Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 150/5335-2

AIRPORTS

EFFECTIVE:

1/27/65

SUBJECT: AIRPORT APRONS

1. PURPOSE. This circular is one of a series being made available to replace the material in the "Airport Design", 1961, standards. The publication "Airport Design", 1961, and its Supplement No. 1, 1962, are no longer in print. Substantive changes to the "Airport Design" material have been avoided, although review of the material is continuous with the view of making appropriate changes. The standards in this series of circulars are the Federal Aviation Agency recommendations for airport design. This particular circular presents the criteria for airport aprons which are acceptable in accomplishing a project meeting the eligibility requirements of the Federal-aid Airport Program.

2. CANCELLATION. This circular replaces the following material in the Federal Aviation Agency "Airport Design" dated 1961, including Supplement No. 1 dated 1962.

    a. "Terminal Apron" and "Cargo Aprons", Page 67.
    b. "Parking Aprons", "Service Apron", "Hangar Apron", and "Holding Aprons", Page 74.
    c. Figures 4-7 through 4-9c (10 total), Pages 68 through 73.2.
    d. Figure 4-10, "Typical Holding Apron", Page 75.

3. REFERENCES. Additional copies of this circular and the referenced circulars may be ordered from the Federal Aviation Agency, Distribution Section, HQ-438, Washington, D. C. 20553. Identify the circulars by number and title.

    a. AC 150/5300-1, "VFR Airports", dated March 15, 1963.
    b. AC 150/5325-3, "Effects of Jet Blast", to be published early in 1965.

4. BACKGROUND. On all airports, airplane operators require areas on which they may position the airplanes during ground operations not involving landing, taxiing, and takeoff. Such areas are generally referred to as aprons, and each is defined according to its use as one of the following:

terminal, cargo, parking, service, hangar, or holding apron. The types and sizes of aprons required vary for each airport depending on the amount of activity and size of airplanes to be accommodated. Unless the need for these areas is considered along with other important factors, the design of the airport is not complete.

5. TYPES OF APRONS. In various locales aprons may be referred to as ramps, stands, or turnarounds. In addition, various terms descriptive of their use may be applied so that phrases such as "passenger ramp", "refueling stands", etc., may be heard. It is generally accepted, however, that the following terminologies apply in referencing the pavement areas as described below.

a. Terminal Apron.

(1) The terminal apron is that area designed for use by airplanes which is adjacent or readily accessible to the terminal building. It is the key transitional area between air carriers and surface carriers; therefore, this apron must be designed to provide, during peak periods, expeditious handling of aircraft as well as passengers, mail, cargo, express, enroute aircraft servicing, and personal services. This prompt handling is accomplished by positioning individual aircraft on the terminal apron in locations known as "gate" or loading positions. Factors influencing the size, number, and the location of gate positions are size and configuration of the aircraft, its maneuvering capability, methods of moving into and out of position, method of loading, volume of activity, propeller wash, blast, heat, noise, and fumes.

(2) The number of gate positions for loading, unloading, and enroute servicing of aircraft is derived from the typical peak-hour operations and the time required to complete all activities at the gate position. The aircraft time at the gate will depend on the type of aircraft, the number of deplaning and enplaning passengers, the amount of baggage and express, the amount of fuel and routine services required, and the efficiency of ground servicing personnel. This information for various types of aircraft can best be determined by survey at the airport concerned.

(3) The size of a gate position is determined by such factors as aircraft maneuvering capabilities (turning radii), taxiing procedures, wing tip clearance, parking angle, and whether or not blast fences are used. The taxiing procedures include the methods of handling an aircraft in a gate position, i.e., (a) whether it taxies in and out under its own power, (b) whether it taxies in under its own power and is towed out, and (c) whether it is towed in and out. Of these methods, the one

usually requiring the least time and number of supporting ground personnel is that in which the airplane is maneuvered under its own power. Under these conditions, the apron size is usually minimal.

(4) Figures 1 through 7 in the Attachment are so designed that clearances can be readily determined for any parking configuration for the aircraft depicted.

(5) Figures 2 and 4 in the Attachment, in which an aircraft turns and taxies out of a parked position between two aircraft, show a more efficient use of space as compared with the straight-out taxi procedure shown in Figures 3 and 5. A method for computing the clearances for incoming aircraft is shown in Example 2, Figures 2 and 4.

(6) Figure 1, used in conjunction with Figures 8 through 11 of the Attachment, gives clearances for aircraft taxiing into and out of parked positions adjacent to terminals and between parallel loading fingers.

(7) The effect that jet blast may have on various elements which should be considered in determining the size and location of gate positions is discussed in FAA Advisory Circular 150/5325-3.

b. Cargo Aprons. Aircraft that carry only cargo are generally positioned on an apron near a cargo building located separately and at some distance from the terminal building. A cargo apron configuration would be similar in airplane positioning and spacing to that of a terminal apron. There should be enough space to accommodate as many aircraft as are expected at any one time. The intermingling of passenger and cargo traffic is not recommended; however, where the number of cargo operations is small, it would be possible to utilize a position on the terminal apron located as far as possible from any passenger activity.

c. Parking Aprons.

(1) Air Cargo and Air Carrier Aircraft. At airports with air cargo or air carrier service, location of a parking apron close to the loading position, at a safe distance from maneuvering aircraft, should be considered for parking or storing aircraft during extended layovers. This apron is frequently used for servicing and light maintenance of temporarily grounded aircraft. The positioning and spacing would be similar to that used for terminal aprons.

(2) Executive and Small Aircraft. At airports that accommodate executive and small aircraft operations, either paved or turfed parking areas should be provided. These areas should be located in the vicinity of the fixed-base operational area if possible. The fixed-base operational area should be separate so as not to interfere with air cargo and air carrier activities if they exist. The apron configuration will be governed by the number and type of aircraft to be accommodated.

d. Service Apron. A service apron is an area near a repair hangar used for performing light services to aircraft.

e. Hangar Apron. A hangar apron is an area from which aircraft move into and out of the hangar.

f. Holding Aprons.

(1) A holding apron is located contiguous to the taxiway at or near the runway entrance. This apron is provided to permit the aircraft cockpit checks and engine runups that are necessary before takeoff without interference with other aircraft.

(2) General space requirements may be approximated by applying factors to the wingspans of the aircraft that will be using the facility. These factors will provide a guide for space requirements for maneuvering and wingtip clearance. Studies of aircraft equipped with dual-wheel undercarriages reveal that the diameter of the space required to maneuver and hold such aircraft may be closely approximated by multiplying the wingspan by factors varying between 1.35 and 1.50. Similar investigations for dual tandem gear aircraft reveal that factors of between 1.60 and 1.75 will suffice. This factor for small aircraft with a conventional single-wheel gear varies between 1.50 and 1.65.

(3) Figure 12 of the Attachment shows a holding apron with future expansion possible in either direction.

(4) Many airports have been constructed without a parallel taxiway. As traffic increases, the need for this facility is obvious although it may not be economically feasible. In lieu of a parallel taxiway, it is recommended that a turnaround be constructed that will also serve as a holding apron and bypass taxiway (see Figure 13 of the Attachment).

6. APRON SLOPES. For fueling, ease of towing, and taxiing, apron slopes or grades should be kept to the minimum consistent with local drainage requirements. Slopes should not in any case exceed 1.0 percent. In airplane fueling areas, every effort should be made to keep the apron slope within 0.5 percent.

Chester G. Bowers
for Cole Morrow, Director
Airports Service

Attachment

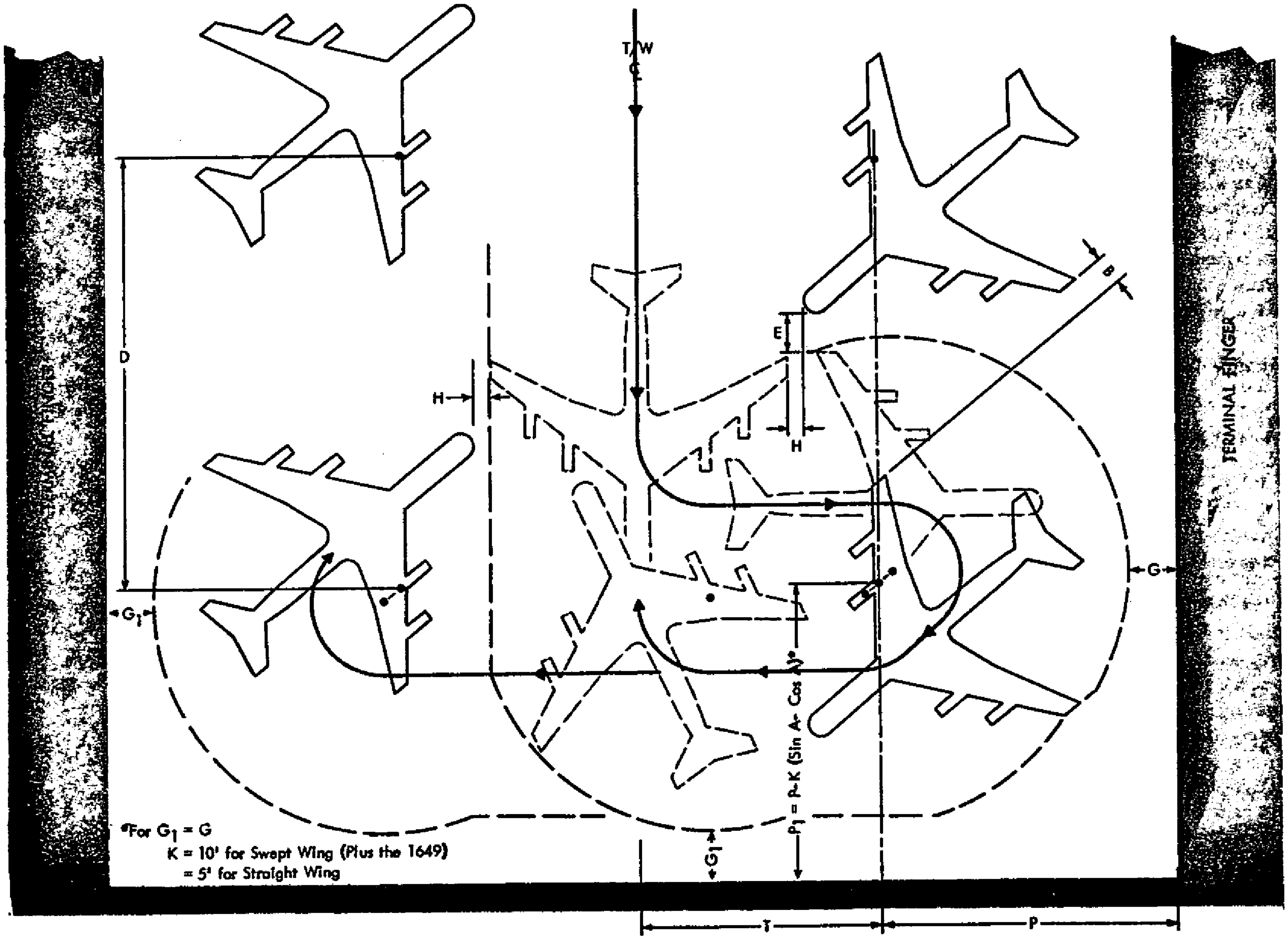
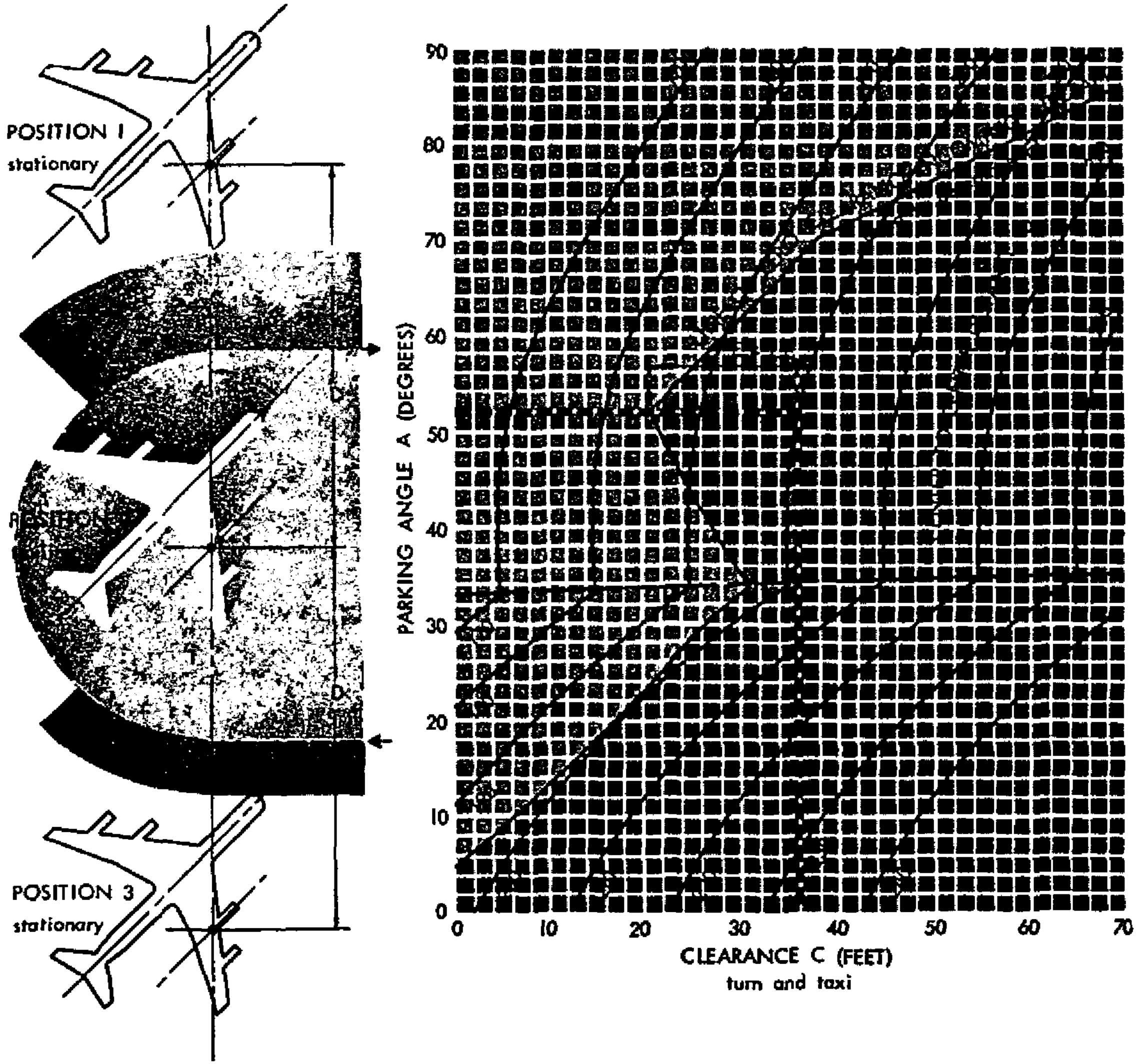


FIGURE 1. Terminal Building Parking Configuration (Boeing 707-300)



CONDITIONS - 10' forward roll prior to turn for taxiing out and 10' forward roll prior to stopping, for purposes of wheel alignment, during parking maneuver

SWEPT WING

The values obtained from this graph when substituted in the following formulas will yield relatively applicable clearance values between A=40° and A=90° for all other swept wing airplanes and also the Lockheed 1649A.

Incoming:

$$E_2 = E_1 + (109.8-R_2)(1 + \text{Sin } A - 0.8 \text{ Cos } A) + 0.5\left[(109.8-R_2) - (142.4-S_2)\right] \text{Cos } A$$

Outgoing:

$$C_2 = C_1 + (142.4-S_2)(\text{Sin } A + \tfrac{1}{2}\text{ Cos } A) - (109.8-R_2)\left[(\text{Sin } A + \tfrac{1}{2}\text{ Cos } A) - 1\right]$$

Where E_1 and C_1 are obtained from the graph for the 707-320

R_2 = Turning radii of the airplane under consideration

S_2 = Wing span of the airplane under consideration

EXAMPLE 1

Given: Parking angle A = 52°
Center to center spacing D between positions 1 & 2 = 200'

Find: Wing tip clearance C

Solution: Enter graph at 52°, continue horizontally to spacing distance 200'
Read clearance distance C = 36' at bottom

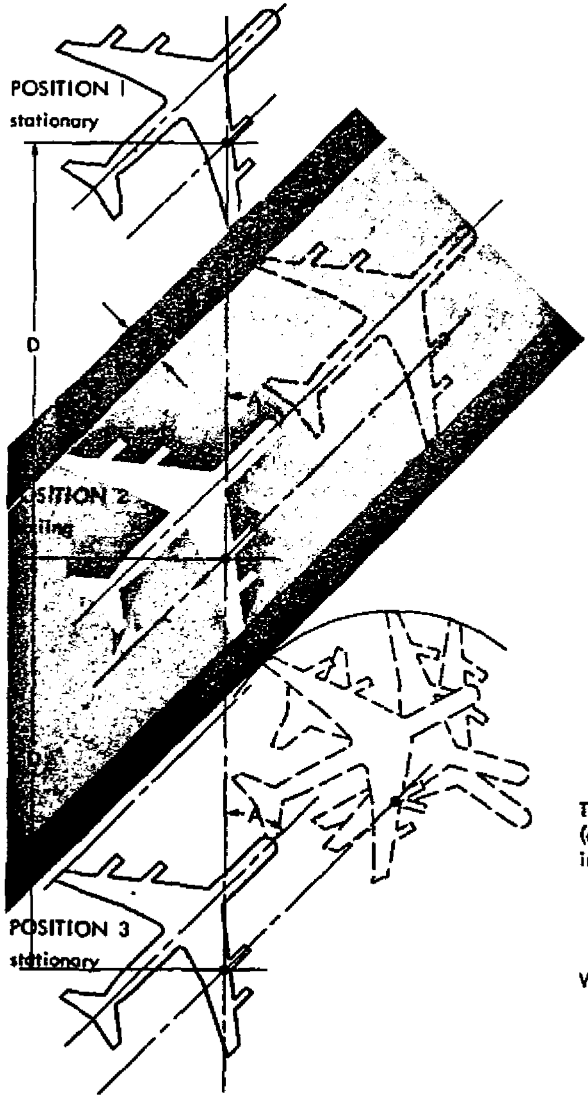
EXAMPLE 2

Given: Same as Example 1

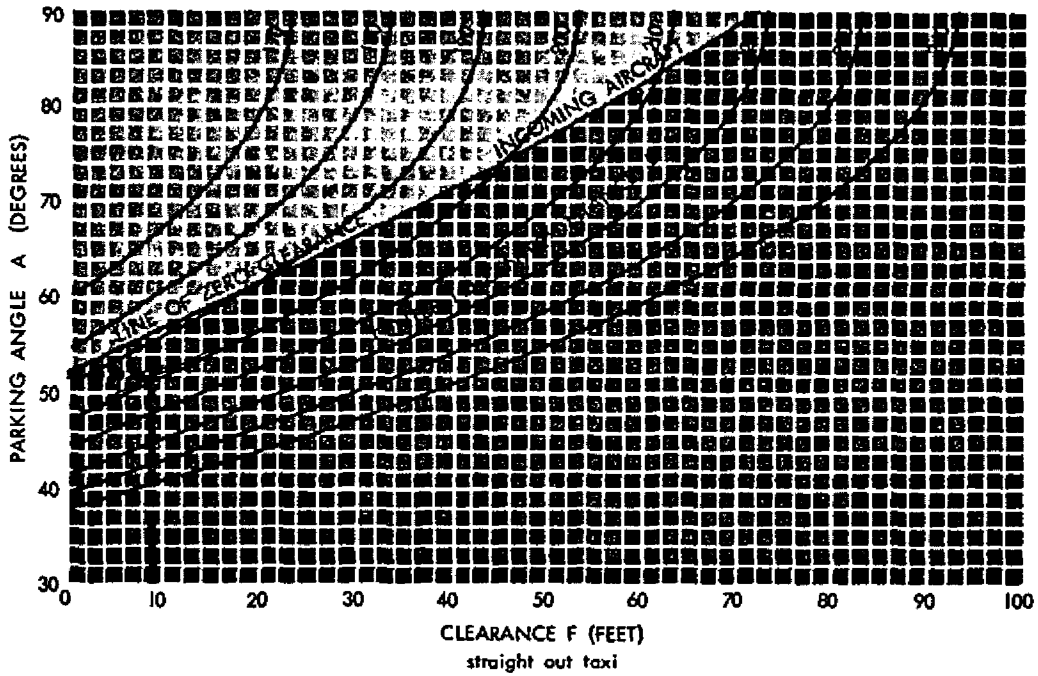
Find: Clearance E between positions 2 & 3

Solution: Scale distance from line of zero clearance to point on 200' spacing at 52°. Answer = 15'

FIGURE 2. Turn and Taxi Out Clearance and Incoming Clearance (Boeing 707-300)



Clearance F is straight out taxi with the aircraft turning at the most critical distance. Clearance B is obtained when no turn is initiated, and is 4.5' more than F.



SWEPT WING

To obtain these clearances for other swept wing (and L 1649A) airplanes make direct substitutions in the following formulas:

$$B = D \sin A - S$$
$$F = D \sin A - (a + R)$$

Where D = Spacing between parking position
S = Airplane wing span
a = The distance perpendicular to the center line of the airplane from the pivot point to the wing tip

APRON PARKING CONFIGURATION

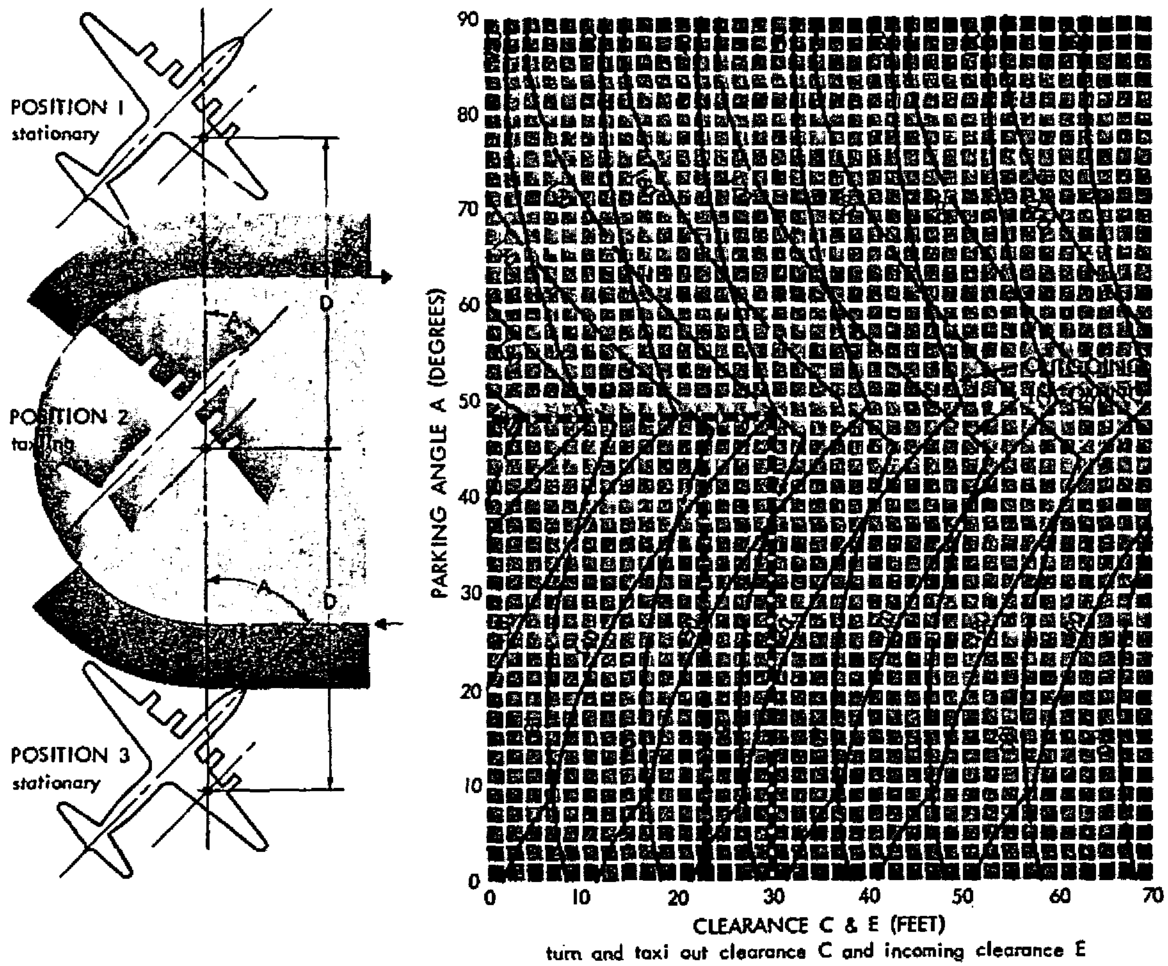
EXAMPLE 1

Given: Parking angle A = 52°
Center to center distance D = 199'

Find: Clearance B

Solution: Enter graph with parking angle of 52° continue horizontally to intersection with center to center distance D = 199'. Read clearance distance F = 9' at bottom.
Clearance distance B = 9' + 4.5 = 13.5'

FIGURE 3. Straight Out Taxi Clearances (Boeing 707-300)



CONDITIONS - 5' forward roll prior to turn for taxiing out and 5' forward roll prior to stopping, for purposes of wheel alignment, during parking maneuver

The values obtained from this graph when substituted in the following formulas will yield relatively applicable clearance values between A=40° and A=90° for all the other straight wing airplanes with the exception of the Lockheed 1649A which is included with the swept wing airplanes.

Incoming:

$$E_2 = E_1 + (72.7 - R_2)(1 + \sin A - 1.2 \cos A)$$

Outgoing:

$$C_2 = C_1 + (117.5 - S_2)(\sin A) + (72.7 - R_2)(1 - \sin A)$$

Where E_1 and C_1 are obtained from the graph for the DC 6/6B

R_2 = Turning radii of the airplane under consideration

S_2 = Wing span of the airplane under consideration

EXAMPLE 1

Given: Parking angle A = 48°
Center to center spacing D between positions 1 & 2 = 140'

Find: Clearance C (outgoing)

Solution: Enter graph at 48°, continue horizontally to spacing distance 140'. Read clearance distance C = 30' at bottom

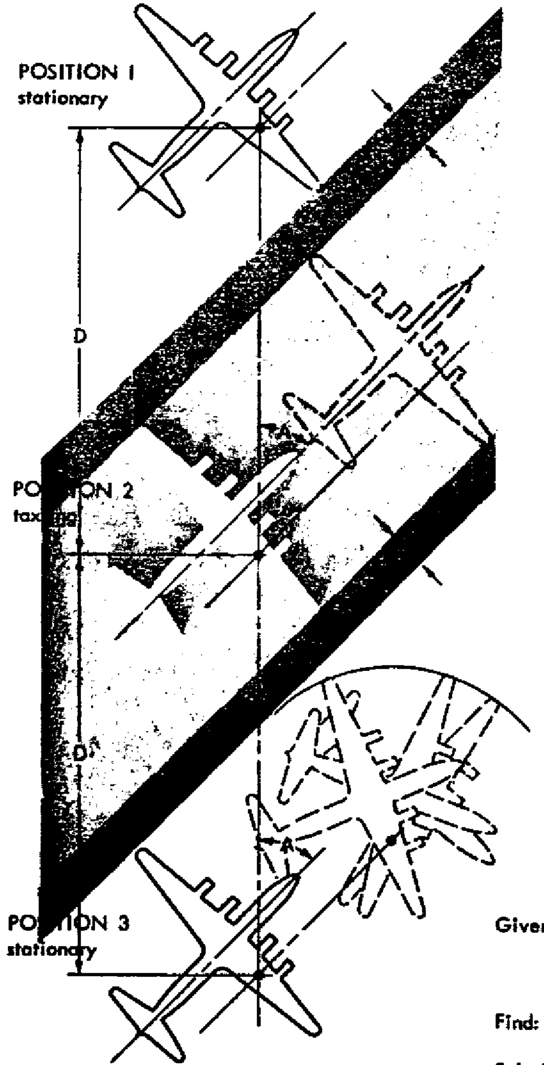
EXAMPLE 2

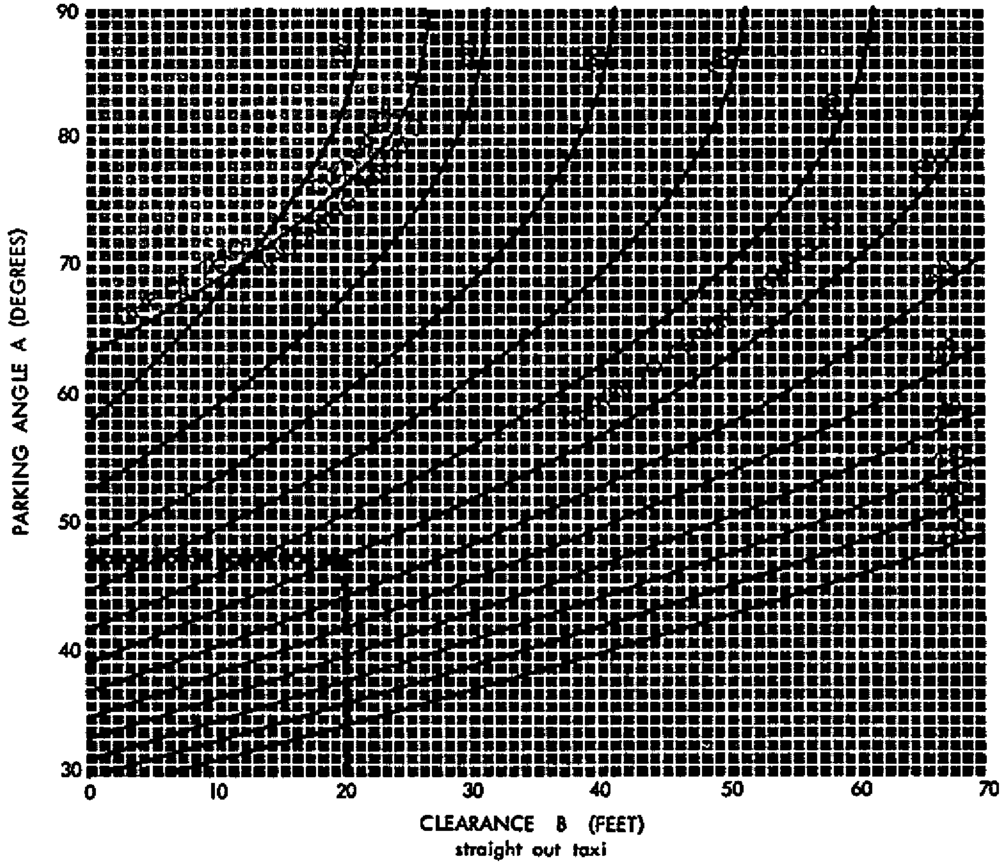
Given: Same as Example 1

Find: Clearance E (incoming)

Solution: Enter graph at 48°, continue horizontally to spacing distance 140'. Read clearance distance E = 23' at bottom

FIGURE 4. Turn and Taxi Out Clearance and Incoming Clearance (Douglas DC-6A & 6B)





Given: Parking angle A = 47°
Center to center spacing D between positions 1 & 2 = 190'

Find: Clearance B

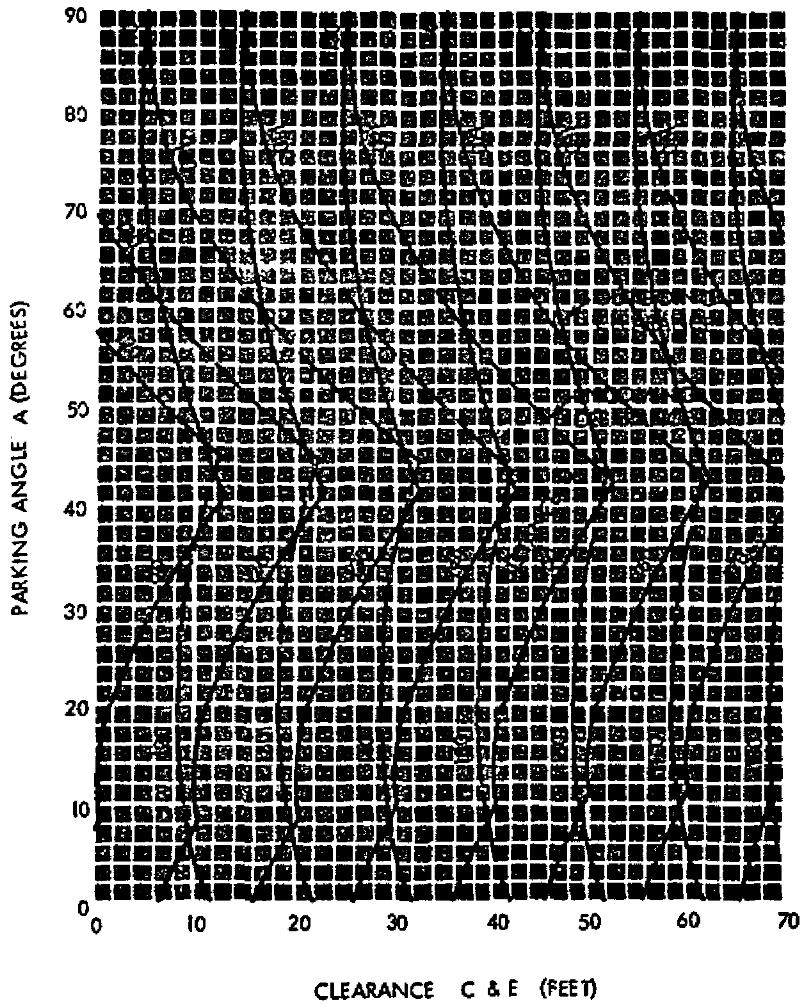
Solution: Enter graph of 47°, continue horizontally to spacing distance 190'.
Read clearance distance B = 20' at bottom

To obtain this clearance for other straight wing (excluding L1649A) airplanes make direct substitutions into the following formula:

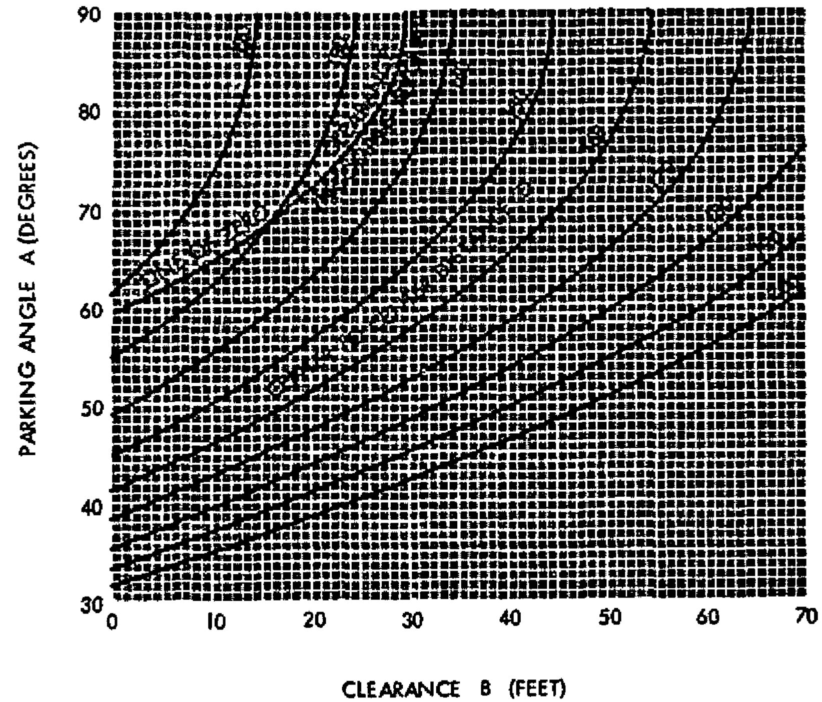
$$B = D \sin A - S$$

Where D = Spacing between parking positions
S = Airplane wing span

FIGURE 5. Straight Out Taxi Clearance (Douglas DC-6A & 6B)

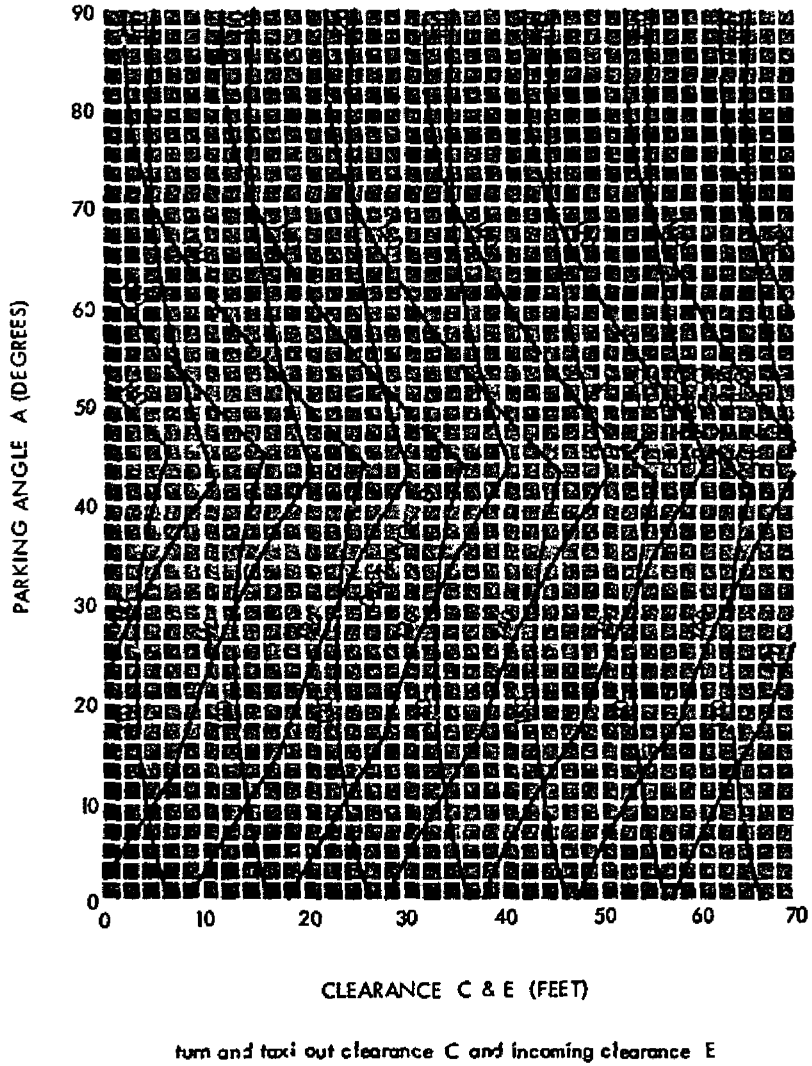


turn and taxi out clearance C and incoming clearance E



straight out taxi

FIGURE 6. Straight Out Taxi Clearance, Turn and Taxi Out Clearance, and Incoming Clearance (Convair 440)



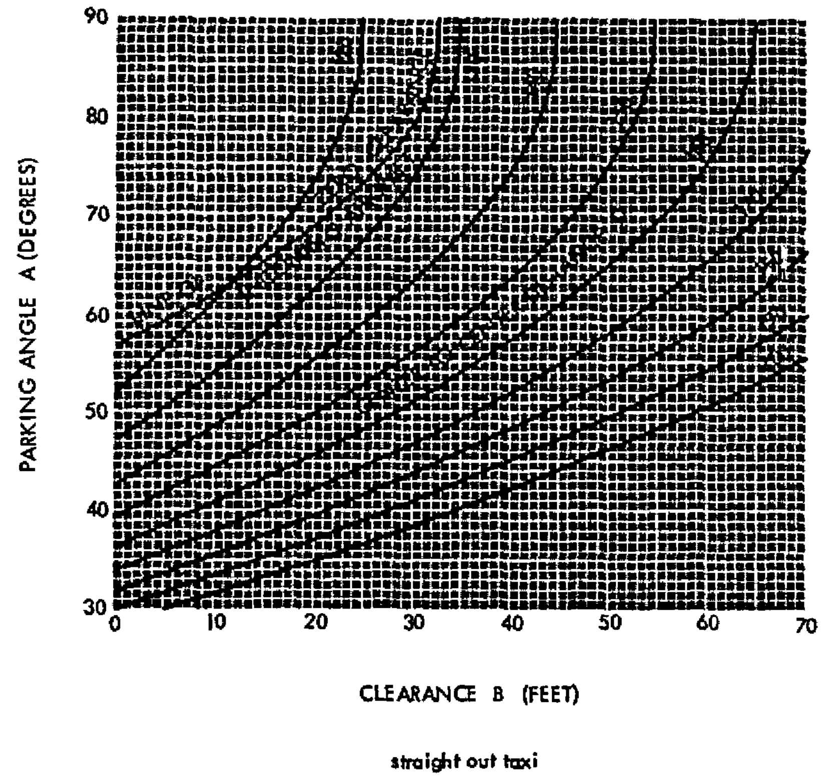
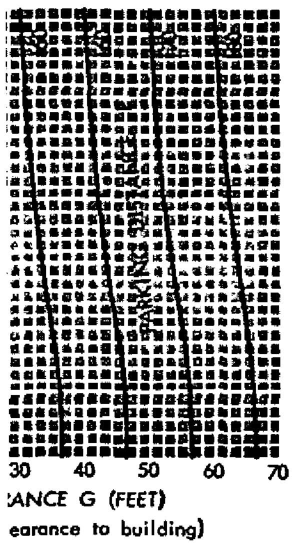
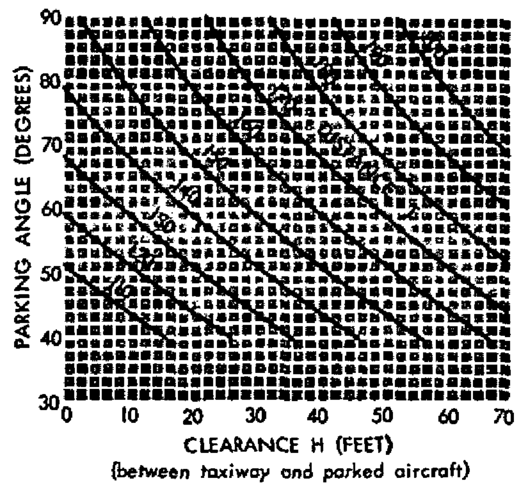


FIGURE 7. Straight Out Taxi Clearance, Turn and Taxi Out Clearance, and Incoming Clearance (Fairchild F-27)





SWEPT WING

To obtain these clearances for other swept wing (and L 1649A) airplanes make direct substitutions in the following formulas:

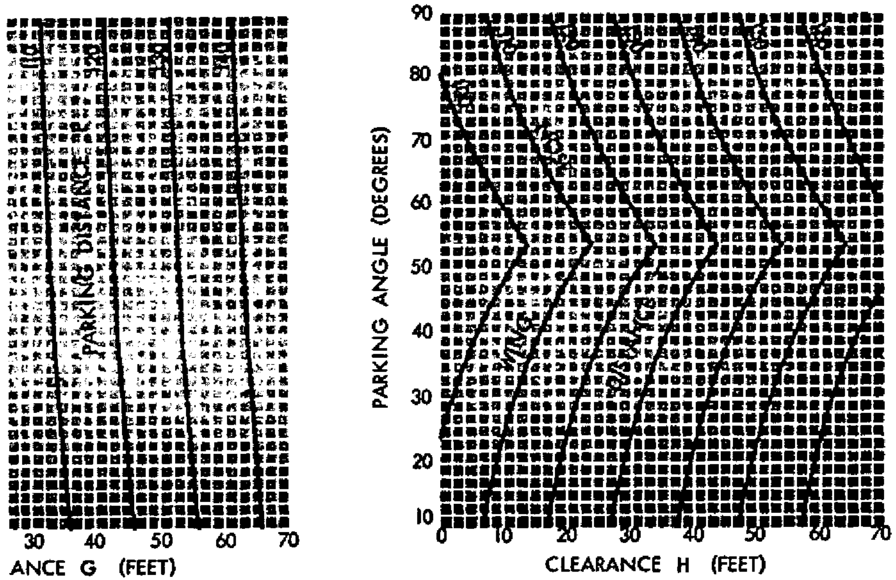
G = P-10 Sin A-R
H = T-(b Sin A-b' Cos A) - S/2

Where b = Distance along the airplane center line from the nose to the main landing gear

b' = Perpendicular distance from the center line of the airplane to the pivot point

S = Airplane wing span

FIGURE 8. Wing Tip Clearance to Building and Clearance Between Taxiing and Parked Aircraft (Boeing 707-300)



To obtain these clearances for other straight wing (excluding L1649A) airplanes make direct substitutions into the following formulas:

$G = P - 5 \sin A - R$

$H_{nose} = T - (b \sin A - b' \cos A) - S/2$

$H_{wing} = T - a \cos A - S/2$

Where b = Distance along the airplane center line from the nose to the main landing gear

b' = Perpendicular distance from the center line of the airplane to the pivot point

S = Airplane wing span

a = The distance perpendicular to the centerline of the airplane from the pivot point to the wing tip

FIGURE 9. Wing Tip Clearance to Building and Clearance Between Taxiing and Parked Aircraft (Douglas DC-6A & 6B)

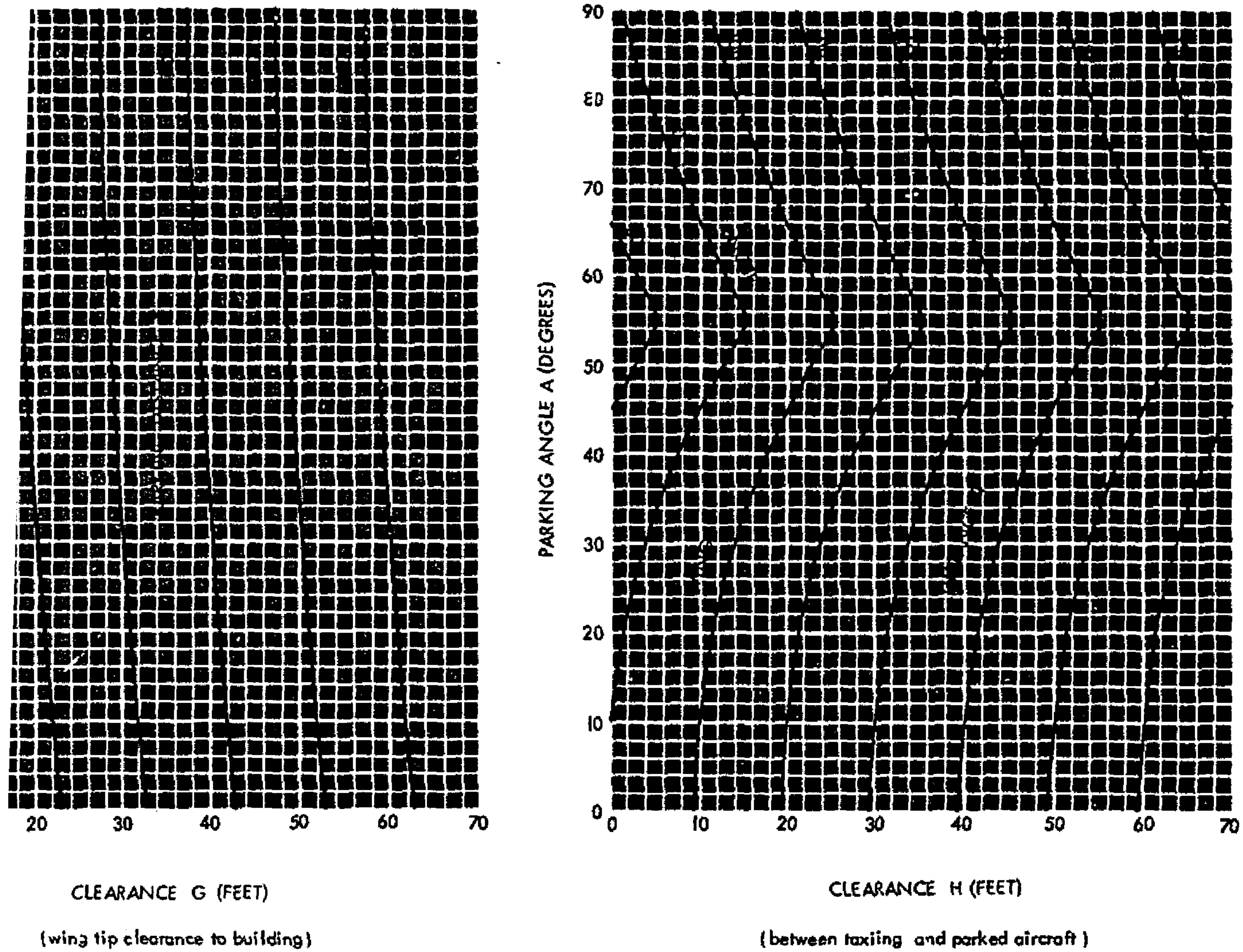


FIGURE 10. Wing Tip Clearance to Building and Clearance Between Taxiing and Parked Aircraft (Convair 440)

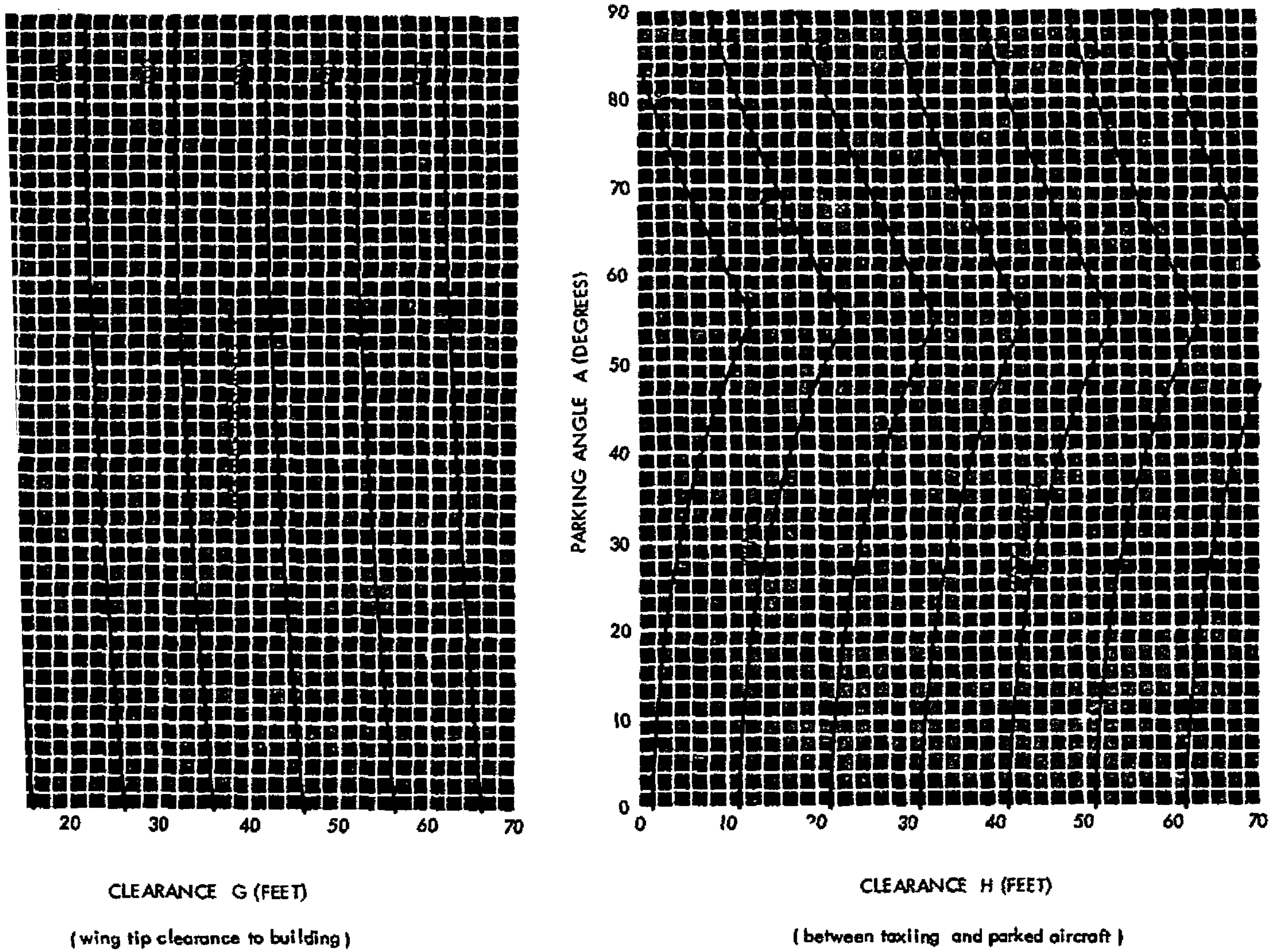


FIGURE 11. Wing Tip Clearance to Building and Clearance Between Taxiing and Parked Aircraft (Fairchild F-27)

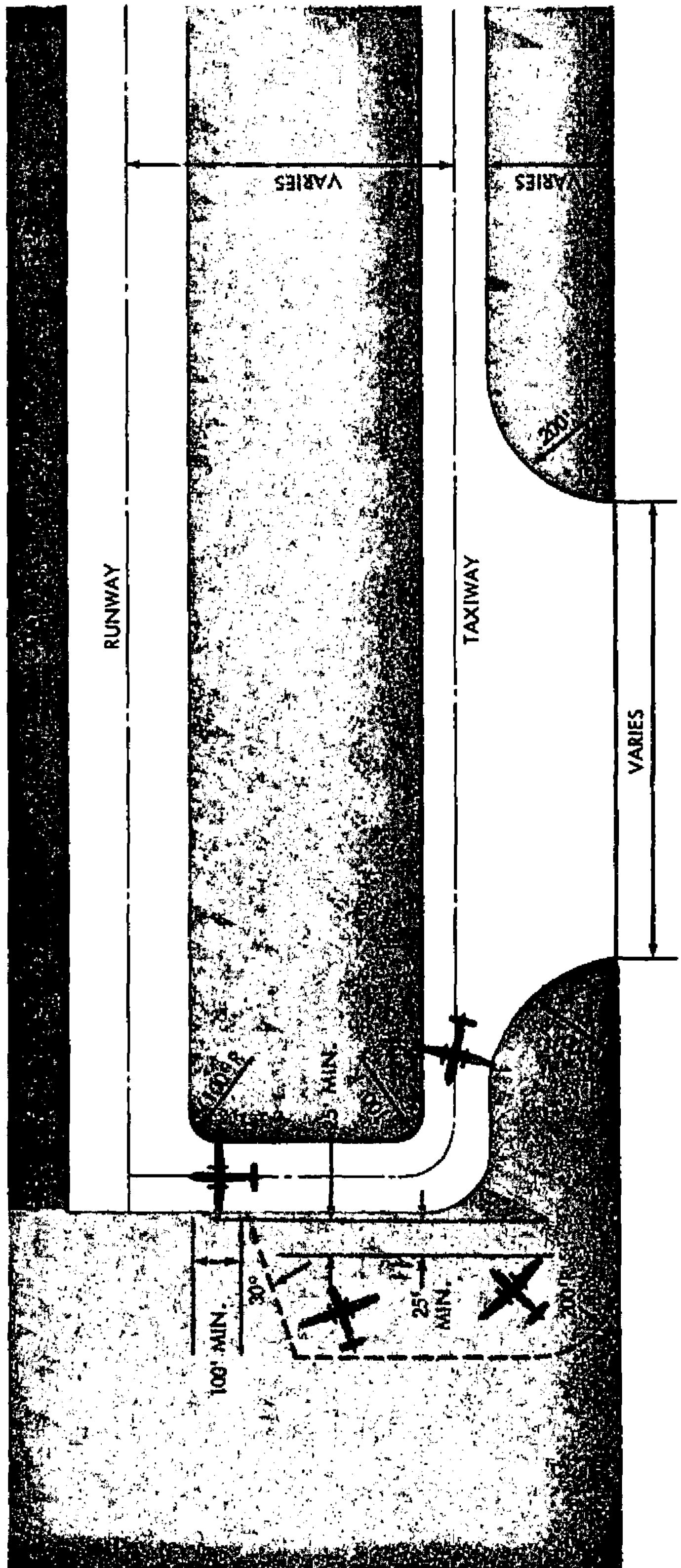


FIGURE 12. Typical Holding Apron

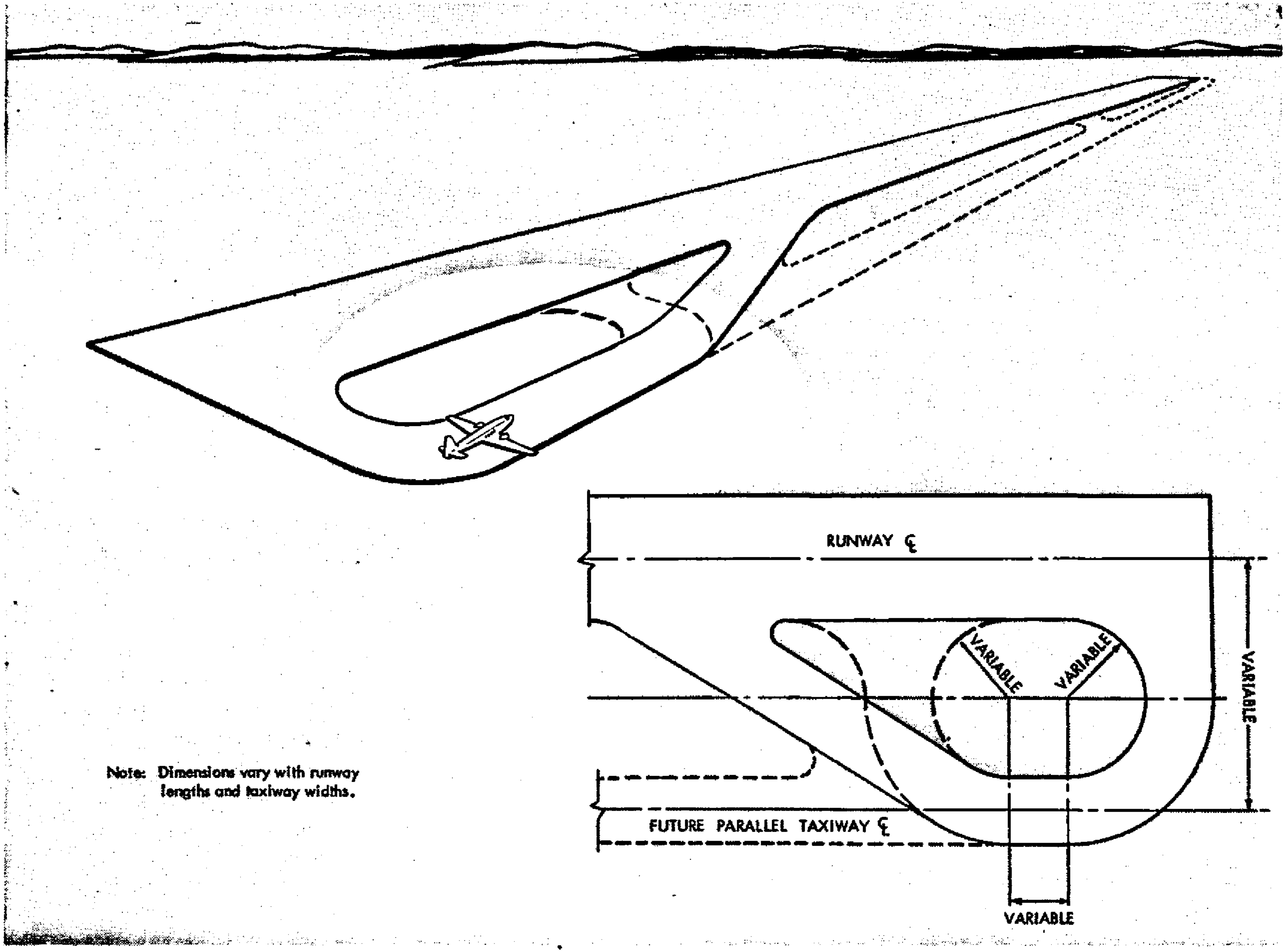


FIGURE 13. Typical Taxiway Turnaround