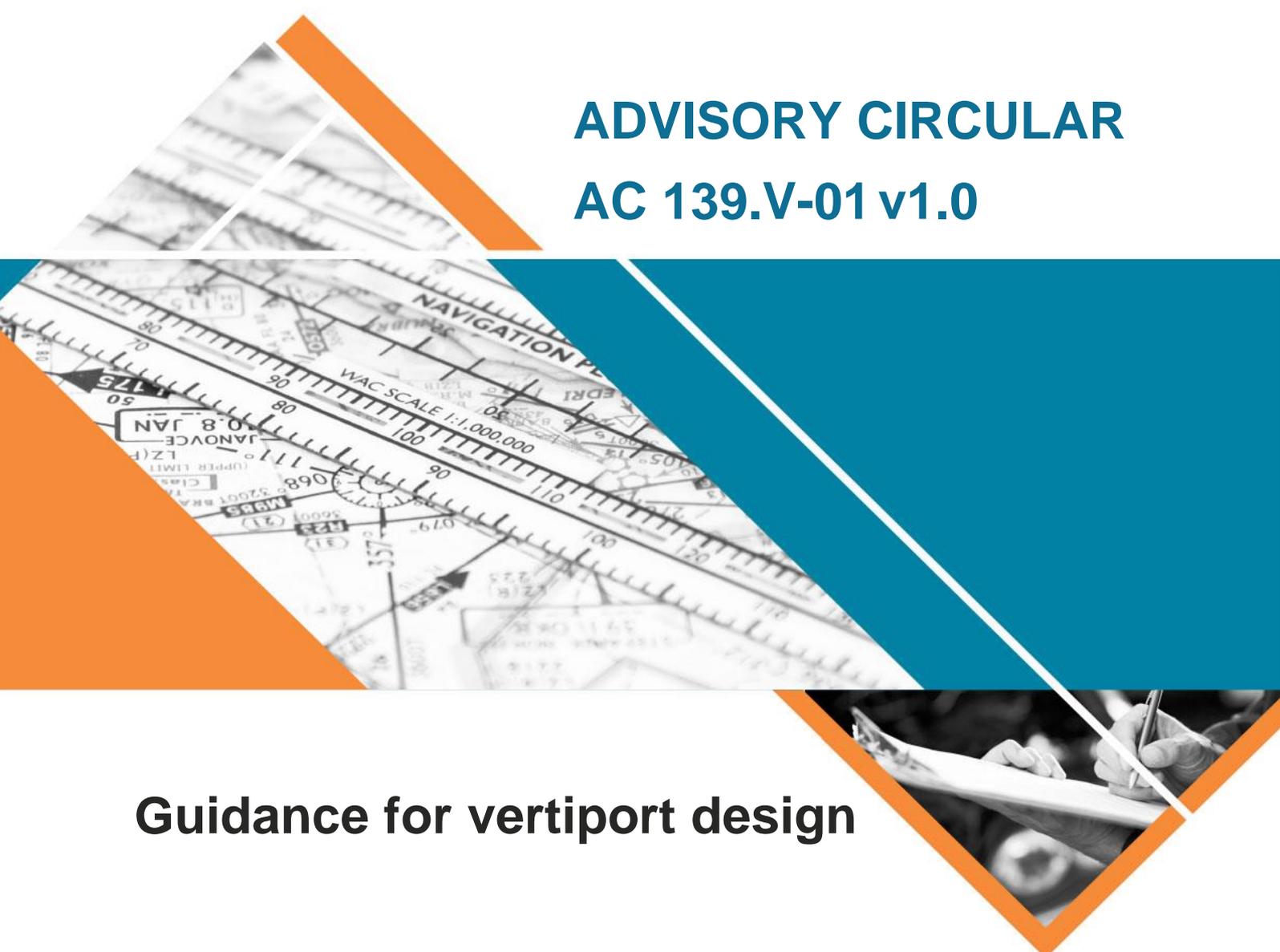




Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR

AC 139.V-01 v1.0



Guidance for vertiport design

Date July 2023
File ref D23/134615

Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- persons involved in the design, construction, and operation of vertiports
- proponents of vertiports
- AAM aircraft owners/operators
- planning authorities
- aerodrome operators
- the Civil Aviation Safety Authority (CASA).

Purpose

This AC provides initial guidance in the planning and physical design of vertiports to support the safe and efficient operation of vertical take-off and landing (VTOL) capable aircraft operating with a pilot on board in visual conditions only.

This AC is not intended to restrict or limit a pilot from determining the most suitable area for landing or take-off for the VTOL-capable aircraft operation.

Where possible, outcome-based guidance is provided. While regulations were previously written in a prescriptive manner, organisations are now also required to develop processes that will deliver an effective outcome.

For more information on understanding outcome-based legislation see [AC 1-01 - Understanding the legislative framework](#).

For further information

For further information, contact CASA's Personnel Licensing, Aerodromes and Air Navigation Standards (telephone 131 757).

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Status

This version of the AC is approved by the Branch Manager, Flight Standards.

Version	Date	Details
v1.0	July 2023	Initial AC.

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1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AAM	Advanced Air Mobility
AC	advisory circular
AFM	aircraft flight manual
AIP	aeronautical information publication
CASA	Civil Aviation Safety Authority
CASR	<i>Civil Aviation Safety Regulations 1998</i>
FATO	final approach and take-off area
FOD	foreign object debris
FPA	FATO protection area
FPAGLS	Flight path alignment guidance lighting system(s)
ICAO	International Civil Aviation Organization
MOS	Manual of Standards
MTOW	maximum take-off weight
NASF	national airports safeguarding framework
OFV	obstacle free volume
OLS	obstacle limitation surface
RTODRV	rejected take-off distance required (for VTOL-capable aircraft)
SARPS	standards and recommended practices
TDPC	touchdown/positioning circle
TDPM	touchdown/positioning marking
TLOF	touchdown and lift off area
UCW	undercarriage width
VCA	VTOL-capable aircraft
VPS	vertical procedure surface
VPT	vertiport
VTOL	vertical take-off and landing

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified

by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Term	Definition
Aerodrome	An area on land or water (including any buildings, installations, and equipment), the use of which as an aerodrome is authorised under the regulations, being such an area intended to be used either wholly or in part for the arrival, departure, and movement of aircraft.
Barrette	means 3 or more lights closely spaced in a transverse line so that from a distance they appear as a short bar of light.
D	for VTOL-capable aircraft, means the diameter of the smallest circle enclosing the aircraft projected on a horizontal plane, while the aircraft is in the take-off or landing configuration, with lift/thrust units turning, if applicable. Note: If the aircraft changes dimensions during taxiing or parking (e.g. folding wings), a corresponding D_{taxiing} or D_{parking} should also be provided.
Design D	the D of the design aircraft.
Design aircraft	means a virtual aircraft type that has the largest set of dimensions, the greatest maximum take-off weight (MTOW), and the most critical obstacle avoidance criteria of the aircraft that the vertiport, or for a defined area within the vertiport, is intended to serve.
Downwash protection zone	The downwash protection zone is designed to protect the general public, other aircraft and those working in the immediate vicinity of operating VCA from the effect of buffeting.
D-Value	A limiting dimension, in terms of D, for a vertiport, or for a defined area within the vertiport.
Elevated vertiport	is a vertiport with a FATO location that would introduce a risk of fall from height or introduces a hazard to aircraft operations or to other people within the structure under the vertiport.
Elongated	when used with TLOF or FATO, elongated means an area which has a length more than twice its width.
Essential objects permitted	includes, but may not be limited to, around the touchdown and lift-off area (TLOF), perimeter lights and floodlights, guttering and raised kerb, foam monitors or ring-main system, handrails and associated signage, other lights.
Final approach and take-off area (FATO)	For the operation of a VTOL-capable aircraft, is defined as a solid area: <ul style="list-style-type: none"> a. from which a take-off is commenced; or b. over which the final phase of approach to hover is completed.
Lighting element	A lighting element is a light source within a lighting segment that may be discrete (e.g., a Light Emitting Diode (LED)) or continuous (e.g., fibre optic cable, electro luminescent panel). An individual lighting element may consist of a single light source or multiple light sources arranged in a group or cluster and may include a lens/diffuser.
Lighting segments	Lighting segments are low profile lighting fixtures that consists of a line of lighting elements within unit or frame. For the purposes of this circular, the dimensions of a lighting segment are the length and width of the smallest possible rectangular area that is defined by the outer edges of the lighting elements, including any lenses/diffusers. Arrays of segmented point source lighting (ASPSL) or luminescent panels

Term	Definition
	(LPs) are examples of lighting segments.
Obstacle	An object (whether temporary or permanent) or part of such an object that: <ul style="list-style-type: none"> a. is located on an area provided for the movement of aircraft; or b. extends above a defined surface designated to protect aircraft in flight
Obstacle free volume (OFV)	is a defined volume of airspace between the FATO protection area and the VPS, designed to protect aircraft conducting vertical procedures.
Protection area	means a defined area on a vertiport, which surrounds either the FATO or a stand, intended to reduce the risk of damage to an aircraft diverging from the FATO or stand.
Reference circle	is a horizontal circle, of the specified dimension, that is centred on any intended position/flight path at or above the applicable area/surface.
Rejected take-off distance required (RTODRV)	means the horizontal distance that is required from the start of the take-off to the point where the aircraft comes to a full stop, following a critical failure that is recognised at the TDP.
Take-off decision point (TDP)	means the first point that is defined by a combination of speed and height from which a safe take-off can be continued following a critical failure and is the last point in the take-off path from which a rejected take-off is ensured.
Touchdown and lift-off area (TLOF)	an area where a VTOL-capable aircraft may touch down or lift off.
Touchdown/positioning circle (TDPC)	a TDPM in the form of a circle, which is used for omnidirectional positioning in a TLOF.
Touchdown/positioning marking (TDPM)	a marking or set of markings that provide visual cues for the positioning of an aircraft.
Vertical procedures	take-off and landing procedures that include an initial and/or final vertical profile. The profile may or may not include a horizontal component.
Vertical procedure surface (VPS)	a surface at which a VTOL-capable aircraft either: <ul style="list-style-type: none"> a. begins its arriving vertical procedure, or b. ends its departing vertical procedure.
Vertiport elevation	the highest point of the FATO, or where there are multiple FATOs, the highest point of the highest FATO.
Vertiport	an area of land, water, or structure that is used or intended to be used for the landing, take-off, and movement of VTOL-capable aircraft, that meets or exceeds the specifications contained within this advisory circular. <p><i>For the purposes of this AC the term vertiport also includes vertihubs and vertistops:</i></p> <ul style="list-style-type: none"> a. Vertihub: a vertiport with infrastructure for maintenance, repair, fuelling, and parking spaces for storage of VTOL-capable aircraft. b. Vertistop: a vertiport intended for take-off and landing of VTOL-capable aircraft to drop off or pick up passenger or cargo, but where there are no facilities for fuelling, defueling, scheduled maintenance, scheduled repairs, or storage of aircraft.

Term	Definition
Vertiport clearway	means a defined horizontal surface selected and/or prepared as a suitable area over which an aircraft, capable of continued safe flight after a critical failure, may operate between the FATO/VPS and the approach/climb-out surface inner edge.
VCA (VTOL-capable aircraft)	a heavier-than-air aircraft, other than aeroplane or helicopter, capable of performing vertical procedures by means of more than two lift/thrust units.
VCA stand	a defined area that is intended to accommodate aircraft for loading or unloading passengers, mail, or cargo, fuelling/charging, parking, or maintenance.
VCA taxi-route	a defined path that is established for the movement of aircraft from one part of a vertiport to another: <ul style="list-style-type: none"> a. an air taxi-route: a marked taxi-route that is intended for air taxiing; and b. a ground taxi-route: a taxi-route that is intended for ground movement of aircraft centred on a VCA taxiway.
VCA taxiway	a defined path on a vertiport that is intended for the ground movement of aircraft from one part of a vertiport to another.

1.3 References

Advisory material

CASA's advisory materials are available at <https://www.casa.gov.au/publications-and-resources/guidance-materials>

Document	Title
AC 1-01	Understanding the legislative framework

2 Introduction

2.1 Background

- 2.1.1 This advisory circular (AC) provides guidance on the design elements of vertiports. This document assumes initial operations of pilot-on-board vertical take-off and landing (VTOL) capable aircraft (VCA) flying visual operations only.
- 2.1.2 With Advanced Air Mobility (AAM) evolving rapidly, these specifications have been prepared to support the progress of necessary aerodrome infrastructure. The guidance outlined below is flexible and structured such that it can evolve with this emerging industry.
- 2.1.3 However, it should be noted that these specifications are subject to change as aircraft performance and other data becomes available. Likewise, international standards are also in development and may impact on this guidance. Any significant revision of this guidance will be subject to industry consultation.
- 2.1.4 In addition to this, the introduction of AAM may impact and be impacted by considerations outside of aviation safety. Vertiport owners and operators should refer to local, state and other federal agencies to ensure appropriate adherence to their requirements.
- 2.1.5 As the following specifications are focused on VCA, runway-type final approach and take-off areas (FATO) have not been considered in the development of this AC.
- 2.1.6 This AC is the first in a collection of guidance material to be published. Additional ACs and supplementary material will provide further detail on design concepts as well as address operational considerations such as inspections, emergency response, aeronautical data and obstacle control.

2.2 Site selection

2.2.1 Fundamental considerations

- 2.2.1.1 The selection of a vertiport site involves the consideration of a range of variables including intended aircraft types, area available, vertiport configuration and obstacle environment.

Note: Limitations and restrictions to certain activities, such as aviation, may be imposed by State, Territory or Local Government on properties or locations through planning schemes or environmental planning instruments.

Site locations for proposed vertiport locations should consider suitability from a land-use planning perspective including any limitations or restrictions that could apply to the site.

Information in this advisory circular is additional to any limitation or restriction to the use of a site imposed by State, Territory or Local Government.

- 2.2.1.2 Full consideration of some of these variables relies on effective engagement with a range of stakeholders. Vertiport operators should establish open communication channels with aircraft operators, government stakeholders, nearby aerodrome (including certified aerodromes, non-certified aerodromes, helicopter landing sites and vertiport) operators and, where appropriate, the local community.

2.2.1.3 The aircraft type or types that are expected to use the vertiport form the basis for most design considerations when developing a vertiport. Where the vertiport owner intends on supporting a single aircraft type, that aircraft type will be the design aircraft. For vertiports intended to service multiple aircraft, the design aircraft is a virtual aircraft composed of the most demanding characteristics of these aircraft including the largest set of dimensions, the greatest maximum take-off weight (MTOW), and the most critical flight path requirements (i.e., approach/climb-out gradient and/or horizontal flight requirements following a critical failure).

Note: Additional considerations of design aircraft may include considerations other than those mentioned in 2.2.1.3. Other considerations may include undercarriage width, landing distance requirements, rejected take-off distance requirements and the impact of downwash and outwash when VCA are landing, manoeuvring on the vertiport or at take-off.

2.2.1.4 The vertiport area available and the intended scope of operations may impact on the vertiport configuration. The number of facilities, such as FATOs, taxi routes, stands and associated buildings, may be limited by the physical environment. This AC provides specifications for each vertiport facility associated with the operation of aircraft without establishing a standard vertiport layout.

2.2.1.5 The potential for vertiports to be constructed in a complex wind (turbulent) environment means that specific considerations should be made when a vertiport is to be established in the vicinity of buildings, and significant terrain.

2.2.1.6 For vertiports within obstacle-rich environments or that may be impacted by future development, careful consideration of preferred and/or future flight paths should be made in consultation with appropriate stakeholders.

2.2.1.7 A gap analysis has identified that potential vertiport locations may be subject to multiple federal, state and local government regulatory requirements, as well as requirements from non-government sources, and these requirements may vary between different vertiport locations and jurisdictions.

2.2.1.8 This AC does not, and cannot, cover all vertiport development considerations. Vertiport owners and operators should consult with appropriate stakeholders (such as federal, state and local government agencies) on topics that are outside of CASA's remit including but not limited to noise, security, environmental concerns, weather reporting and privacy.

2.2.1.9 A vertiport and VCA compatibility study should be undertaken as part of the introduction of a new VCA, or when the mode of VCA operation changes to ensure the facilities at the vertiport remain suitable for all VCA using the vertiport.

2.2.2 Proximity to other vertiports or other aerodrome infrastructure

2.2.2.1 Where vertiports are located within the vicinity of other vertiports or aerodromes, the siting and design of FATOs and their associated flight paths should carefully consider interactions between own vertiport traffic, and other vertiport and aerodrome traffic.

2.2.3 Downwash and outwash protection

- 2.2.3.1 The characteristics and impacts of VCA downwash and outwash type effects¹ are still unknown, however vertiport designers and operators will need to take into consideration their potential effects during the design process.
- 2.2.3.2 A vertiport and its facilities should be designed and located to protect the following from damage or injurious effects of downwash/outwash type effects associated with VCA operating to/from the vertiport:
- people
 - other aircraft
 - buildings
 - vehicles
 - equipment.
- 2.2.3.3 An evaluation of downwash/outwash type impacts should be carried out. The evaluation should consider the VCAs downwash/outwash characteristics, the specific local conditions and relevant wind comfort criteria for affected persons and facilities.
- 2.2.3.4 At vertiports intended to service multiple types of VCA, or VCA operated by different operators, a detailed safety assessment and an operational evaluation of individual aircraft types operating to/from a given vertiport may need to be considered.
- 2.2.3.5 Information on potential downwash and outwash characteristics may be sought from VCA manufacturers and VCA operators. The manner in which a VCA may be operated could vary the actual downwash/outwash experienced.
- 2.2.3.6 To avoid or reduce the potential of incidents and accidents associated with VCA downwash/outwash, downwash protection zones² around vertiports in the form of boundaries, or areas of restriction/control on movement of persons during VCA operations, should be considered.
- 2.2.3.7 This downwash protection zone should recognise that, in addition to the hover over the landing point, downwash/outwash will be prevalent during the final approach to the hover, the initial take-off, and whenever the VCA is positioning to or away from the FATO.

Note: The combined risk from an aviation safety and occupational health and safety perspective may require supervision of vehicular and pedestrian traffic during VCA movements, provision of robust maintenance and foreign object damage (FOD) prevention processes, and safeguarding of the downwash/outwash protection zone from future development to reduce the likelihood of injury or third-party damage.

¹ The use of the words "downwash" and "outwash" in this AC should be considered to encompass any potentially hazardous air movement effects that could be caused by VCAs, including vertical and horizontal airflow velocities, volumes of air movement, and turbulence effects during different flight profiles that may be flown by VCAs within the vertiport and its vicinity.

² The downwash protection zone should not be confused with the FATO protection area or stand protection areas which are designed to protect the VCA from obstacles. Further information on downwash protection zones can be found in ICAO Doc 9261 - Heliport Design Manual.

3 Vertiport physical characteristics

3.1 General

- 3.1.1 A vertiport consists of set of essential components or defined areas as well as some optional components. These are the basic building blocks of a vertiport, as shown in Figure 1, and include:
- one or more FATO
 - one or more touch down and lift-off areas (TLOF)
 - protection areas
 - taxiways and/or taxi-routes
 - stands
- 3.1.2 The following specifications are based on the design assumption that no more than one VCA will be in the FATO at the same time.
- 3.1.3 Further, it is also assumed that operations to/from a FATO in proximity to another FATO will not be simultaneous. If simultaneous operations are planned, appropriate separation distances between FATOs should be determined with due regard to issues such as downwash, flight paths and other airspace limitations.
- 3.1.4 Safety devices to mitigate the risk of fall from height at elevated vertiports should not penetrate the OLS or exceed the height of the protection area.

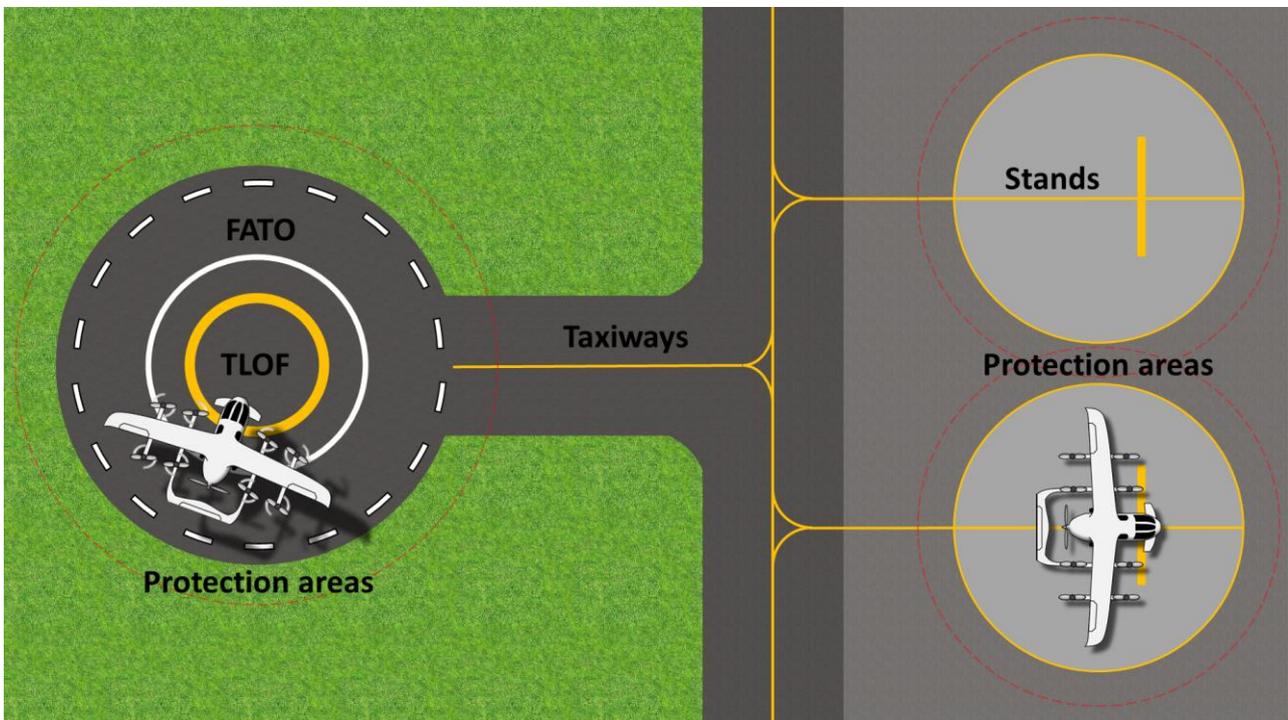


Figure 1 – Vertiport components

3.2 Essential vertiport components

3.2.1 Final approach and take-off (FATO) area

3.2.1.1 A vertiport should be provided with at least one FATO.

3.2.1.2 A FATO should have the following features:

- a. A sufficient size and shape to ensure containment of every part of the design aircraft in the final phase of approach and commencement of take-off in accordance with the intended procedures. The shape of the FATO is optional as represented in Figures 1, 2 and 12.
- b. When collocated with a touchdown and lift-off (TLOF) area, contiguous and flush with the TLOF, and meet the requirements of 3.2.2.3 b.
- c. When non-collocated with a TLOF, free of obstacles, except for essential objects, free of hazards to a potential forced landing and resistant to the effects of downwash.

3.2.1.3 The dimensions of a FATO should be the:

- a. length of the rejected take-off distance required (RTODRV) prescribed in the design aircraft flight manual (AFM), or 1.5 Design D, whichever is greater: and
- b. width prescribed in the design aircraft AFM, or 1.5 Design D, whichever is greater.

3.2.1.4 Essential objects should not exceed 5 cm in height.

3.2.1.5 The slope of a FATO should not exceed 2 % in any direction.

3.2.1.6 A FATO should be located to minimize the influence of the surrounding environment, including turbulence, which could have an adverse impact on aircraft operations.

3.2.1.7 A FATO should be surrounded by a FATO Protection Area (FPA) as per 4.1.1.

3.2.1.8 Where a vertiport intends to have more than one FATO, the distance between any two proximate FATOs should be determined by a safety assessment that supports the safe operations of intended VCA movements.

Note: As VCA performance data becomes available, changes to FATO requirements such as minimum size or the requirement for the FATO being solid may be reviewed.

3.2.2 Touchdown and lift-off (TLOF) area

3.2.2.1 A vertiport should be provided with at least one TLOF.

3.2.2.2 A TLOF should be provided within a FATO as shown in Figure 2, or stand as shown in Figure 13c, whenever it is intended that the undercarriage of the VCA will touch down or lift off.

3.2.2.3 A TLOF should have the following features:

- a. A sufficient size and shape to ensure containment of the undercarriage of the design aircraft aligned with the intended orientation.
- b. An area which:
 - i. is free of obstacles

- ii. has sufficient bearing strength to accommodate the dynamic loads associated with the design aircraft.
- iii. is free of irregularities that would adversely affect the touchdown, lift-off or taxi of VCA
- iv. has sufficient friction to avoid skidding of VCA or slipping of persons
- v. is resistant to the effects of downwash
- vi. ensures effective drainage while having no adverse effect on the control or stability of a VCA during touchdown, lift-off, or when stationary.

3.2.2.4 The minimum dimensions of a TLOF should be the dimensions prescribed in the design aircraft AFM, or 0.83 Design D, whichever is greater.

3.2.2.5 The slope of a TLOF should not exceed 2 % in any direction.

3.2.2.6 When a TLOF is within a FATO, it should be:

- a. centred on the FATO, or
- b. for an elongated FATO, centred on the longitudinal axis of the FATO.

3.2.2.7 When a TLOF is within a VCA stand, it should be centred on the stand.

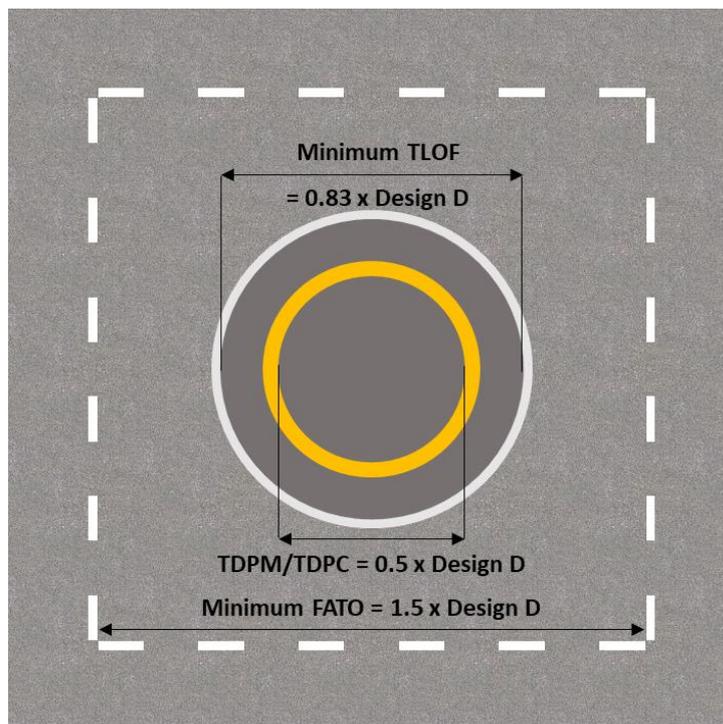


Figure 2 - FATO, TLOF (with TDPC)

3.3 Optional vertiport components

3.3.1 VCA taxiways

3.3.1.1 A VCA taxiway should be provided for the intended ground movement of a VCA within the vertiport under its own power or by means of ground movement equipment.

3.3.1.2 A VCA taxiway should be located within a taxi-route and have the following features:

- a. sufficient width to ensure containment of the undercarriage of the design aircraft;
- b. area which:
 - i. is free of obstacles
 - ii. has the bearing strength to accommodate the taxiing loads of the aircraft the taxiway is intended to serve
 - iii. is free of irregularities that would adversely affect the ground taxiing of a VCA
 - iv. is resistant to the effects of downwash
 - v. ensures effective drainage while having no adverse effect on the control or stability of a VCA when being manoeuvred under its own power, or by ground movement equipment, or when stationary.

3.3.1.3 The minimum width of a VCA taxiway should be two times the undercarriage width (UCW) of the design aircraft, as shown in Figure 3.

3.3.1.4 The transverse slope of a taxiway should not exceed 2 % and the longitudinal slope should not exceed 3 %.

3.3.1.5 When defining the distance between ground taxiways, the separation distance between an aircraft on a ground taxiway and an aircraft on a parallel ground taxiway or an object should take into consideration a minimum wingtip clearance of at least 0.25 maximum width of the design aircraft.

Note: Where taxiways are intended to be used by vehicles and equipment considerations should be made to taxiway width and bearing strength.

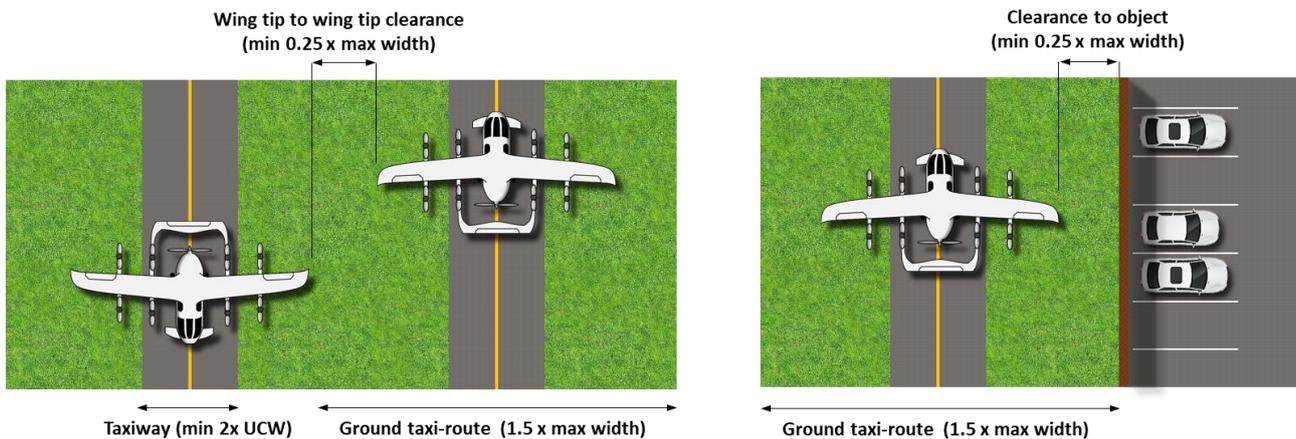


Figure 3 - VCA taxiways and clearance distances

3.3.2 Taxi routes for VCA

3.3.2.1 A VCA taxi-route should be provided for the intended movement of a VCA within the vertiport under its own power or by means of ground movement equipment.

3.3.2.2 A VCA taxi-route should have the following features:

- a. sufficient width to ensure containment of the design aircraft
- b. free of obstacles, except for essential objects
- c. resistant to the effects of downwash
- d. when collocated with a taxiway:
 - i. is contiguous and flush with the taxiway
 - ii. does not present a hazard to operations
 - iii. ensures effective drainage
 - iv. not exceed an upward transverse slope of 4 % outwards from the edge of the taxiway.
- e. when not collocated with a taxiway, is free of hazards if a forced landing is required.

3.3.2.3 Where collocated with a taxiway, essential objects located in the VCA taxi-route should not:

- a. be located at a distance of less than 50 cm outwards from the edge of the taxiway
- b. penetrate a surface originating 50 cm outwards of the edge of the taxiway and a height of 25 cm above the taxiway and sloping upwards and outwards at a gradient of 5 % up to the outer edge of the ground taxi-route.

Note: Consideration of low-mounted lift/thrust units may be required to ensure that appropriate clearances are maintained.

Ground taxi-routes for VCA

3.3.2.4 A VCA ground taxi-route should have a minimum width of 1.5 times the overall width of the design aircraft it is intended to serve and be centred on a taxiway, as shown in Figure 4.

Note: Where the VCA operating width differs (e.g. folding wings) while taxiing, the reduced width may be considered for defining the taxi-route width.

Air taxi-route for VCA

3.3.2.5 A VCA air taxi-route should have a minimum width of twice the overall width of the design aircraft it is intended to serve, as shown in Figure 4.

3.3.2.6 When not collocated with a taxiway, the slopes of the ground below an air taxi-route should not exceed the slope landing limitations of the design aircraft the taxi-route is intended to serve. In any event, the transverse slope should not exceed 10 % and the longitudinal slope should not exceed 7 %.

Note: When determining the width of an air taxi route, the potential impact of downwash or outwash from an of air-taxiing VCA should be considered.

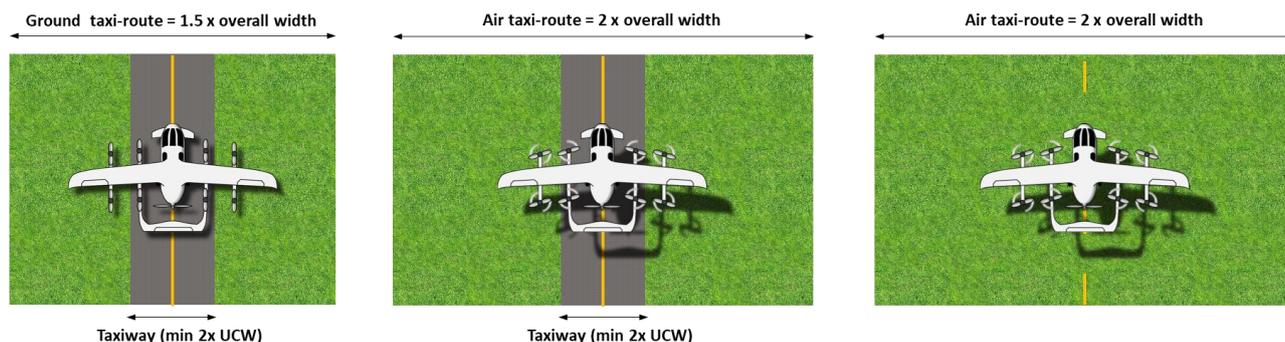


Figure 4 - VCA taxi-routes

3.3.3 VCA stands

3.3.3.1 VCA stands may be provided to permit the safe loading and off-loading of passengers and/or cargo, as well as the servicing of the VCA without interfering with other traffic.

3.3.3.2 A VCA stand, as shown in Figure 6, should have the following features:

- a. sufficient size and shape to ensure containment of every part of the design aircraft when it is being positioned within the stand
- b. An area which:
 - i. Is free of obstacles
 - ii. has bearing strength capable of withstanding the intended loads
 - iii. is free of irregularities that would adversely affect the manoeuvring of VCA
 - iv. has sufficient friction to avoid skidding of VCA or slipping of persons
 - v. is resistant to the effects of downwash
 - vi. ensures effective drainage while having no adverse effect on the control or stability of a VCA when being manoeuvred under its own power, when being moved by means of ground movement equipment, or when stationary.

3.3.3.3 The slope of a VCA stand should not exceed 2 % in any direction.

3.3.4 D-Value-based VCA stand

3.3.4.1 When the VCA stand design is based on D-value, the minimum dimensions should be:

- a. a circle of diameter of 1.2 Design D
or
- b. when there is a limitation on manoeuvring and positioning, of sufficient width to meet the requirement of 3.3.3.2 (a) above, but not less than 1.2 times overall width of design aircraft.

3.3.4.2 A D-value based VCA stand should be located within a protection area.

3.3.5 Geometry-based VCA stand

3.3.5.1 For VCA that enter/exit the stand with surface movement either under own power or by means of ground movement equipment, where practical, stands may be designed in accordance with the geometry of the aircraft, as shown in Figure 5, following the aerodrome apron concept.

- 3.3.5.2 The clearances should be based on the dimensions of all the VCAs expected to use the stand.
- 3.3.5.3 The clearance distance between a VCA and other adjacent VCA, buildings or objects on the apron should be sufficient to meet the requirement of 3.3.3.2 (a) above, but not less than:
- a. For VCA with a width of less than 18 m:
 - i. 3 m
 - or
 - ii. 0.25 the overall width of the widest VCA expected to use the stand, whichever is greater
 - b. For VCA with a width greater than 18 m not less than 4.5 m.

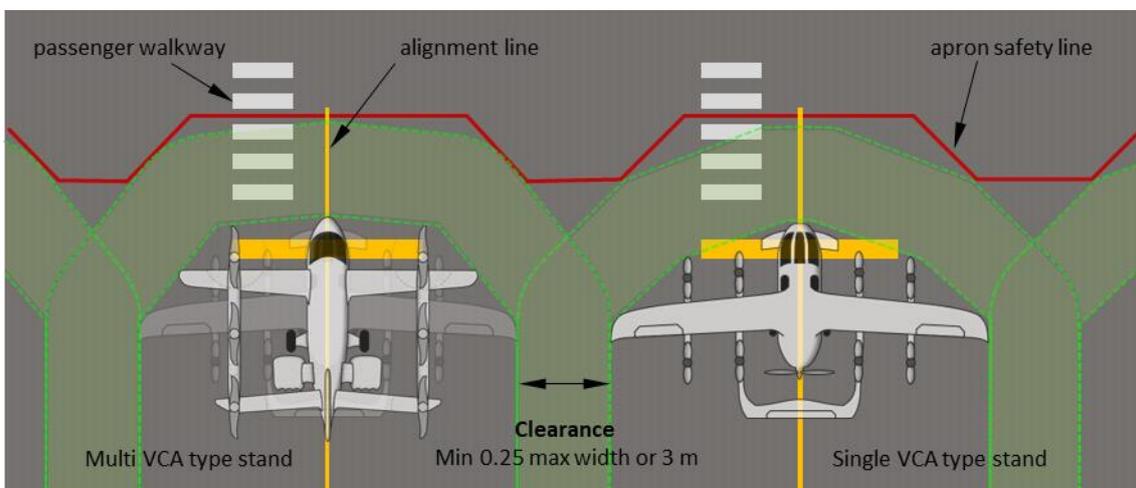


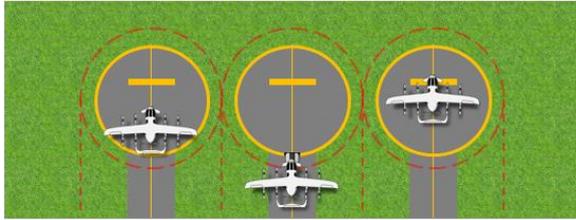
Figure 5 - Example of geometry-based stands (VCA less than 18m in width)

3.3.6 Protection areas for D-value-based VCA stands

- 3.3.6.1 A stand protection area should be provided for D-value-based VCA stands, as shown in Figure 6.
- 3.3.6.2 A protection area should have the following features:
- a. free of obstacles, except for essential objects
 - b. resistant to the effects of downwash
 - c. when solid, flush with the stand, not exceed an upward slope of 4 % outwards from the edge of the stand and ensures effective drainage.
- 3.3.6.3 When associated with a stand designed for turning, the protection area should extend outwards from the periphery of the stand for a distance of 0.4 Design D. Otherwise, the minimum width of the stand and the protection area should not be less than the width of the associated taxi-route.
- 3.3.6.4 When associated with a stand designed for non-simultaneous aircraft operations:
- a. the protection area of adjacent stands may overlap but should not be less than the required protection area for the larger of the adjacent standards
 - b. the adjacent stand may contain a static aircraft.

3.3.6.5 Essential objects located in the protection area should not:

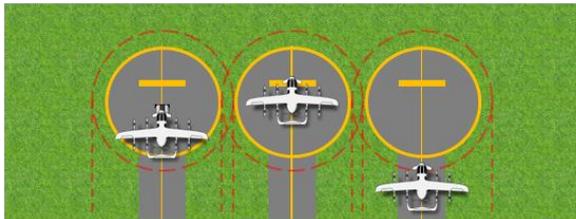
- a. If located at a distance of less than 0.75 Design D from the centre of the VCA stand, penetrate a surface at a height of 5 cm above the level of the stand.
- b. If located at a distance of 0.75 Design D or more from the centre of the VCA stand, penetrate a surface at a height of 25 cm above the level of the stand and sloping upwards and outwards at a gradient of 5 %.



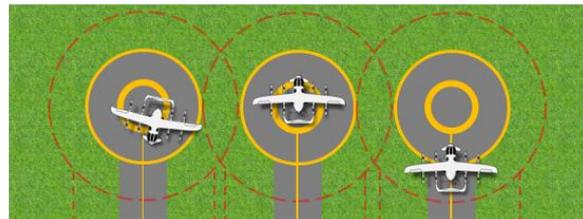
Example A: Ground taxi. Simultaneous taxi-on/push-back stands



Example B: Ground taxi. Simultaneous turning stands



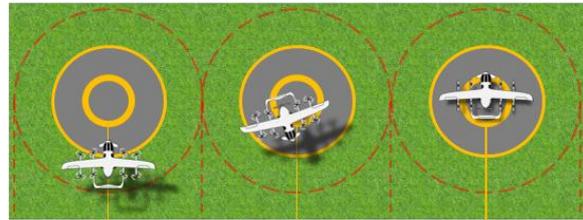
Example C: Ground taxi. Non-simultaneous taxi-on/push-back stands dependent on other stand being clear or with static aircraft



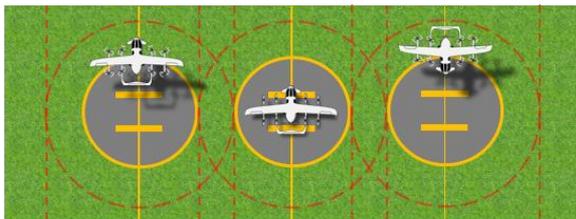
Example D: Ground taxi. Non-simultaneous turning stands dependent on other stand being clear or with static aircraft only



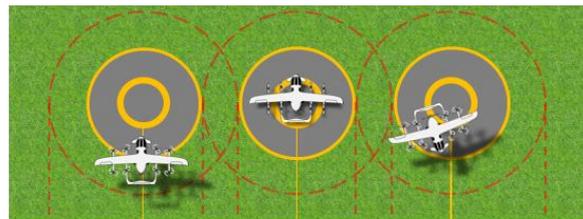
Example E: Air taxi. Simultaneous taxi-through stands



Example F: Air taxi. Simultaneous turning stands



Example G: Air taxi. Non-simultaneous taxi-through stands dependent on other stand being clear or with static aircraft only



Example H: Air taxi. Non-simultaneous turning stands dependent on other stand being clear or with static aircraft only

Figure 6 - Protection areas for VCA stands and the associated VCA taxi-routes for different operational scenarios

4 Obstacle limitation surfaces (OLS)

4.1 Introduction

4.1.1 Establishing obstacle limitation surfaces

4.1.1.1 A vertiport operator should establish the obstacle limitation surfaces (OLS) applicable to the critical performance of the design VCA.

Note: Refer to AC 139.V-02 for the monitoring of obstacles in navigable airspace in the vicinity of the vertiport.

4.2 Obstacle limitation surfaces origins

4.2.1 The following section outlines the protected areas from which obstacle limitation surfaces (OLS) originate. The dimensions of the OLS serve a general objective of protection of approach, climb-out and balked landing manoeuvres in the visual phase of the approach-to-land below a height of 152 m above the FATO elevation.

4.2.2 FATO Protection Area (FPA)

4.2.2.1 An FPA should be provided for each FATO, as shown in Figure 7.

4.2.2.2 An FPA should have the following features:

- a. free of obstacles, except for essential objects
- b. where solid, flush with the edge of the FATO, resistant to the effects of downwash and ensures effective drainage.

4.2.2.3 Where a FATO supports landing/take-off without vertical procedures, the FPA is an area surrounding the FATO that encompasses:

- a. the area(s) bordered by a circumscribed square aligned with the landing/take-off flight path(s) centred on the FPA reference circle(s)
- b. any area contained within the direct common tangents of any multiple FPA reference circles.

4.2.2.4 Where a FATO supports landing/take-off with vertical procedures only, the FPA is an area surrounding the FATO that encompasses:

- a. the FPA reference circle(s)
- b. any area contained within the direct common tangents of any multiple FPA reference circles.

4.2.2.5 The radius of an FPA reference circle should be half the FATO width plus 3 m or 0.25 Design D, whichever is greater.

4.2.2.6 Where the FATO length is greater than its width, separate FPA reference circles are centred on the FATO centreline at a distance of half the FATO width from the FATO ends, as shown in Example C of Figure 7.

4.2.2.7 Essential objects located in the FPA should not exceed 25 cm in height and should be frangibly mounted.

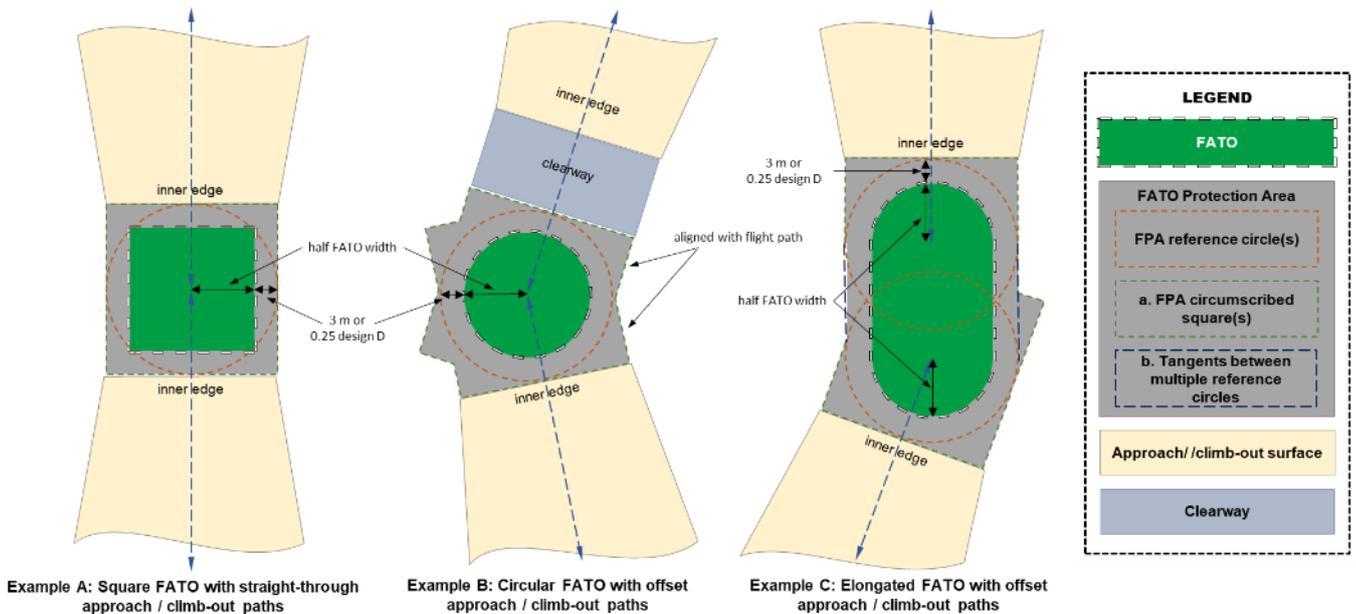


Figure 7 - Protection surfaces for vertiports without vertical procedures

4.2.3 Vertical Procedure Surface

- 4.2.3.1 A vertical procedure surface (VPS) should be established for where vertical procedures are used for landing or take-off from the vertiport.
- 4.2.3.2 The VPS is a surface that encompasses the area bordered by a circumscribed square(s) aligned with the intended aircraft flight path(s) centred on the VPS reference circle, as shown in Figures 8, 9 and 11.
- 4.2.3.3 A VPS should be free of obstacles.
- 4.2.3.4 A VPS reference circle should be established above and centred on the FATO.
- 4.2.3.5 The diameter of a VPS reference circle should be the diameter of the associated FPA reference circle, plus 1 Design D per 100 ft increase in height above the FATO.
- 4.2.3.6 The vertiport operator should determine the elevation of the VPS subject to the performance characteristics of the most demanding VCA intended to use the vertiport or the VCA operator's intended operational requirements.

4.2.4 Obstacle Free Volume (OFV)

- 4.2.4.1 An OFV should be established between a VPS and the associated FPA.
- 4.2.4.2 An OFV should be free of obstacles.
- 4.2.4.3 The OFV is a truncated cone extending between the edge of the FPA reference circle to the edge of the VPS reference circle, as shown in Figure 8, 9 and 11.

4.2.5 Vertiport clearway

- 4.2.5.1 A vertiport clearway should be established when a VCA needs to manoeuvre, horizontally, between the FPA/VPS outer edge and the approach/climb-out surface inner edge.

- 4.2.5.2 A vertiport clearway should have the following features:
- sufficient size and shape to ensure containment of the design aircraft when it is operating between the FPA/VPS and the approach/climb-out surface
 - free of obstacles, except for essential objects
 - resistant to the effects of downwash
 - when at ground level, contiguous surface flush with the FPA, and free of hazards should a forced landing be required.
- 4.2.5.3 The width of a vertiport clearway should not be less than that of the associated FPA/VPS and centred on the intended flight path, as shown in Figure 7 and 11.

4.3 Surfaces

4.3.1 Approach/Climb-Out Surface

- 4.3.1.1 An approach/climb-out surface should be established for each approach and climb-out flight path to and from the vertiport, as shown in Figures 8 to 11.
- 4.3.1.2 The approach/climb-out surface consists of an inclined plane or a combination of planes or, when turns are involved, a complex surface, sloping upwards from the inner edge and centred on the intended flight path that must be clear of obstacles.
- 4.3.1.3 The limits of an approach/climb-out surface should comprise:
- an inner edge coincident with and of equal length to the outer edge of the associated FPA/VPS/clearway
 - two side edges originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane, aligned with the intended flight path to a specified width and continuing thereafter at that width for the remaining length of the approach/climb-out surface
 - an outer edge horizontal and perpendicular to the centre line of the approach surface intended flight path at a specified height above the vertiport elevation.
- 4.3.1.4 The specified values of the above characteristics are outlined in table 2.

Table 2 - OLS surface values - Approach/climb-out surface characteristics

Characteristics	Value
Inner edge width:	Width of FPA/VPS/clearway
Day use only final width:	7x Design D
Day use only divergence:	10%
Night use final width:	10x Design D
Night use divergence:	15%
Outer edge height above FATO elevation	500' (152 m)

- 4.3.1.5 In the case of an approach/climb-out surface involving turns, the surface is a complex surface containing the horizontal normals to its centre line and the slope of the centre line should be the same as that for a straight approach surface.
- 4.3.1.6 The slope(s) of the approach/climb-out surface should be measured in the vertical plane containing the centre line of the surface.
- 4.3.1.7 The approach/climb-out surface slope or combination of slopes and section lengths should be determined with reference to the obstacle environment and intended aircraft performance capabilities. If multiple slope/sections are established, the divergent portion of the approach/climb-out surface should be a single consistent slope.

4.3.2 Transitional surface

- 4.3.2.1 A transitional surface should be established on each side of an approach/climb-out surface and its associated clearway/VPS/FPA, as shown in Figures 8 to 11.
- 4.3.2.2 The transitional surfaces should be clear of obstacles.
- 4.3.2.3 The transitional surface should comprise:
 - a. a lower edge beginning at the point on the outer edge of the approach/climb-out surface where it reaches its final width then extending downwards and along the side of the approach/climb-out surface to the inner edge and from there
 - b. where provided, along the side of the clearway parallel to intended flight path
 - c. along the length of the side of the VPS
 - d. along the length of the side of the FPA parallel to the intended flight path
 - e. an upper edge beginning at the point where the outer edge of the approach/climb-out surface reaches its final width and then parallel to the intended flight path at a constant height.

Note: As the transitional surface is dependent on the approach/climb-out angle and Design D, it may extend the full length of the approach/climb-out surface. It may also be impacted by the extent of any vertical procedure such that it is no longer present.

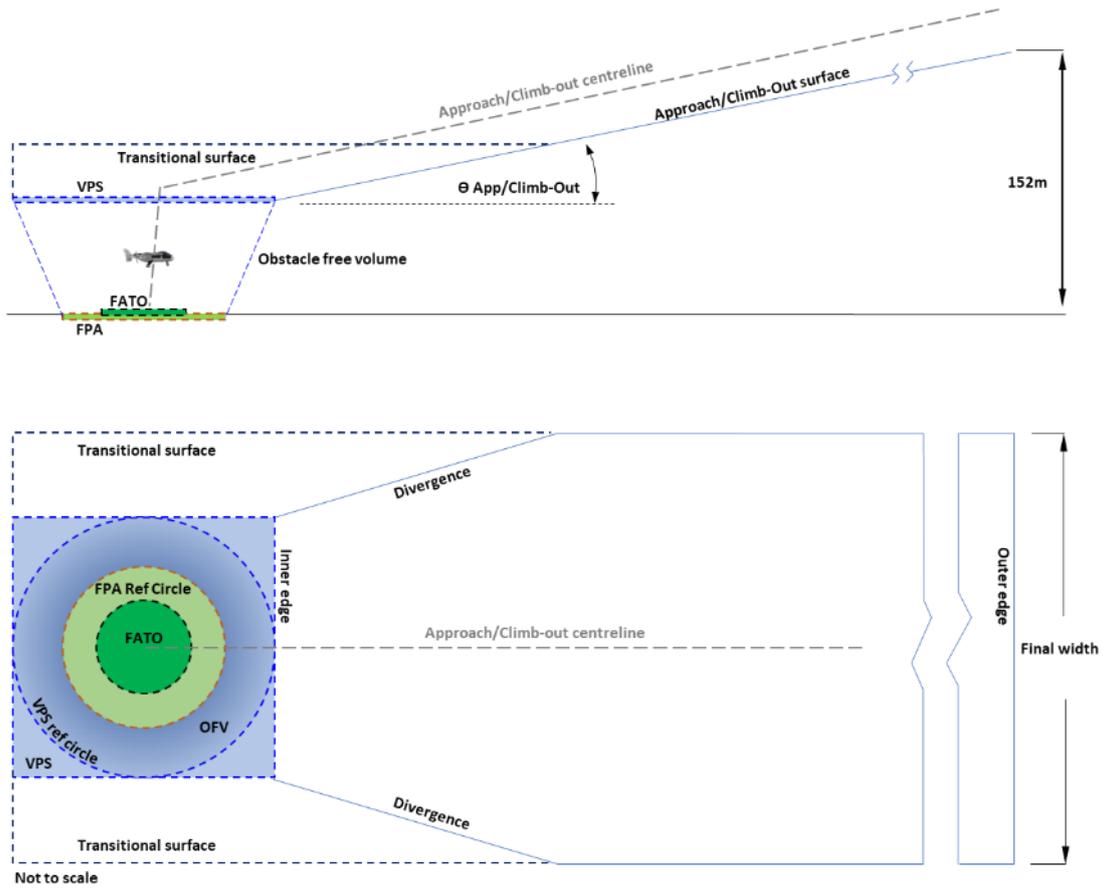


Figure 8 - An example OLS design for a vertiport accommodating vertical procedures

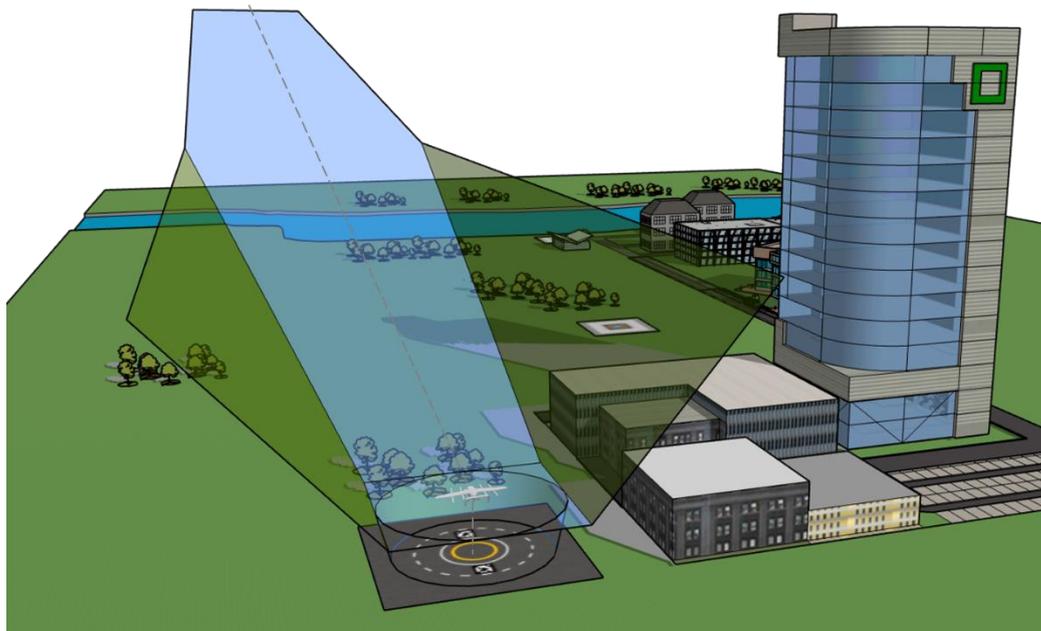


Figure 9 - Illustration of a simple vertiport OLS. Showing an OFV, VPS, VPS reference circle, a single approach/climb-out surface and transitional surfaces

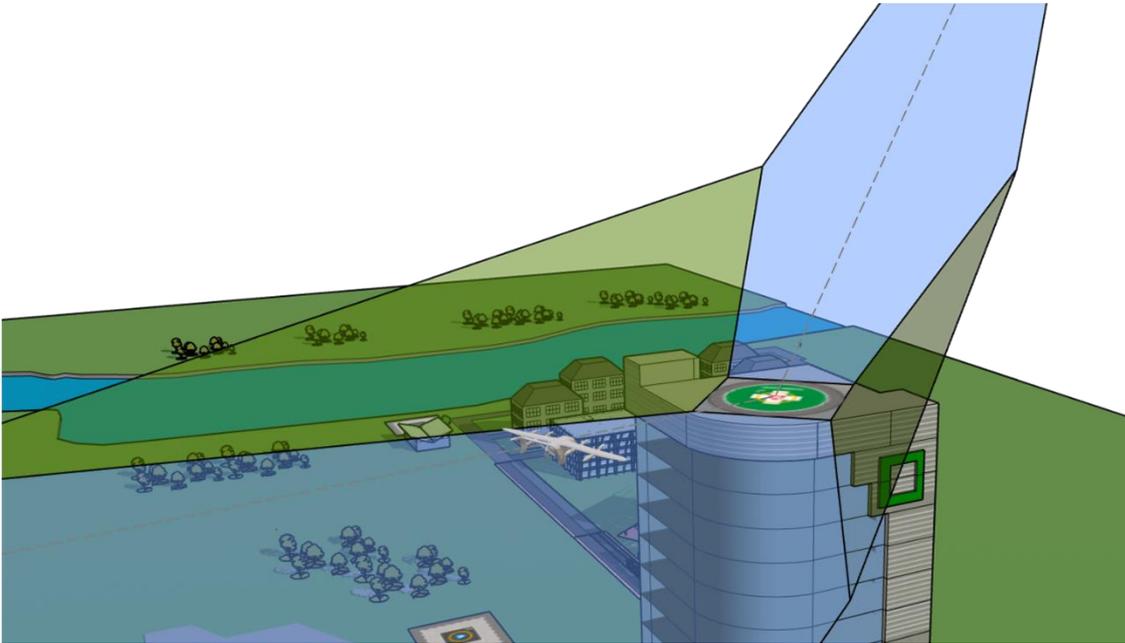


Figure 10 - Illustration of a simple elevated vertiport OLS. Showing an FPA, dual approach/climb-out surfaces and transitional surfaces

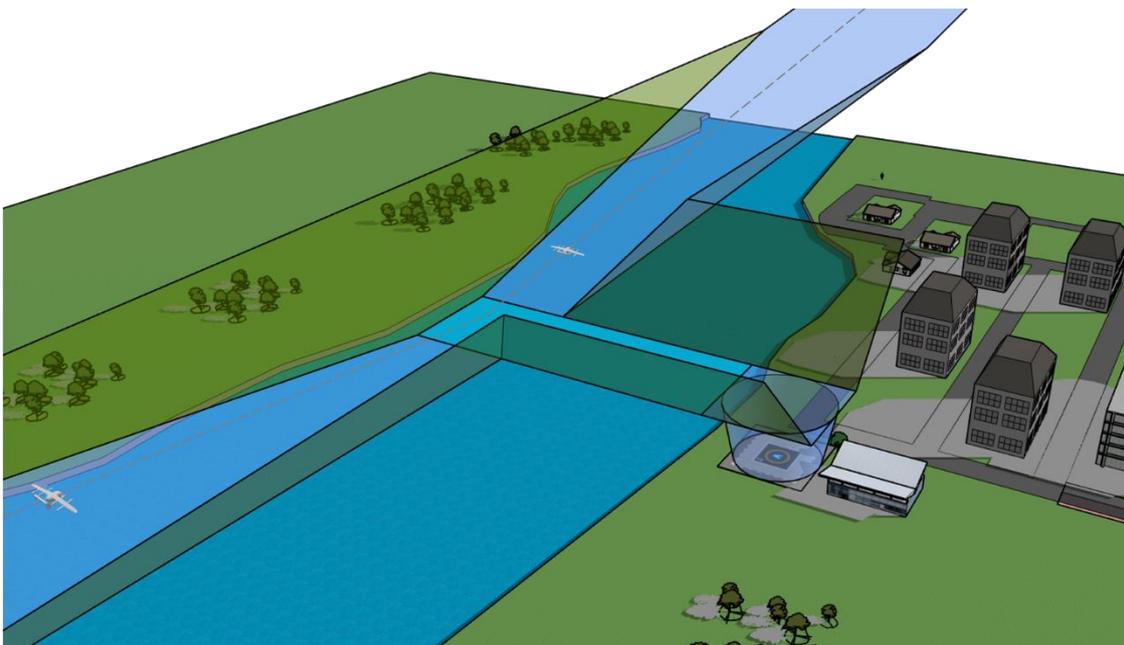


Figure 11 - Illustration of a complex vertiport OLS. Showing an FPA, OFV, FPA, clearway, dual approach/climb-out surfaces over the river and transitional surfaces

5 Visual aids

5.1.1 Wind direction indicators

- 5.1.1.1 A wind direction indicator should be provided at a vertiport to provide a visual indication of the wind direction and speed.
- 5.1.1.2 A wind direction indicator should be located to indicate the wind conditions over the FATO in such a way as to be free from the effects of airflow disturbances caused by nearby objects or downwash from the lift/thrust units. It should be visible from a VCA in flight, in hover or on the movement area.
- 5.1.1.3 A wind direction indicator sleeve should be a truncated cone made of lightweight fabric and should have the dimensions of 1.2 m in length, with a diameter of 0.3 m (at the larger end) to 0.15 m (at the smaller end).
- 5.1.1.4 The colour(s) of the wind direction indicator sleeve should such that it is clearly visible against its visual background.
- 5.1.1.5 A wind direction indicator at a vertiport intended for use at night should be lit such that it is clearly visible against its visual background.

5.2 Markers and markings - General

- 5.2.1.1 Markers and markings should be installed, in accordance with the following specifications, at a vertiport used or available for operations in daylight or at night.
- 5.2.1.2 Markers and markings should be clearly visible to the vertiport user by way of:
- provision of a contrasting background marking (a box or border)
 - where allowed for in the specifications below, the selection of an appropriate contrasting colour
 - any other method that would increase the conspicuity of the marking or marker in operational conditions.
- 5.2.1.3 The night-time visibility of markers and markings may be supplemented by reflective/refractive material and/or electroluminescent paint providing that such material does not pose a hazard if dislodged.

5.3 Markers and markings - FATOs

5.3.1 Flight path alignment guidance marking

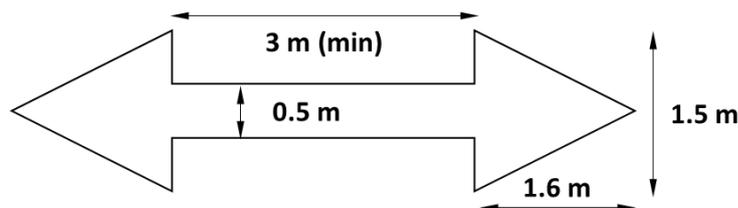


Figure 12 - Flight path alignment guidance marking

- 5.3.1.1 Flight path alignment guidance marking(s) should be provided at a vertiport where it is desirable and practicable to indicate available approach and/or departure path direction(s).
- 5.3.1.2 The flight path alignment guidance marking should be located in a straight line along the direction of landing and/or take-off path to the FATO.
- 5.3.1.3 A flight path alignment guidance marking should consist of each of the following characteristics:
- one or more arrows marked on the TLOF, FATO and/or FPA
 - the stroke of the arrow(s) shall be 0.5 m in width and at least 3 m in length
 - take the form shown in Figure 12 which includes the scheme for marking 'heads of the arrows' which are constant regardless of stroke length.
- 5.3.1.4 In the case of a flight path limited to a single landing direction or single take-off direction, the arrow marking may be unidirectional. In the case of a vertiport with only a single landing/take-off path available, one bidirectional arrow is marked. Both cases are shown in Figure 16b.
- 5.3.1.5 The marking should be white.

5.3.2 FATO Perimeter marking or markers

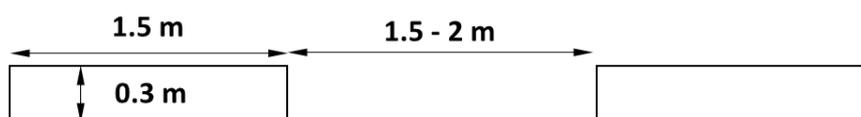


Figure 13 – FATO perimeter markings/markers

- 5.3.2.1 FATO perimeter markings or markers should be provided at a vertiport where the extent of a FATO is not self-evident as shown in Figures 16a and 16d.
- 5.3.2.2 For an unpaved FATO, the perimeter should be defined by flush in-ground markers.
- 5.3.2.3 For a paved FATO, the perimeter should be defined with a painted dashed line.
- 5.3.2.4 The FATO perimeter marking, or markers should have the following characteristics:
- be located on the edge of the FATO
 - be 30 cm in width, and 1.5 m in length, as shown in Figure 13
 - have end-to-end spacing of not less than 1.5 m and not more than 2 m with corners of a square or rectangular FATO defined
 - coloured white.

5.3.3 TLOF perimeter marking

- 5.3.3.1 A TLOF perimeter marking should be displayed if the perimeter of the TLOF is not self-evident, as shown in Figures 16a to 16d.
- 5.3.3.2 A TLOF perimeter marking should be located along the edge of the TLOF.
- 5.3.3.3 A TLOF perimeter marking should consist of a continuous white line with a width of 30 cm.

5.3.4 Touchdown positioning marking (TDPM)

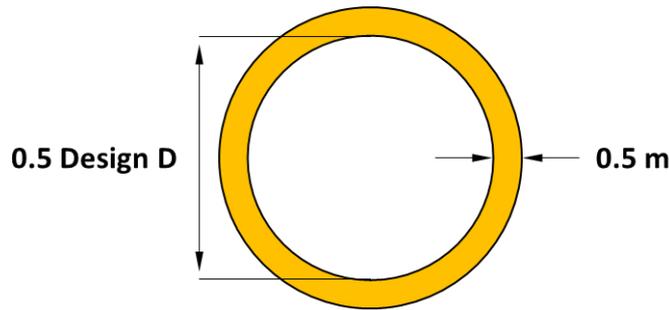


Figure 14 – Touchdown positioning circle marking

5.3.4.1 A TDPM should be provided where a VCA is to touchdown or be accurately placed in a specific position, as shown in Figures 16a to 16d.

5.3.4.2 The TDPM should be:

- a. when there is no limitation on the direction of touchdown/positioning, a touchdown/positioning circle (TDPC) marking
- b. when there is a limitation on the direction of touchdown/positioning a single shoulder line with an associated centreline
- c. be a yellow line with a width of at least 0.5 m.

5.3.4.3 The TDPM should have the following characteristics:

- a. the inner edge/inner circumference of the TDPM should be at 0.25 Design D from the centre of the area in which the VCA is to be positioned
- b. when a shoulder line, the length of the marking should be 0.5 Design D
- c. be a yellow line with a width of at least 0.5 m.

5.3.4.4 The TDPM should be the primary marking when used in conjunction with other markings on the TLOF.

5.3.5 Aiming point marking

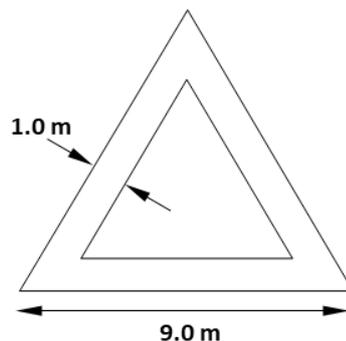


Figure 15 – Aiming point marking

5.3.5.1 An aiming point marking should be provided at a vertiport where it is necessary for a pilot to make an approach to a particular point above a FATO before proceeding to a TLOF,

as shown in Figure 16c. The aiming point marking should be located at the centre of the FATO.

5.3.5.2 The aiming point marking should be located at the centre of the FATO

5.3.5.3 The aiming point marking should have the following characteristics:

- a. be an equilateral triangle with the bisector of one of the angles aligned with the preferred landing direction
- b. consist of continuous lines
- c. the dimensions of the marking should conform to those shown in Figure 15.

5.3.6 Vertiport identification marking

5.3.6.1 A vertiport identification marking may be provided within a FATO, as shown in Figures 16a, 16b and 16d.

5.3.6.2 Where a TDPC is provided, the vertiport identification marking should be in the centre of the TDPC. Otherwise, the vertiport identification marking should be located at or near the centre of the FATO.

5.3.6.3 A vertiport identification marking should have the following characteristics:

- a. a form that identifies the vertiport
- b. have colour(s) that do not conflict with or detract from the TDPC where used
- c. have a size that not less than 3 m and not greater than 0.5 Design D in its longest dimension
- d. have a form that allows the marking to be aligned with the preferred landing direction.

5.3.6.4 The use of the letter "H" and "X" should be avoided as to not conflict with the heliport identification marking and an unserviceability marking. Markings with a white cross should also be avoided.

Note: The vertiport identification marking need not be limited to a single form for all vertiports, however the marking used should be consistent across a facility. For example, a vertiport operator may choose to use a vertiport identification marking defined by another aviation authority, or they may choose to use a corporate logo or brand that aligns with the characteristics in 5.3.5.3.

5.3.6.5 Where a vertiport is equipped with two or more FATOs, vertiport identification markings may be supplemented or replaced with an ordinal number marking, as shown in Figure 16d.

5.3.6.6 An ordinal number marking should consist of the following characteristics:

- a. arranged as to be readable from the preferred landing direction
- b. a number, beginning with 1 and ending in the last of the numbered FATOs
- c. have a colour consistent with the vertiport identification marking
- d. have a size not less than 1.5 m and not greater than 0.5 Design D in its longest dimension.

5.3.7 Vertiport name marking

5.3.7.1 A vertiport name marking may be provided at a vertiport, as shown in Figure 16d.

- 5.3.7.2 A vertiport name marking should consist of the name or the alphanumeric designator of the vertiport.
- 5.3.7.3 A vertiport name marking intended for use at night should be illuminated, either internally or externally.
- 5.3.7.4 The characters of the marking should be not greater than 1.2 m in height.

5.3.8 Maximum allowable weight marking

- 5.3.8.1 A maximum allowable weight marking may be displayed to provide the weight limitation of the TLOF, as shown in Figures 16a and 16d.
- 5.3.8.2 A maximum allowable weight marking should be located within the TLOF.
- 5.3.8.3 A maximum allowable weight marking should consist of a one-, two- or three-digit number.
- 5.3.8.4 The maximum allowable weight should be expressed in tonnes to the nearest 100 kg. The marking should be presented to one decimal place and rounded to the nearest 100 kg followed by the letter 't'.
- 5.3.8.5 The maximum allowable weight marking should consist of the following characteristics:
 - a. arranged as to be readable from the preferred landing direction
 - b. have a size that not less than 0.6 m in its longest dimension.

5.3.9 D-Value marking

- 5.3.9.1 A D-value marking may be displayed to provide the pilot with the limiting D of the FATO or TLOF, as shown in Figures 16a and 16d.
- 5.3.9.2 A D-value marking should be located within the FATO or TLOF and so arranged as to be readable from the preferred landing direction(s).
- 5.3.9.3 The D-value marking should be rounded to the nearest whole metre with 0.5 rounded down.
- 5.3.9.4 The D-Value marking should consist of the following characteristics:
 - a. arranged as to be readable from the preferred landing direction
 - b. have a size that not less than 0.6 m in its longest dimension.

5.3.10 Vertiport marking examples

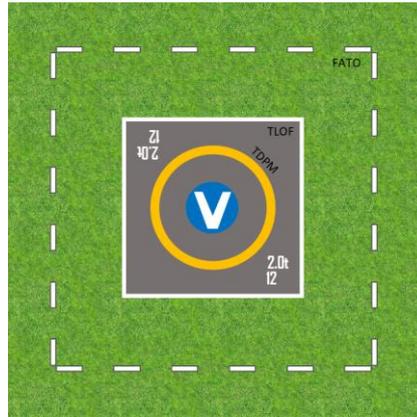


Figure 16a – Vertiport marking example 1

Figure 16a illustrates an example of marking a FATO on a natural surface and includes:

- FATO – Natural surface. White flush markers (1.5m x 0.3m)
- TLOF – Grey painted square with edge marked by continuous white line (>0.3m)
- TDPM – Always an internal diameter 0.5 of Design D. Marked by a continuous yellow circle (0.5-1m wide)
- vertiport identification – European Union Aviation Safety Agency (EASA) white V on a blue background
- D-Value and maximum allowable weight markings.

Note: The image is an example only and does not limit possible marking combination on a natural surface.

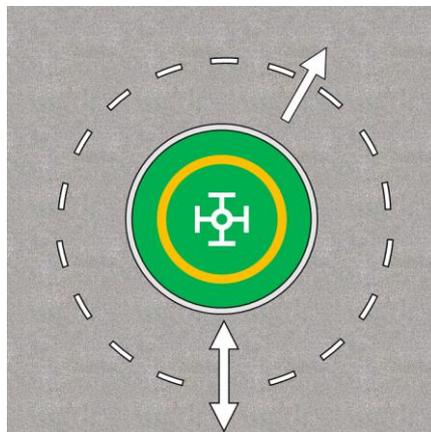


Figure 16b – Vertiport marking example 2

Figure 16b illustrates an example of marking a FATO on a paved surface and includes:

- FATO – Light coloured paving. White markings (1.5m x 0.3m) with black outline for contrast with paving
- TLOF – Green painted circle with edge marked by continuous white line (>0.3m) and a black outline for contrast with paving
- TDPM – Always an internal diameter 0.5 of Design D. Marked by a continuous yellow circle (0.5-1m wide)
- vertiport Identification – Federal Aviation Administration broken wheel
- 2 types of flight path alignment guidance markings.

Note: The image is an example only and does not limit possible marking combination on a paved surface.

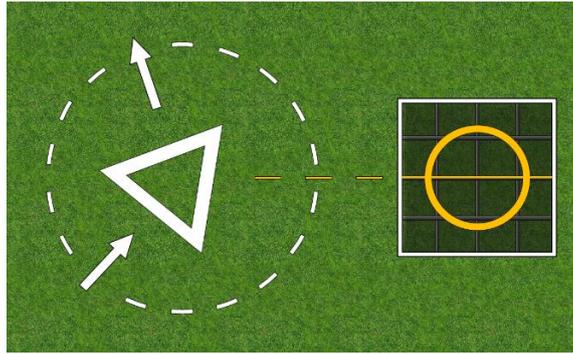


Figure 16c – Vertipoint marking example 3

Figure 16c illustrates an example of marking a FATO with an aiming point and stand and includes:

- FATO – Natural surface. White flush markers (1.5m x 0.3m)
- Air-taxi route markers – 1.5 m x 0.15 m yellow markers
- TLOF – Mesh deck with edge marked by continuous white line (>0.3m)
- TDPM – Internal diameter 0.5 of Design D, marked by a continuous yellow circle (0.5-1m wide)
- vertipoint identification – none
- flight path alignment – white arrow markings.

Note: The image is an example only and does not limit possible marking combinations.

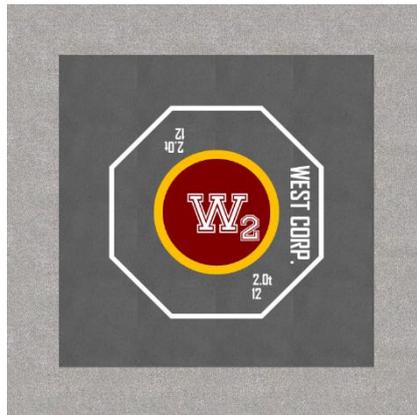


Figure 16d – Vertipoint marking example 4

Figure 16d illustrates an example of marking a FATO on a paved surface and includes:

- FATO – Self-evident as dark paving against light concrete
- TLOF (at 1 Design D) – Painted paved octagon with edge marked by continuous white line (>0.3m.)
- TDPM – Internal diameter 0.5 of Design D marked by a continuous yellow circle (0.5-1m wide)
- vertipoint identification – Corporate logo with ordinal number
- vertipoint name marking.

Note: The image is an example only and does not limit possible marking combinations.

5.4 Markers and markings - taxiways and stands

5.4.1 VCA taxiway markings and markers

5.4.1.1 The centreline of a VCA taxiway should be marked, as shown in Figure 4.

5.4.1.2 A VCA taxiway centre line marking should be a continuous yellow line 15 cm in width.

5.4.1.3 A VCA taxiway that will not accommodate painted markings should be marked with flush in-ground yellow markers, 15-cm-wide and approximately 1.5 m in length, spaced at intervals sufficient to provide directional guidance to pilots.

5.4.2 VCA air taxi-route markings and markers

5.4.2.1 The centre line of a VCA air taxi-route should be marked, as shown in Figure 4.

5.4.2.2 A VCA air taxi-route centre line marking should be a continuous yellow line 15 cm in width.

5.4.2.3 A VCA air taxi-route that will not accommodate painted markings should be marked with flush in-ground 15 cm-wide and approximately 1.5 m in length yellow markers, spaced at intervals sufficient to provide directional guidance to pilots.

5.4.3 VCA stand markings

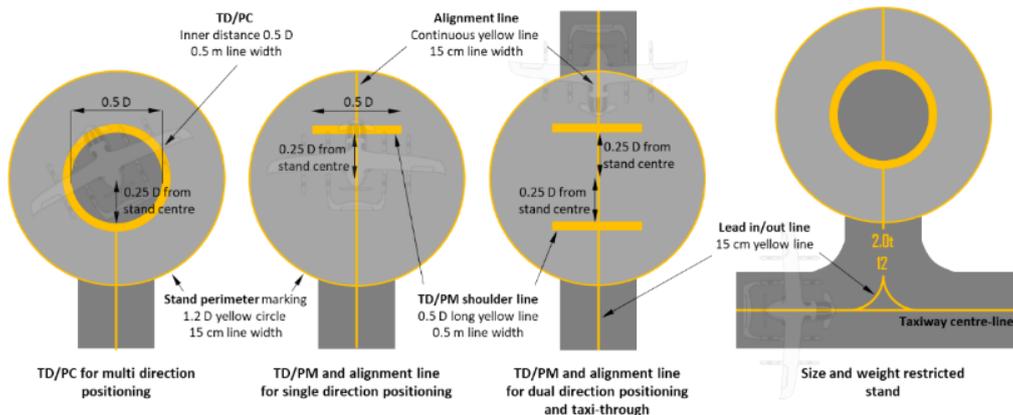


Figure 17 – D-value-based stand markings

5.4.3.1 A VCA stand should be marked, as shown in Figure 17 and consist of the following elements:

- a. a TDPM
- b. a stand perimeter marking
- c. lead-in/lead-out markings.

5.4.3.2 VCA stand markings may also include:

- a. an alignment line
- b. a stand designation marking
- c. stand limitation markings
- d. apron safety lines.

Touchdown positioning marking (TDPM)

5.4.3.3 A stand should be provided with the appropriate TDPM, according to 5.3.4.

Stand perimeter marking

5.4.3.4 A VCA stand perimeter marking should consist of a continuous yellow line and have a line width of 15 cm.

5.4.3.5 When unpaved, the stand perimeter should be marked with flush in-ground markers.

Lead-in/lead-out lines and alignment line

5.4.3.6 The TDPM, alignment lines and lead-in/lead-out lines should be located such that every part of the VCA can be contained within the VCA stand during positioning and permitted manoeuvring.

5.4.3.7 Curved portions of alignment lines and lead-in/lead-out lines should have radii appropriate to the design aircraft or the ground equipment used to position aircraft for that stand.

5.4.3.8 Alignment lines and lead-in/lead-out lines should be continuous yellow lines and have a width of 15 cm. Where it is intended that VCA proceed in one direction only, arrows indicating the direction to be followed may be added as part of the alignment lines.

Stand designation marking

5.4.3.9 VCA stand designation markings may be provided where there is a need to identify individual stands.

5.4.3.10 A stand designation marking should consist of the following characteristics:

- a. arranged as to be readable from the preferred approach direction/s
- b. an ordinal designation of alphanumeric characters
- c. be yellow in colour
- d. have a size that not less than 0.5 m and not greater than 0.25 Design D in its longest dimension.

Stand limitation marking

5.4.3.11 Where a stand is designed to accommodate a design aircraft with a smaller D-value, or a lesser weight than is accommodated by other vertiport facilities, the marking showing the limiting D-value or weight should be displayed on the lead-in line to that stand.

5.4.3.12 The stand limitation marking should consist of the following characteristics:

- a. arranged as to be readable prior to entering the stand
- b. be yellow in colour
- c. have a size that not less than 0.5 m and not greater than 0.25 D in its longest dimension
- d. centrally located on the lead-in line, with the lead in line broken to accommodate the marking.

5.4.3.13 A weight-based stand limitation marking should be consistent with 5.3.8.

5.4.3.14 A D-value based stand limitation marking should be consistent with 5.3.9.

Apron safety line marking

- 5.4.3.15 Apron safety lines may be provided on an apron as required by the parking configurations and ground facilities.
- 5.4.3.16 Apron safety lines may be located to define the areas intended for use by ground vehicles and other aircraft servicing equipment, passengers and pedestrians, etc., to provide safe separation from aircraft.
- 5.4.3.17 Apron safety lines should have the following characteristics:
- be of a conspicuous colour, preferably red, which should contrast with that used for VTOL-capable aircraft stand markings
 - be continuous in length and at least 10 cm in width.

5.5 Visual aids - Lighting

5.5.1 General

- 5.5.1.1 Lights and lighting systems should be installed, in accordance with the following specifications, at a vertiport used or available for operations at night.
- 5.5.1.2 The photometrics for vertiport lights and lighting elements (including light output, vertical and horizontal distribution, and chromaticity) should be appropriate to the vertiport environment and intended operations without being visually distracting or confusing to pilots.
- Note:** Annex 14 Volume II may be used as a starting point for vertiport designers and operators to gain an understanding of legacy heliport lighting systems and from there determine the appropriate photometrics (such as light output, vertical and horizontal distribution, and chromaticity) that will provide the safest outcome for their intended VCA operations.
- However, the application of Annex 14 Volume II may not suit VCA operations or the location of a vertiport where vertical procedures are intended or the vertiport is in a community sensitive location.
- 5.5.1.3 If the operating environment varies, lighting systems should be adjustable in order to achieve the appropriate intensity, if needed.

5.5.2 Approach lighting system

Reserved

5.5.3 Flight path alignment guidance lighting system

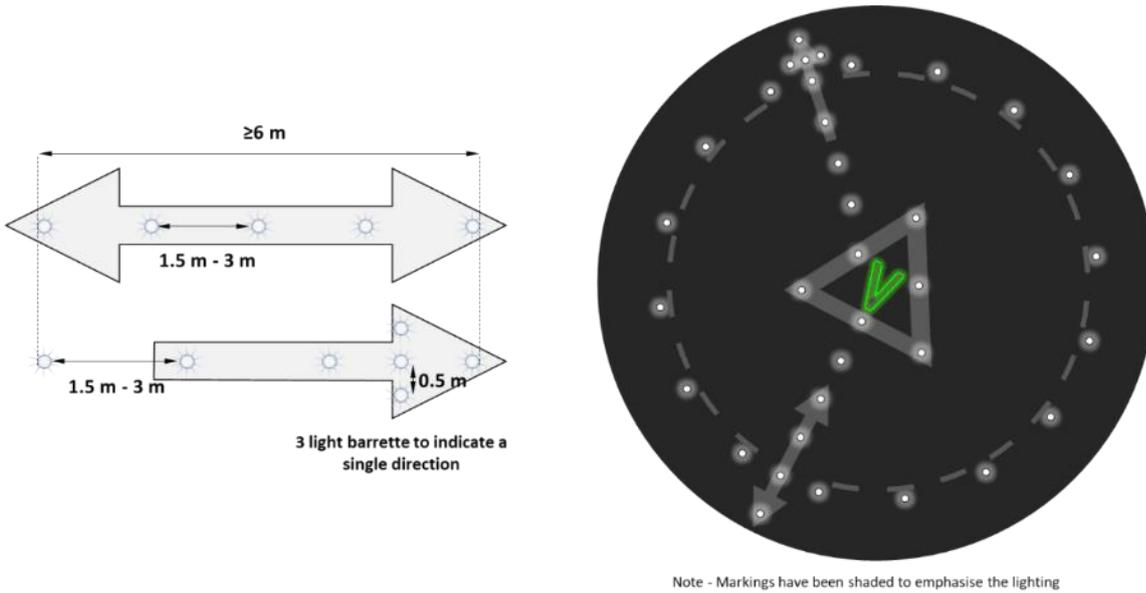


Figure 18 - Flight path alignment guidance lights and arrangement for aiming point lights

- 5.5.3.1 Flight path alignment guidance lighting system(s) (FPAGLS) should be provided at a vertiport where it is desirable and practicable to indicate available landing and/or take-off path direction(s), as shown in Figure 18.
- 5.5.3.2 The flight path alignment guidance lighting system should be located in a straight line along the direction(s) of approach and/or departure path to/from the TLOF or FATO within FATO, TLOF or protection area.
- 5.5.3.3 If combined with a flight path alignment guidance marking, as far as is practicable the lights should be located inside the “arrow” markings.
- 5.5.3.4 A flight path alignment guidance lighting system should consist of the following characteristics:
 - a. a row of three or more lights spaced uniformly with a total minimum distance of 6 m
 - b. intervals between lights should not be less than 1.5 m and should not exceed 3 m
 - c. where space permits, there should be 5 lights
 - d. be steady omnidirectional inset white lights.
- 5.5.3.5 Where a FPAGLS is for an approach only or departure only (but not both), additional lights can be added to indicate the desired direction. These lights should have the following characteristics:
 - a. a barrette of 3 lights, spaced 0.5 m apart
 - b. perpendicular to the line of the FPAGLS
 - c. located centrally between the last and second to last light to form an arrow-head.
- 5.5.3.6 The system should allow an adjustment of light intensity to meet the prevailing conditions and to balance the flight path alignment guidance lighting system with other vertiport lights and general lighting that may be present around the vertiport.

5.5.4 Visual alignment guidance system

Reserved

5.5.5 Visual approach slope indicator

Reserved

5.5.6 FATO Perimeter lights

5.5.6.1 Where a FATO is established at a vertiport for use at night, the FATO should be provided with perimeter lights

5.5.6.2 FATO perimeter lights should be placed along, outside and within 0.3 m of the edge(s) of the FATO. The lights should be uniformly spaced as follows:

- a. for a straight edge, a light at the end of each edge, then with lights evenly spaced at not more than 5 m apart
- b. for a curved edge, lights evenly spaced and not more than 5 m apart.

5.5.6.3 FATO perimeter lights should have the following characteristics:

- a. be fixed omnidirectional lights
- b. white in colour
- c. be inset where the FATO and TLOF are collocated and accessed by a taxiway, otherwise, be not more than 25 cm in height.

5.5.7 Aiming point lights

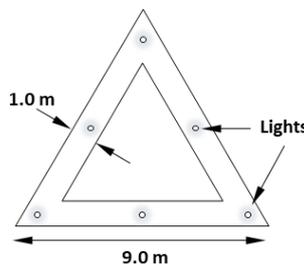


Figure 19 – Arrangement for aiming point lights

5.5.7.1 Where an aiming point marking is provided at a vertiport intended for use at night, aiming point lights should be provided, as shown in Figure 18 and 19.

5.5.7.2 Aiming point lights should be collocated with the aiming point marking.

5.5.7.3 Aiming point lights should form a pattern of at least six omnidirectional white lights. The lights should be inset when a light extending above the FATO could endanger VCA operations.

5.5.8 TLOF lighting system

5.5.8.1 Where a TLOF is established at a vertiport for use at night, the TLOF perimeter should be lit, unless the TLOF is centrally located within the FATO, the TDCP is lit, or is located within a stand lit by floodlighting, as shown in Figures 20a and 20c.

5.5.8.2 The lighting for the TLOF should consist of:

- a. TLOF perimeter lights
and/or
- b. TDPC lighting segments.

TLOF - perimeter lights

5.5.8.3 TLOF perimeter lights should be placed along, outside and within 0.3 m of the edges of the TLOF. The lights should be uniformly spaced as follows:

- a. for a straight edge, a light at the end of each edge, then with lights evenly spaced between at not more than 3 m apart
- b. for a curved edge, light evenly spaced and not more than 3 m apart.

5.5.8.4 TLOF perimeter lights should have the following characteristics:

- a. be fixed omnidirectional lights
- b. green in colour
- c. be inset where the TLOF is accessed by a taxiway, otherwise, be not more than 5 cm in height.

TLOF - lighting segments

Reserved

TDPC - lighting segments

5.5.8.5 Lighting segments should have the following characteristics:

- a. a width no larger than the marking it defines
- b. a frame the same colour as the marking it defines
- c. have a finish that does not reduce surface friction of the TLOF.

5.5.8.6 Lighting segments, where provided to identify the TDPC, as shown in Figure 20b, should have the following characteristics:

- a. a total length of lighting segments, in a pattern, of between 50% and 75% of the length of the pattern
- b. be evenly spaced with gaps between lighting segments of not less than 0.5 m
- c. be placed within the marking designating the TDPC such that the lighting segments are within 10 cm of the inner edge of the marking
- d. show yellow light.

5.5.9 Vertiport identification marking lighting

5.5.9.1 The vertiport identification marking may be lit.

5.5.9.2 Vertiport identification marking lighting should not adversely impact the TLOF surface.

5.5.10 VCA taxiway/air taxi-route lighting

5.5.10.1 Where a taxi-route is established at a vertiport for use at night, the taxi-route centreline should be lit.

5.5.10.2 Taxi-route lights should be placed along the taxiway centreline spaced at intervals sufficient to provide directional guidance to pilots.

5.5.10.3 Taxiway lighting should be yellow, and air taxi-route lighting should be alternating yellow and green, as shown in Figure 20c.

5.5.11 VCA stand lighting

5.5.11.1 VCA stand lighting should be provided on a stand intended to be used at night by VCA.

5.5.11.2 VCA stand lighting floodlights, as shown in Figure 20c, should be located to provide adequate illumination, with a minimum of glare to the pilot of an aircraft in flight and on the ground, and to personnel on the stand. The arrangement and aiming of floodlights should be such that a VCA stand receives light from two or more directions to minimise shadows.

5.5.11.3 The spectral distribution of stand floodlights should be such that the colours used for surface and obstacle markings can be correctly identified.

5.5.11.4 Horizontal and vertical illuminance should be sufficient to ensure that visual cues are discernible for required manoeuvring and positioning, and essential operations round the VTOL aircraft can be performed expeditiously without endangering personnel or equipment.

5.5.12 Vertiport lighting examples

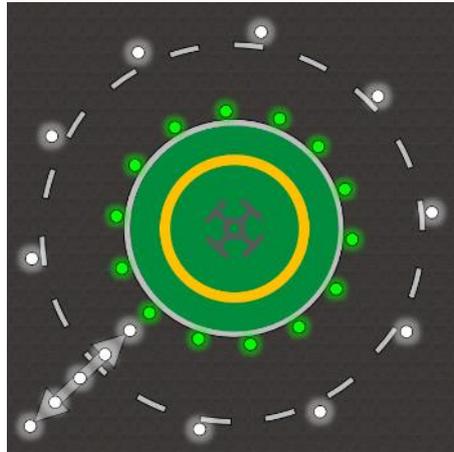


Figure 20a – Vertiport lighting example 1

Figure 20a illustrates an example of lighting a FATO that includes:

- FATO - white omnidirectional lights not more than 5 m apart
- TLOF - green omnidirectional perimeter lights not more than 3 m apart
- TDPC - in this case not lit
- flight path alignment guidance lighting - 5 white omnidirectional lights.

Note: The image is an example only and does not limit possible vertiport lighting combinations.

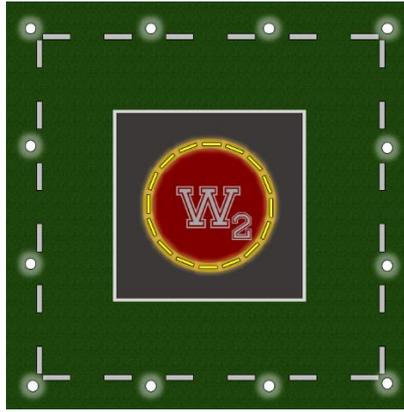


Figure 20b – Vertipoint marking example 2

Figure 20b illustrates an example of lighting a FATO that includes:

- FATO - white omnidirectional lights not more than 5 m apart
- TLOF - not lit as the TDPC is lit
- TDPC - yellow lighting segments.

Note: The image is an example only and does not limit possible vertipoint lighting combinations.

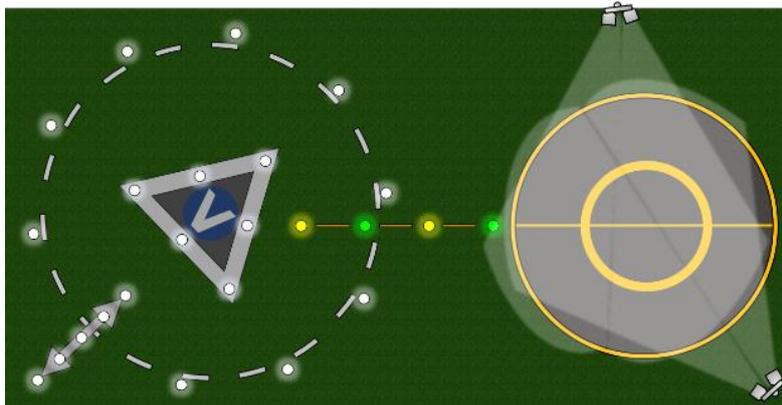


Figure 20c – Vertipoint marking example 3

Figure 20c illustrates an example of lighting a FATO and stand that includes:

- aiming point with 6 white omnidirectional lights
- FATO white omnidirectional lights evenly spaced not more than 5 m apart
- flight path alignment guidance lights of 5 white omnidirectional lights
- air-taxi route markers – yellow/green alternating omnidirectional lights
- stand TLOF & TDPM – stand floodlights
- vertipoint identification is not lit.

Note: The image is an example only and does not limit possible vertipoint lighting combinations.

5.6 Machine-readable visual aids

Nothing in the specifications above preclude the use of machine-readable aids, such as QR codes, being used for aircraft or vehicle guidance on a vertipoint.