*A SunCam online continuing education course*

# Airport Engineering

## Part VI: Heliport Design

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# Table of Contents



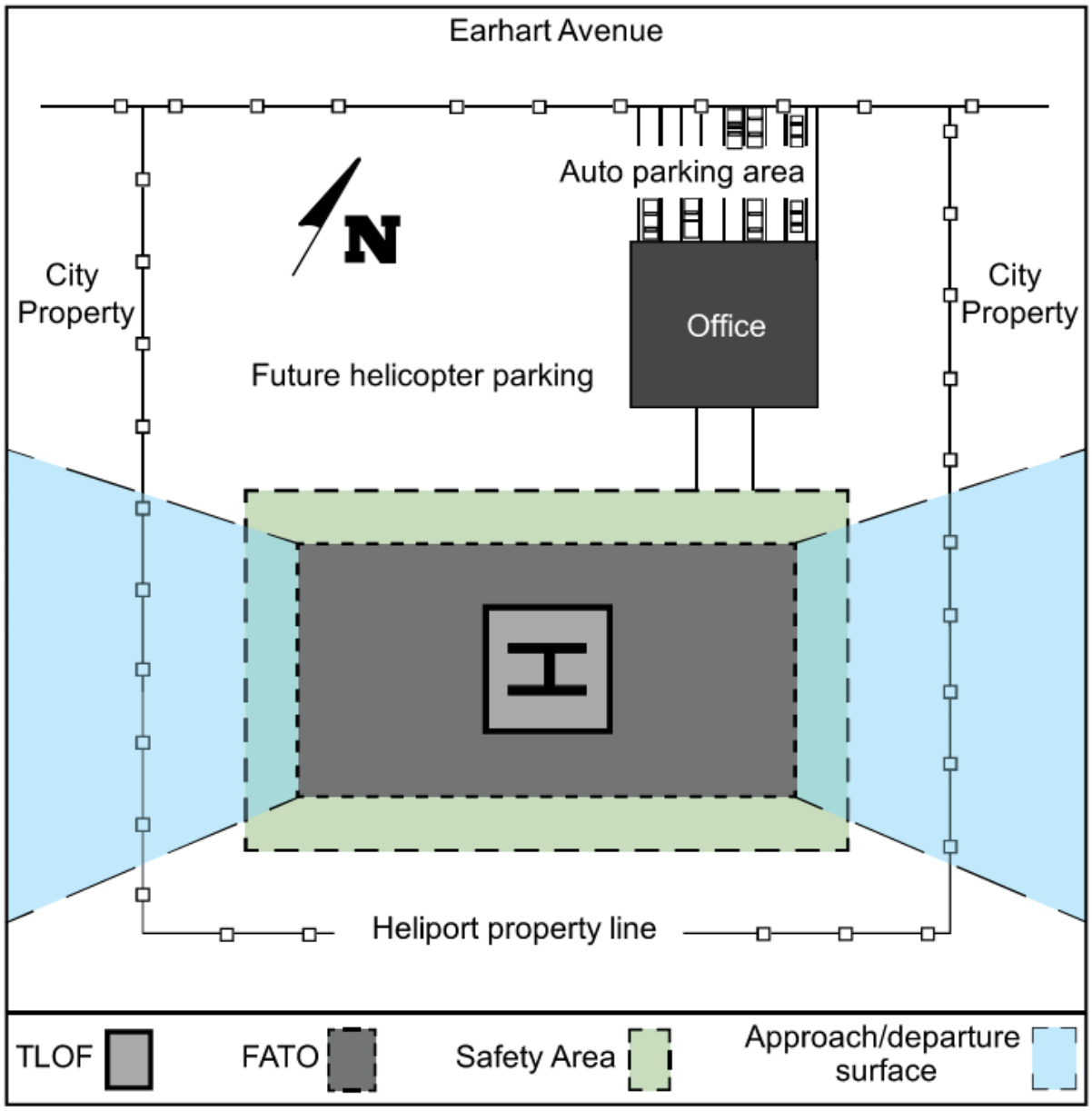
# Introduction

This course, the sixth in the series, focuses on the design of civil heliports/helipads in the United States, under the jurisdiction of the FAA. Like airports, heliports demand comprehensive analysis and consideration to maintain safety and functionality. The basis for this document is FAA Advisory Circular 150/5390-2D, *Heliport Design*. This course does not cover military or offshore heliports, nor instrument procedures and specifications for heliports. While not a substitute for the advisory circular, this course will guide you through the technical aspects in a condensed and convenient way. The most accurate and current technical information should be sourced from FAA documents.

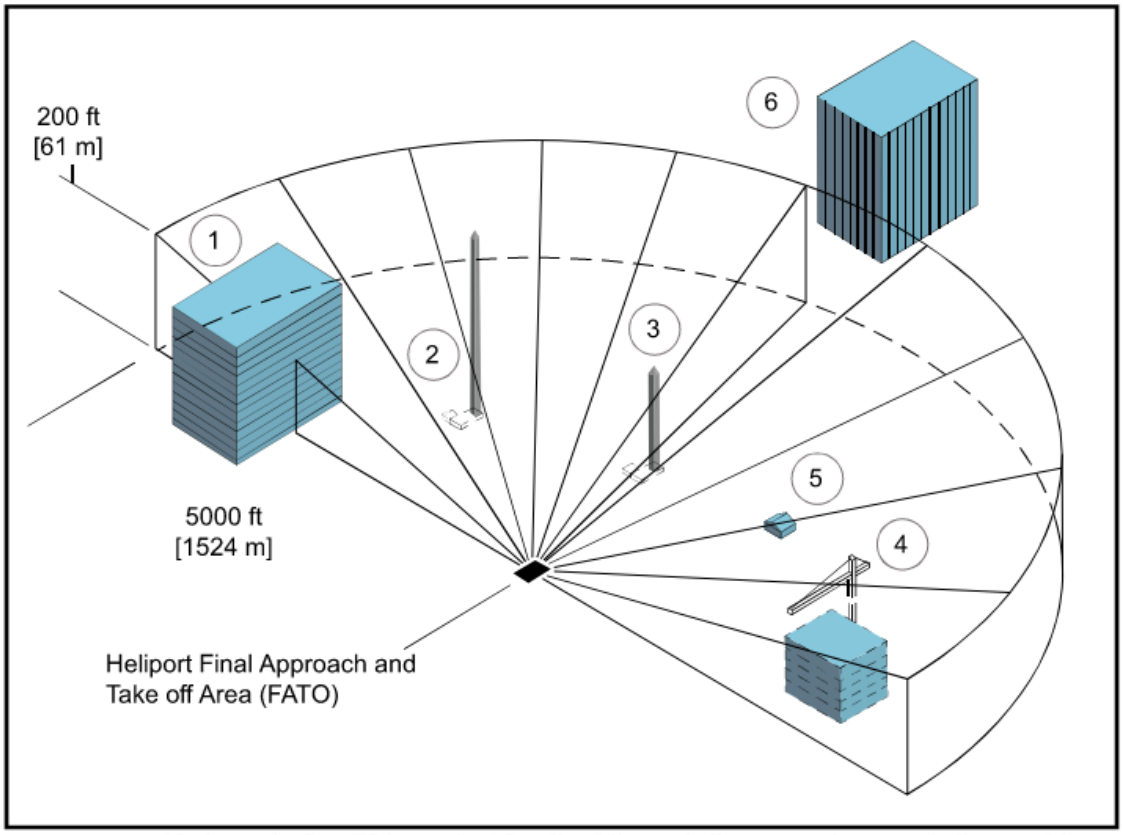
We'll begin with a few definitions. In general terms, a **heliport** is an area of land, water, or structure for helicopter landings and takeoffs, including associated facilities. A **helipad**, however, is a small area on a heliport or airport that is used for takeoffs, landing, and parking of helicopters. Note: a helipad on an airport does not constitute a heliport. A **helistop** is a heliport that provides no amenities, such as fuel, maintenance, repair, or parking. This course will avoid the use of this term to avoid confusion.


As usual with aviation construction projects, proper notification is required per Part 77 Airspace analysis via Form 7460-1 and/or Form 7480-1 and having an updated layout plan & map. A sample heliport layout plan is shown here:



If a development has potential offsite interference with approach paths, Part 77 requires notification based on these criteria:




**Note**: Notice under Part 77 is required for all public-use heliports or private-use heliports with at least one FAA-approved instrument approach procedure.

**Offsite Development Examples for Figure 1-4:**

① Building is less than 200 feet (ft) (61 meters (m)) in height, but top will penetrate the 25:1 surface (notice required by § 77.9).

② Antenna is over 200 ft (61 m) in height (notice is required by § 77.9(a)).

③ Antenna is less than 200 ft (61 m) in height and penetrates the 25:1 surface (notice is required by § 77.9(b)(3)).

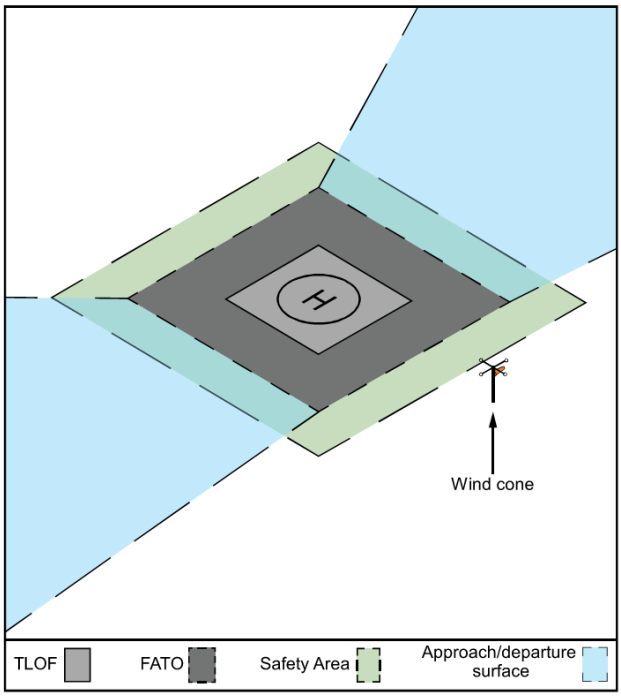
④ Construction crane penetrates 25:1 surface (notice is required by § 77.9(b)(3)).

⑤ Building is less than 200 ft (61 m) in height and does not penetrate the 25:1 surface (notice is not required).

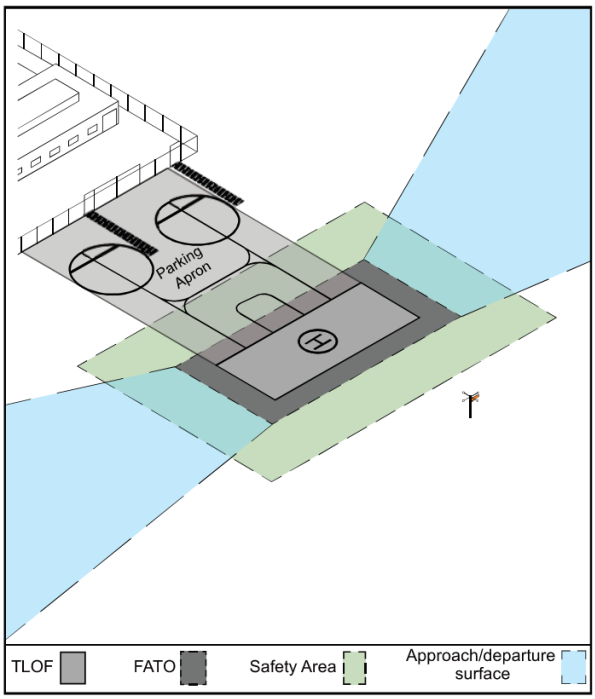
⑥ Building is more than 5,000 ft (1,524 m) from heliport (notice is required if building will be 200 ft (61 m) or more in height).

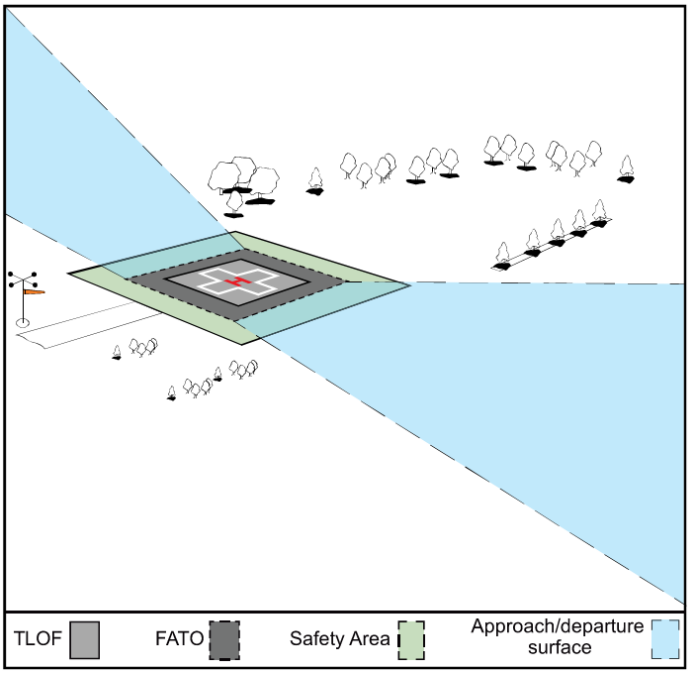
The following image shows generic diagrams for ground-level general aviation, transport, and hospital heliports. TLOF is Touchdown and Liftoff Area. FATO stands for Final Approach and Takeoff Area.




*General Aviation*

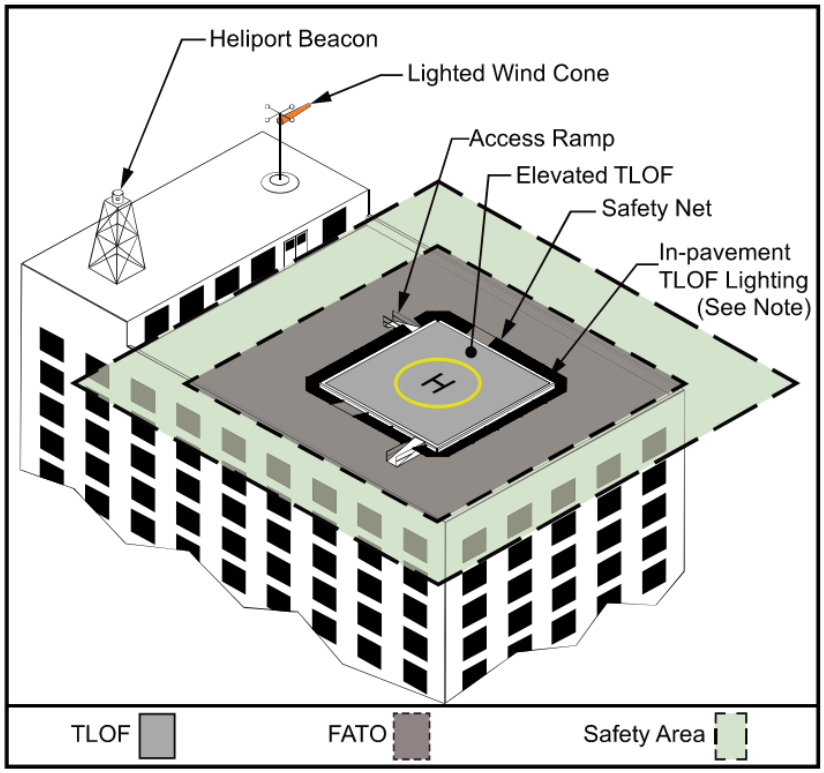



*Transport*

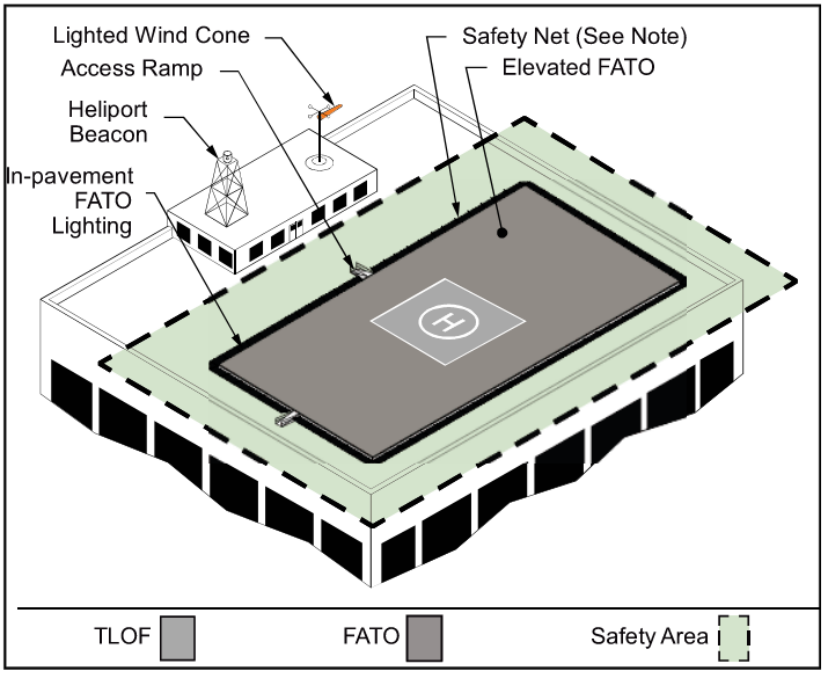



*Hospital*

These images show elevated heliports for general aviation and hospitals, and transport.




*Elevated Heliport for General Aviation and Hospitals*

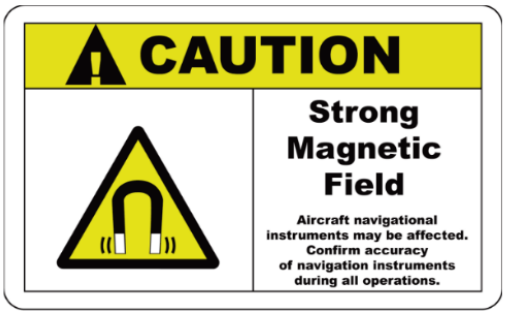



*Elevated Heliport for Transport*

# Heliport Design

General heliport location necessitates long-term planning and analysis of future use. For example, a heliport may normally be a hospital drop-off zone for life-flight helicopters. However, in the event of a disaster, the same helipad may be used by military aircraft, so advanced planning is prudent.

## Heliport Location




Heliports should be located away from adjacent obstructions, such as trees, buildings, antenna, etc. Also, magnetic interference must be avoided, such as an MRI machine at a hospital, which can disrupt aircraft instruments and navigation equipment. When an airport and heliport exist in the same vicinity, the TLOF should be located away from aircraft movement areas, such as runways, taxiways, and parking aprons. Standoff distances between FATO center and runway centerlines are shown here:

| Airplane Size | Small Helicopter 7,000 lbs (3,175 kg) or less | Medium Helicopter 7,001 (3,176 kg) to 12,500 lbs (5,670 kg) | Large Helicopter over 12,500 lbs (5,670 kg) |
|---|---|---|---|
| Small airplane 12,500 lbs (5,670 kg) or less | 300 feet (91 m) | 500 feet (152 m) | 700 feet (213 m) |
| Large airplane 12,500 lbs (5,670 kg) to 300,000 lbs (136,079 kg) | 500 feet (152 m) | 500 feet (152 m) | 700 feet (213 m) |
| Heavy airplane Over 300,000 lbs (136,079 kg) | 700 feet (213 m) | 700 feet (213 m) | 700 feet (213 m) |

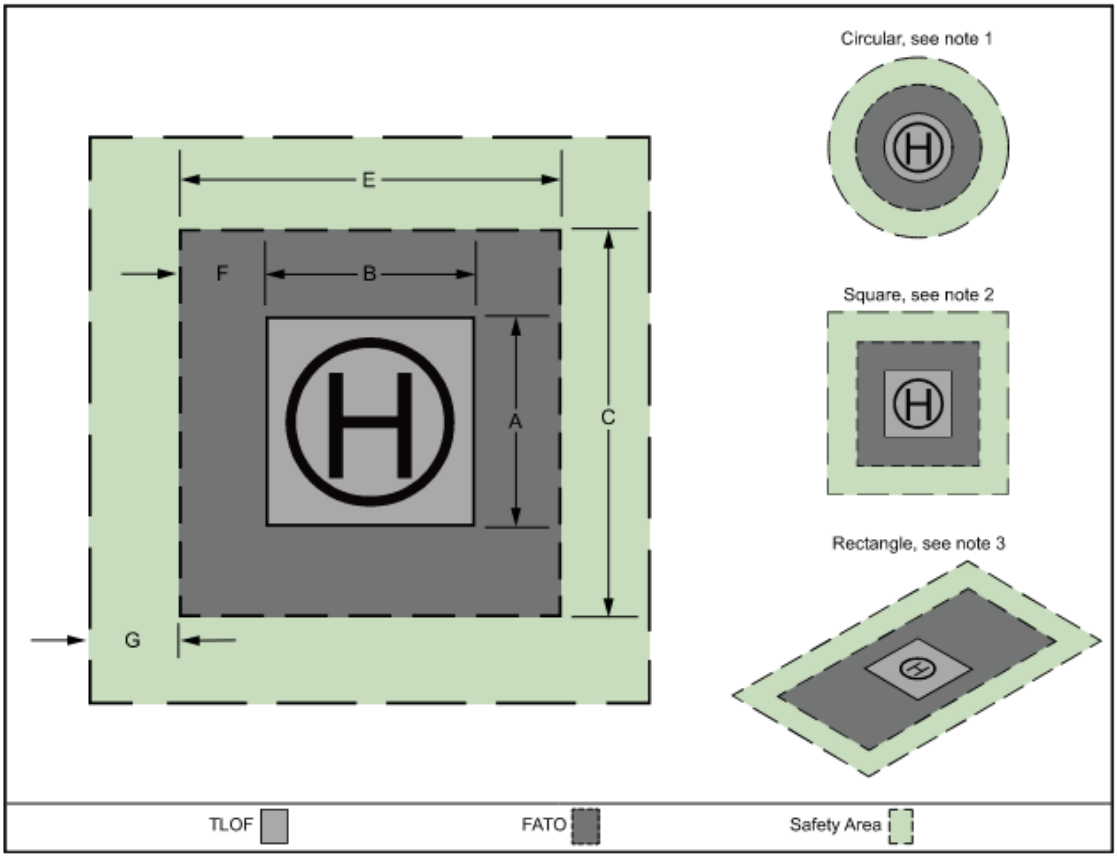
Every heliport should have at least one TLOF, located on the ground, elevated structure, or rooftop. Regarding shape, helipad TLOFs can be circular, square, or rectangular. Circular TLOFs are more recognizable in urban environments and are more common for general aviation and hospital heliports.

Another location factor to consider is adjacent building air quality. Aircraft engine exhaust can migrate into fresh air vents, causing hazards. If relocating a helipad isn't possible, HVAC systems may need to be retrofitted with filters or other components.

Heliport wind cones should conform with AC 150/5345-27. Placement must be so the pilot can see it clearly from the TLOF. If the heliport is intended for night operations, the wind cone should be illuminated.

## Heliport Dimensions

Sizing a helipad depends on the design aircraft(s) for current and future use. The figure shows the relative dimensions of helipad zones and required minimum dimensions. Note that dimensions are based on the controlling helicopter dimension, D, which can be found in the helicopter data table in AC 150/5390-2D (see below for an excerpt).

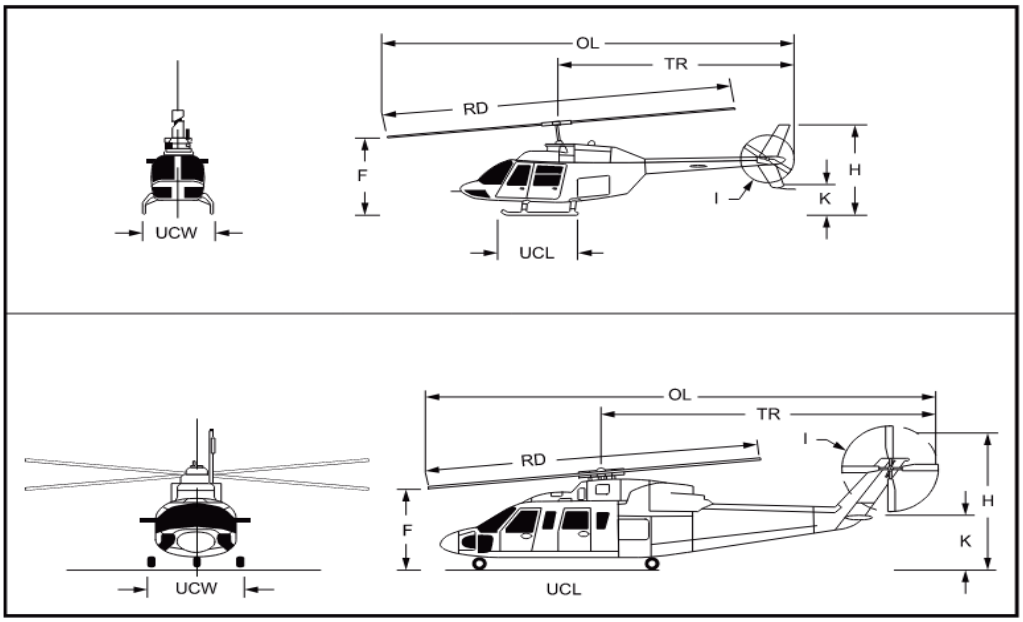



**Note 1:** For a circular TLOF and FATO, dimensions A, B, C, and E refer to diameters.
**Note 2:** For a square TLOF and FATO, all sides of the TLOF and FATO have equal length (e.g., dimension E = dimension C and dimension A = dimension B).
**Note 3:** For a square TLOF with a rectangular FATO, dimension E ≠ dimension C.

| Dim | Item | GA | TRANSPORT | HOSPITAL |
|---|---|---|---|---|
| A | TLOF Width | 0.83 D | 0.83 D but not less than 50 ft (15.2 m) | 0.83 D but not less than 40 ft (12.2 m) |
| B | TLOF Length | 0.83 D | 0.83 D but not less than 50 ft (15.2 m) | 0.83 D but not less than 40 ft (12.2 m) |
| C | FATO Length [2] | 1.50 D | 1.66 D but not less than 100 ft (30.5 m) | 1.50 D |
| E | FATO Width | 1.50 D | 1.66 D but not less than 100 ft (30.5 m) | 1.50 D |
| F | Separation between TLOF and FATO perimeters [3] | 0.34 D | 0.34 D | 0.34 D |
| G | Safety Area Width | See Table 2-4 | 0.42 D but not less than 30 ft (9.1 m) | See Table 2-4 |

| Manufacturer/ Model | Maximum Takeoff Weight | Controlling Dimension (ft) | Overall Length (ft) | Overall Height (ft) | Main Rotor | | | | Tail Rotor | | | Undercarriage | | | Number of Engines/ Type | Crew Number/ Pax Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (ft) | Number of Blades | Ground Clearance (ft) | Tail Rtr Circle Radius (ft) | Diameter (ft) | Number of Blades | Ground Clearance (ft) | Type | Length (ft) | Width (ft) | | |
| A | B | D | OL | H | RD | E | F | TR | I | J | K | L | UCL | UCW | M | N |
| **AgustaWestland** | | | | | | | | | | | | | | | | |
| A-109A | 5,732 | 42.8 | 42.8 | 11.2 | 36.1 | 4 | 10 | 25 | 6.7 | 2 | 2.3 | wheel | 11.6 | 7.5 | 2-T | 1-2& 6-7 |
| A-119 Koala | 5,997 | 42.7 | 42.7 | 12.4 | 36.6 | 4 | 8.3 | 25.5 | 6.4 | 2 | 4.2 | skid | 13.4 | 5.5 | 1-T | 1&6-7 |
| AW-109E Power | 6,283 | 42.8 | 42.8 | 11.5 | 36.1 | 4 | 8 | | 6.4 | 2 | 3 | wheel | 11.5 | 7.1 | 2-T | 1&7 |
| AW-109S Grand | 7,000 | 42.5 | 42.5 | 11.2 | 35.5 | 4 | 8 | | 6.4 | 2 | 3.3 | wheel | 12.3 | 7.1 | 2-T | 1-2& 6-7 |
| AW-119 Ke | 6,283 | 42.4 | 42.4 | 11.8 | 35.5 | 4 | 9.3 | | 6.4 | 2 | 3.8 | skid | 11.1 | 7 | 1-T | 1&6-7 |
| AW-139 | 14,991 | 54.7 | 54.7 | 16.4 | 42.6 | 5 | 12.9 | | 8.9 | 4 | 7.5 | wheel | 14.2 | 10 | 2-T | 1-2& 15 |
| AW-101 | 34,392 | 74.8 | 74.8 | 21.7 | 61 | 5 | 15.4 | 45 | 13.1 | | 8.4 | wheel | 23 | 14.8 | 3-T | 3&30 |
| Westland WG30 | 12,800 | 52.2 | 52.2 | 15.5 | 43.7 | 4 | 12.5 | 31 | 8 | 4 | 7.5 | wheel | 17.9 | 10.1 | 2+T | 2&19 |
| **Bell Helicopter** | | | | | | | | | | | | | | | | |
| 47G | 2,950 | 43.6 | 43.6 | 9.3 | 37.1 | 2 | 5 | 25 | 6.1 | 2 | 3.5 | skid | 9.9 | 7.5 | 1-P | 1&2-3 |

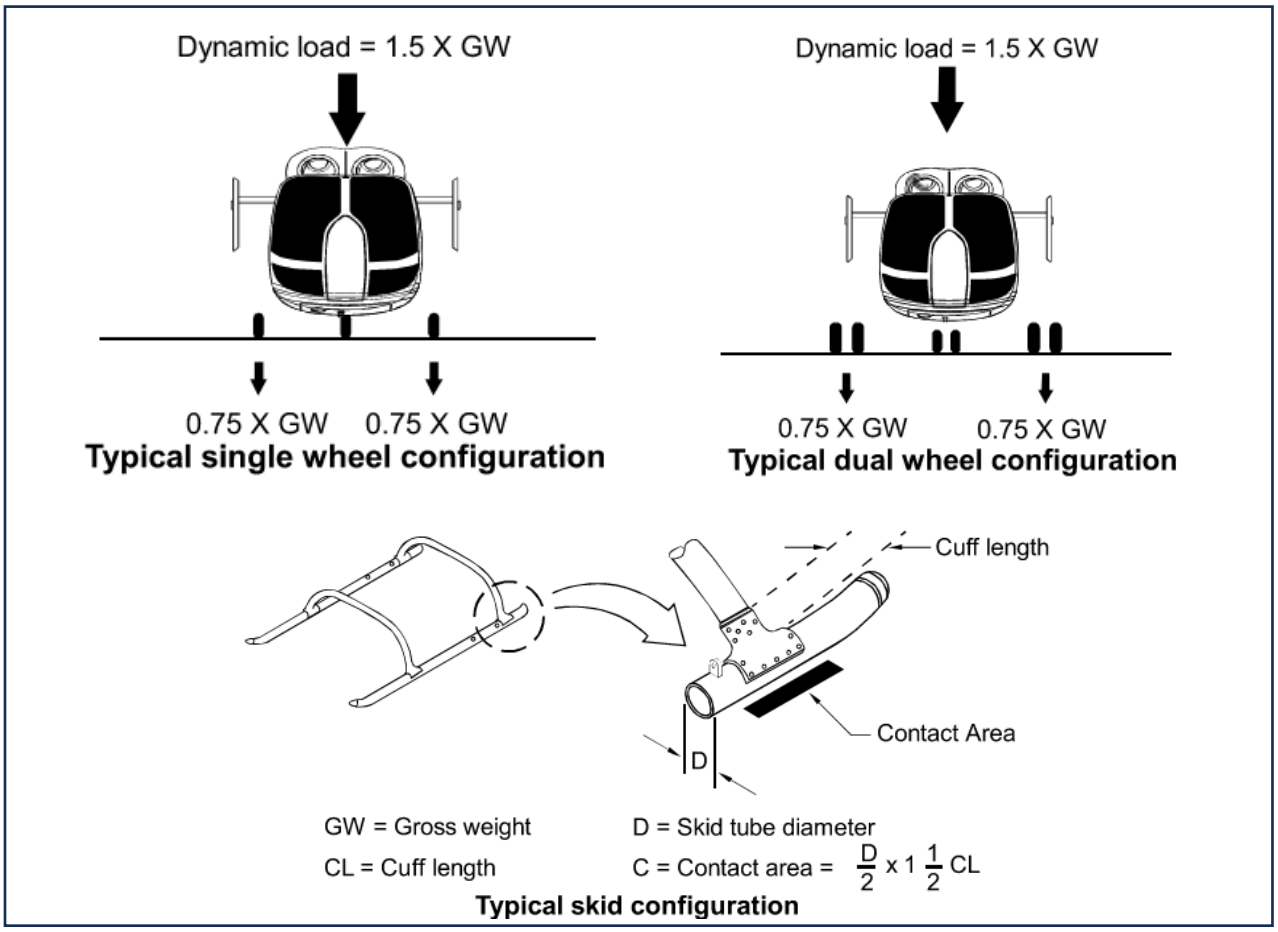
*Helicopter Data Table*




## TLOF Design Loads

Design loads for TLOFs include both the design helicopter and any ground support vehicle. **Static loads** are the helicopter's max gross weight applied to the ground contact area (wheels or skids). **Dynamic loads** should be considered for raised/elevated TLOF structures and may occur for 0.2 seconds or less during a hard landing. Dynamic loads are assumed to be 150% of the helicopter takeoff weight. If load data is unavailable, assume 75% of the weight is applied through the contact area of the rear two wheels or aft skids. Rotor wash downward loads are basically equal to the weight of the aircraft spread over the rotor disc area, and are normally less than snow, rain, or wind loads.

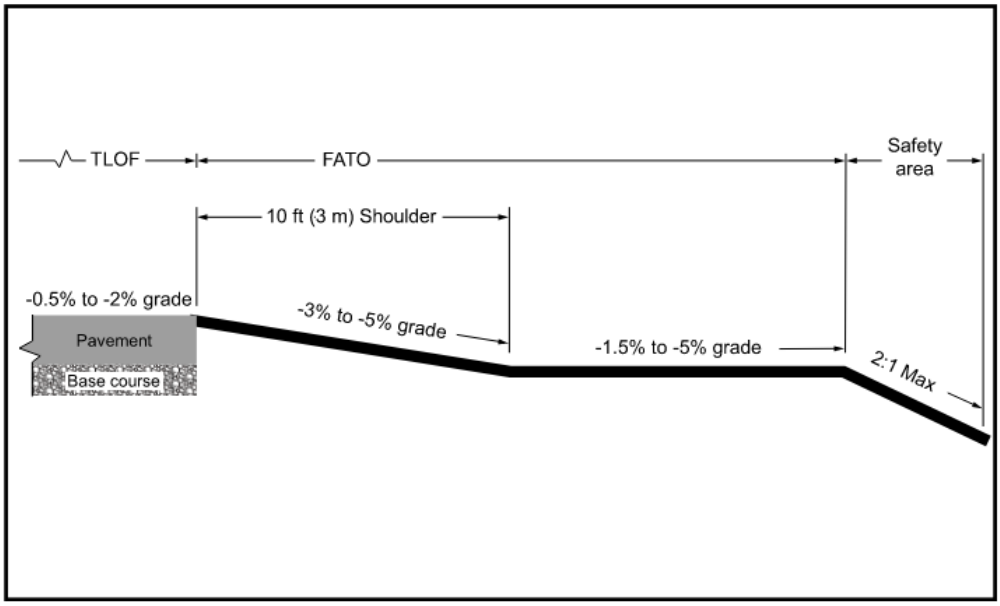



## TLOF Surface Types


Ground level TLOF surfaces should be paved or aggregate-turf. Concrete is preferred because asphalt can develop ruts, which can cause rollovers. Asphalt can also stick to aircraft skids and cause further hazards. A skid resistant surface is a must for both aircraft and people. For elevated TLOFs, surfaces may be metal or concrete, depending on building construction. Either way, pavement improves load carrying ability and minimizes erosion due to rotor wash and surface runoff. If a TLOF is unpaved, soil should be stabilized in the form of well-drained, dense turf or aggreagate turf (mixed granular materials with soil). Precast masonry blocks may be used and infilled with soil for grass to grow in the natural openings. Perforated metal panels may be used as well.

## TLOF Surface Gradients

Ground level general aviation and hospital TLOF surface gradients must have 0.5%-2.0% negative grade. Transport TLOF grades must be between -0.5%-1.0% (longitudinal) and -0.5%-1.5% (transverse). Steeper grades for the FATO areas ensure rapid runoff zones. Hospitals need easy access to the TLOF to transport patients to/from the helicopter via a ramp at least 6' wide.




## FATO Dimensions

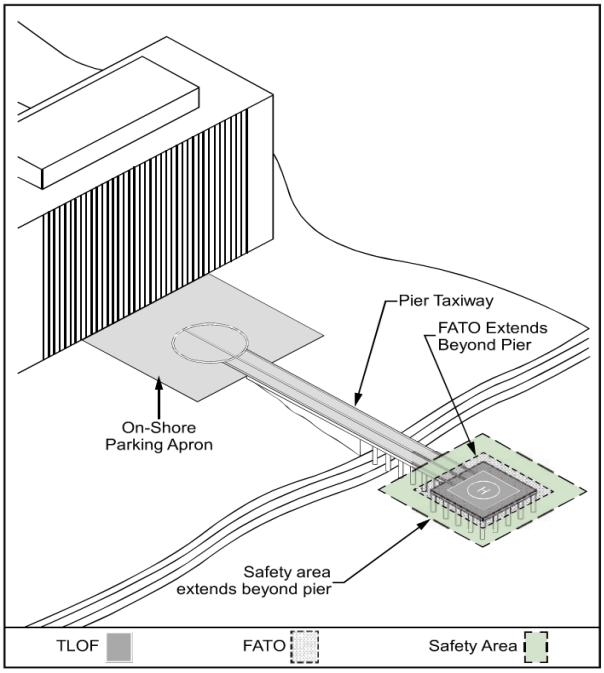
The Final Approach and Takeoff Area, FATO, contains a TLOF within its boundaries, where helicopters come and go. If the TLOF is square or rectangular, the FATO must match. Likewise, if the TLOF is round, the FATO will be round as well. FATO dimensions are found on the same chart seen in the Heliport Dimensions section. Additional FATO length may be required for heliports at high elevations (>1000' MSL). FATO separation must be greater than 200' to the next adjacent landing or takeoff zone.

## FATO Surfaces & Gradients

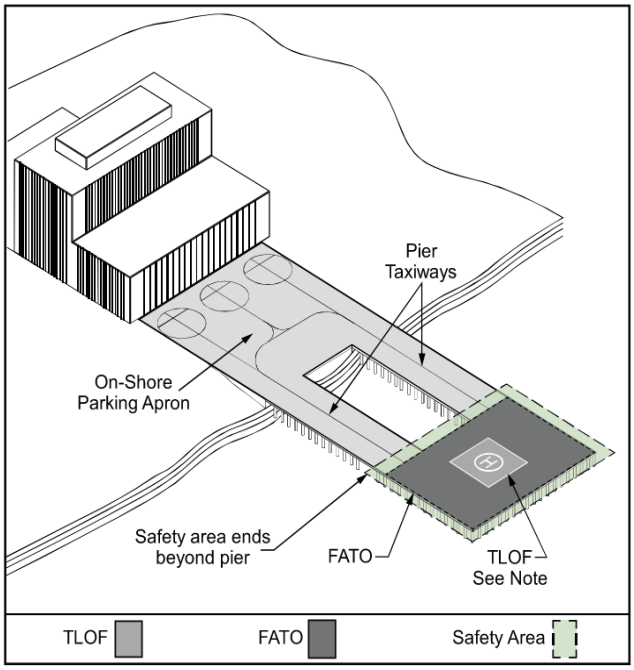
FATO zones need not be load-bearing, so long as the TLOF is. The TLOF/FATO surface transition should be even. Non-load bearing areas are not expected to be used by aircraft, so gradients have no specific requirements, although -5% is an adequate minimum. All fixed objects (except frangible lights no more than 2" high) must be removed from FATO areas.

## Safety Areas

The safety zone surrounding a FATO offers an additional space for aircraft movement and hazard avoidance. Safety areas need not be load-bearing and surfaces should be even with adjacent areas. Safety areas can extend over water. Gradients should be no steeper than 2:1.




*Non-Load Bearing Safety Area (GA/Hospital)*




*Non-Load Bearing Safety Area (Transport)*

## Safety Nets

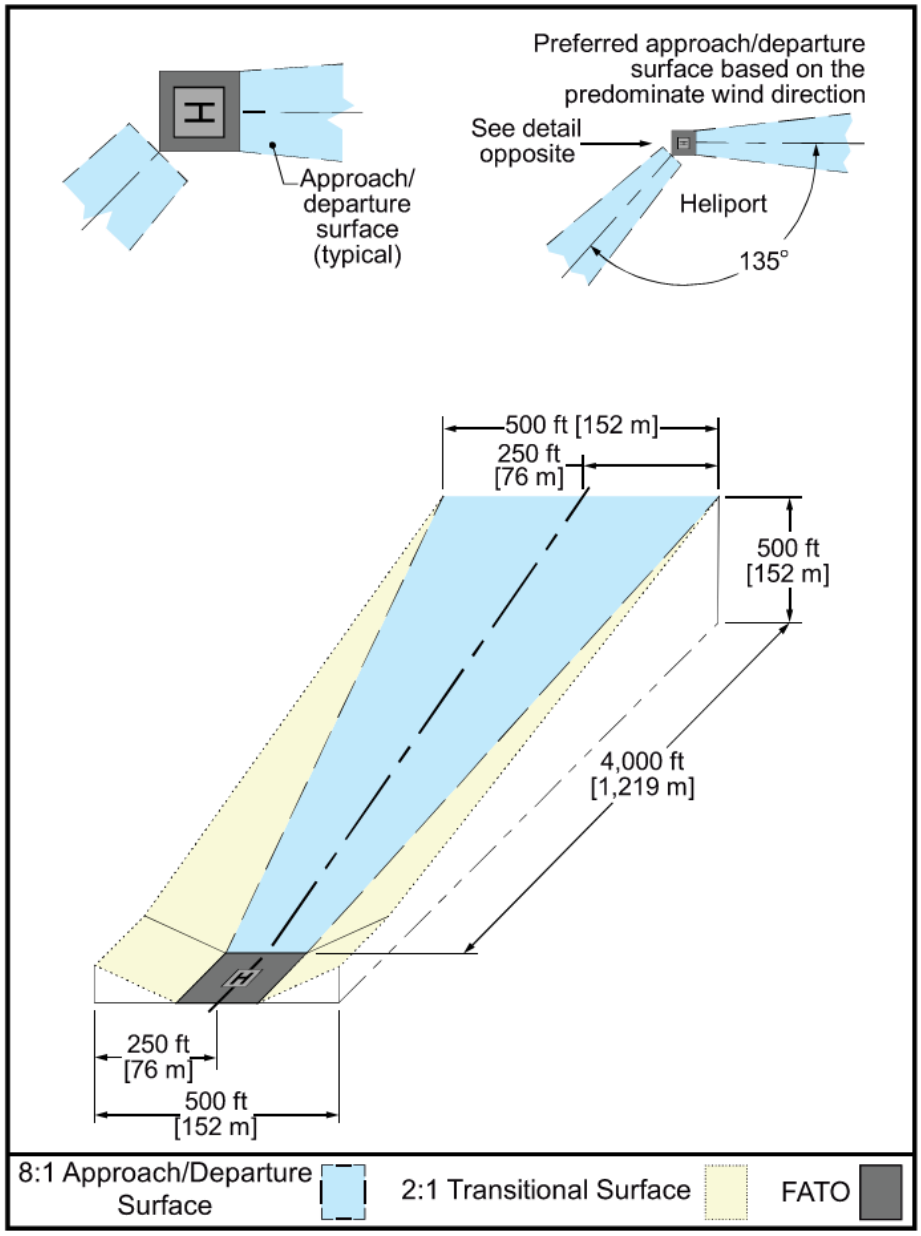
Elevated helipads must provide fall protection; the FAA recommends a safety net for platforms higher than 30". The net must be at least 5' wide and resistant to UV and weather conditions. This chart describes the required differences between types of heliports:

| | GA | TRANSPORT | HOSPITAL |
|---|---|---|---|
| **Load** | Design the safety net to have a load carrying capability of 25 lbs/sq ft (122 kg/sq m) | Design the safety net to have a load carrying capability of 50 lbs/sq ft (244 kg/sq m) | Design the safety net to have a load carrying capability of 25 lbs/sq ft (122 kg/sq m) |
| **Elevation** | Design the safety net to be at or below the elevation of the TLOF | Design the safety net to be at or below the elevation of the FATO | Design the safety net to be at or below the elevation of the TLOF |

## Approach & Departure Paths

Sufficient airspace clear of hazards is needed for approaching or departing aircraft. Accommodations for both straight and curved approaches are available. For the sake of brevity, only brief attention will be called to this topic. For further details, see AC 150/5390-2D §2.12.

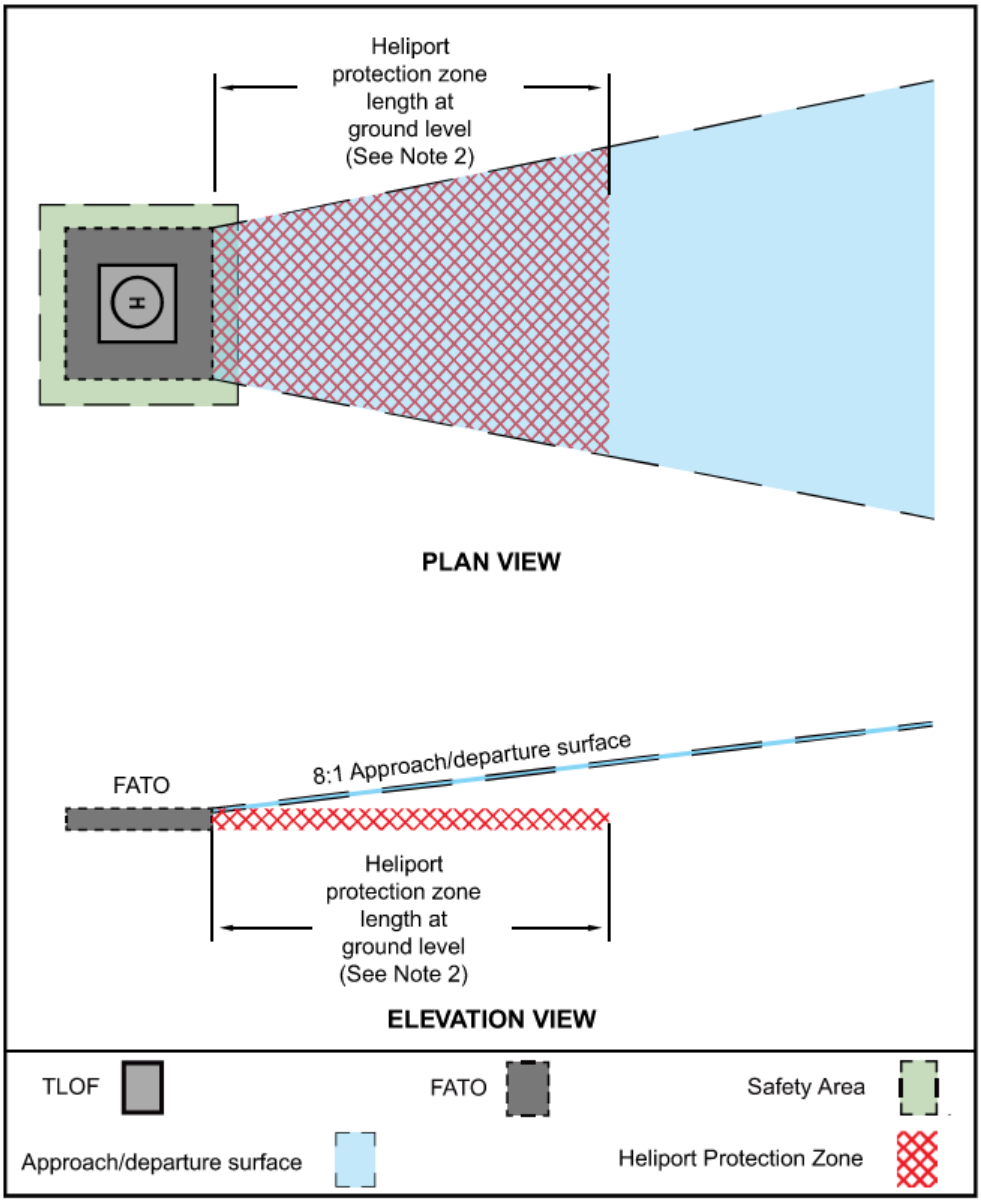
From the edge of the FATO, the approach/departure path slopes up at 8:1 for 4,000'. The transitional surface slopes at 2:1 outward from the centerline for 250'. Periodic re-examination of obstacles near the heliport should occur at least on an annual basis.



## Helicopter Protection Zone

To protect people and property on the ground, a helicopter protection zone (HPZ) is recommended to be established. The HPZ the area underneath the 8:1 approach/departure surface extending 280' (GA/Hospital) and 400' (Transport). Public assembly or residences are discouraged from being in the HPZ. When possible, the heliport owner should purchase the land in the HPZ.

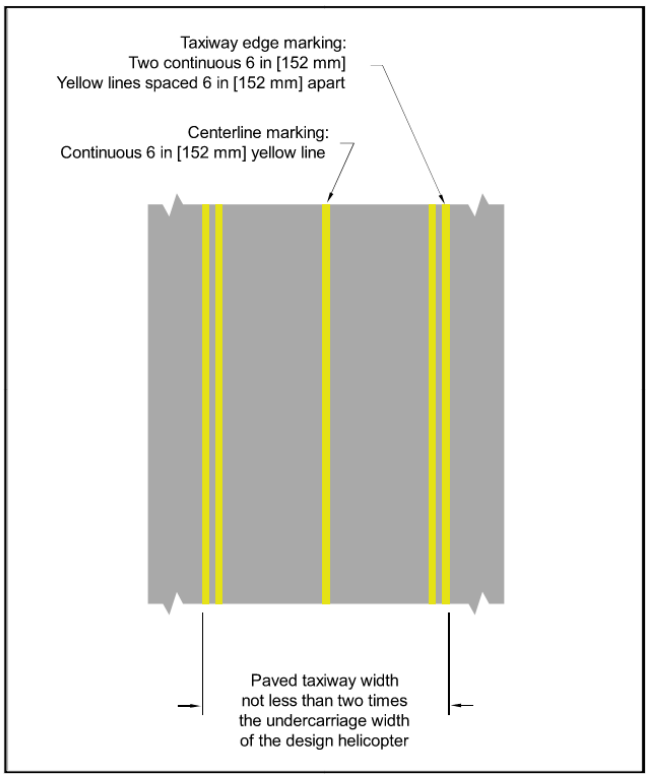



**Note 1:** The approach surface starts at the edge of the FATO.
**Note 2:** The length of the Heliport Protection Zone is 400 ft (122 m) for TRANSPORT heliports and 280 ft (85 m) for GENERAL AVIATION and HOSPITAL heliports.

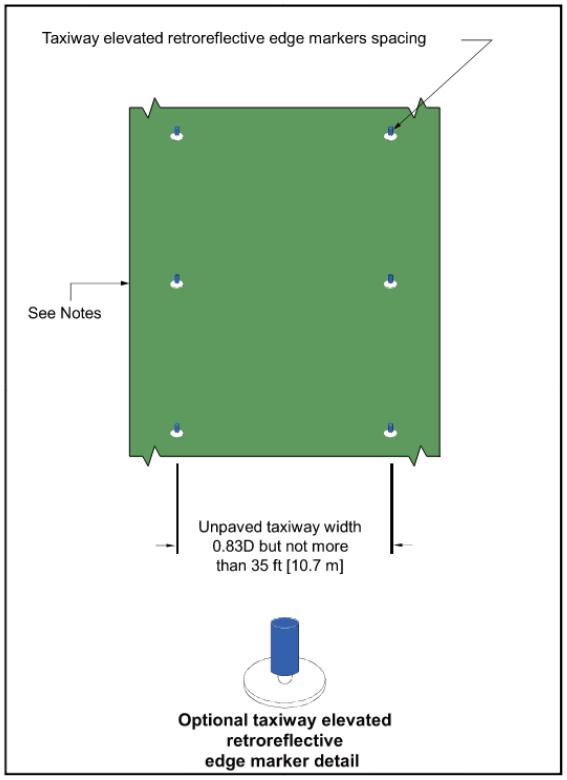
  

# Heliport Taxiways, Tiedowns, and Parking

As on an airport, taxiways for heliports provide for movement for aircraft from one area to another. Specifically, taxiways are between the FATO and the parking or tiedown area. Since helicopters can hover, ground taxiing isn't always necessary or even possible. Either way, taxiways are there. Taxiways can be paved or unpaved, as shown below. Gradients are limited to 2% (longitudinal) and 0.5%-2.0% (transverse). Also, keep in mind that turning radii of helicopters varies greatly between ground taxiing and hover taxiing.

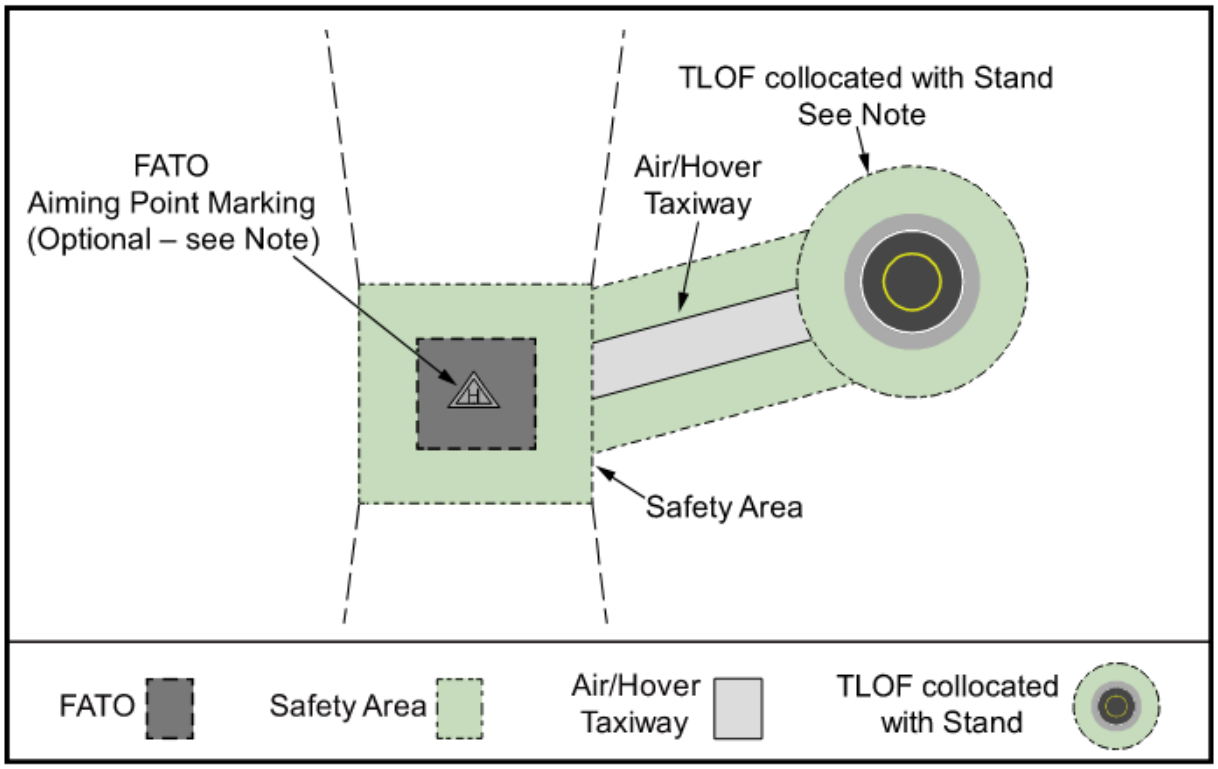



*Paved Taxiway*




*Unpaved Taxiway w/ Elevated Markers*

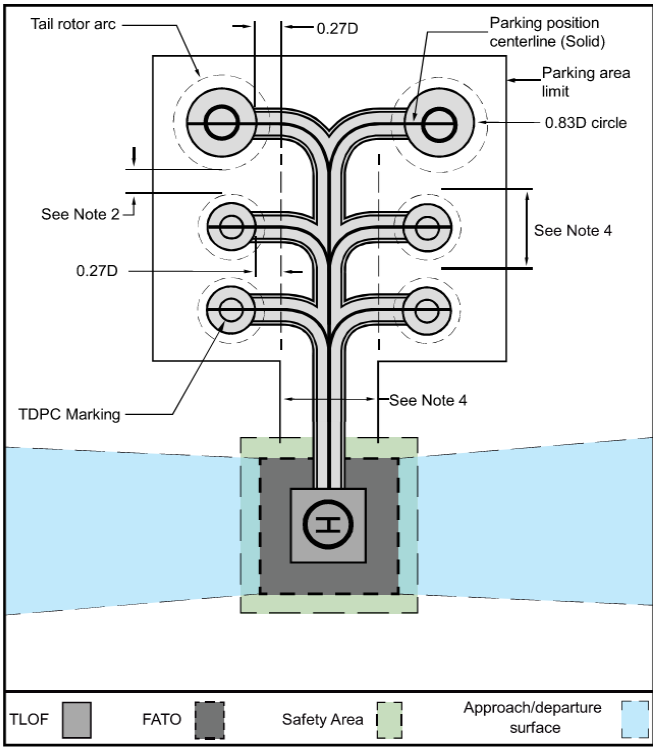



Dimensions for taxiways are based on UCW (Undercarriage Width) and D (Controlling Dimension):

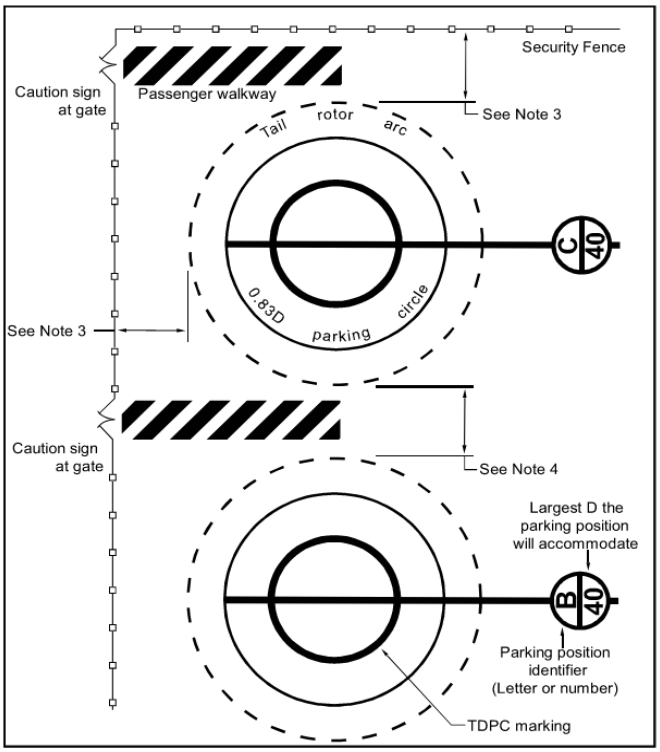
| Taxiway (TW) Type | Minimum Width of Paved Area | Centerline Marking Type | TW Edge Marking Type | Lateral Separation Between TW Edge Markings | Total Taxi Route Width |
|---|---|---|---|---|---|
| Ground Taxiway | 2 × UCW | Painted | Painted | 2 × UCW | 1.25 D |
| | | | Elevated | 0.83 D but not greater than 35 ft (10.7 m) | |
| | Unpaved but stabilized for ground taxi | None | In-pavement | 2 × UCW | |
| | | | Elevated | 0.83 D but not greater than 35 ft (10.7 m) | |
| Hover Taxiway | 2 × UCW | Painted | Painted | 2 × UCW | 1.67 D |
| | Unpaved | None | Elevated or In-pavement | 0.83 D but not greater than 35 ft (10.7 m) | |

When more than one helicopter is expected at a heliport, a parking area should be designated, outside of the approach/departure surfaces. Although all individual parking spaces do not have to accommodate the design helicopter, it does determine separation distances. Parking areas should be designed to support the static loads of the anticipated aircraft. Orient passenger walkways to avoid tail rotors. Other obstacles should be at least 10' (GA/Hospital) or 30' (Transport) from the tail rotor arc.

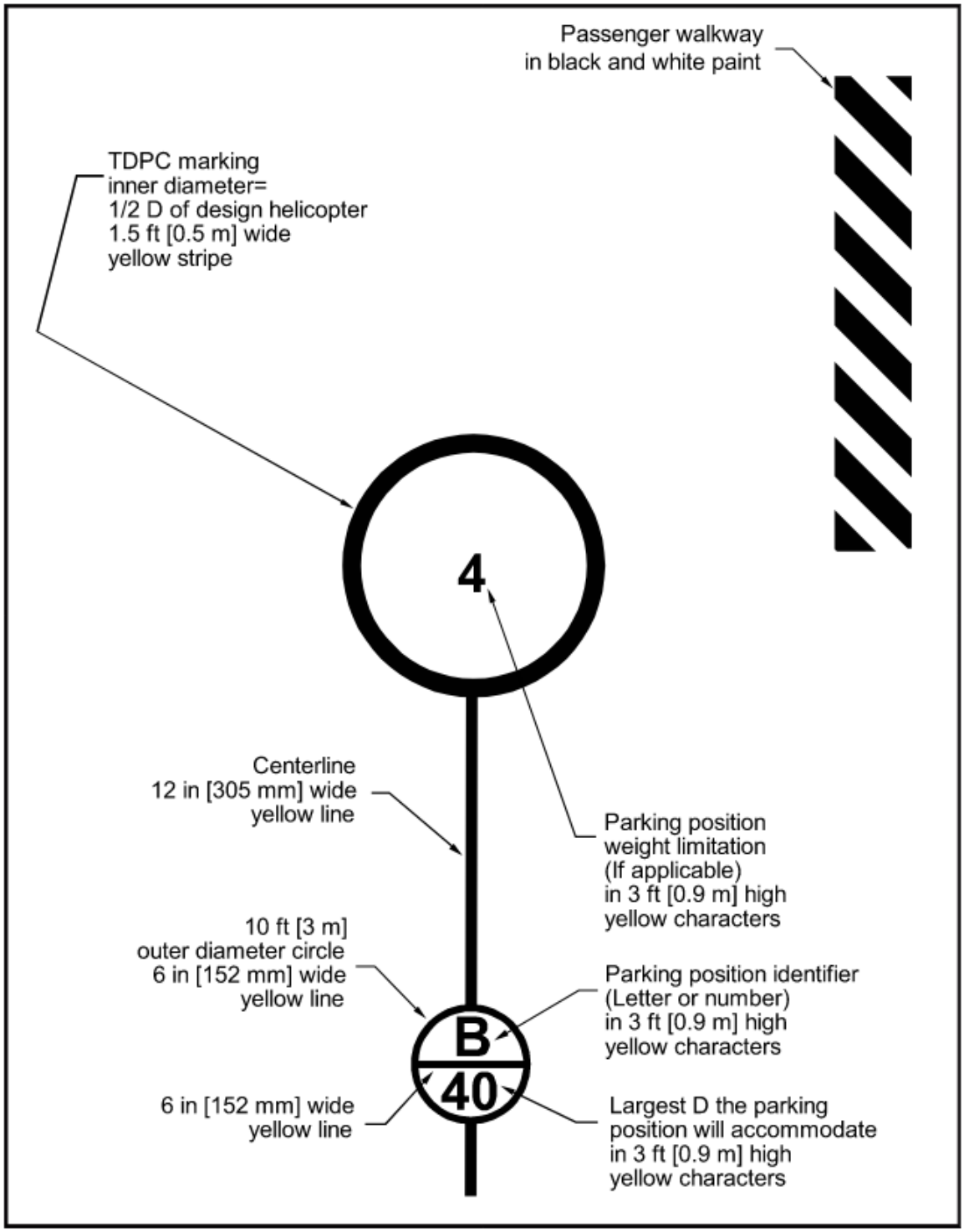



*Parking Area w/ Turn-Around Parking Positions*




*Turn-Around Parking Markings*

Tiedowns accommodate parked helicopters and should be recessed to prevent hazards. Depressions for recessed tiedowns should be no greater than half the width of the smallest anticipated helicopter wheel.




*Parking Position Identification, Paved, Turn-Around*

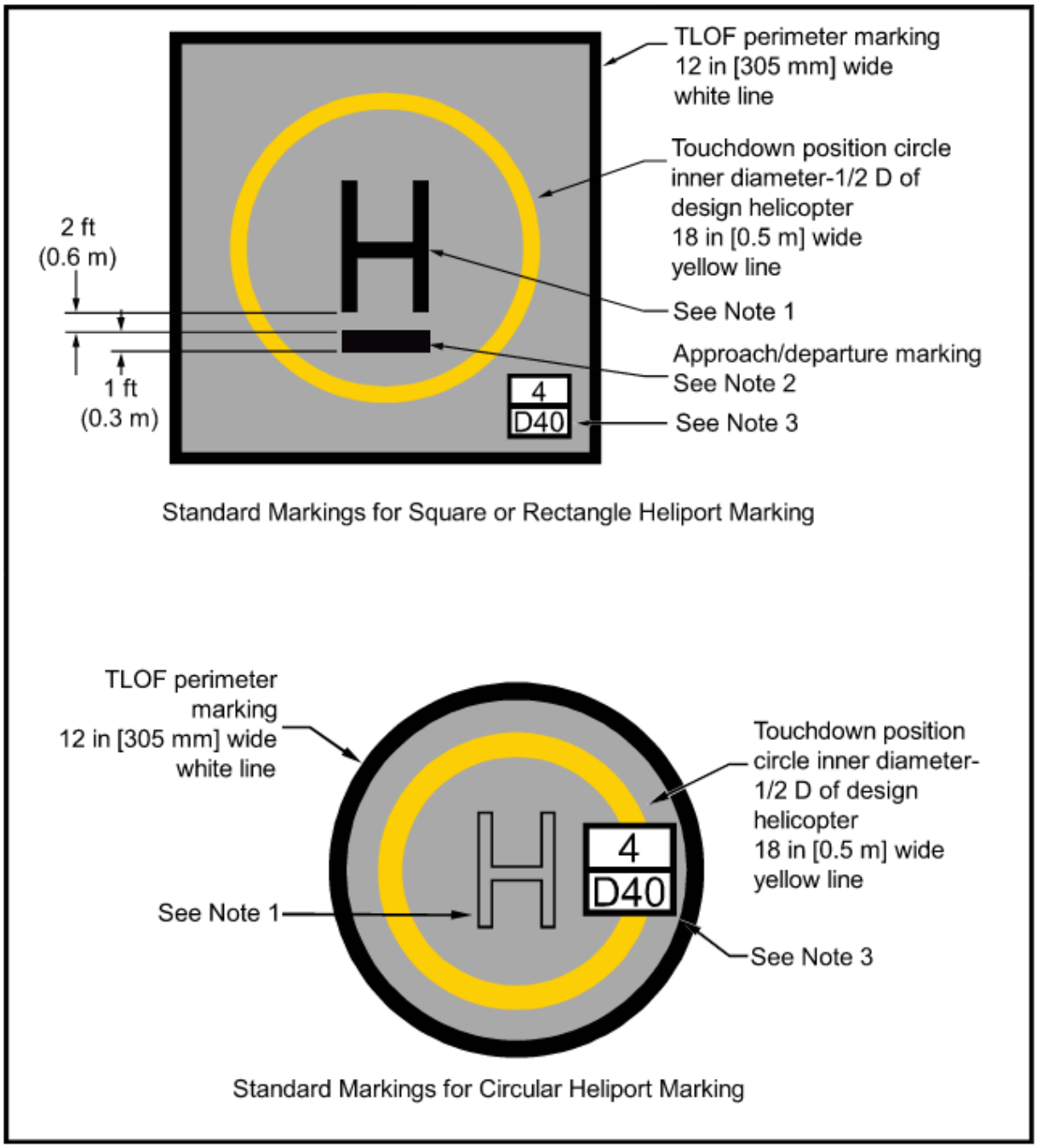
  

## Marking & Lighting

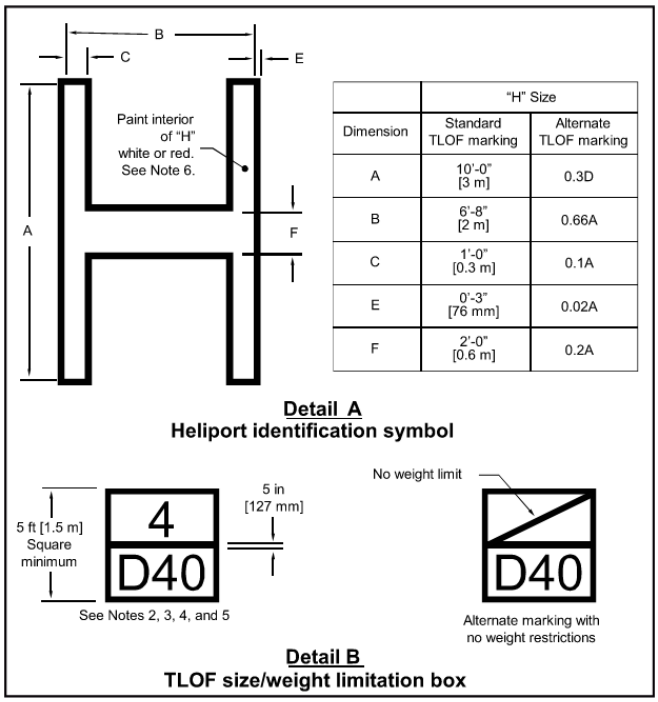
Heliport and taxiway markings should comply with AC 150/5730-10 for specs and materials. Typical markings are necessary to define edges of the TLOF, FATO, taxiway, parking areas, and tiedowns. Taxiways are marked with 6" yellow centerlines. Transport taxiways need two 6" yellow lines spaced 6" apart to delineate taxiway edges. Unpaved taxiways should have retroreflective markers at 15' intervals.

Heliports are identified by a large "H" in the TLOF. To indicate the preferred approach/departure direction, a 1' wide bar is placed under the H. At a hospital, a red H may be used with white borders inside a red TLOF area, or a similar variation.

Standard TLOF and FATO markings include a touchdown positioning circle (TDPC) to guide the pilot during landing. A TDPC marking is a yellow circle in the center of the TLOF. Size and weight limitation markings present the heaviest and largest aircraft (indicated by dimension "D" in feet and max takeoff weight in thousands of pounds) the heliport will accommodate. These are optional for turf surfaces and private heliports.

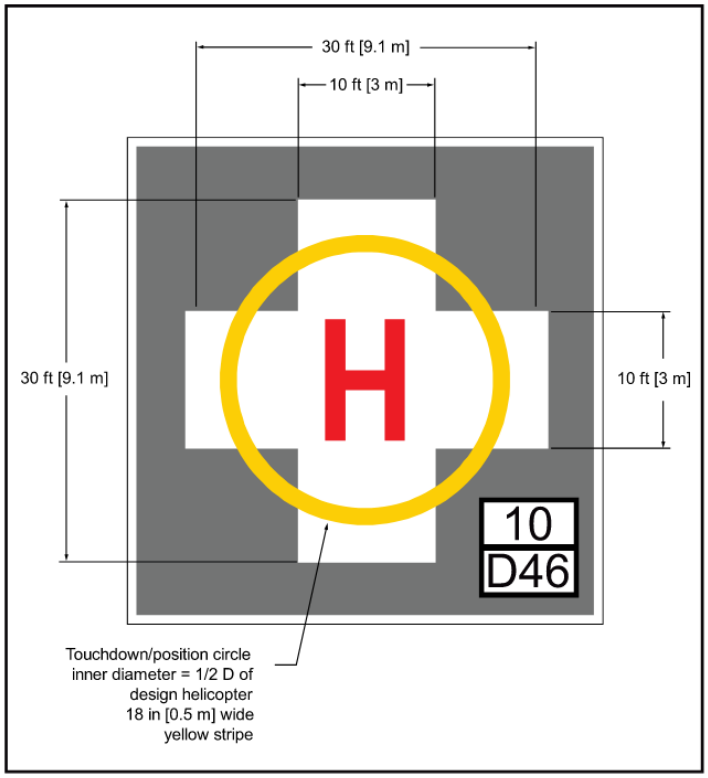



*Standard TLOF Markings*



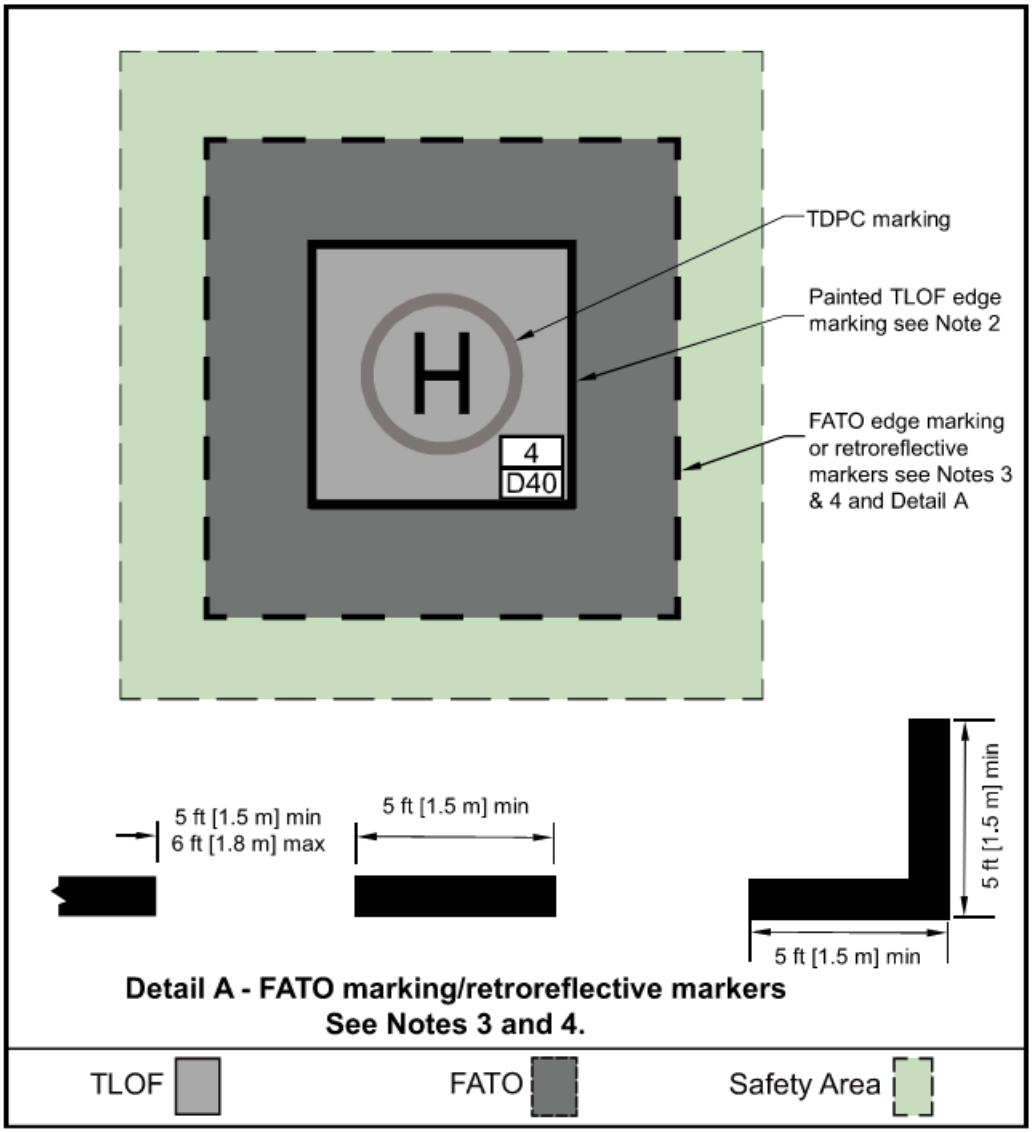

| Dimension | "H" Size | |
|---|---|---|
| | Standard TLOF marking | Alternate TLOF marking |
| A | 10'-0" [3 m] | 0.3D |
| B | 6'-8" [2 m] | 0.66A |
| C | 1'-0" [0.3 m] | 0.1A |
| E | 0'-3" [76 mm] | 0.02A |
| F | 2'-0" [0.6 m] | 0.2A |

*Standard Heliport ID Symbol*



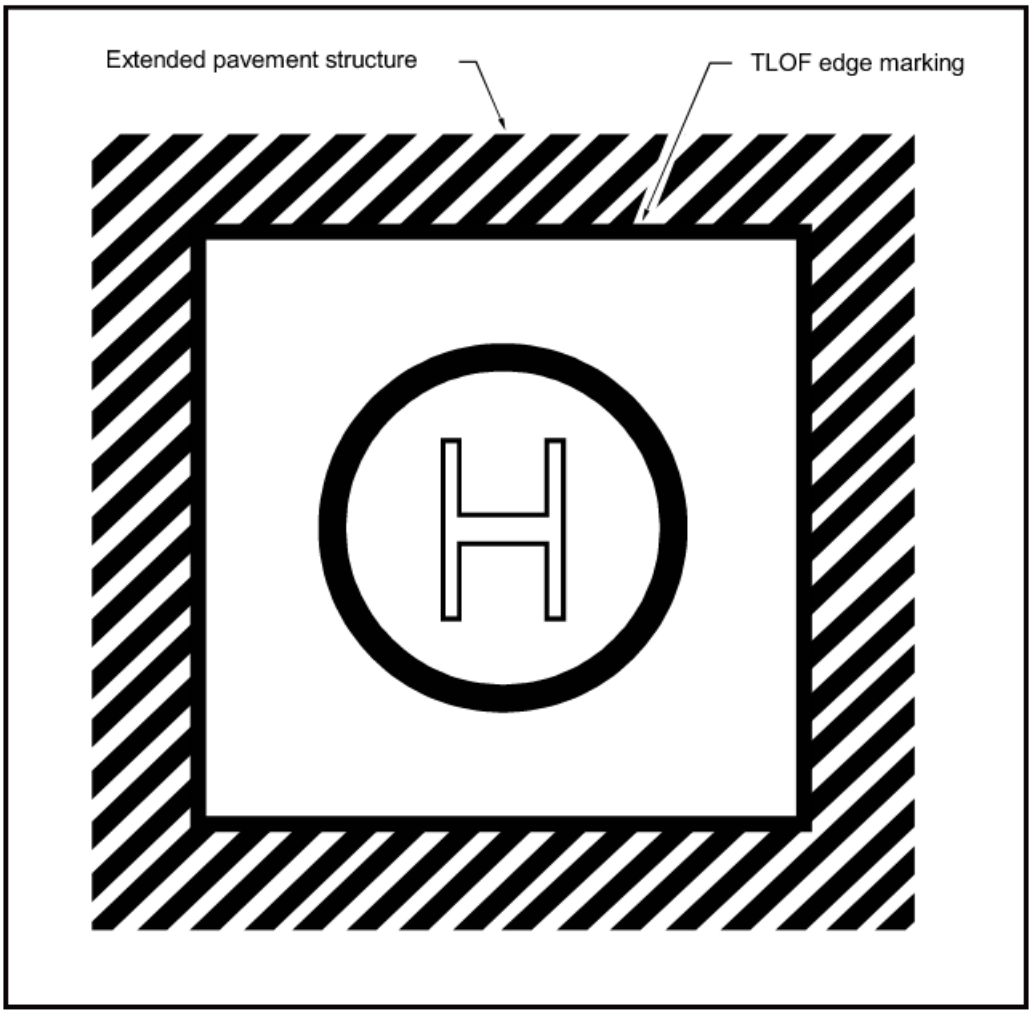

*Hospital Heliport ID*

If the FATO is non-load bearing, it doesn't need perimeter markings. If the FATO is paved, dashed 12" wide white lines around the perimeter are necessary. Unpaved load bearing FATO get 12" in-ground retroreflective markers.




*Paved TLOF & FATO Markings (Transport)*

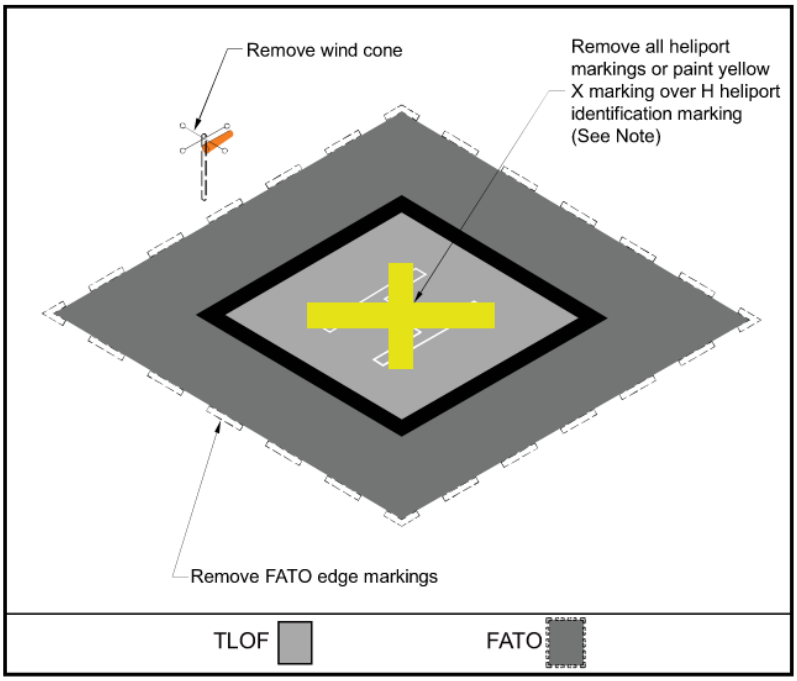
  



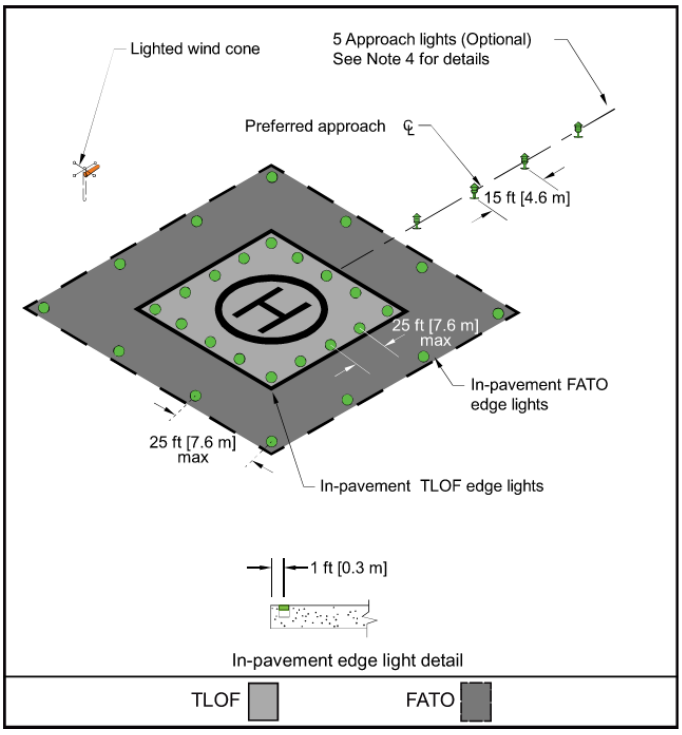

*Extended Pavement Marking (GA/Hospital)*

Optional flight path alignment markings consist of arrows on the TLOF or FATO indicating preferred approach and departure directions. Unidirectional or bidirectional arrows are acceptable, depending on flight path options.

If a heliport is to be closed (say, during construction) markings and wind cone should be removed and a large X painted over the H.




For heliports that support night operations, lighting is required for the TLOF. FATO perimeter lights are optional. This image shows perimeter lighting; due to length, this course will not cover the details of heliport lighting. See AC 150/5390-2D §4.13 for details.



# Appendix A: Example Heliports



## Reference Material

1. AC 150/5390-2D, *Heliport Design*
2. FAA Form 7480-1, *Notice for Construction, Alteration and Deactivation of Airports*
3. AC 150/5730-10H, *Standard Specifications for Construction of Airports*
4. AC 150/5300-13B, *Airport Design*

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