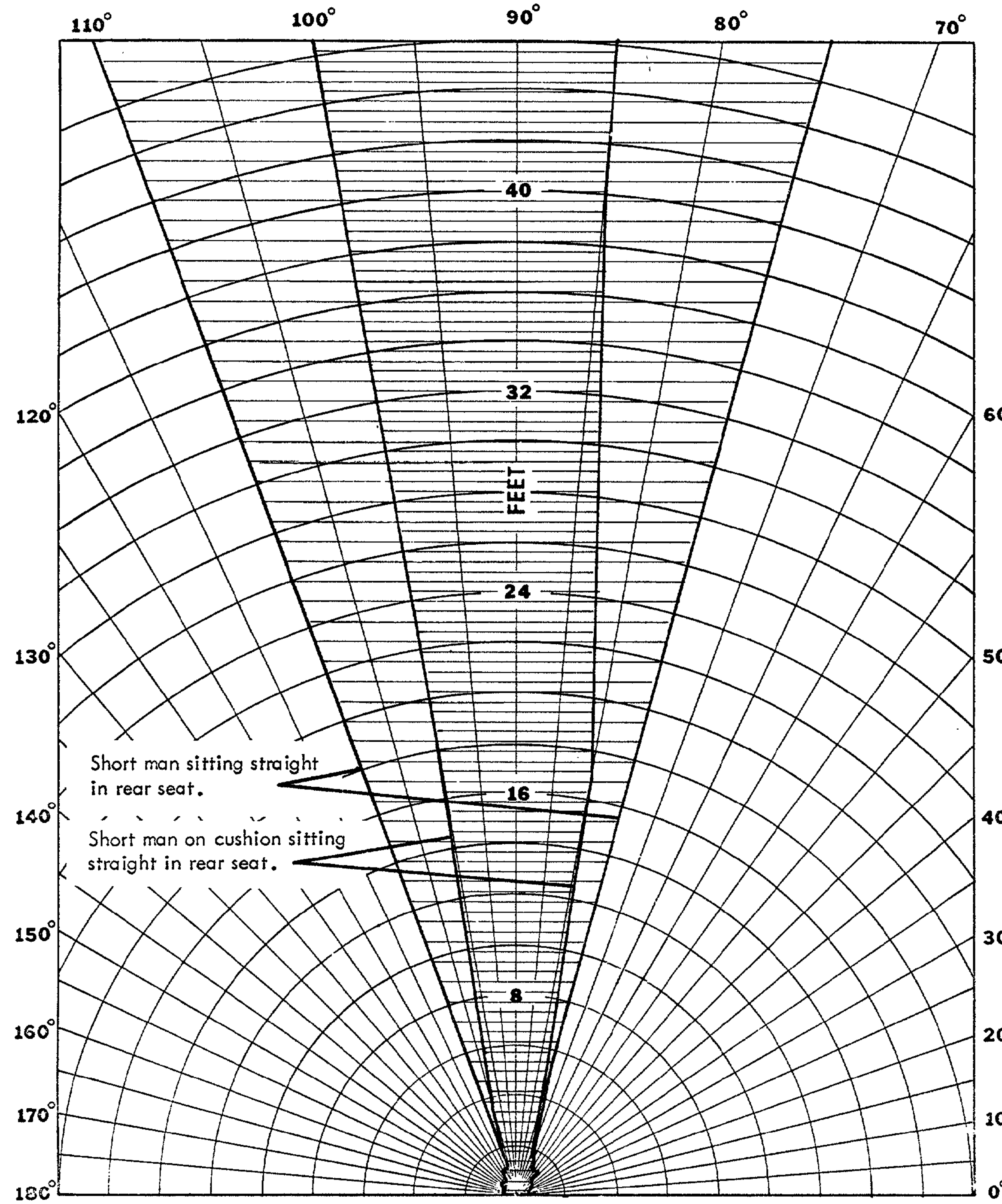
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Short man on cushion sitting straight in rear seat.

Figure 9a

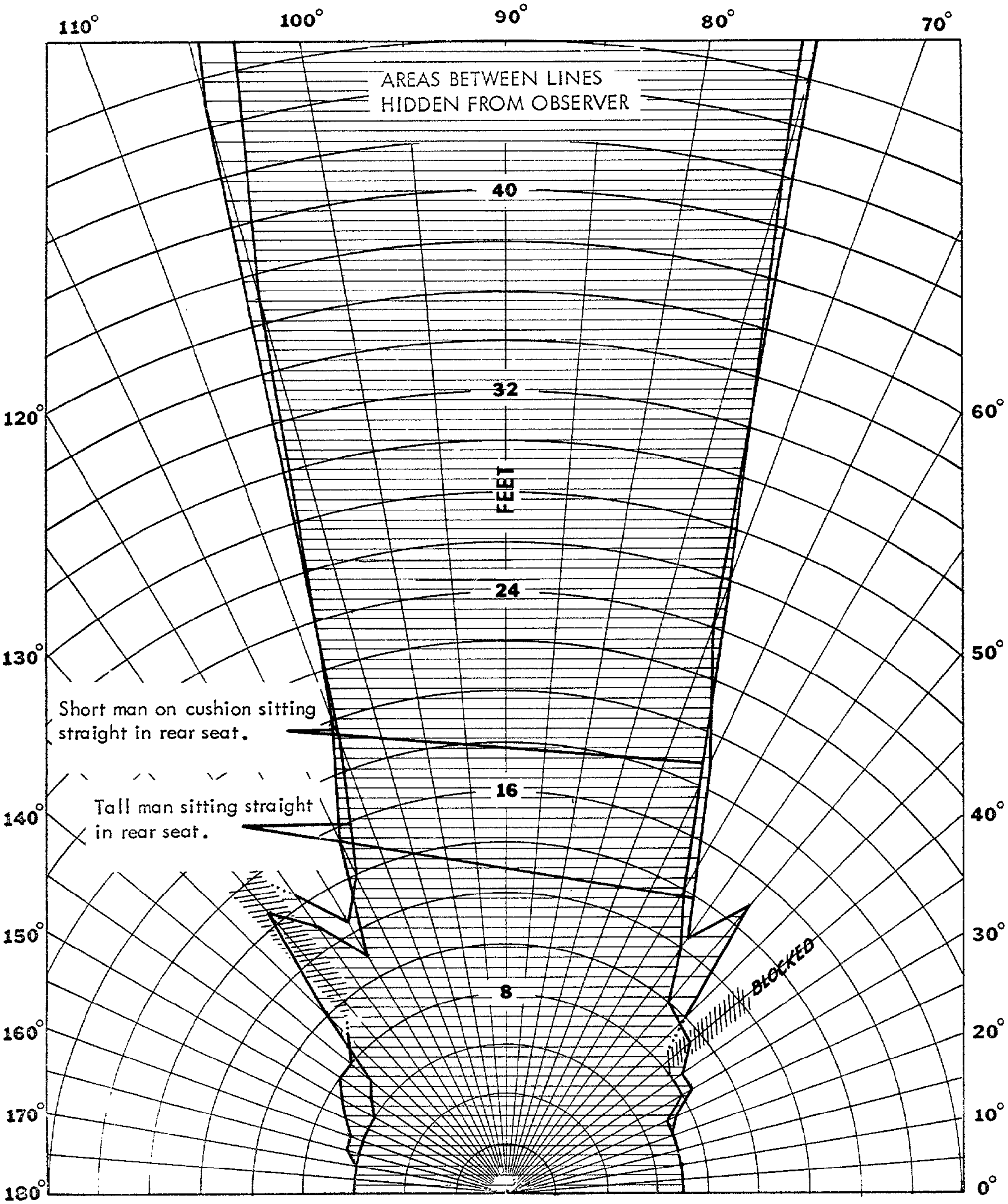
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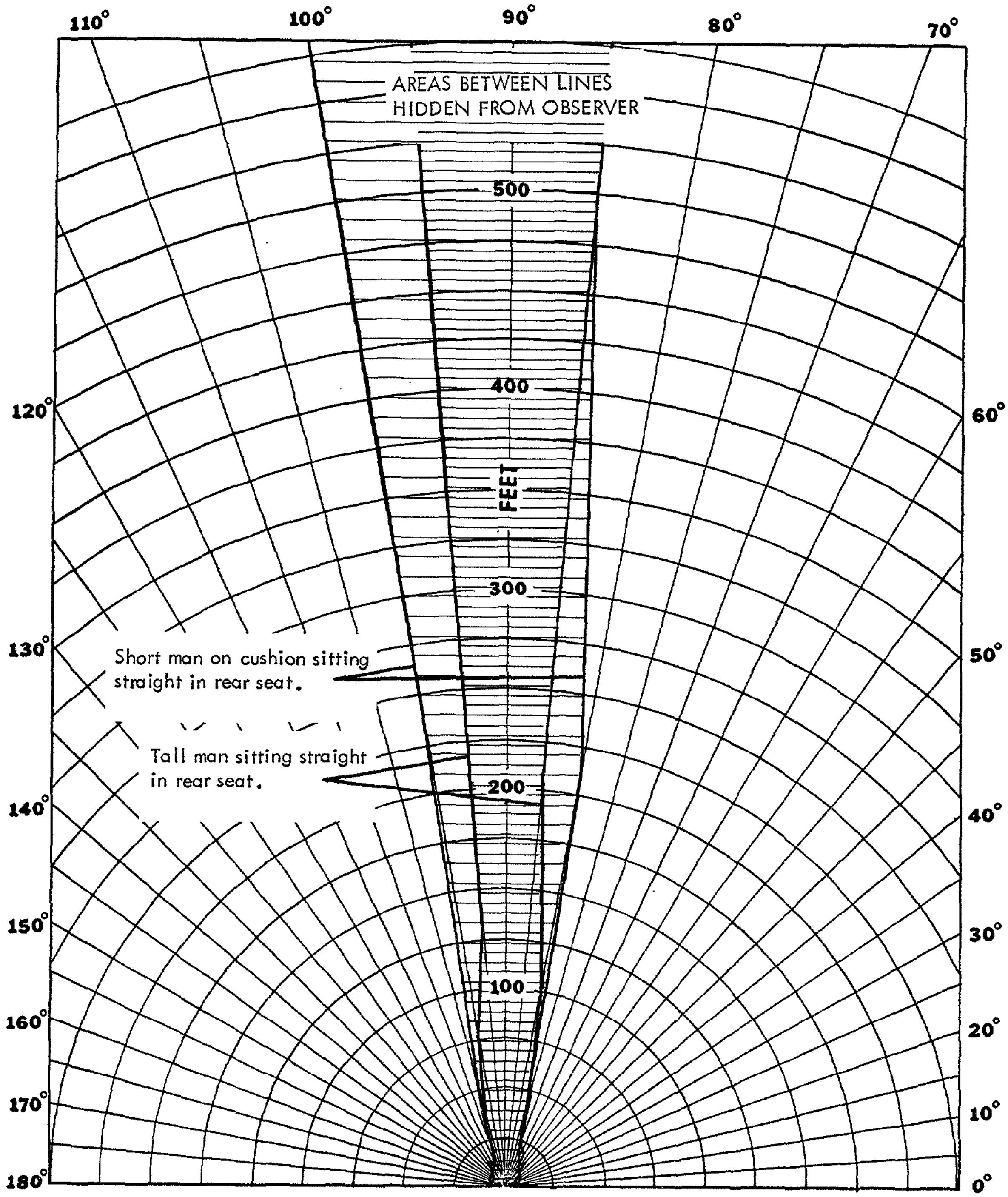
Figure 10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Short man on cushion sitting
straight in rear seat.
Tall man sitting straight
in rear seat.

Figure 10a

RECOMMENDATIONS

Based upon information gained from this study, this Laboratory makes the following recommendations:

1. Retrofit all O-1A aircraft with a rear seat that adjusts both vertically and fore and aft, and require that all future models of this aircraft be so equipped.

2. Alter the design of the rear windows such that, when opened, they do not restrict the head room of the rear seat occupant.

3. Make those instruments which are critical during the landing sequence available to the aft pilot, either by repositioning or by duplication.

4. Change the present weather standards to require 700 feet and 2 miles for dual flight.

REFERENCE

U. S. Army Aviation Materiel Laboratories Report No. 67-22, Revised December 1967, pp. 98-100.