

## Introduction

In response to multiple requests from customers to assess the suitability of a visual glideslope indicator for landing on a given runway in a GIV-X or GV-SP aircraft, Flight Operations requested information on eye-to-wheel height in the landing attitude from Human Factors to include in the airplane flight manual (AFM). Flight Operations also requested information on visual eye references for ground operation. This memo presents the eye-to-wheel height and other visual references for GIV-X and GV-SP and describes the assumptions and procedure used to determine them.

## Assumptions

The following assumptions were used for the analysis:

### Eye-to-Wheel Height

- The effect of ground effect on the landing attitude was not accounted for, making the eye-to-wheel heights slightly higher (more conservative).
- The touchdown airspeed is  $V_{REF}$ .
- The eye-to-wheel height data is given for the lowest landing weight for each model, resulting in the highest (most conservative) deck angle.
- The eye-to-wheel height is based on the main landing gear in the unloaded position.
- There are no significant differences in landing attitude between G350 and G450 at the lowest weight.
- There are no significant differences in landing attitude between G500 and G550 at the lowest weight.

### Visual Eye References for Ground Operation

- The range of distances is defined by the following ground planes:
  - maximum zero fuel weight, forward-most center-of-gravity (CG)
  - maximum zero fuel weight, aft-most center-of-gravity
  - maximum ramp weight, forward-most center-of-gravity
  - maximum ramp weight, aft-most center-of-gravity
- Vertical viewing angles at design eye position (DEP) are for vision directly ahead of the pilot and are relative to the horizon.
- The maximum vision aft is with the head rotated, eyes at design eye position and looking at a point level with the pilot's head. This angle is limited only by window structure.

## Procedure

### Eye-to-Wheel Height

Flight Sciences provided deck angle and landing gear position data for GIV-X and GV-SP and Preliminary Design provided landing gear ground contact points based on the assumptions given above. Eye-to-wheel height and eye-to-wheel horizontal distances were then calculated and verified by CATIA analysis, using coordinates for design eye position. In addition, aircraft-relative horizontal and vertical distances from DEP to the main landing gear wheels in the unloaded position were calculated, and ground-relative horizontal distances from DEP to the main landing gear wheels in the unloaded position and landing attitude were determined by CATIA analysis.

### Visual Eye References for Ground Operation

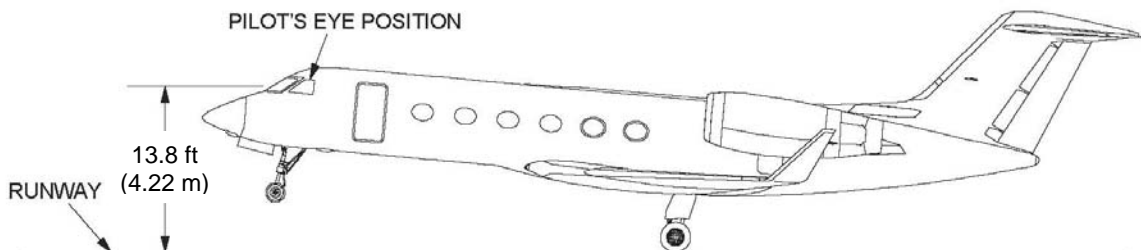
Preliminary Design provided ground contact points based on the assumptions given above, and data on outside viewing angles was obtained based on a CATIA analysis of GV-SP performed by Flight Deck and Furnishings during GVI development. The following dimensions were then determined by CATIA analysis, using the provided information and coordinates for design eye position and the tip of the nose cone:

- DEP height above ground,
- Horizontal distance from DEP to the tip of the nose cone,
- Horizontal distance from the nose landing gear ground contact point to the tip of the nose cone,
- Horizontal distance from DEP to the closest point visible on the ground when looking directly forward, and
- Horizontal distance from the tip of the nose cone to the closest point visible on the ground when looking directly forward.

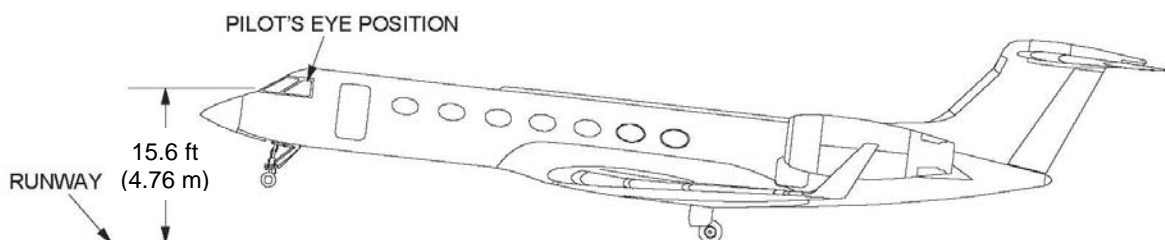
## Results

### Eye-to-Wheel Height

Figures 1 and 2 show eye-to-wheel height for GIV-X and GV-SP, respectively. Additional data on distance from DEP to the main landing gear wheel contact points is listed in Table 1.



**Figure 1. GIV-X Eye-to-Wheel Height for Landing Approach Operation  
(Drawing courtesy Flight Crew Technical Information)**



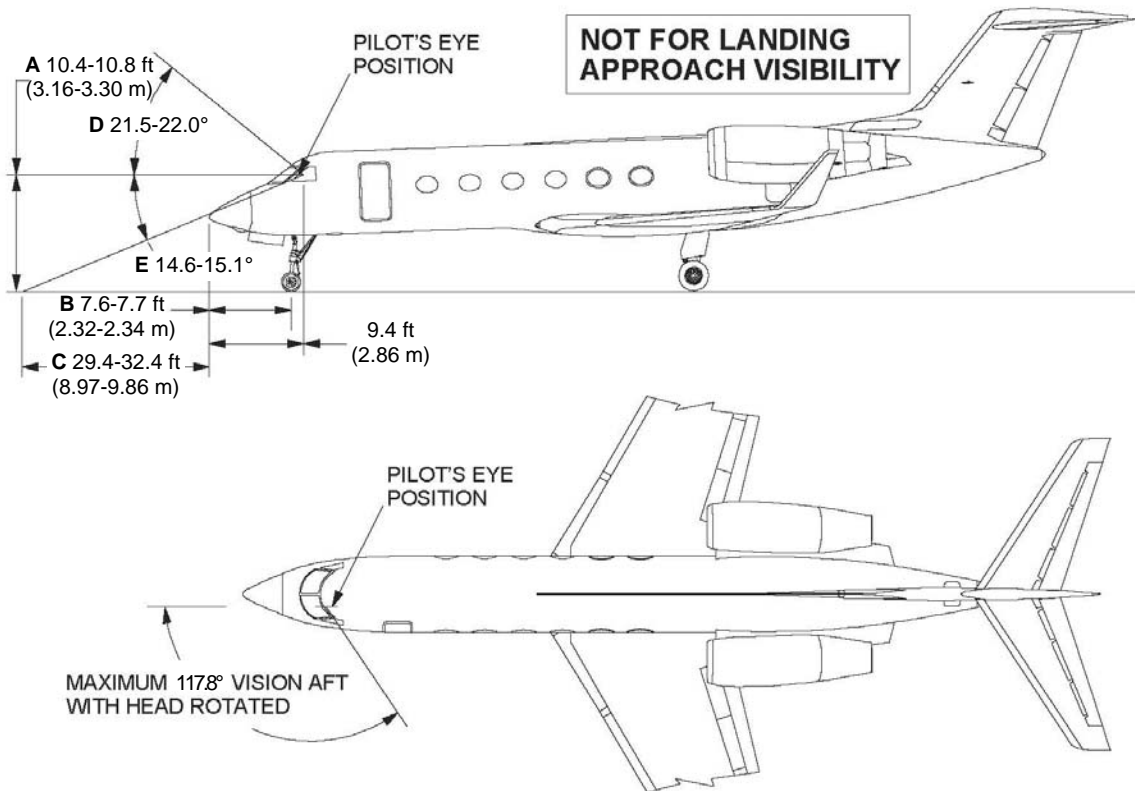
**Figure 2. GV-SP Eye-to-Wheel Height for Landing Approach Operation  
(Drawing courtesy Flight Crew Technical Information)**

**Table 1. Distances from DEP to Unloaded Main Landing Gear in the Landing Attitude**

	GIV-X		GV-SP	
	Aircraft-Relative	Ground-Relative (1.9° Nose Up)	Aircraft-Relative	Ground-Relative (3.3° Nose Up)
Horizontal	36.5 ft (11.14 m)	36.1 ft (11.00 m)	42.4 ft (12.91 m)	41.5 ft (12.66 m)
Vertical	12.6 ft (3.85 m)	13.8 ft (4.22 m)	13.2 ft (4.02 m)	15.6 ft (4.76 m)

Visual Eye References for Ground Operation

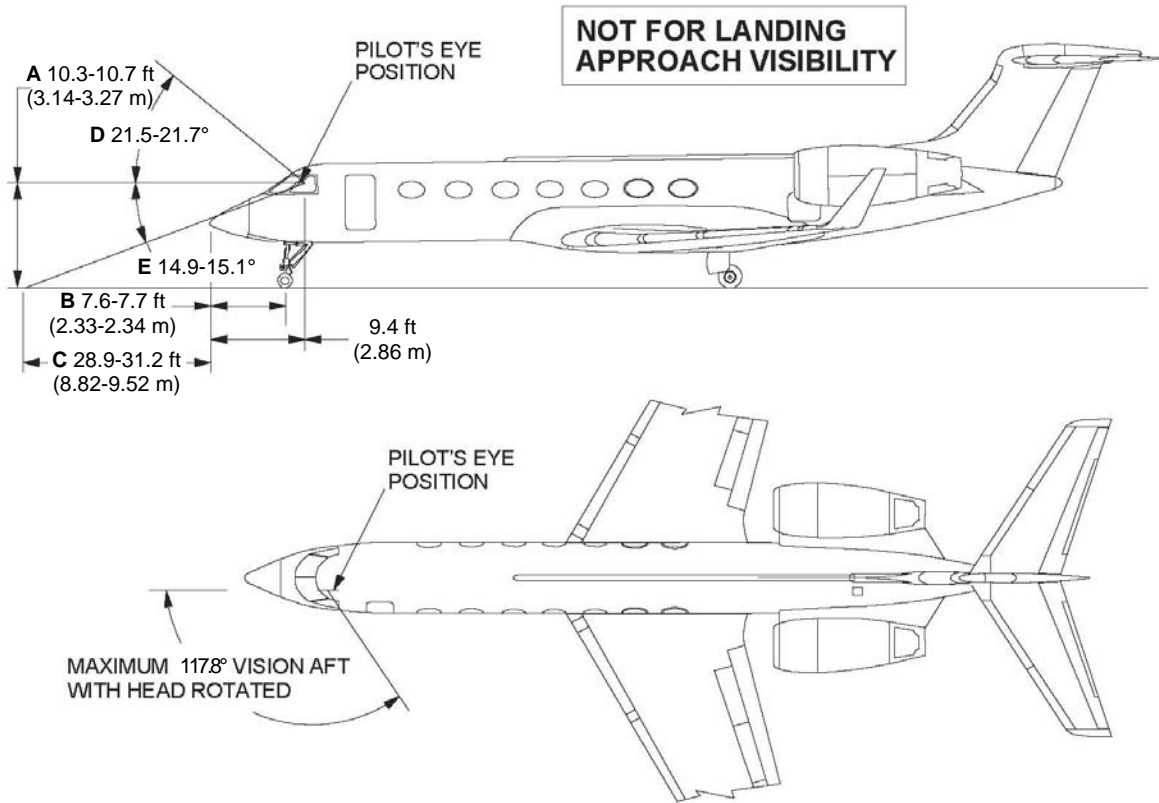
Figures 3 and 4 show visual eye references for ground operation for GIV-X and GV-SP, respectively.



**Figure 3. GIV-X Visual Eye References for Ground Operation  
(Drawing courtesy Flight Crew Technical Information)**

**Table 2. GIV-X Visual Eye References for Ground Operation at Weight and CG Limits  
(Letters refer to dimensions shown in Figure 3.)**

	Forward CG		Aft CG	
	Max Zero Fuel Weight (49,000 lb)	Max Ramp Weight (74,300 lb)	Max Zero Fuel Weight (49,000 lb)	Max Ramp Weight (74,300 lb)
A	10.5 ft (3.21 m)	10.4 ft (3.16 m)	10.8 ft (3.30 m)	10.4 ft (3.18 m)
B	7.7 ft (2.33 m)	7.7 ft (2.34 m)	7.6 ft (2.32 m)	7.7 ft (2.34 m)
C	30.0 ft (9.14 m)	29.4 ft (8.97 m)	32.4 ft (9.86 m)	30.1 ft (9.17 m)
D	21.5°	21.6°	22.0°	21.7°
E	15.1°	15.0°	14.6°	14.9°



**Figure 4. GV-SP Visual Eye References for Ground Operation  
(Drawing courtesy Flight Crew Technical Information)**

**Table 3. GV-SP Visual Eye References for Ground Operation at Weight and CG Limits  
(Letters refer to dimensions shown in Figure 4.)**

	Forward CG		Aft CG	
	Max Zero Fuel Weight (54,500 lb)	Max Ramp Weight (91,400 lb)	Max Zero Fuel Weight (54,500 lb)	Max Ramp Weight (91,400 lb)
A	10.5 ft (3.21 m)	10.3 ft (3.14 m)	10.7 ft (3.27 m)	10.3 ft (3.15 m)
B	7.7 ft (2.33 m)	7.7 ft (2.34 m)	7.6 ft (2.33 m)	7.7 ft (2.34 m)
C	30.0 ft (9.13 m)	28.9 ft (8.82 m)	31.2 ft (9.52 m)	29.2 ft (8.91 m)
D	21.5°	21.5°	21.7°	21.5°
E	15.1°	15.1°	14.9°	15.1°