Designation: F3423/F3423M − 22

Standard Specification for Vertiport Design[1]

This standard is issued under the fixed designation F3423/F3423M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification defines the requirements for the planning, design, and establishment of vertiports intended to service vertical takeoff and landing (VTOL) aircraft. These aircraft include, but are not limited to, standard category aircraft, optionally piloted aircraft, and unmanned aircraft. Aircraft not covered by this specification include VTOL aircraft less than 55 lb [25 kg]. In developing these standards, identified types of eVTOL aircraft, for example, Multi-Rotor, Lift & Cruise, Vectored Thrust, Tilt Wing, Tilt Rotor, etc., were considered. Ultimately it is up to the authorities having jurisdiction (AHJ) as to how and to what extent these standards are applied. Vertiports may provide commercial or private services in support of the operation of eVTOL aircraft including, but not limited to, some or all of occupant and cargo transport, air medical, flight instruction, aerial work, aircraft rental, fueling, charging of energy storage devices, battery exchange, hangaring, and maintenance services.

1.2 This specification is intended to support the design of civil vertiports and vertistops, however, it may also be used as a best practice document for other facilities.

1.2.1 *Vertiport* is a generic reference to the area of land, water, or structure used, or intended to be used, for the landing and takeoff of VTOL aircraft, together with associated buildings and facilities. At this time, aircraft with floats conducting water landings and takeoffs are not included in this specification.

1.2.2 *Vertistop*—The same as *Vertiport*, except that no fueling, defueling, scheduled maintenance, scheduled repairs, or storage of aircraft is permitted. Unscheduled maintenance and repairs to return an aircraft in an AOG (Aircraft on Ground) status to a serviceable status are permissible.

1.3 This document may present information in either SI units, English Engineering units, or both. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3060 Terminology for Aircraft

F3341/F3341M Terminology for Unmanned Aircraft Systems

2.2 *AIA Standards:*[3]

NAS National Aerospace Standards

2.3 *FAA Standards:*[4]

14 CFR Part 77 Safe, Efficient Use and Preservation of the Navigable Airspace

14 CFR Part 157 Notice of Construction, Alteration, Activation, and Deactivation of Airports

AIM Aeronautical Information Manual

FAA Pilot/Controller Glossary

FSIMS 8900.1 Vol 8, Ch 3, Sec 3 Evaluation and Surveillance of Heliports

AC 00-34A Aircraft Ground Handling and Servicing

AC 70/7460 Obstruction Marking and Lighting

AC 150/5200-33B Hazardous Wildlife Attractants on or Near Airports

AC 150/5345-27E Specification for Wind Cone Assemblies

AC 150/5390 Heliport Design Guide

Order JO 6700.20B Non-Federal Navigational Aids, Air

[1] This specification is under the jurisdiction of ASTM Committee F38 on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee F38.02 on Flight Operations.

Current edition approved July 1, 2022. Published August 2022. DOI: 10.1520/F3423_F3423M-22.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Aerospace Industries Association (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209, http://www.aia-aerospace.org.

[4] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov.

Traffic Control Facilities, and Automated Weather Systems Document Information
Order JO 7110.65X Air Traffic Organization
Order JO 7400.2 Procedures for Handling Airspace Matters
Airports Engineering Brief #87 Heliport Perimeter Lights for Visual Meteorological Conditions (VMC)

2.4 *ICAO Standards:*[5]
ICAO Heliport Manual/Doc 9261
ICAO Annex 14, Aerodromes Volume II Heliports

2.5 *ICC, International Code Council*[6] Standards:[7]
IBC[6] International Building Code[6]
IFC[6] International Fire Code[6]

2.6 *IES Standard:*[8]
RP-37-15 Outdoor Lighting for Airport Environments

2.7 *NFPA*[9] Standards:[10]
NFPA 70[9] National Electrical Code[9]
NFPA 101[9] Life Safety Code[9]
NFPA 407 Standard for Aircraft Fuel Servicing
NFPA 409 Standard on Aircraft Hangars
NFPA 418 Standard for Heliports
NFPA 855 Standard for the Installation of Stationary Energy Storage Systems

2.8 *OSHA/ANSI Standards:*[11]
Title 29 CFR Part 1910.23 Ladders
Title 29 CFR Part 1926.502 Fall Protection Systems Criteria and Practices

3. Terminology

3.1 *Unique and Common Terminology*—Terminology used in multiple standards is defined in F3341/F3341M, UAS Terminology Standard, and F3060, Aircraft Terminology Standard. Terminology that is unique to this specification is defined in this section.

3.2 *Definitions:*

3.2.1 *Air Gap, n*—An unobstructed clear area dimensionally dependent on site-specific conditions that is located under a rooftop vertiport and between it and the architectural structure immediately below it, which is designed to allow the air circulating around and over a building to flow under the vertiport rather than over the vertiport to reduce turbulence at the landing and takeoff site(s).

3.2.2 *Air Taxi, n*—Used to describe a VTOL aircraft movement conducted above the surface but typically below 100 ft [30.5 m] AGL, which allows for more rapid aircraft movement from one point to another.

3.2.3 *Approach Surface (VFR), n*—The approach surface begins at each edge of the vertiport FATO with the same width as the FATO and extends outward and upward for a horizontal distance of 4000 ft [1219.2 m] where its width is then 500 ft [152.4 m]. The slope of the approach surface is 8:1. Although VTOL approach/departure paths may curve, the length of the approach/departure surface remains fixed. The approach surface slope may be reevaluated on a case-by-case basis at such time performance data for individual aircraft has been certified and published that would indicate a steeper, higher performance profile may be safely accomplished and accommodated for.

3.2.4 *Controlling Dimension (CD), n*—The greatest distance between the two outermost opposite points on an aircraft as measured along either the horizontal or longitudinal axis (that is, wingtip to wingtip, rotor tip to rotor tip, rotor tip to wingtip, fuselage to rotor tip, fuselage to fuselage, etc.), measured on a level horizontal plane that includes all adjustable components extended to their maximum outboard deflection. This equates to the smallest circle enclosing the VTOL aircraft projection on a horizontal plane in all possible operational configurations with rotor(s) turning.

3.2.5 *Design Aircraft, n*—A single or composite, that is, multiple, aircraft that reflects the maximum weight, maximum contact load/minimum contact area, controlling dimension, undercarriage dimensions, and pilot's eye height of all aircraft expected to operate at the vertiport.

3.2.6 *Dynamic Load, n*—For design purposes, assume the dynamic load at 150 percent of the maximum takeoff weight of the design aircraft applied through the main undercarriage on a wheel-equipped aircraft or aft contact areas of skid-equipped aircraft.

3.2.7 *Elevated Vertiport, n*—A vertiport located on a raised structure on land. (A ground-level vertiport where the TLOF is located on an earthen mound is not considered an elevated vertiport).

3.2.8 *Electric Vehicle Power Transfer System, n*—A means of replenishing an aircraft's electrical energy reserves. This includes portable and stationary charging systems that are designed to be connected to an aircraft as well as battery swapping programs. **NFPA 70**

3.2.9 *Energy Storage System (ESS), n*—Complete energy storage device consisting of one or more energy storage cells arranged into one or more packs, with ancillary subsystems for physical support and enclosure, thermal management, and electronic control. Typical energy storage cells include, but are not limited to, batteries or capacitors.

3.2.10 *FATO, n*—Final Approach and Takeoff area; a defined area over which the aircraft completes the final phase of the approach to a hover or a landing, and from which the aircraft initiates takeoff that has an unobstructed perimeter area that allows for safe maneuvering of the design aircraft in all modes of operation. The FATO elevation is the lowest elevation of the edge of the TLOF. The FATO may or may not need to be load bearing dependent upon the type of operations that are intended to be conducted.

[5] Available from International Civil Aviation Organization (ICAO), 999 Robert-Bourassa Blvd., Montréal, Québec H3C 5H7, Canada, https://www.icao.int.
[6] A registered trademark of the International Code Council, Inc.
[7] Available from International Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001, http://www.iccsafe.org.
[8] Available from Illuminating Engineering Society (IES), 120 Wall Street, 17th Floor, New York, NY 10005-4001, https://www.ies.org.
[9] A registered trademark of National Fire Protection Association.
[10] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[11] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, http://www.osha.gov.

3.2.11 *Ground Taxi, n*—The surface movement of a wheeled VTOL under its own power with wheels touching the ground.

3.2.12 *Ground Towing, n*—The movement of an aircraft while in contact with the ground with the assistance of a ground handling device where the aircraft is not producing thrust or lift.

3.2.12.1 *Discussion*—See FAA AC 00-34A, Aircraft Ground Handling and Servicing.

3.2.13 *Hover Taxi, n*—Used to describe the movement of a wheeled or skid-equipped VTOL aircraft above the surface, typically used to move short distances from one point to another. Generally, this task takes place at a wheel/skid height of 1 ft to 5 ft [0.3 m to 1.5 m] and at a ground speed of less than 20 knots [37 km/h]. For facility design purposes, assume a skid-equipped eVTOL aircraft to hover-taxi.

3.2.14 *Imaginary Surfaces, n*—Surfaces used for the purposes of preventing existing or proposed man-made objects, objects of natural growth, or terrain from extending upward into navigable airspace. These surfaces include the Approach Surface, Primary Surface, and Transitional Surface.

3.2.15 *Parking Position, n*—A designated location at a Vertiport designed for transient aircraft to be positioned by means of ground or air taxi taxiways for the purpose of loading and unloading of cargo or passengers, charging, fueling, or short duration maintenance. Landing and takeoff operations are not permitted from designated parking positions. A TLOF may be used as a parking position with the understanding that it may reduce or halt landing and takeoff operations until the aircraft has cleared the location.

3.2.16 *Predesignated Emergency Landing Area (PELA), n*—A location identified as a potential emergency landing site for an aircraft in distress to land when continued flight is unadvised due to an off-nominal situation concerning maintenance, weather, or an inflight emergency.

3.2.17 *Primary Surface, n*—An imaginary surface positioned along a horizontal plane at the established elevation of a vertiport that coincides in size and shape with the designated takeoff and landing area FATO.

3.2.18 *Rotor Load, n*—Rotor downwash loads are approximately equal to the weight of the aircraft distributed uniformly over the disk area of the rotors.

3.2.19 *Safety Area, n*—A defined unobstructed area surrounding the FATO of a vertiport designed to allow for any accidental divergence of an aircraft from the FATO perimeter.

3.2.20 *Safety Net, n*—A physical and structurally supported safety device surrounding any landing/takeoff surface, parking areas, taxiway, walkway, access point, passenger area, and crew area that is elevated greater than 30 in. that is designed to provide fall protection in accordance with OSHA standard Title 29 CFR Part 1910.23 Ladders and Title 29 CFR Part 1926.502 Fall Protection Systems Criteria and Practices.

3.2.21 *Static Load, n*—For design purposes, the design static load is equal to the aircraft's maximum takeoff weight applied through the total contact area of the wheels or skids.

3.2.22 *Taxiway (TW), n*—Defined unobstructed clear path established for the taxiing (air, ground, or both) of aircraft from one part of a vertiport to another.

3.2.23 *TLOF, n*—Touchdown and Liftoff Area; a load-bearing surface area normally centered in its own FATO, on which the aircraft may touchdown or liftoff.

3.2.24 *Transitional Surfaces, n*—These surfaces extend outward and upward from the lateral boundaries of the primary surface and from the approach surfaces at a slope of 2:1 for a distance of 250 ft [76.3 m] measured horizontally from the centerline of the primary and approach surfaces.

3.2.25 *Vertical Lift Aircraft, n*—Heavier-than-air aircraft capable of vertical takeoff and vertical landing.

3.2.26 *Vertiport Elevation, n*—The highest point of a vertiport's FATO measured in feet or meters above mean sea level or equivalent elevation component as approved by the authority having jurisdiction.

3.3 *Performance Classifications:*

3.3.1 *Ground Effect, n*—When hovering near the ground, a phenomenon known as ground effect takes place. This effect usually occurs at a consistent distance above the surface that is proportional to the main rotor diameter for helicopters, or total disk area for multirotor vehicles. As the induced airflow through the rotor disc is reduced by the surface friction, the lift vector increases. This allows a lower rotor blade angle, or reduced RPM, for the same amount of lift, which reduces induced drag.

3.3.2 *Hover In Ground Effect (HIGE), v*—Hovering in close proximity to the surface to where the aircraft is under the influence of ground effect.

3.3.3 *Hover Out of Ground Effect (HOGE), v*—Hovering at a height above the surface to where the aircraft is not influenced or assisted by ground effect. Because induced drag is greater while hovering out of ground effect, it takes more power to achieve a hover.

3.3.3.1 *Discussion*—Aircraft that land or takeoff from a rooftop or elevated vertiport will generally need to meet HOGE power requirements to ensure safe operations can be maintained as indicated by the aircraft manufacturer's performance standards for the environmental conditions present. Additional performance considerations to consider include situations of high-density altitude, high aircraft gross weights, site location, wind direction, wind speed, high environmental temperatures, and increased elevations.

3.4 *Abbreviations:*

3.4.1 *AGL*—above ground level

3.4.2 *CAA*—civil aviation authority

3.4.3 *eVTOL*—electric vertical takeoff and landing

3.4.4 *IFR*—instrument flight rules

3.4.5 *NFPA*[9]—National Fire Protection Association

3.4.6 *VFR*—visual flight rules

3.5 See FAA Aeronautical Information Manual (AIM) and FAA Pilot/Controller Glossary for additional clarification of aviation terminology.

4. Significance and Use

4.1 The purpose of this specification is to establish minimum standards for vertiports and vertistops on which aircraft capable of vertical takeoff and landing may operate safely.

4.2 *Classifications:*

4.2.1 *All Electric Powered*—A vertiport that is designated to support electric aircraft only.

4.2.2 *Hybrid Powered*—A vertiport that is designated to accommodate both electric aircraft, fueled aircraft, and aircraft that are a combination of the two.

4.2.3 *Emergency Medical Site Patient Transfer Facility*—RESERVED.

4.2.4 *Emergency Medical Site Pickup/Delivery Facility* (for the purposes of organ transplant, medical equipment, laboratory samples, etc.)—RESERVED.

4.2.5 *Water-based Fixed or Floating Facility*—RESERVED.

4.2.6 *Water-based Purpose-built Shipboard Facility*—RESERVED.

4.2.7 *Water-based Open-water Facility for Aircraft with Floats*—RESERVED.

4.2.8 *eSTOL Compatible Facility*—RESERVED.

4.2.9 *Airport-based Vertiport*—RESERVED.

5. Vertiport General Requirements

5.1 *General*—A vertiport site shall consider the need to ensure safe approaches and departures of all aircraft for which it is designed to support.

5.1.1 Vertiports shall have an appropriate written Emergency Action Plan (EAP) in place. EAPs should be updated regularly to reflect any changes as well as tested and practiced on an annual basis. As a reference, NFPA 418, Sec. 10.1 and Annex B, may provide additional guidance if needed.

5.1.2 Each facility shall have a functioning wind cone in the case of any manned operations or an alternative means of communicating real-time active winds to the operator of an unmanned aircraft or directly to the controlling operations system of an autonomous aircraft. Additional information on wind cone design and construction may be found in FAA Advisory Circular AC 150/5345-27E, Specification for Wind Cone Assemblies.

5.1.2.1 The wind cone shall provide the onboard pilot with valid wind direction and speed information in the vicinity of the vertiport under normal and typical wind conditions during approach, landing, and ground operations.

5.1.2.2 The wind cone should be placed near the FATO, not penetrate any of the vertiport's imaginary surfaces, and be clearly identifiable by manned aircraft pilots during approach, landing, and ground operations.

5.1.2.3 To avoid presenting an obstruction hazard, the wind cone shall be located outside the safety area, so it does not penetrate the approach/departure or transitional surfaces.

5.1.2.4 At a vertiport intended for night operations, the wind cone shall be illuminated, either internally or externally, to ensure it is clearly visible.

5.1.3 Vertiport Gradients

5.1.4 *General*—Grading of the vertiport, that is, the slope of a vertiport's surface, shall be designed so as to protect, that is, slope down and away from, at a minimum, the primary egress path, passenger holding area, rooftop hangars, and fire protection activation systems such that in the event of a fuel spill the fuel will flow away from these areas.

5.1.4.1 *TLOF Gradients*—To ensure drainage, design the TLOF to have a gradient between 0.5 percent and 2 percent.

5.1.4.2 *Load-bearing FATO Gradients*—Design a load-bearing FATO to have a gradient between 0.5 percent and 5 percent. Design the gradient to be not more than 2 percent in any areas where an aircraft is expected to land. To ensure TLOF drainage, design gradients of rapid runoff shoulders to be between 3 percent and 5 percent.

5.1.4.3 *Non-load-bearing FATO Gradients*—When the FATO is non-load bearing or not intended for use by the aircraft, that is, those areas not associated with a taxiway, parking area, or ramp area, there are no specific requirements for the gradient of the surface. In this case, design the gradient to be 5 percent or more to ensure adequate drainage away from the area of the TLOF.

5.1.4.4 *Safety Area Gradients*—A safety area need not be solid, when solid, for those areas that are not associated with a taxiway, parking area, or ramp area, design the surface of the safety area to be no steeper than a downward slope of 2:1 (2 units horizontal in 1 unit vertical). In addition, make sure the surface of the safety area is not higher than the FATO edge.

5.1.4.5 *Parking Area Gradients*—Design all aircraft parking area grades to not exceed 2 percent.

5.1.4.6 *Taxiway and Taxi Route Gradients*—Design taxiway longitudinal gradients to not exceed 2 percent. Design transverse gradients to be between 0.5 percent and 2 percent.

5.1.4.7 *Surface Material*—All load-bearing surfaces that an aircraft will rest on or traverse across shall meet International Building Code,[6] International Fire Code,[6] and NFPA[9] standards. Due to its malleability and susceptibility to deformation in high-temperature environments, asphalt susceptible to this type of deformation should be avoided as a load-bearing surface. Turf may be utilized if properly stabilized; however, if the location is to support a high volume of ground movement operations, turf may not be the most suitable surface for inclement weather environments. Gravel shall not be utilized within the TLOF, FATO, and safety area due to the inherent dangers of flying debris caused by the aircraft's downwash.

5.1.5 *Design Loads*—The TLOF shall be designed and constructed to support the static and dynamic loads of the design aircraft and the static weight of any ground support vehicles or equipment. Areas outside the TLOF area to be utilized for the purposes of aircraft parking, aircraft movement, aircraft refueling, and aircraft recharging shall be designed to support the static weight of the design aircraft. Loads are applied through the contact area of the tires for wheel-equipped aircraft or the contact area of the skid for skid-equipped aircraft.

5.1.6 A vertiport shall have smooth, well-drained, operational areas with sufficient stability to permit the safe movement of aircraft along all adjoining surfaces that an aircraft may need to transition.

5.1.7 *Drainage Gutters*—RESERVED.

5.2 *Notification*—All vertiport construction shall be communicated to the authority having jurisdiction prior to construction commencing.

5.3 *Airspace Study*—Aviation authority policy may require an airspace study to be conducted to ensure that there will be no material negative impact on current and future airspace as well as identify hazards to be removed or mitigated through proper marking and lighting.

5.4 *Identification*—All Vertiports shall be assigned a permanent identifier in accordance with aviation authority policy for identification in the airspace system for all recognized operational and management purposes.

5.5 *Location Accuracy*—At a minimum, VFR Vertiports shall be accurately referenced through accepted survey practices by latitude and longitude to within ±20 ft [6 m] horizontal accuracy and ±3 ft [1 m] vertical accuracy. In accordance with aviation authority policy, all IFR vertiports shall be accurately referenced through governing and applicable survey practices by latitude and longitude in accordance with the IFR procedures to be associated with the Vertiport.

5.6 *Information*—All Vertiport information shall be checked, evaluated, and updated by the owner as appropriate as new information becomes available or old information is changed. At a minimum, all vertiport information shall be verified and updated on an annual basis or more frequently if required by the civil aviation authority.

5.7 *Local Requirements*—Most communities have established zoning laws, building codes, fire regulations, and other legal requirements to provide for public safety and comfort. A thorough study of these requirements should be made to determine when compliance criteria must be followed for the establishment and operation of a vertiport. (See NFPA 70, NFPA 101, NFPA 407, NFPA 409.)

5.8 *Simultaneous VFR Approach/Departure Operations*—Aircraft may land and takeoff from a vertiport simultaneously. For simultaneous operations to be conducted, the following criteria shall be met:

5.8.1 The distance between independent landing/takeoff positions shall be sufficient to provide for safe operations, taking into account aircraft wake turbulence, airspace protection, aircraft emergency operations, and traffic avoidance.

5.8.2 No airspace overlap or conflict may exist between two or more independent landing/takeoff surfaces that are to be operated simultaneously.

6. Vertiport Dimensional Standards

6.1 For the purposes of dimensional standards set forth in the following section, the terms *vertiport* and *vertistop* are to be considered synonymous, each having the exact same dimensional and airspace standards and requirements. The primary reason for differentiation in terminology is for municipality code, compliance, and conformance standards. Refer to the definitions outlined in Section 1 for clarification.

6.2 *Site Requirements:*

6.2.1 *General*—From an aeronautical standpoint, the optimum location for a vertiport is one that allows for multiple approach/departure paths, avoids downwind operations to the extent feasible and to the degree prescribed by the aircraft manufacturer, has minimal impact on surrounding residential areas, provides for a minimum noise impact footprint, and provides for unobstructed airspace.

6.2.2 *Local Requirements*—Where the State, region, or municipality has adopted code criteria from the International Fire Code[6] (IFC[6]), International Building Code[6] (IBC[6]), or the National Fire Protection Association (NFPA[9]), compliance with such criteria shall be required when applicable. Consult with the local authority having jurisdiction for interpretations.

6.3 *Vertiport Geometry*—Given the variability in aircraft and aircraft design reflecting the latest technological advancements in the aviation industry, specifically VTOL platforms, the dimensional criteria should be based on the largest CD, for example, overall length or overall width, whichever is greater. This shall also include making accommodations for the unfolding/folding of wings, rotors, or combinations thereof, associated with normal operations.

6.3.1 Minimum TLOF shall be no less than 1.0 × CD of the largest design aircraft.

6.3.2 Minimum FATO shall be no less than 1.5 × CD of the largest design aircraft. This dimension does not include a rejected takeoff area.

6.3.3 Minimum Safety Area shall be at least ⅓ CD of the largest design aircraft but not less than 10 ft [3 m]. (See Fig. 1.)

6.3.4 *Surface Characteristics:*

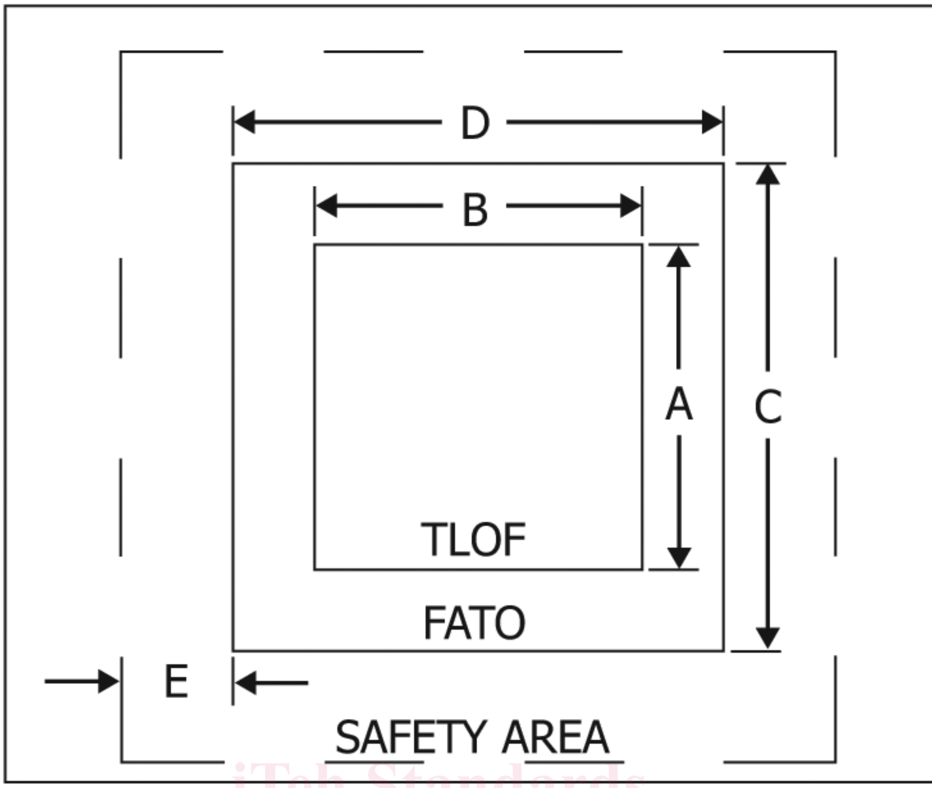
6.3.4.1 *Temperature Impact*—In a situation where a VTOL aircraft creates a downward flow of exhaust gases that impact the vertiport surface, the surface shall be noncombustible and resistant to deformation and heat stress.

6.3.5 *Electrical Hazards*—All applicable building and fire codes shall be followed as it applies to electrical systems, wiring, grounding, charging, storage, and human interaction. Refer to all applicable standards as adopted by the local municipality from the International Building Code,[6] International Fire Code,[6] and the National Fire Protection Association.

6.3.6 *Wind*—The preferred approach/departure path is aligned with the predominant wind direction to the maximum extent possible so downwind operations are avoided in keeping with the aircraft manufacturer's limitations, and crosswind operations are kept to a minimum. Additional approach/departure paths should also be based on the assessment of the prevailing winds. When this information is not available, secondary approach/departure paths should be separated by at least 135 degrees. If it is not feasible to provide adequate separation and coverage for the prevailing winds through multiple approach/departure paths, operational limitations shall be developed and implemented as needed.

6.3.7 *Airspace Availability:*

6.3.7.1 *Obstructions to Air Navigation*—In identifying a vertiport's approach/departure paths, TLOF, FATO, and Safety Areas, all obstructions in the vicinity of the Vertiport shall be evaluated for compliance. Obstruction shall not penetrate any of the aforementioned imaginary surfaces. Some obstructions, while clear of the imaginary surfaces, may still need to be



DIM	ITEM	VALUE
A	Minimum TLOF Length	1 × CD
B	Minimum TLOF Width	1 × CD
C	Minimum FATO Length	1.5 × CD
D	Minimum FATO Width	1.5 × CD
E	Minimum Safety Area Width	⅓ CD

NOTE 1—For circular TLOF and FATO, dimensions A, B, C, and D refer to diameters.

FIG. 1 TLOF, FATO, and Safety Area Relationships and Minimum Dimensions

marked and lighted for added conspicuousness. For additional information, see FAA AC 70/7460-1L, Obstruction Marking and Lighting.

6.3.7.2 *Wildlife Hazards*—To prevent potential hazardous incursions between aircraft and wildlife, proponents should evaluate the types of wildlife in the region and their potential response, interaction, and hazard to aircraft. Care should be taken to avoid introducing attractants into the vicinity of a vertiport, for example, species of plants and habitats that may be attractive to wildlife. Refer to FAA AC 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports, for additional information.

6.3.8 *Protection of Imaginary Surfaces and Vertiport Airspace:*

6.3.8.1 Vertiport owners shall work to protect all "imaginary surfaces" and airspace as defined in this section from penetration and encroachment. This may be accomplished in collaboration with local authorities through accepted practices of master planning, zoning, ordinances, easements, or regulations, or combinations thereof. If a penetration of an imaginary surface is in question or potentially anticipated, the vertiport's airspace will need to be reevaluated to assure compliance. This may require an adjustment to the existing airspace to ensure safety prior to conducting subsequent flight operations.

(1) Primary Surface—The area of the primary surface coincides in size and shape with the designated FATO area. This surface is a horizontal plane at the elevation of the established vertiport elevation.

(2) VFR Approach Surface—The approach surface shall begin at each end of the Vertiport primary surface (FATO) with the same width as the primary surface and extends outward and upward for a horizontal distance of 4000 ft [1219 m] where its width is 500 ft [152 m]. The slope of the approach surface shall be 8:1 for civil VTOL aircraft.

(3) VFR Transitional Surfaces—These surfaces shall extend outward and upward from the lateral boundaries of the primary surface and from the approach surfaces at a slope of 2:1 for a distance of 250 ft [76 m] measured horizontally from the centerline of the primary and approach surfaces. (See Figs. 2 and 3.)

(4) VFR Curved Approach Surfaces—As an option, include one curve in VFR approach/departure paths. Curved approach/departure paths can be useful in dealing with noise-sensitive areas, obstructions, and conflicting airspace situations. When

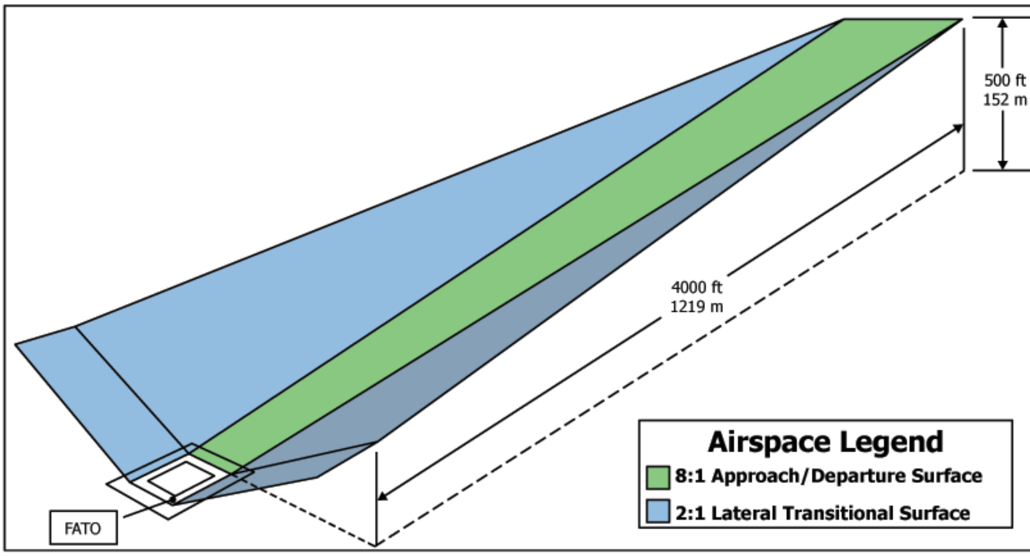


FIG. 2 VFR Vertiport Approach/Departure and Transitional Surfaces

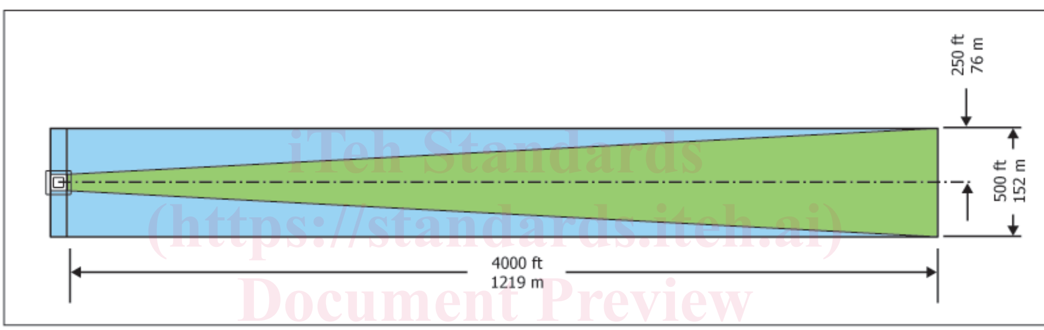


FIG. 3 VFR Vertiport Approach/Departure and Transitional Surfaces (Overhead View)

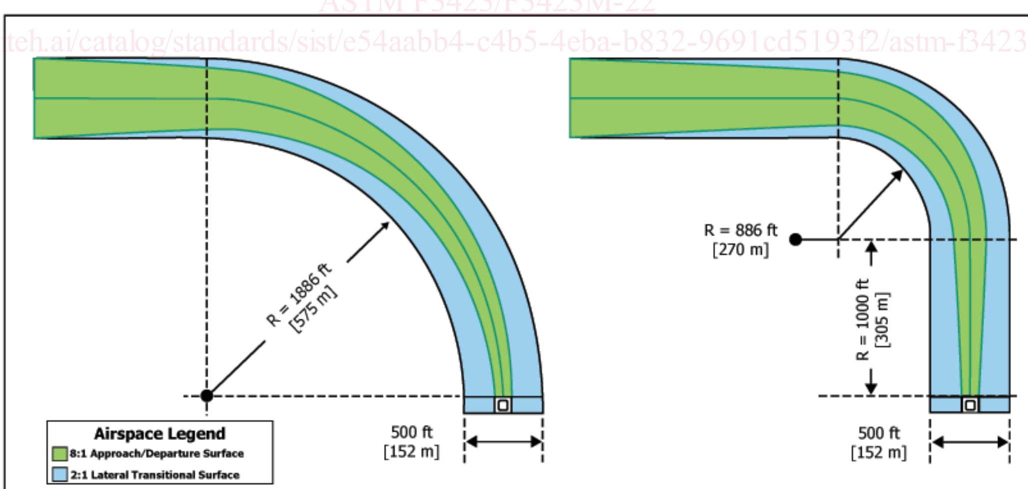


FIG. 4 VFR Curved Vertiport Approach/Departure and Transitional Surfaces

including a curved portion in the approach/departure path, make sure the sum of the radius of the arc defining the centerline and the length of the straight portion originating at the FATO is not less than 1886 ft [575 m]. Alternatively, design the approach/departure path so the minimum radius of the curve is 886 ft [270 m], and the curve follows a 1000 ft [305 m] straight section attached to the FATO. Design the approach/departure path so the combined length of the centerline of the curved portion and any straight portion equals 4000 ft [1219 m]. (See Fig. 4.)