Federal Aviation Administration

美国联邦航空管理局

Memorandum

备忘录

Date: September 21, 2022

To: All Airports Regional Division Managers

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Subject: Engineering Brief No. 105, Vertiport Design

This Engineering Brief provides interim guidance for the design of vertiports for aircraft with vertical takeoff and landing (VTOL) capabilities. Note that this interim guidance will be subject to update as data, analysis, and VTOL aircraft and operations develop in the future.

本工程简报提供了关于设计垂直起降 (VTOL) 飞机使用的直升机场的临时指导。请注意，随着数据、分析和 VTOL 飞机及运营在未来的发展，此临时指导将进行更新。

Attachment

附件

ENGINEERING BRIEF #105 Vertiport Design

工程简报 #105 直升机场设计

I Purpose.

I 目的。

This Engineering Brief (EB) specifies design guidance for public and private vertiports and vertistops, including modification of existing helicopter and airplane landing facilities, and establishment of new sites. While the design guidance contained herein refers to vertiport design, the design guidance applies to both vertiports and vertistops where appropriate. This EB is written for vertical takeoff and landing (VTOL) aircraft powered with electric motors and utilizing distributed electric propulsion in contrast to propulsion systems built solely around an internal combustion engine.

本工程简报 (EB) 规定了公共和私人直升机场和临时起降点的设计指导，包括对现有直升机和飞机着陆设施的修改以及新地点的建立。虽然本简报中的设计指导是指直升机场设计，但在适当的情况下，该设计指导也适用于直升机场和临时起降点。本 EB 是为使用电动机作为动力，采用分布式电动推进的垂直起降飞机编写的，以区别于仅围绕内燃机构建的推进系统。

At this time, the Federal Aviation Administration (FAA) does not have enough validated VTOL aircraft performance data and necessarily is taking a prescriptive and conservative approach with the recommendations in this EB. Vertiport guidance is expected to evolve into a performance-based design standard, potentially with aircraft grouped by their performance characteristics. This EB is written for aircraft with a maximum takeoff weight (MTOW) of 12,500 lbs (5,670 kg) or less.

目前，美国联邦航空管理局 (FAA) 没有足够的经过验证的 VTOL 飞机性能数据，因此在本 EB 中的建议采取了规定性和保守性的方法。预计直升机场指导将发展成为基于性能的设计标准，可能将飞机按其性能特征分组。本 EB 适用于最大起飞重量 (MTOW) 为 12,500 磅 (5,670 千克) 或以下的飞机。

This EB is a living document that serves as the FAA's initial interim guidance and will be updated over time to adapt and address new aircraft and technology as performance data is received. Figures in this document are general representations and are not to scale.

本 EB 是一个动态文件，作为 FAA 的初步临时指导，并将随着时间的推移进行更新，以适应和解决新飞机和技术，随着性能数据的接收。

II Background.

II 背景。

The FAA has identified a need for guidance for vertiports to be utilized by VTOL aircraft.

FAA 已经确定了对 VTOL 飞机使用的直升机场指导的需求。

The FAA's previous Advisory Circular (AC) on Vertiport Design, published on May 31, 1991, provided guidance for vertiport design and was based on civil tiltrotors modeled after military tiltrotor technology. However, the intended aircraft were never used commercially, and the AC was cancelled on July 28, 2010. Currently the closest type of aviation infrastructure, being used by many for comparison purposes, is heliports and helistops. AC 150/5390-2, Heliport Design, is based on helicopters with single, tandem (front and rear) or dual (side by side) rotors. The emerging VTOL aircraft are not proven to perform like conventional helicopters or very large tiltrotor aircraft.

美国联邦航空管理局 (FAA) 之前于 1991 年 5 月 31 日发布的关于直升机场设计的咨询通告 (AC)，为直升机场设计提供了指导，该指导基于模仿军用倾斜旋翼技术的民用倾斜旋翼机。然而，预期的飞机从未商业化使用，该 AC 于 2010 年 7 月 28 日被取消。目前最接近的航空基础设施类型，被许多人用于比较目的的是直升机机场和直升机停机坪。AC 150/5390-2，《直升机场设计》，基于具有单旋翼、串联 (前后) 或双旋翼 (并排) 的直升机。新兴的垂直起降 (VTOL) 飞机尚未证明能够像传统直升机或非常大的倾斜旋翼飞机那样表现。

This EB provides the interim guidance needed to support initial infrastructure development for VTOL operations. This EB provides guidance for existing vertiport design and geometry elements. This guidance is correlated to the reference VTOL aircraft described in paragraph 1.5 below. The Reference Aircraft represents a VTOL aircraft that integrates certain performance and design characteristics of nine emerging aircraft currently in development and is used to specify certain performance and design characteristics that informed the guidance in this EB. The Reference Aircraft was developed based on interactions with original equipment manufacturers (OEMs) and multiple FAA lines of business (LOBs).

本紧急修订 (EB) 提供了支持垂直起降操作初始基础设施开发所需的临时指导。本 EB 为现有直升机场设计和几何要素提供了指导。本指导与下面第 1.5 段描述的参考 VTOL 飞机相关联。参考飞机代表了一种集成目前正在开发的九种新兴飞机的某些性能和设计特征的垂直起降飞机，用于指定某些性能和设计特征，这些特征为本 EB 中的指导提供了信息。参考飞机是基于与原始设备制造商 (OEMs) 和多个 FAA 业务线 (LOBs) 的互动而开发的。

There is currently limited demonstrated performance data on how VTOL aircraft operate. Research efforts are underway to better understand the performance capabilities and design characteristics of emerging VTOL aircraft. The FAA will develop a performance-based AC on vertiport design in the future, as additional performance data is gleaned about these emerging VTOL aircraft. The AC will detail categories of vertiport facilities requiring different design criteria depending on the characteristics of the aircraft they plan to support as well as the activity levels at the facility.

目前关于 VTOL 飞机如何操作的可展示性能数据有限。研究工作正在进行中，以更好地了解新兴 VTOL 飞机的性能能力和设计特征。随着关于这些新兴 VTOL 飞机的额外性能数据的获取，FAA 将在未来开发基于性能的直升机场设计咨询通告 (AC)。该 AC 将详细说明根据计划支持的飞机特性以及设施的活动水平，需要不同设计标准的直升机场设施类别。

The future guidance will address more advanced operations including autonomy, different propulsion methods, density, frequency, and complexity of operations facilities. The AC on vertiport design will also address VTOL aircraft using alternative fuel sources such as hydrogen and hybrid. Future guidance will also include aircraft that do not currently conform to the Reference Aircraft included in this EB (for example, aircraft with an MTOW over12,500pounds(5,670kg)) and address instrument flight rules (IFR) capability and the use of multiple final approach and takeoff areas (FATOs).

未来的指导将涉及更高级的操作，包括自主性、不同的推进方法、操作的密度、频率和复杂性。关于垂直机场设计的 AC 还将涉及使用替代燃料 (如氢气和混合动力) 的垂直起降飞机。未来的指导还将包括目前不符合本 EB 中包含的参考飞机的飞机 (例如，最大起飞重量超过 12,500 磅 (5,670 公斤) 的飞机)，以及仪表飞行规则 (IFR) 能力和使用多个最终进近和起飞区域 (FATOs)。

To support the development of a comprehensive vertiport design AC, additional research is required to garner VTOL aircraft performance data on downwash/outwash, failure conditions or degradation of performance, landing precision, climb/descend gradients, and all azimuth weather capabilities. The data will be collected and used by the FAA research team to fill in aircraft information gaps. This will require coordination within the FAA across the various LOBs, as well as external collaboration with manufacturers and other stakeholders. A proponent interested in sharing data must work with FAA Office of Airport Safety and Standards to provide validated empirical data that addresses these performance data gaps.

为了支持全面垂直机场设计 AC 的开发，需要额外的研究来收集垂直起降飞机在向下洗/向外洗、故障条件或性能下降、着陆精度、爬升/下降梯度以及全方位天气能力方面的性能数据。这些数据将由 FAA 研究团队收集并用于填补飞机信息空白。这将需要在 FAA 内部跨各个业务线进行协调，以及与制造商和其他利益相关者的外部合作。有兴趣共享数据的提案者必须与 FAA 机场安全和标准办公室合作，提供经过验证的实证数据，以解决这些性能数据空白。

III Application.

III 应用。

This EB is intended as interim guidance for vertiport design until a more comprehensive performance-based vertiport design AC is developed. The guidance herein is not legally binding in its own right and will not be relied upon by the FAA as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with this guidance, as distinct from existing statutes, regulations, and grant assurances, is voluntary only, and nonconformity will not affect existing rights and obligations. The standards and guidance contained in this EB are practices the FAA recommends to establish an acceptable level of safety, performance and operation in the design of new civil vertiports, and for modifications of existing helicopter and airplane landing facilities to accommodate operations of VTOL aircraft.

本 EB 旨在为垂直机场设计提供临时指导，直到开发出更全面的基于性能的垂直机场设计 AC。本指南本身在法律上不具有约束力，FAA 不会将其作为采取肯定执法行动或其他行政处罚的独立依据。与现有法律、法规和补助金保证不同的，遵守本指南是自愿的，不遵守不会影响现有的权利和义务。本 EB 包含的标准和指导是 FAA 推荐的做法，以在新的民用垂直机场设计中，以及为适应垂直起降飞机的运行而对现有直升机和飞机着陆设施进行修改时，建立可接受的安全、性能和运行水平。

The vertiport design criteria in this EB is intended for VTOL aircraft that meet the performance criteria and design characteristics of the Reference Aircraft described in paragraph 1.5 and Table 1-1, flying in visual meteorological conditions (VMC) with the pilot on board. These design recommendations are for a single aircraft using the touchdown and lift off (TLOF) area, FATO area, and Safety Area at one time. Vertiport operators working with the proponent referencing this EB are responsible for confirming the ingress and egress path is clear. See paragraph 2.5.

本 EB 中的垂直机场设计标准旨在适用于满足第 1.5 段和表 1-1 中所述参考飞机的性能标准和设计特征的垂直起降 (VTOL) 飞机，在飞行员在场的视距气象条件下 (VMC) 飞行。这些建议设计适用于单架飞机同时使用触地与起飞 (TLOF) 区域、FATO 区域和安全区域。参照本 EB 的提议方与垂直机场运营商负责确认入口和出口路径是否畅通。参见第 2.5 段。

Table 1-1: Reference Aircraft

表 1-1: 参考飞机

Design Characteristics	Criteria
Propulsion	Electric battery driven, utilizing distributed electric propulsion
Propulsive units	2 or more
Battery systems	2 or more
Maximum takeoff weight (MTOW)	12,500 pounds (5,670 kg) or less
Aircraft length	50 feet (15.2 m) or less
Aircraft width	50 feet (15.2 m) or less
Operating Conditions	Criteria
Operation location	Land-based (ground or elevated) - no amphibian or float operations
Pilot	On board
Flight conditions	VFR
Performance	Criteria
Hover	Hover out of ground effect (HOGE) in normal operations
Takeoff	Vertical
Landing	Vertical
Downwash/Outwash	Must be considered in TLOF/FATO sizing and ingress/egress areas to ensure no endangerment to people/property in the vicinity, and no impact to safety critical navigational aids and surfaces, supporting equipment, nearby aircraft, and overall safety

设计特性	标准
推进系统	电动电池驱动，利用分布式电动推进
推进单元	2 或更多
电池系统	2 或更多
最大起飞重量 (MTOW)	12,500 磅 (5,670 千克) 或以下
飞机长度	50 英尺 (15.2 米) 或以下
飞机宽度	50 英尺 (15.2 米) 或以下
操作条件	标准
操作地点	陆基 (地面或升高)- 无两栖或浮筒操作
飞行员	在机上
飞行条件	VFR(目视飞行规则)
性能	标准
悬停	在正常操作中的地面效应外悬停 (HOGE)
起飞	垂直
着陆	垂直
下洗/外洗	在确定 TLOF/FATO 尺寸和进出区域时必须考虑，以确保附近的人员/财产不受危害，不对安全关键的导航辅助设备和表面、支援设备、附近飞机和整体安全造成影响

Further research is needed to understand VTOL taxiing and parking needs. In future guidance, parking and taxiway guidance will be included. If necessary in the interim, vertiports designed for ground taxiing can follow AC 150/5300-13, Airport Design, taxiway guidelines for Group 1 aircraft. For hover taxi, vertiport design should follow taxiway guidance in AC 150/5390-2, Heliport Design, for the Transport Category. For parking, vertiport design should follow guidance in AC 150/5390-2 for the Transport Category.

需要进一步研究以了解 VTOL 滑行和停机需求。在未来的指导中，将包括停车和滑行道的指导。在过渡期间，如果需要，为地面滑行设计的垂直机场可以遵循 AC 150/5300-13《机场设计》中关于 1 组飞机的滑行道指导。对于悬停滑行，垂直机场设计应遵循 AC 150/5390-2《直升机机场设计》中关于运输类别的滑行道指导。对于停车，垂直机场设计应遵循 AC 150/5390-2 中关于运输类别的指导。

For vertiport facilities that will also accommodate helicopter operations, the proponent should follow the recommendations in this EB and mark the facility as a vertiport unless the facility is built to the Transport Category heliport design standard, as described in paragraph 3.0.

对于还将容纳直升机运行的垂直机场设施，提议方应遵循本 EB 的建议，并将该设施标记为垂直机场，除非该设施按照第 3.0 段中描述的运输类别直升机机场设计标准建造。

This EB provides guidance on marking, lighting, and visual aids that identify the facility as a vertiport. This guidance applies to new vertiports or to heliports that are altered to vertiports.

本 EB 提供了关于标记、照明和视觉辅助设备的指导，以标识设施为垂直机场。本指导适用于新的垂直机场或更改为垂直机场的直升机机场。

Vertiport facilities that are intended to serve aircraft that do not meet the performance criteria and design characteristics of the Reference Aircraft included in this EB should begin coordination with the applicable FAA Regional or Airports District Office early in the planning and design process for the takeoff and landing area and will be subject to review on a case-by-case basis.

计划服务于本紧急情况通报 (EB) 中包含的参考飞机性能标准和设计特性不符的航空器的直升机场设施，应在规划和设计起飞和降落区域的早期阶段开始与适用的联邦航空局 (FAA) 地区或机场分区办公室进行协调，并将根据具体情况接受审查。

V Questions.

V 问题。

Contact the FAA Airport Engineering Division, AAS-100, for any questions about this

如有关于此的任何问题，请联系联邦航空局机场工程处，AAS-100。EB.

VI Effective Date.

VI 生效日期。

This EB becomes effective as of the date the associated memorandum is signed by the Manager, FAA Airport Engineering Division, AAS-100.

本紧急情况通报自联邦航空局机场工程处经理，AAS-100 签署相关备忘录之日起生效。

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1.0 Introduction.

1.0 引言。

1.1. Engineering Brief (EB) Guideline Justification.

1.1 工程简报 (EB) 指南的合理性。

Information collected through a literature review and original equipment manufacturer (OEM) coordination indicates that emerging VTOL aircraft will demonstrate similar performance characteristics to helicopters. However, limited data is available on VTOL aircraft operational characteristics, performance, maneuverability, downwash/outwash impacts, and vertiport obstacle information needs. Consequently, this EB is limited to pilot-on-board, visual flight rule (VFR) operations, and VTOL aircraft that have the characteristics and performance of the Reference Aircraft described in paragraph 1.5.

通过文献回顾和原始设备制造商 (OEM) 协调收集的信息表明，新兴的垂直起降 (VTOL) 飞机将展现出与直升机相似的性能特征。然而，关于 VTOL 飞机的操作特性、性能、机动性、下洗/外洗影响以及垂直起降场障碍信息需求的数据有限。因此，本 EB 限于机上飞行员、目视飞行规则 (VFR) 操作，以及具有第 1.5 段描述的参考飞机特征和性能的 VTOL 飞机。

Heliports provide the most analogous present-day model for vertiports. However, despite the similarities between the two types of aircraft, there are design differences between traditional helicopters and VTOL aircraft. VTOL aircraft have varied configurations and propulsion systems, with and without wings, and with varied landing configurations. As a result, the conversion ratio in $\underline{AC150/5390-2}$ of $0.83\times$ the overall length being used to calculate the main rotor diameter of the design helicopter is not representative of the diverse characteristics associated with the various VTOL aircraft being developed. In addition, there persists a lack of validated data on the performance capabilities of VTOL aircraft.

直升机场为目前最类似于垂直起降机场 (vertiports) 的现有模型。然而，尽管这两种类型的航空器之间存在相似性，传统直升机与垂直起降飞机之间仍存在设计上的差异。垂直起降飞机具有多种配置和推进系统，有的带翼，有的不带翼，且着陆配置也有所不同。因此，$AC150/5390-2$ 中用于计算设计直升机主旋翼直径的总长度转换率 $0.83\times$ 并不能代表各种正在开发的垂直起降飞机的多样化特性。此外，关于垂直起降飞机性能能力的验证数据仍然不足。

The limited tangible data available to validate OEM performance, especially in failure conditions, recommends a wider touchdown and liftoff area (TLOF) and load bearing final approach and takeoff area (FATO) than currently required for a general aviation heliport in AC 150/5390-2. Due to these performance data gaps, including downwash, the larger physical dimensions would accommodate a potentially wider landing scatter and decreased climb performance in different scenarios

可用于验证原始设备制造商 (OEM) 性能的有限具体数据，特别是在故障条件下，建议设置比《AC 150/5390-2》中为通用航空直升机场规定的更宽的着陆和起飞区域 (TLOF) 以及承载着陆和起飞的最终进近区域 (FATO)。由于这些性能数据缺口，包括向下洗流，更大的物理尺寸将能够适应可能更宽的着陆散布和不同情况下的爬升性能降低。

The anticipated Advanced Air Mobility (AAM) density, frequency, and complexity of operations is expected to be high in some cases. These operations are also anticipated to include commercial and air carrier operators, and will require certain safety levels and infrastructure requirements most analogous to the predetermined level of safety set in the Transport Category heliport design guidelines in AC 150/5390-2.

预期的先进空中出行 (AAM) 密度、频率和操作复杂性在某些情况下预计将会很高。这些操作还预计将包括商业和航空运营商，并将需要某些安全水平和基础设施要求，这些要求与《AC 150/5390-2》中运输类别直升机场设计指南设定的预定安全水平最相似。

Preliminary data garnered from the VTOL aircraft manufacturers to support the development of this EB claims no need by the aircraft for effective transitional lift (ETL) to fly and an ability to hover out of ground effect (HOGE). Therefore, the minimum sizing standards that accommodate the need for ETL per the Transport Category heliport criteria (e.g.,100 feet(30.5m)by200feet(61m)FATO) is not specified in this EB. As such, this EB is intended for aircraft that have HOGE capability. If the vertiport design VTOL aircraft is proven not to perform HOGE, this EB is not applicable, and the sponsor must work directly with the FAA to determine alternative vertiport sizing for that design VTOL aircraft. 1.2. Explanation of Terms. Terms used in this EB:

初步数据来源于 VTOL 飞机制造商，以支持本紧急情况修正案 (EB) 的开发，声称该飞机无需有效的过渡升力 (ETL) 即可飞行，且具有在地效外悬停的能力 (HOGE)。因此，本 EB 中未指定满足运输类别

直升机机场标准所需的 ETL 的最小尺寸标准 (例如，100 英尺 (30.5 米)× 200 英尺 (61 米)FATO)。因此，本 EB 适用于具有 HOGE 能力的飞机。如果垂直起降机场设计的 VTOL 飞机被证明无法执行 HOGE，则本 EB 不适用，赞助商必须直接与 FAA 合作，确定该设计 VTOL 飞机的替代垂直起降机场尺寸。1.2. 术语解释。本 EB 中使用的术语:

1. Approach/Departure Path: The approach/departure path is the flight track that VTOL aircraft follow when landing at or taking off from a vertiport.

1. 进近/起飞路径: 进近/起飞路径是 VTOL 飞机在降落或从垂直起降机场起飞时遵循的飞行轨迹。

2. Battery: One or more electrically connected cells, assembled in a single container having positive and negative terminals. A battery may include inter-cell connectors and other devices.

2. 电池: 一个或多个电连接的电池单元，组装在具有正负极的单个容器中。电池可能包括单元格间连接器和其他设备。

3. Battery pack: Two or more battery systems.

3. 电池包: 两个或更多的电池系统。

4. Battery system: Comprised of the battery, the battery charger and any protective, monitoring, and alerting circuitry or hardware inside or outside of the battery. It also includes vents (where necessary) and packaging.

4. 电池系统: 包括电池、电池充电器以及电池内部或外部的保护、监控和警报电路或硬件。它还包括通风口 (如有必要) 和包装。

5. Controlling dimension (D): The diameter of the smallest circle enclosing the VTOL aircraft projection on a horizontal plane, while the aircraft is in the takeoff or landing configuration, with rotors/propellers turning, if applicable. See Figure 1-1.

5. 控制尺寸 (D):VTOL 飞机在起飞或着陆配置时，在水平平面上的投影所包含的最小圆的直径，如果适用，转子/螺旋桨旋转。见图 1-1。

6. Design VTOL aircraft: The design VTOL aircraft is the largest electric, hydrogen, or hybrid VTOL aircraft that is expected to operate at a vertiport. This design VTOL aircraft is used to size the TLOF, FATO and Safety Area. Note that the design VTOL aircraft is different from the Reference Aircraft used to define the performance and design criteria in this EB.

6. 设计垂直起降飞机: 设计中的垂直起降飞机是预期在立体港口运营的最大型电动、氢能或混合动力垂直起降飞机。这种设计垂直起降飞机用于确定 TLOF、FATO 和安全区域的大小。注意，设计垂直起降飞机与用于定义本 EB 中性能和设计标准的参考飞机不同。

7. Downwash/Outwash: The downward and outward movement of air caused by the action of rotating rotor blade, propeller, or ducted fan. When this air strikes the ground or some other surface, it causes a turbulent outflow of air from the aircraft.

7. 下洗/外洗: 由于旋转的旋翼叶片、螺旋桨或管道风扇的作用，空气向下和向外的运动。当这股空气撞击地面或其他表面时，它会导致从飞机中涌出的空气变得湍流。

8. Elevated vertiport: A vertiport is considered elevated if it is located on a rooftop or other elevated structure where the TLOF and FATO are at least 30 inches(0.8m) above the surrounding surface (a ground level vertiport with the TLOF on a mound is not an elevated vertiport).

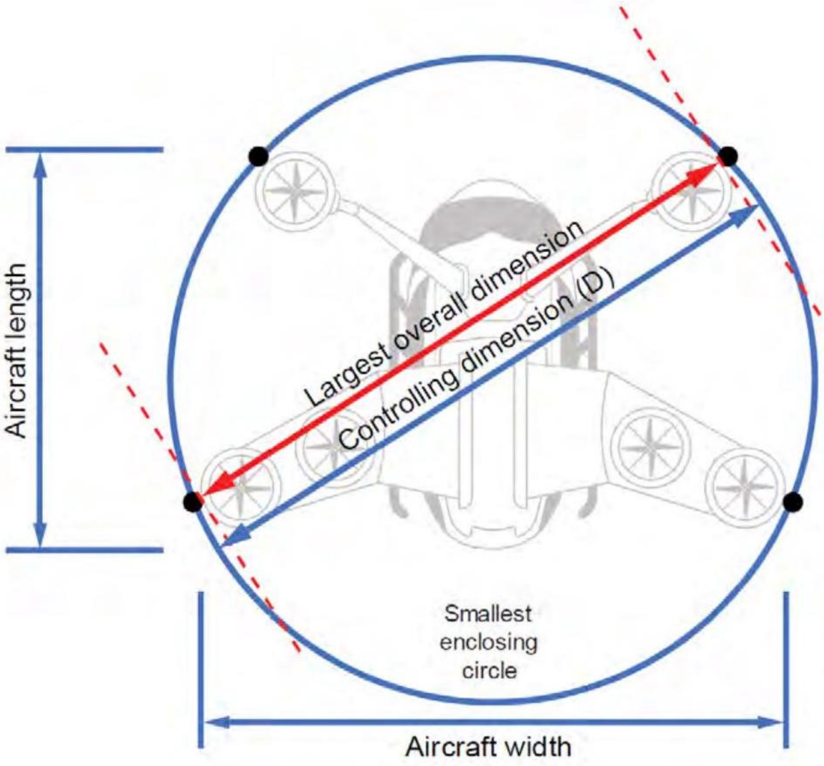
8. 高架立体港口: 如果立体港口位于屋顶或其他高架结构上，且 TLOF 和 FATO 至少高于周围表面 30 英寸 (0.8 米)，则认为该立体港口是高架的 (地面立体港口的 TLOF 位于土堆上并不算是高架立体港口)。

9. Effective transitional lift (ETL): The pronounced increase in translational lift during transition to forward flight due to the rotor/propeller experiencing a significantly decreased induced airflow.

9. 有效过渡升力 (ETL): 在过渡到前飞过程中，由于旋翼/螺旋桨经历显著降低的诱导气流，产生的显著增加的过渡升力。

10. Failure condition (FC): FC is generally defined as an occurrence of any likely event, caused or contributed to by one or more failures, which affects the aircraft's ability to generate lift or thrust and results in a consequential state that has an impact for a given flight phase. landing, and from which the aircraft initiates takeoff.

10. 故障条件 (FC):FC 通常定义为任何可能事件的发生，该事件由一个或多个故障引起或促成，影响了飞机产生升力或推力的能力，并导致对给定飞行阶段有影响的后果状态，例如着陆，飞机由此开始起飞。



11. Final approach and takeoff area (FATO): The FATO is a defined, load-bearing area over which the aircraft completes the final phase of the approach, to a hover or a

11. 最终进近和起飞区 (FATO):FATO 是一个定义明确的承重区域，飞机在此区域内完成进近的最后阶段，以达到悬停或起飞。

12. Ground Effect: A condition of usually improved performance encountered when the aircraft is operating very close to the ground or a surface. It results from a reduction in upwash, downwash, and/or blade tip vortices, which provide a corresponding decrease in induced drag.

12. 地效: 当飞机在地面或某一表面附近飞行时通常遇到的性能提升状况。这是由于上洗流、下洗流和/或叶尖涡流的减少，从而提供了相应的诱导阻力的降低。

13. Hover: The word ”hover” applies to an aircraft that is airborne and remaining in one place at a given altitude over a fixed geographical point regardless of wind. Pure hover is accomplished only in still air. For the purpose of this EB, the word ”hover” will mean pure hover.

13. 悬停: 单词“悬停”适用于在空中静止悬停在给定高度上固定地理点上的飞机，不受风速影响。纯悬停仅在静止空气中实现。为本 EB 的目的，单词“悬停”将指纯悬停。

14. Hover out of ground effect (HOGE): The ability to achieve hover without the benefit of the ground or a surface.

14. 地效外悬停 (HOGE): 在不借助地面或某一表面的情况下实现悬停的能力。

15. Imaginary surface(s): The imaginary planes defined in Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace, centered about the FATO and the approach/departure paths, which are used to identify the objects where notice to and evaluation by the FAA is required.

15. 想象表面: 根据《联邦法规》第 14 卷第 77 部分，关于航行空域的安全、高效使用和保护的法规中定义的想象平面，以 FATO 和进近/起飞路径为中心，用于识别需要通知和由 FAA 评估的对象。

16. Obstruction to air navigation: Any fixed or mobile object, including a parked aircraft, of greater height than any of the heights or surfaces presented in subpart C of 14 CFR Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace.

16. 飞行障碍物: 任何高于《联邦法规》第 14 卷第 77 部分 C 分部中给出的任何高度或表面的固定或移动对象，包括停放的飞机。

17. Reference Aircraft: The Reference Aircraft represents a VTOL aircraft that integrates certain performance and design characteristics of nine emerging aircraft currently in development. This Reference Aircraft is used to specify certain performance and design characteristics that informed the vertiport design guidance in this EB.

17. 参考飞机: 参考飞机代表了一种 VTOL 飞机，它整合了目前正在开发的九种新兴飞机的某些性能和设计特性。这个参考飞机用于指定某些性能和设计特性，这些特性为本文档中给出的垂直机场设计指导提供了信息。

18. Safety Area: The Safety Area is a defined area surrounding the FATO intended to reduce the risk of damage to aircraft accidentally diverging from the FATO.

18. 安全区域: 安全区域是围绕 FATO 定义的区域，旨在降低飞机意外偏离 FATO 时的损坏风险。

19. Translational Lift: Translational lift is the improved rotor/propeller efficiency resulting from directional flight.

19. 转向升力: 转向升力是由于定向飞行导致的旋翼/螺旋桨效率的提升。

20. Touchdown and liftoff area (TLOF): The TLOF is a load bearing, generally paved area centered in the FATO, on which the aircraft performs a touchdown or liftoff.

20. 着陆和起飞区域 (TLOF):TLOF 是位于 FATO 中心的一个承重区域，通常铺设路面，飞机在此区域进行着陆或起飞。

21. Vertiport: An area of land, or a structure, used or intended to be used, for electric, hydrogen, and hybrid VTOL aircraft landings and takeoffs and includes associated buildings and facilities.

21. 垂直机场: 一块土地或一个结构，用于或打算用于电动、氢能和混合动力垂直起降 (VTOL) 飞机的着陆和起飞，包括相关的建筑物和设施。

22. Vertiport elevation: The highest elevation of all usable TLOFs within the vertiport expressed in feet above mean sea level (MSL).

22. 垂直机场高程: 垂直机场内所有可用 TLOF 的最高海拔，以平均海平面 (MSL) 以上的英尺表示。

23. Vertistop: A vertistop is a term generally used to describe a minimally developed vertiport for boarding and discharging passengers and cargo (i.e., no fueling, defueling, maintenance, repairs, or storage of aircraft, etc.). The design standards and recommendations in this EB apply to all vertiports, which includes vertistops.

23. 垂直停靠站: 垂直停靠站是一个通常用于描述最小开发程度的垂直机场的术语，用于乘客和货物的装卸 (例如，不涉及加油、放油、维护、修理或飞机的储存等)。本指南中的设计标准和建议适用于所有垂直机场，包括垂直停靠站。

1.3. Airspace Approval Process and Coordination.

1.3. 空域审批流程和协调。

For vertiport development on federally obligated airports, the infrastructure or equipment must be depicted on the Airport Layout Plan (ALP) and a Form 7460-1 submitted for an airspace determination prior to development. The FAA's review of the ALP and airspace determination must be completed prior to the start of operations.

在联邦有义务的机场上开发垂直机场，基础设施或设备必须在机场布局计划 (ALP) 上标明，并提交 Form 7460-1 以进行空域判定，开发前需完成 FAA 对 ALP 和空域判定的审查。在开始运营之前，必须完成对 ALP 和空域判定的审查。

For development on non-federally obligated airports or heliports or for non-federally funded standalone vertiport sites, and in compliance with 14 CFR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports, the proponent must submit FAA Form 7480-1, Notice for Construction, Alteration and Deactivation of Airports, at least 90 days in advance of the day that construction work is to begin on the takeoff and landing area. Note: Airspace determination is not tied to this 90-day advance notice. Given the nascence of the AAM industry, the FAA highly encourages that engagement with the appropriate FAA regional or district office begin before the submission of the Form 7480-1, but an FAA evaluation is predicated on the submitted Form 7480-1.

对于非联邦义务机场或直升机场的建设，或对于非联邦资助的独立垂直起降场地的建设，且符合 14 CFR 第 157 部分《机场建设、变更、启用和停用通知》的规定，提案方必须至少在起飞和着陆区域施工开始前 90 天提交 FAA 表格 7480-1,《机场建设、变更和停用通知》。注意: 空域确定与 90 天提前通知无关。鉴于先进空中交通 (AAM) 行业的初期阶段，FAA 强烈建议在提交表格 7480-1 之前与 FAA 相应的地区或分区办公室进行沟通，但 FAA 评估是基于提交的表格 7480-1。

Heliport facilities that are being altered in geometry in accordance with the design criteria in this EB, if non-federally funded, the sponsor will need to submit a new Form 7480-1 to re-designate the facility as a vertiport before VTOL operations should commence at the site. The Form 7480-1 can be submitted electronically as a Landing Area Proposal (LAP) at OEAAA.faa.gov. The FAA's Flight Standards Service Office will determine when to do an onsite evaluation using risk-based analysis.

根据本紧急指令 (EB) 中的设计标准，正在改变几何形状的直升机场设施，如果未获得联邦资助，则在垂直起降 (VTOL) 操作在该场地开始之前，主办方需要提交新的表格 7480-1，将该设施重新指定为垂直起降场。表格 7480-1 可以作为着陆区域提案 (LAP) 以电子方式提交至 OEAAA.faa.gov。FAA 的飞行标准服务办公室将使用基于风险的分析来确定何时进行现场评估。

1.4. State/Local Role.

1.4. 州/地方角色。

Many state departments of transportation, aeronautics commissions, or similar authorities require prior approval and, in some instances, a license or permit to establish and operate landing facilities. Those seeking to establish a vertiport should first contact their respective state or local transportation or aeronautics departments or commissions for specifics on applicable licensing or permitting. Several states and municipalities also administer a financial assistance program like the federal program and are staffed to provide technical advice. Contact information for state aviation agencies is available at

许多州的交通部门、航空委员会或类似机构要求在建立和运营着陆设施之前获得批准，有时还需要获得许可证或许可。那些希望建立垂直起降场的人应首先联系各自州或地方的交通或航空部门或委员会，了解有关适用许可或许可的具体信息。有几个州和地方政府还管理着类似于联邦计划的财务援助计划，并配备了提供技术建议的人员。州航空机构的联系信息可在... 获取。https://www.faa.gov/airports/resources/state_aviation/.

In addition to state requirements, many local communities have enacted zoning ordinances, building and fire codes, and conditional use permitting requirements that can affect the establishment and operation of landing facilities. Some communities have developed codes or ordinances regulating environmental issues such as noise and air pollution. Therefore, communities, proponents, or sponsors seeking to establish a public-or private-use vertiport should make early contact with:

除了州的要求外，许多地方政府还制定了分区条例、建筑和消防法规以及条件性使用许可要求，这些可能会影响着陆设施的建设和运营。一些社区制定了规范环境问题的法规或条例，如噪声和空气污染。因此，寻求建立公用或私用垂直起降场的社区、倡议者或赞助者应尽早与以下方面联系:

- local officials or agencies representing the local zoning board;
- 当地官员或代表当地分区委员会的机构；
- the fire, police, or sheriff's department; and
- 消防、警察或治安部门；以及
- stakeholders who represent the area where the vertiport is to be located.
- 代表拟建垂直起降场所在区域的利益相关者。

State regulators, departments of transportation, and local communities can also use the guidance and best practices outlined in this EB when reviewing a proposed vertiport facility or developing independent standards.

州监管机构、交通部门和地方政府在审查拟议的垂直起降场设施或制定独立标准时，也可以参考本指南中概述的指导原则和最佳实践。

In addition to state and local coordination, vertiport proponents are encouraged to coordinate potential sites with any nearby airports or aviation stakeholders. Lack of early coordination can cause airspace, operational, safety, capacity, and financial impacts. While the FAA will review all new vertiport proposals for the safe and efficient utilization of navigable airspace by aircraft and the safety of persons and property on the ground, early coordination with these entities may offer early insights into airspace and capacity conflicts before investments are made.

除了州和地方的协调外，垂直起降场的倡议者还被鼓励与附近的机场或航空利益相关者协调可能的场址。缺乏早期的协调可能会导致空域、运营、安全、容量和财务影响。虽然联邦航空管理局 (FAA) 将审查所有新的垂直起降场提案，以确保飞机对可航行空域的安全和高效使用以及地面人员财产的安全，但与这些实体的早期协调可能会在投资之前提供有关空域和容量冲突的早期洞察。

1.5. Reference Aircraft.

1.5. 参考飞机。

The Reference Aircraft represents a VTOL aircraft that integrates certain performance and design features of nine emerging aircraft currently in development. This Reference Aircraft is used to specify the performance and design characteristics for the purposes of vertiport design in this EB.

参考飞机代表了一种垂直起降 (VTOL) 飞机，该飞机整合了目前正在开发的九种新兴飞机的某些性能和设计特点。本指南中使用该参考飞机来规定性能和设计特性，以用于垂直起降场的设计。

Emerging VTOL aircraft models are evolving rapidly with OEMs approaching aircraft certification from a wide range of different designs. While aircraft classifications are useful in takeoff and landing area design and airspace analysis, new VTOL aircraft concepts vary significantly in terms of design, aircraft dimensions, performance, and operational characteristics. Furthermore, these new VTOL aircraft do not have an established safety record and have not yet received FAA airworthiness certification. This makes it impractical to categorize VTOL aircraft as the FAA has traditionally done with FAA certificated fixed wing and rotor aircraft. However, OEM engagement has revealed some common characteristics among VTOL aircraft prototypes including multiple propulsion systems, HOGE capability, and helicopter performance similarities.

不断涌现的垂直起降 (VTOL) 飞机模型正在迅速发展，原始设备制造商 (OEMs) 正在从各种不同的设计中接近飞机认证。虽然飞机分类在起飞和降落区域设计以及空域分析中很有用，但新的 VTOL 飞机概念在设计、飞机尺寸、性能和运营特性方面存在很大差异。此外，这些新的 VTOL 飞机没有确立的安全记录，也尚未获得联邦航空管理局 (FAA) 的适航认证。这使得将 VTOL 飞机按照 FAA 传统对固定翼和旋翼飞机进行分类变得不切实际。然而，OEM 的参与揭示了一些 VTOL 飞机原型之间的共同特征，包括多推进系统、高升力/低能耗 (HOGE) 能力和与直升机相似的性能。

The vertiport design guidance in this EB relies on design characteristics, expected performance capabilities, and preliminary assumptions regarding takeoff and landing area design until there is adequate research on these emerging aircraft to develop a performance-based vertiport design AC. Accordingly, the aircraft features and performance capabilities listed in Table 1-1 create a Reference Aircraft type to inform this EB. The design characteristics, performance, and operating conditions that make up this reference VTOL aircraft will be reviewed in the future as the FAA continues to engage with emerging VTOL aircraft manufacturers.

本紧急情况简报 (EB) 中的垂直机场设计指导依赖于设计特性、预期的性能能力和关于起飞和降落区域设计的初步假设，直到对这些新兴飞机的研究足够充分，以开发基于性能的垂直机场设计咨询 Circular(AC)。因此，表 1-1 中列出的飞机特性和性能能力创建了一种参考飞机类型，以通知本 EB。组成参考 VTOL 飞机的设计特性、性能和运营条件将在未来进行审查，因为 FAA 继续与新兴 VTOL 飞机制造商进行接触。

2.0 Vertiport Design and Geometry.

2.0 垂直机场设计与几何形状。

2.1. Overview.

2.1. 概述。

The takeoff and landing area design and geometry contained in this EB includes the TLOF, the FATO, and the Safety Area. The dimensions for these areas are presented in Table 2-1 and are based on the controlling dimension (D) of the design VTOL aircraft as defined for each vertiport facility. The D is the diameter of the smallest circle enclosing the VTOL aircraft projection on a horizontal plane, while the aircraft is in the takeoff or landing configuration, with rotors/propellers turning, if applicable. See Figure 1-1. 1D is equal to the longest distance described above. The following sections provide specific details about these areas. See Figure 2-1 for the relationship among the TLOF, FATO, and Safety Area.

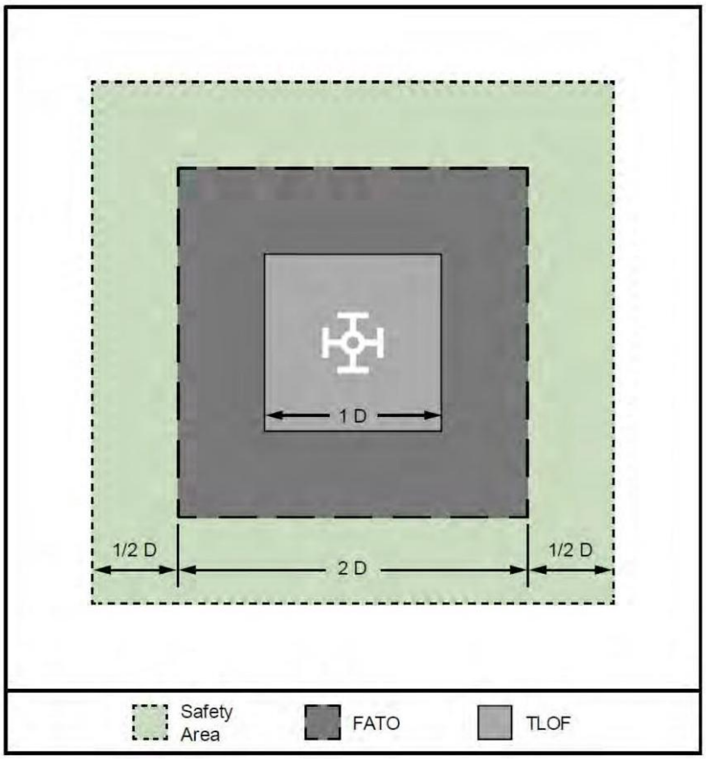
本 EB 中包含的起飞和着陆区域设计与几何形状包括 TLOF、FATO 和安全区域。这些区域的尺寸在表 2-1 中给出，基于每个垂起降设施设计的 VTOL 飞机的控制度量 (D)。D 是最小圆的直径，该圆围住 VTOL 飞机在水平面上的投影，在起飞或着陆配置时，旋翼/螺旋桨旋转，如适用。见图 1-1。1D 等于上述描述的最长距离。以下各节提供了有关这些区域的详细信息。见图 2-1，了解 TLOF、FATO 和安全区域之间的关系。

Table 2-1: Takeoff and Landing Area Dimensions
表 2-1: 起飞和着陆区域尺寸

Element	Dimension
TLOF	1D
FATO	2D
Safety Area	3D (½ D added to edge of FATO)

元素	尺寸
TLOF(起飞和着陆区)	1D
FATO(最终着陆和起飞区)	2D
安全区域	3D(½ D 加至 FATO 边缘)

Figure 2-1: Relationship and Dimensions of TLOF, FATO, and Safety Area
图 2-1:TLOF、FATO 和安全区域的关系及尺寸



Note: As empirical validated performance data for individual VTOL aircraft is analyzed and understood, this criteria may be adjusted appropriately.
注意: 随着对个别 VTOL 飞机实证验证性能数据的分析和理解，此标准可能会适当调整。

2.2. TLOF Guidance.

2.2. TLOF 指导。

The TLOF is a load bearing, generally paved area centered in the FATO, on which the VTOL aircraft performs a touchdown or liftoff. The following guidelines apply to the
TLOF 是一个承重区域，通常铺有路面，位于 FATO 中心，VTOL 飞机在此区域进行触地或起飞。以下指导原则适用于 TLOF:
1. Located at ground level, on elevated structures*, or at rooftop level.
1. 位于地面水平、升高结构 * 或屋顶水平。
2. On level terrain or a level structure.
2. 在水平地形或水平结构上。

3. Clear of penetrations and obstructions to the approach/departure and transitional surfaces.

3. 清除进近/离场和过渡表面的穿透物和障碍物。

4. Load bearing (static and dynamic for design VTOL aircraft).

4. 承重 (设计 VTOL 飞机的静态和动态)。

a. Supports the weight of the design VTOL aircraft and/or any ground support vehicles, whichever is more demanding for pavement design. The static loads are equal to the aircraft's maximum takeoff weight applied through the total contact area of the landing gear.

a. 支持设计 VTOL 飞机和/或任何地面支持车辆的重量，对铺装设计要求更高。静态载荷等于飞机最大起飞重量通过起落架总接触面积施加的力。

b. Supports the dynamic loads based on 150 percent of the maximum takeoff weight of the design VTOL aircraft. For design purposes, assume the dynamic load at 150 percent of the maximum takeoff weight applied over the whole landing gear for a landing gear with wheels, and at the single point of contact for a landing gear with skids.

b. 支持基于设计垂直起降飞机最大起飞重量 150% 的动态负载。出于设计目的，假设在带有轮子的起落架上，150% 最大起飞重量的动态负载作用于整个起落架；而在带有滑橇的起落架上，该动态负载作用于单点接触。

c. Accounts for rotor/propeller downwash load in load-bearing capacity.

c. 考虑了旋翼/螺旋桨下洗载荷对承载能力的影响。

5. Centered within its own FATO.

5. 在其自身的 FATO 内居中。

6. Minimum width is 1D† .

6. 最小宽度为 1D† 。

7. For a circular TLOF, minimum diameter is 1D.

7. 对于圆形 TLOF，最小直径为 1D。

8. Minimum length is 1Dξ .

8. 最小长度为 1Dξ 。

9. Circular, square, or rectangular in shape ‡ . The TLOF should have the same shape as the FATO and Safety Area.

9. 形状为圆形、正方形或矩形 ‡ 。TLOF 应与 FATO 和安全区域具有相同的形状。

10. Design the distance between the TLOF, FATO and Safety Area perimeters to be equidistant regardless of the shape of the TLOF.

10. 设计 TLOF、FATO 和安全区域边界之间的距离，使其无论 TLOF 的形状如何都保持等距。

11. Meets general surface characteristics and pavement guidelines including the following:

11. 符合一般表面特性和铺装指南，包括以下内容:

a. Has a paved or aggregate-turf surface (see AC 150/5370-10, Standard Specifications for Construction of Airports, items P-217, Aggregate-Turf Runway/Taxiway, and P-501, Cement Concrete Pavement).

a. 具有铺砌或集料草皮表面 (参见 AC 150/5370-10，《机场建设标准规范》，项目 P-217，集料草皮跑道/滑行道，和 P-501，水泥混凝土道面)。

b. Uses cement concrete pavement when feasible. An asphalt surface is discouraged as it is susceptible to heat stress and may rut under the weight of a parked VTOL aircraft, creating loose debris and potential catch points for landing gear.

b. 在可行的情况下使用水泥混凝土道面。不鼓励使用沥青表面，因为它容易受到热应力的影响，并且在停放的垂直起降飞机重量下可能会产生车辙，从而产生松散的碎片和潜在的起落架绊点。

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* A vertiport is considered elevated if it is located on a rooftop or other elevated structure where the TLOF and FATO are at least 30 inches(0.8m)above the surrounding surface.

* 如果升降港口位于屋顶或其他高层结构上，且 TLOF 和 FATO 至少高于周围表面 30 英寸 (0.8 米)，则该升降港口被视为升高。

† The controlling dimension (D) of an aircraft is the longest distance between the two outermost opposite points on the aircraft (e.g., wingtip to wingtip, rotor tip to rotor tip, rotor tip to wingtip, fuselage to rotor tip) measured on a level horizontal plane that includes all adjustable components extended to their maximum outboard deflection. 1D is equal to the longest distance described above. 2D is equal to twice the long distance describe above.

† 飞机的控制尺寸 (D) 是飞机上最外侧相对两点之间的最长距离 (例如，翼尖到翼尖、旋翼尖到旋翼尖、旋翼尖到翼尖、机身到旋翼尖)，在包含所有可调节组件伸展到最大外侧偏移的水平平面上测量。1D 等于上述描述的最长距离。2D 等于上述长度的两倍。

‡ In 2011, the National EMS Pilots Association conducted a survey of 1,314 EMS pilots and found that the square was the preferred visual cue for judging aircraft closure rate, altitude, attitude, and angle of approach. It was rated higher than a circle, triangle, or octagon.

‡ 2011 年，国家紧急医疗服务飞行员协会对 1314 名紧急医疗服务飞行员进行了一项调查，发现正方形是判断飞机闭合率、高度、姿态和接近角度的首选视觉提示。它的评级高于圆形、三角形或八边形。

c. Has a roughened pavement finish (e.g., brushed or broomed concrete) to provide a skid-resistant surface for VTOL aircraft and a non-slippery footing for people.

c. 具有粗糙的道面处理 (例如，刷子或扫帚处理过的混凝土)，以提供垂直起降飞机的防滑表面和人员的非滑腻立足点。

d. Elevations between any paved and unpaved portions of the TLOF and FATO are equal.

d. TLOF 和 FATO 的任何铺砌和非铺砌部分之间的高程相等。

e. Surface is stabilized to prevent erosion or damage from rotor/propeller downwash or outwash from VTOL aircraft operations. (Find guidance on pavement design and soil stabilization in AC 150/5320-6, Airport Pavement Design and Evaluation, and AC 150/5370-10.)

e. 表面得到稳定，以防止侵蚀或因旋翼/螺旋桨向下洗流或向外洗流造成的损坏，这些洗流来自垂直起降飞机的运行。(在 AC 150/5320-6，《机场道面设计与评估》和 AC 150/5370-10 中查找有关道面设计和土壤稳定的指导。)

f. Preferred surface of elevated TLOFs is concrete or metal. If the surface is conductive, it may need to be insulated and/or grounded to the extent feasible to eliminate the threat of conducting electricity in cases of a short circuit or lightning strike. If the surface is metal, it should be grounded. Insulation is permissible if grounding is not feasible. Construct rooftop and other elevated TLOFs of metal, concrete, or other materials subject to local building codes.

f. 倾斜 TLOF 的首选表面是混凝土或金属。如果表面导电，可能需要将其绝缘并/或接地，以尽可能消除短路或雷击时导电的威胁。如果表面是金属，则应将其接地。如果接地不可行，允许使用绝缘。根据当地建筑法规，使用金属、混凝土或其他材料构建屋顶和其他升高 TLOF。

g. Elevated TLOFs comply with 29 CFR Section 1926.34, Means of Egress, and 29 CFR Section1910.25, Stairways, as applicable.

g. 提升的 TLOFs 遵守 29 CFR 第 1926.34 节，出口设施，以及 29 CFR 第 1910.25 节，楼梯，视情况而定。

12. Gradient provides positive drainage (between -0.5 and -1.0 percent) off of and away from the pavement as shown in Figure 2-2.

12. 横坡提供了正排水 (在-0.5 至-1.0 百分比之间)，从路面排出并远离路面，如图 2-2 所示。

13. For rooftop or other elevated TLOFs, ensure that:

13. 对于屋顶或其他提升的 TLOFs，确保:

a. The FATO and TLOF are at or above the elevation of the adjacent Safety Area.

a. FATO 和 TLOF 位于相邻安全区域的海拔或以上。

b. Elevator penthouses, cooling towers, exhaust vents, fresh-air vents, and other elevated features or structures do not affect VTOL aircraft operations or penetrate the TLOF, FATO, Safety Area, Approach Surface, or Transition Surface.

b. 电梯机房、冷却塔、排气通风口、新鲜空气通风口以及其他提升特征或结构不影响 VTOL 飞机的运行，也不穿透 TLOF、FATO、安全区域、进近面或过渡面。

c. Fresh air vents for any attached building are not impacted by landing facility operations.

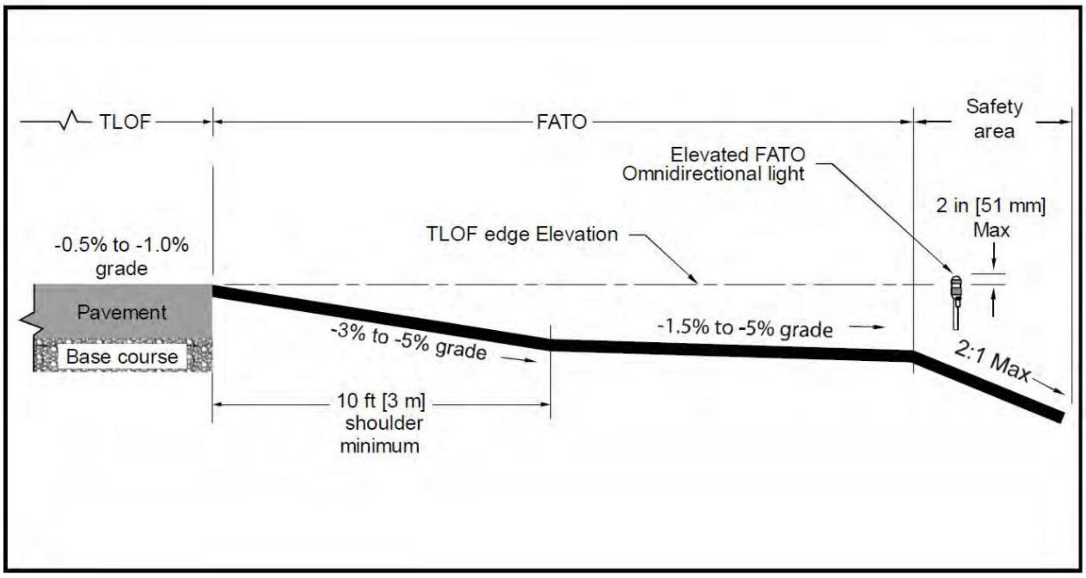
c. 任何附建建筑的新鲜空气通风口不受着陆设施运行的影响。

d. See paragraph [6.4, Turbulence.

d. 参见 [6.4，湍流。

Figure 2-2: Vertiport Gradients and Rapid Runoff Shoulder

图 2-2: 垂直机场横坡和快速排水肩部



Note 1: The slope direction is based on the topography of the site.

备注 1: 坡向基于场地的地形。

Note 2: Grade the TLOF, FATO, and Safety Area to provide positive drainage of the entire area for the TLOF, FATO, and Safety Area.

备注 2: 对 TLOF、FATO 和安全区域进行坡度处理，以提供整个 TLOF、FATO 和安全区域的正排水。

Note 3: 2:1 maximum Safety Area gradient for vertiports at ground level or where applicable at elevated structures.

备注 3: 地面或提升结构上垂直机场的最大安全区域横坡为 2:1。

2.3. FATO Guidance.

2.3. FATO 指导。

The FATO is a defined area over which the VTOL aircraft completes the final phase of the approach to a hover or a landing and from which the aircraft initiates takeoff. The following guidelines apply to the FATO:

FATO 是一个定义区域，VTOL 飞机在该区域内完成接近的最后阶段以达到悬停或着陆，并从该区域开始起飞。以下指南适用于 FATO:

1. Located at ground level, on elevated structures, or at rooftop level.

1. 位于地面水平、高层结构上或屋顶水平。

2. Clear with no penetrations or obstructions except for navigational aids that are fixed-by-function (e.g., flight path alignment marking and lighting, approach lighting, TLOF lights) [§] , which must be on frangible mounts.

2. 无障碍物或穿透，除了固定功能的导航辅助设备 (例如，飞行路径对齐标记和照明，接近照明，TLOF 灯) [§] ，这些设备必须安装在易碎支架上。

Note: While there is no accepted standard for frangibility regarding VTOL operations, remove all objects from a FATO and Safety Area except those of the lowest mass practicable and frangibly mounted objects no higher than 2 inches(51mm)above the adjacent TLOF elevation, to the extent practicable.

注意: 虽然对于 VTOL 操作没有公认的易碎性标准，但应从 FATO 和安全区域内移除所有物体，除了最低质量的可行物体和安装在高于相邻 TLOF 高度不超过 2 英寸 (51 毫米) 的易碎物体。

3. Load bearing (static and dynamic for design VTOL aircraft), including the following features:

3. 承重 (设计 VTOL 飞机的静态和动态)，包括以下特点:

a. Supports the weight of the design VTOL aircraft and any ground support vehicles. The static loads are to be equal to the aircraft's maximum takeoff weight applied through the total contact area of the landing gear.

[§] An air navigation aid that must be positioned in a particular location to provide an essential benefit for aviation is fixed-by-function.

[§] 一种航空导航辅助设备，必须定位在特定位置以提供对航空的基本益处，是固定功能的。

a. 支持设计 VTOL 飞机和任何地面支援车辆的重量。静态载荷应等于飞机的最大起飞重量，通过起落架的总接触面积施加。

b. Assume dynamic loads at 150 percent of the maximum takeoff weight of the design VTOL aircraft.

b. 假设动态载荷为设计 VTOL 飞机最大起飞重量的 150%。

c. Rotor/propeller downwash load is accounted for in load-bearing capacity.

c. 在承重能力中考虑了旋翼/螺旋桨向下洗流载荷。

4. Centered within its own Safety Area.

4. 位于其自身的安全区域内居中。

5. Minimum width is 2D.

5. 最小宽度为 2D。

6. Minimum length is 2D.

6. 最小长度为 2D。

7. For a circular FATO, minimum diameter is 2D.

7. 对于圆形 FATO，最小直径为 2D。

8. The same geometric shape as the TLOF** and Safety Area.

8. 与 TLOF** 和安全区域具有相同的几何形状。

9. Design the distance between the TLOF, FATO and Safety Area perimeters to be equidistant regardless of the shape of the TLOF.

9. 设计 TLOF、FATO 和安全区域边界之间的距离，使其无论 TLOF 的形状如何都保持等距。

10. Meets general surface characteristics and pavement guidelines including the following:

10. 符合一般表面特征和铺装指南，包括以下内容:

a. Paved or aggregate-turf surface (see AC 150/5370-10, items P-217, Aggregate-Turf Pavement and P-501, Cement Concrete Pavement).

a. 铺设或集料草皮表面 (参见 AC 150/5370-10，项目 P-217，集料草皮铺装和 P-501，水泥混凝土铺装)。

b. Uses cement concrete pavement when feasible. An asphalt surface is less desirable as it may rut under the weight of a parked VTOL aircraft.

b. 在可行的情况下使用水泥混凝土铺装。沥青表面不太理想，因为它可能会在停放的 VTOL 飞机重量下产生车辙。

c. Has a roughened pavement finish (e.g., brushed or broomed concrete) to provide a skid-resistant surface for VTOL aircraft and a non-slippery footing for people.

c. 具有粗糙的铺装表面处理 (例如，刷子或扫帚处理过的混凝土)，为 VTOL 飞机提供防滑表面，并为人员提供非滑动的立足面。

d. Elevations between any paved and unpaved portions of the FATO are equal.

d. FATO 任何铺装和非铺装部分之间的高程相等。

e. Surface is stabilized to prevent erosion of damage from rotor/propeller downwash or outwash from VTOL aircraft operations. (Find guidance on pavement design and soil stabilization in AC 150/5320-6 and AC 150/5370-10.)

e. 表面得到稳定，以防止由于旋翼/螺旋桨向下洗流或 VTOL 飞机操作时的外洗流造成的侵蚀或损坏。(在 AC 150/5320-6 和 AC 150/5370-10 中查找有关铺装设计和土壤稳定的指导。)

f. Preferred surface of elevated FATO is concrete. If the surface is metal, it must be insulated/grounded to the extent feasible to eliminate the threat of conducting electricity in the case of a short circuit or lightning strike.

f. 建议升高 FATO 的表面为混凝土。如果表面是金属，则必须尽可能地绝缘/接地，以消除短路或雷击时导电的威胁。

g. Elevated FATOs should be metal or concrete and comply with 29 CFR Section 1926.34 and 29 CFR Section1910.25, as applicable.

g. 升高的 FATO 应该是金属或混凝土，并符合 29 CFR 第 1926.34 节和 29 CFR 第 1910.25 节的规定，视情况而定。

11. The FATO surface prevents loose stones and any other flying debris caused by rotor/propeller downwash or outwash.

11. FATO 表面防止了由于旋翼/螺旋桨向下洗流或向外洗流造成的松散石块和任何其他飞散碎片。

** In 2011, the National EMS Pilots Association conducted a survey of 1,314 EMS pilots and found that the square was the preferred visual cue for judging aircraft closure rate, altitude, attitude, and angle of approach. It was rated as excellent while the circle was rated as acceptable.

** 在 2011 年，国家紧急医疗服务飞行员协会对 1314 名紧急医疗服务飞行员进行了一项调查，发现正方形是判断飞机闭合率、高度、姿态和接近角度的首选视觉线索。它被评为优秀，而圆形被评为可接受。

12. Gradient provides positive drainage (between 1.5 and 5.0 percent) off of and away from the pavement, with a minimum 10-foot wide (3 m wide) rapid runoff shoulder sloped between 3.0 and 5.0 percent, as shown in Figure 2-2. Design a negative gradient of not more than 2 percent in any areas where a VTOL is expected to land.

12. 横坡提供了正坡排水 (介于 1.5% 至 5.0% 之间)，从路面排出并远离路面，具有至少 10 英尺宽的 (3 m 宽) 快速排水肩，坡度在 3.0% 至 5.0% 之间，如图 2-2 所示。在设计 VTOL 预计降落的任何区域，设计不超过 2% 的负坡度。

13. The edge of the FATO abutting the TLOF is the same elevation as the TLOF.

13. FATO 毗邻 TLOF 的边缘与 TLOF 处于同一高度。

14. If the FATO is located on a rooftop or other elevated structures:

14. 如果 FATO 位于屋顶或其他升高结构上:

a. The FATO and TLOF elevations are at or above the elevation of the adjacent Safety Areas.

a. FATO 和 TLOF 的高度在或高于相邻安全区域的水平。

b. The FATO is above the level of any obstacle in the Safety Area that cannot be removed.

b. FATO 高于安全区域内无法移除的任何障碍物的水平。

c. Title 29 CFR Section 1910.28, Duty to Have Fall Protection and Falling Object Protection, requires the provision of fall protection if the platform is elevated 4 feet(1.2m)or more above its surroundings. The FAA recommends such protection for all platforms elevated 30 inches(0.8m)or more.

c. 标题 29 CFR 第 1910.28 节，关于提供防坠落和防落物保护的责任，要求如果平台高于周围环境 4 英尺 (1.2 米) 或更高，则必须提供防坠落保护。联邦航空管理局建议对所有高于 30 英寸 (0.8 米) 的平台采取此类保护措施。

d. Does not use permanent railings or fences that would be safety hazards during aircraft operations.

d. 不使用在飞机运行期间可能成为安全隐患的永久性栏杆或围栏。

e. Optionally, can use safety nets that meet state and local regulations, are at least 5 feet(1.5m)wide, and meet the following criteria:

e. 可选地，可以使用符合州和地方法规的安全网，宽度至少为 5 英尺 (1.5 米)，并满足以下条件:

i. The insides and outside edges of the nets are fastened to a solid structure.

i. 网的内外边缘都固定在坚固的结构上。

ii. The net is constructed of materials that are resistant to environmental effects and is inspected annually for integrity.

ii. 网由能够抵抗环境影响的材料制成，并且每年检查一次其完整性。

iii. The net has a load carrying capability of 50 pounds per square foot (244 kg/sqm).

iii. 网具有每平方英尺 50 磅 (244 kg/sqm) 的承载能力。

iv. The net is located at or below the edge elevation of the FATO.

iv. 网位于 FATO 边缘高度或以下。

v. The net is attached to the outer perimeter frame of the FATO.

v. 网连接到 FATO 的外围框架。

2.4. Safety Area Guidance.

2.4. 安全区域指导。

The Safety Area is a defined area surrounding the FATO intended to reduce the risk of damage to VTOL aircraft unintentionally diverging from the FATO. The following guidelines apply to the Safety Area:

安全区域是围绕 FATO 定义的一个区域，旨在降低垂直起降飞机无意中偏离 FATO 时造成损坏的风险。以下指导原则适用于安全区域:

1. Located at ground level, on elevated structures, at rooftop level, and can extend over water or in clear airspace.

1. 位于地面、elevated structures(这里缺少具体翻译，可能是指“高架结构”)、屋顶层面，并且可以延伸至水面或开阔空域。

2. Clear with no penetrations or obstructions except for navigational aids that are fixed-by-function [††], which must be on frangible mounts. Note: See paragraph 2.3.

2. 无穿透或障碍，除固定功能导航辅助设备 [††] 外，这些设备必须安装在易碎支架上。注意: 参见第 2.3 段。

[††] An air navigation aid that must be positioned in a particular location to provide an essential benefit for aviation is fixed-by-function.

[††] 必须定位在特定位置以向航空提供基本利益的航空导航辅助设备是固定功能的。

3. For elevated TLOFs, no fixed objects within the Safety Area project above the FATO except those fixed-by-function which must be on frangible mounts. Note: See paragraph 2.3.

3. 对于升高的 TLOF，安全区域内 FATO 以上的固定物体不得有任何固定，除固定功能的物体必须安装在易碎支架上之外。注意: 参见第 2.3 段。

4. Minimum width is 1/2D from the edge of the FATO.

4. 最小宽度是从 FATO 边缘的 1/2D 。

5. Minimum length is 1/2D from the edge of the FATO.

5. 最小长度是从 FATO 边缘的 1/2D 。

6. The same geometric shape as the TLOF and FATO.

6. 与 TLOF 和 FATO 相同的几何形状。

7. Design the distance between the TLOF, FATO and Safety Area perimeters to be equidistant regardless of the shape of the TLOF.

7. 设计 TLOF、FATO 和安全区域边界之间的距离，使其无论 TLOF 的形状如何都等距。

8. If at ground level, the surface prevents loose stones and any other flying debris caused by downwash or outwash.

8. 如果在地面上，表面防止松动的石头和由向下洗或向外洗引起的任何其他飞散碎片。

9. If at ground level, gradient provides positive drainage away from the FATO no steeper than 2:1, horizontal units and vertical units, respectively. See Figure 2-2.

9. 如果在地面上，坡度为正，从 FATO 向外排水，坡度不超过 2:1，分别对应水平单位和垂直单位。见图 2-2。

10. On rooftop or other elevated FATOs, meets requirements contained in Section

10. 在屋顶或其他升高的 FATO 上，满足第 1910.28.

2.5.VFR Approach/Departure Guidance.

2.5.VFR 进近/起飞指导。

2.5.1. VFR Approach/Departure and Transitional Surfaces.

2.5.1. VFR 进近/起飞和过渡面。

The imaginary surfaces defined in14CFR Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace, for heliports are applicable to vertiports and include the primary surface, approach, and transitional surfaces. Part 77 establishes standards and notification requirements for objects affecting navigable airspace. This notification provides the basis for:

在 14CFR 第 77 部分“安全、高效使用和保留可航行空域”中定义的想象表面，适用于直升机场，也适用于垂直机场，包括主表面、进近面和过渡面。第 77 部分确立了影响可航行空域的对象的标准和通知要求。该通知为以下内容提供了依据:

- evaluating the effect of construction or alteration on aeronautical operating procedures;
- 评估建设或修改对航空运行程序的影响;
- determining the potential hazardous effect of proposed construction on air navigation;
- 确定拟建建筑对航空导航的潜在危险影响;
- identifying mitigating measures to enhance safe air navigation; and
- 确定缓解措施以增强航空导航的安全性；以及
- aeronautical charting for new objects.
- 为新对象进行航空制图。

The following applies to these imaginary surfaces:

以下适用于这些想象表面:

1. The primary surface coincides in size and shape with the FATO. This surface is a horizontal plane at the elevation of the established vertiport elevation.

1. 主表面与 FATO 的大小和形状相一致。这个表面是与建立的垂直机场标高相同高度的的水平面。

2. The approach surface (and, by reciprocal, the departure surface) begins at each end of the vertiport primary surface with the same width as the primary surface and extends outward and upward for a horizontal distance of 4,000 feet(1,219m)where its width is 500feet (152 m) . The slope of the approach surface is 8:1, horizontal units and vertical units, respectively.

2. 进近面 (以及相对应的起飞面) 在垂直机场主表面的每端开始，宽度与主表面相同，向外和向上延伸 4,000 英尺 (1,219 米)，在其宽度为 500feet (152 m) 处。进近面的坡度为 8:1，分别是水平单位和垂直单位。

3. The transitional surfaces extend outward and upward from the lateral boundaries of the primary surface and from the approach surfaces at a slope of 2:1, horizontal units and vertical units, respectively, for 250feet (76 m) measured horizontally from the centerline of the primary and approach surfaces.

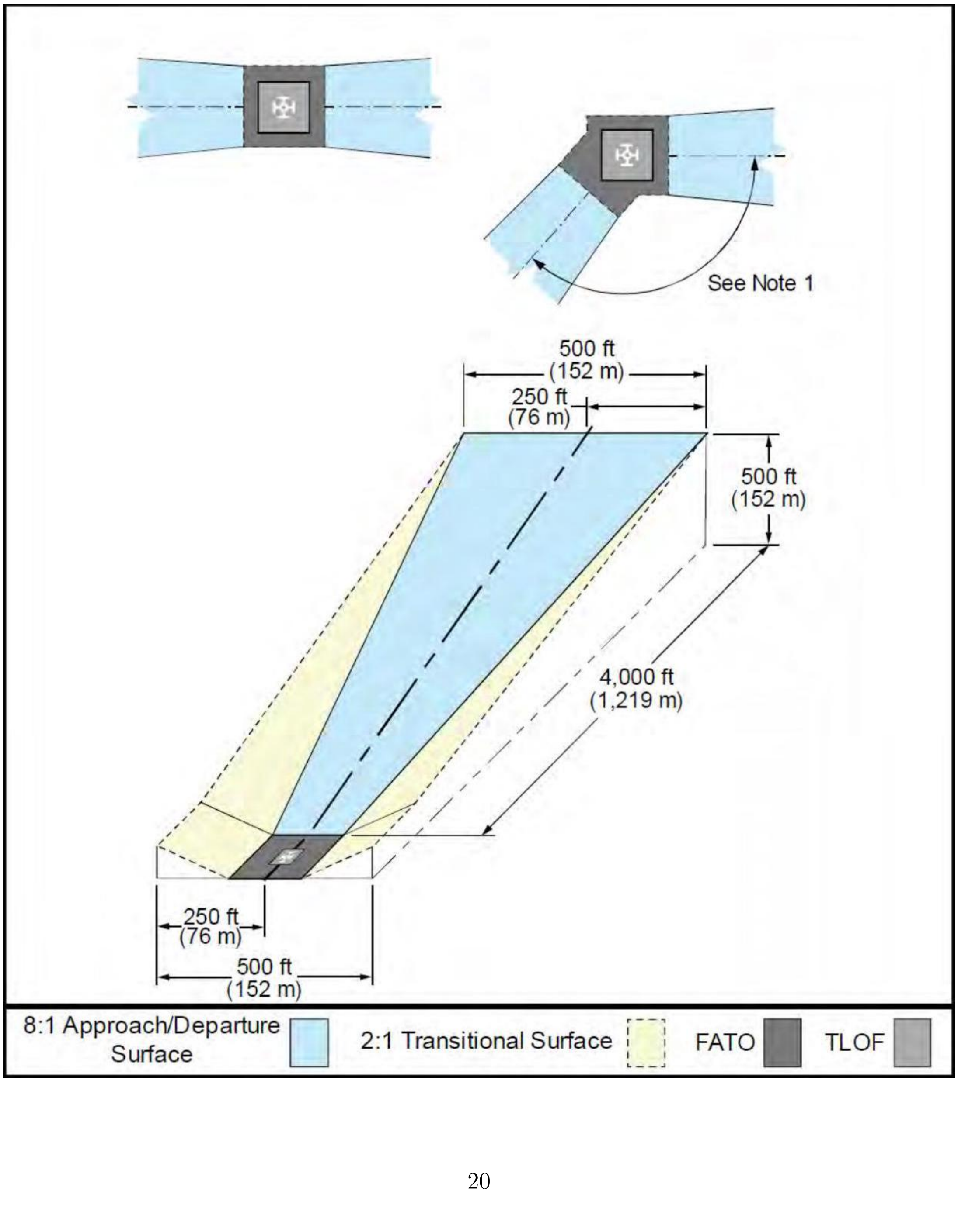
3. 过渡面从主表面的侧边界和进近面向外和向上延伸，坡度为 2:1，分别是水平单位和垂直单位，对于从主表面和进近面中心线测量的 250feet (76 m) 水平距离。

4. The approach and transitional surfaces are clear of penetrations unless an FAA aeronautical study determines penetrations to any of these surfaces not to be hazards.

4. 进近面和过渡面在没有 FAA 航空研究确定穿透这些表面的任何穿透不是危险的情况下，应保持无穿透。

See Figure 2-3 for visual depiction of this guidance.

参见图 2-3，以视觉呈现此指导。



Note 1: The preferred approach/departure surface is based on the predominant wind direction. Where a reciprocal approach/departure surface is not possible in the opposite direction, use a minimum 135-degree angle between the two surfaces.

备注 1: 优选的进近/离场面基于主导风向。在相反方向上无法实现互换来进近/离场面时，请使用两个面之间至少 135 度的角度。

2.5.2.VFR Approach/Departure Path.

2.5.2. VFR 进近/离场路径。

The approach/departure path is the flight track that VTOL aircraft follow when landing at or taking off from a vertiport. The following guidelines apply to the approach/departure path(s):

进近/离场路径是 VTOL 飞机在降落或从垂直机场起飞时遵循的飞行轨迹。以下准则适用于进近/离场路径:

1. Preferred approach/departure paths are aligned with the predominant wind direction as much as possible, to avoid downwind operations and keep crosswind operations to a minimum.

1. 优选的进近/离场路径尽可能与主导风向对齐，以避免逆风操作并将侧风操作降至最低。

2. More than one approach/departure path is provided as close to reciprocal in magnetic heading as possible (e.g., 180 degrees and 360 degrees).

2. 提供一个以上的进近/离场路径，尽可能接近相反的磁航向 (例如，180 度和 360 度)。

3. Additional approach/departure paths are based on an assessment of the prevailing winds or separated from the preferred flight path by at least but not limited to 135 degrees.

3. 额外的进近/离场路径基于对主导风的评估或与优选飞行路径至少分离 135 度。

4. All approach and departure surfaces are free of obstructions.

4. 所有进近和离场面均无障碍物。

5. The approach/departure paths must assure 8:1 horizontal units and vertical units.

5. 进近/离场路径必须确保水平单位和垂直单位为 8:1。

6. To the extent practicable, design vertiport approach/departure paths to be independent of approaches to, and departures from, active runways if separate vertiport takeoff and landing areas are needed.

6. 在可行范围内，设计垂直机场的进近/离场路径，使其独立于活动跑道的进近和离场，如果需要单独的垂直机场起飞和降落区域。

7. The approach and departure path may be curved but only the VFR approach/departure and transitional surfaces outlined in paragraph 2.5.1 are addressed in 14 CFR Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace. Therefore, while they may be used, curved approaches are not evaluated by the FAA for the effect of objects (temporary or permanent, existing or new) on aeronautical operating procedures. These curved approaches are also not considered in aeronautical charting for new objects.

7. 接近和离场路径可以是曲线，但仅第 2.5.1 段中概述的 VFR 接近/离场和过渡面在 14 CFR 第 77 部分《导航空域的安全、高效使用和保存》中予以考虑。因此，虽然可以使用曲线接近，但联邦航空局 (FAA) 不对物体 (临时或永久，现有或新建) 对航空运行程序的影响进行评估。这些曲线接近路径也不会在新物体的航空制图中予以考虑。

See Figure 2-3 for a visual depiction of this guidance.

参见图 2-3，以直观展示此指导。

3.0 Marking, Lighting, and Visual Aids.

3.0 标志、照明和视觉辅助设施。

This section provides guidance on marking, lighting, and visual aids that identify the facility as a vertiport. This guidance applies to new vertiports or to heliports that are altered to vertiports. 3.1. General. The following general guidelines apply to markings:

本节提供了关于标志、照明和视觉辅助设施的指导，这些设施用于将设施标识为垂直机场 (vertiport)。本指导适用于新建的垂直机场或改为垂直机场的直升机机场。3.1 一般规定。以下一般性指导适用于标志:

1. Paint or preformed materials define the TLOF and FATO within the limits of those areas. See AC 150/5370-10, Item P-620, for specifications.

1. 油漆或预成型材料在那些区域的限制内定义了 TLOF 和 FATO。有关规格，请参见 AC 150/5370-10，项目 P-620。

2. Reflective paint and retroreflective markers are optional and should be used with caution, as overuse of reflective material can be blinding to a pilot when using landing lights and/or night vision goggles.

2. 反光漆和反光标记是可选的，应谨慎使用，因为过多使用反光材料可能会在使用着陆灯和/或夜视镜时使飞行员眼花缭乱。

3. Outlining markings and lines with a $2-6-$ inch (55 − 152 mm) -wide line of a contrasting color is an option to enhance conspicuousness.

3. 使用 $2-6-$ inch (55 − 152 mm) 宽的对比色线条勾勒标志和线条是提高显眼性的一个选项。

4. TLOF perimeter marking is a 12-inch-wide(305mmwide)solid white line.

4. TLOF 周边标志是一条 12 英寸宽 (305 毫米宽) 的实心白色线条。

5. TLOF size and weight limitation box is included on a TLOF with a hard surface (described in paragraph 3.3) and as an option on a TLOF with a turf surface.

5. TLOF 尺寸和重量限制框包含在带有硬表面 (在第 3.3 段中描述) 的 TLOF 上，并在带有草皮表面的 TLOF 上作为可选项目。

6. FATO perimeter is marked by 12-inch-wide (305 mm wide) dashed white lines that are 5 feet(1.5m)in length with end-to-end spacing of 5 to 6 feet(1.5to1.8m) apart.

6. FATO 边界由 12 英寸宽 (305 mm 的虚线标出，这些虚线长 5 英尺 (1.5 米)，端对端间距为 5 至 6 英尺 (1.5 至 1.8 米)。

See Figure 3-1 for a visual depiction of the standard vertiport marking.

参见图 3-1，了解标准垂起降场标记的可视化描绘。

Figure 3-1: Standard Vertiport Marking

图 3-1: 标准垂起降场标记

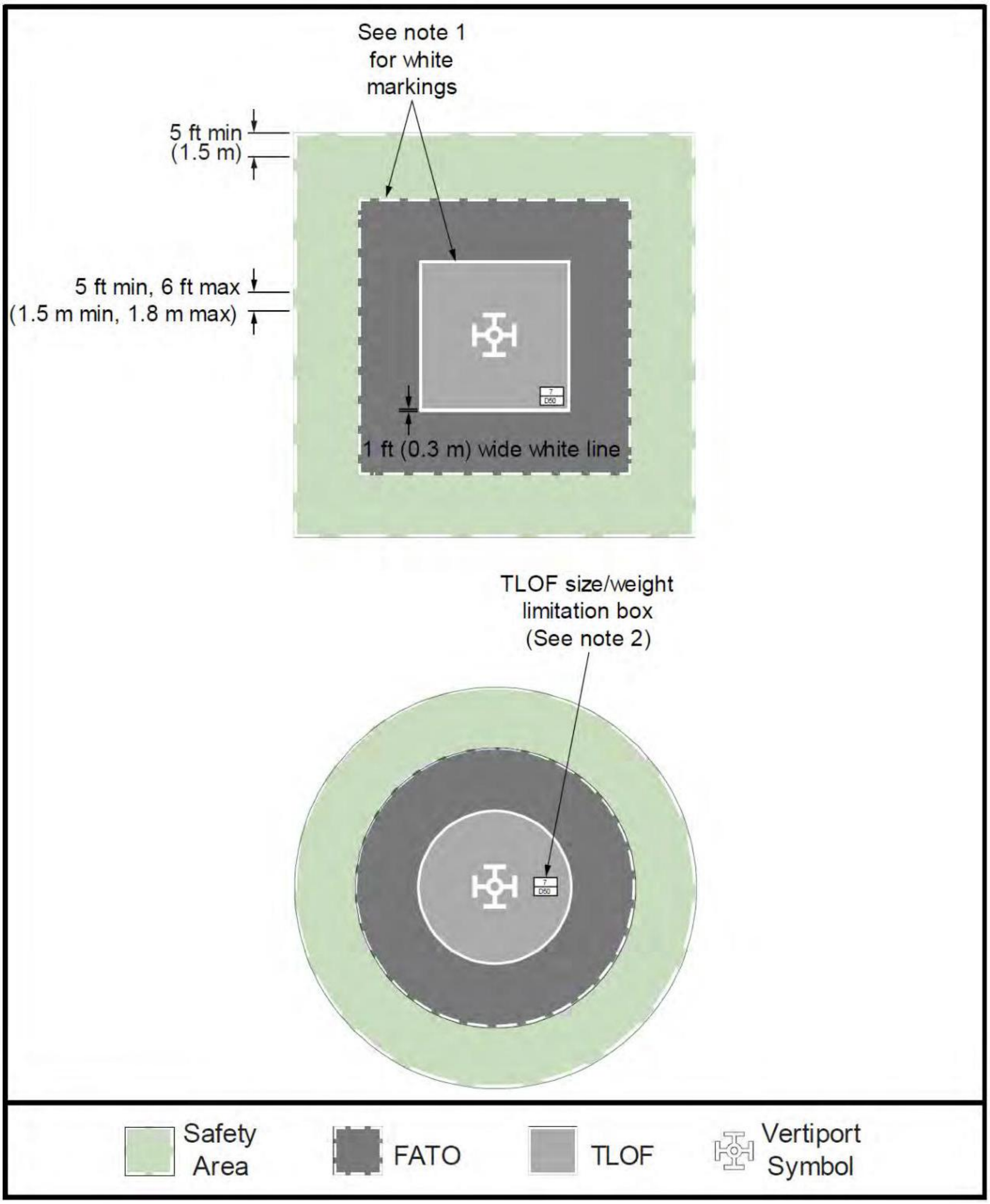


Figure is configured for 50-foot (15.2 m) TLOF.
图为 50 英尺 (15.2 米)TLOF 配置。
Note 1: Solid and dashed white lines are12inches(305mm)in width. Dashed lines are5-foot(1.5m)in length with 5-6-foot (1.5-1.8 m) spaces.
备注 1: 实线和虚线均为 12 英寸 (305 毫米) 宽。虚线长 5 英尺 (1.5 米)，间距为 5-6 英尺 (1.5-1.8 米)。
Note 2: See Figure 3-3 for details on the TLOF size/weight limitation box.
备注 2: 见图 3-3，了解 TLOF 尺寸/重量限制框的详细信息。

3.2. Identification Symbol.

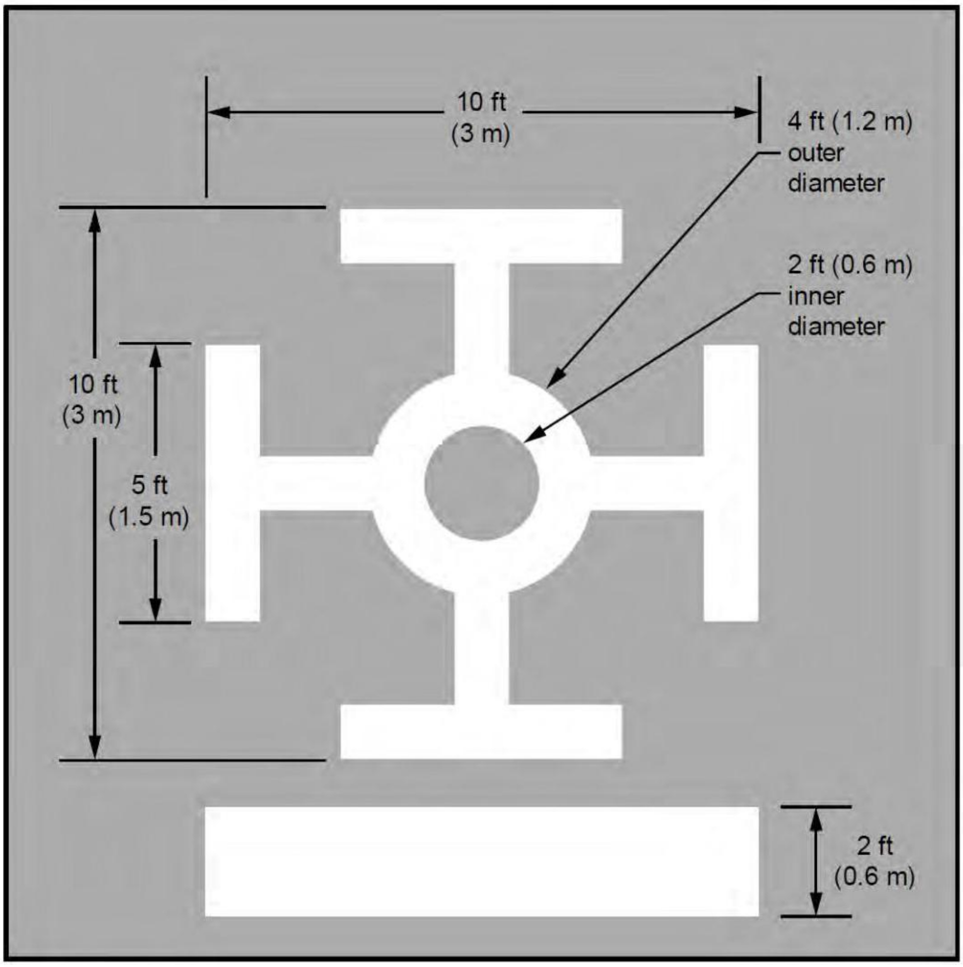
3.2. 识别符号。

The vertiport identification marking or symbol identifies the location as a vertiport, marks the TLOF, and provides visual cues to the pilot. Vertiport facilities should use the broken wheel symbol shown in Figure 3-2.# The symbol is in the center of the TLOF. Paint a 2-foot-wide(0.6mwide)bar, of the same color as the broken wheel, 2ft (0.6 m) below the broken wheel symbol when necessary to distinguish the preferred approach/departure direction.

垂起降场识别标记或符号用于标明该地点为垂起降场，标出 TLOF，并为飞行员提供视觉提示。垂起降场设施应使用图 3-2 所示的断裂轮符号。# 该符号位于 TLOF 的中心。在需要区分首选的进近/离场方向时，在断裂轮符号下方画一条 2 英尺宽 (0.6 米宽) 的条，颜色与断裂轮相同 2ft (0.6 m) 。

Figure 3-2: Vertiport Identification Symbol

图 3-2: 垂起降场识别符号



Note 1: White lines on the vertiport identification symbol at 12 inches(305mm)wide. Note 2: White bar, 10ft × 2ft (3 m × 0.6 m) , denotes preferred approach/departure direction.

备注 1: 垂起降场识别符号上的白线宽 12 英寸 (305 毫米)。备注 2: 白条 10ft × 2ft (3 m × 0.6 m) 表示首选的进近/离场方向。

The broken wheel symbol placed second in a research test conducted in 1967 for most visible and informative symbol for heliports. The most visible and informative was a Maltese Cross, which the FAA adopted for heliports and then repealed. The broken wheel symbol performs the following functions: identifies the vertiport from a minimum distance and angle; offers a means of directional control on approach; serves as a field of reference in maintaining attitude on approach; assists the pilot in controlling the rate of closure on approach; acts as a point of convergence to a desired location; and assists the pilot when the aircraft is directly over the vertiport. It was adopted by the now cancelled Vertiport Design AC. (Smith, Safe Heliports Through Design and Planning, 1994, p. 41).

1967 年进行的一项研究中，损坏的轮子符号在直升机机场最显眼和信息量最大的符号测试中排名第二。最显眼且信息量最大的是马耳他十字架，联邦航空管理局 (FAA) 曾将其用于直升机机场，后来又废除。损坏的轮子符号具有以下功能: 从最小距离和角度识别直升机机场；在接近时提供方向控制的手段；在接近时作为保持姿态的参考场；帮助飞行员控制接近时的闭合速率；作为汇聚到期望位置的点；当飞机直接在直升机机场上空时，帮助飞行员。它被现已取消的直升机机场设计准则 (Vertiport Design AC) 采用。(Smith, Safe Heliports Through Design and Planning, 1994, p. 41)。

3.3. TLOF Size/Weight Limitation Box.

3.3. TLOF 尺寸/重量限制框。

The TLOF size/weight limitation box indicates the controlling dimension (maximum length or width) and the maximum takeoff weight of the design VTOL aircraft that can use the vertiport. Weight limitation boxes should meet the following guidance:

TLOF 尺寸/重量限制框标明了控制尺寸 (最大长度或宽度) 和设计垂直起降飞机 (VTOL) 在该直升机机场使用的最大起飞重量。重量限制框应遵循以下指导原则:

1. The letter ”D” and the weight, in imperial units, of the design VTOL aircraft that the vertiport is designed to accommodate are in a box in the lower right-hand corner of a rectangular TLOF, or on the right-hand side of the symbol of a circular TLOF, when viewed from the preferred approach direction.

1. 字母“D”和设计垂直起降飞机的重量 (以英制单位表示)，该直升机机场旨在容纳，位于矩形 TLOF 右下角的框中，或者从首选接近方向观看时，位于圆形 TLOF 符号的右侧。

2. The numbers are black on a white background.

2. 数字在白色背景上为黑色。

3. The top number is the maximum takeoff weight of the design VTOL aircraft in thousands of pounds for the design VTOL the TLOF will accommodate. It is centered in the top half of the box.

3. 上面的数字是 TLOF 将容纳的设计垂直起降飞机的最大起飞重量 (以千磅为单位)。它位于框的上半部分中央。

4. The bottom number is the controlling dimension of the design VTOL aircraft, is centered in the bottom half of the box, and is preceded by the letter ”D.”

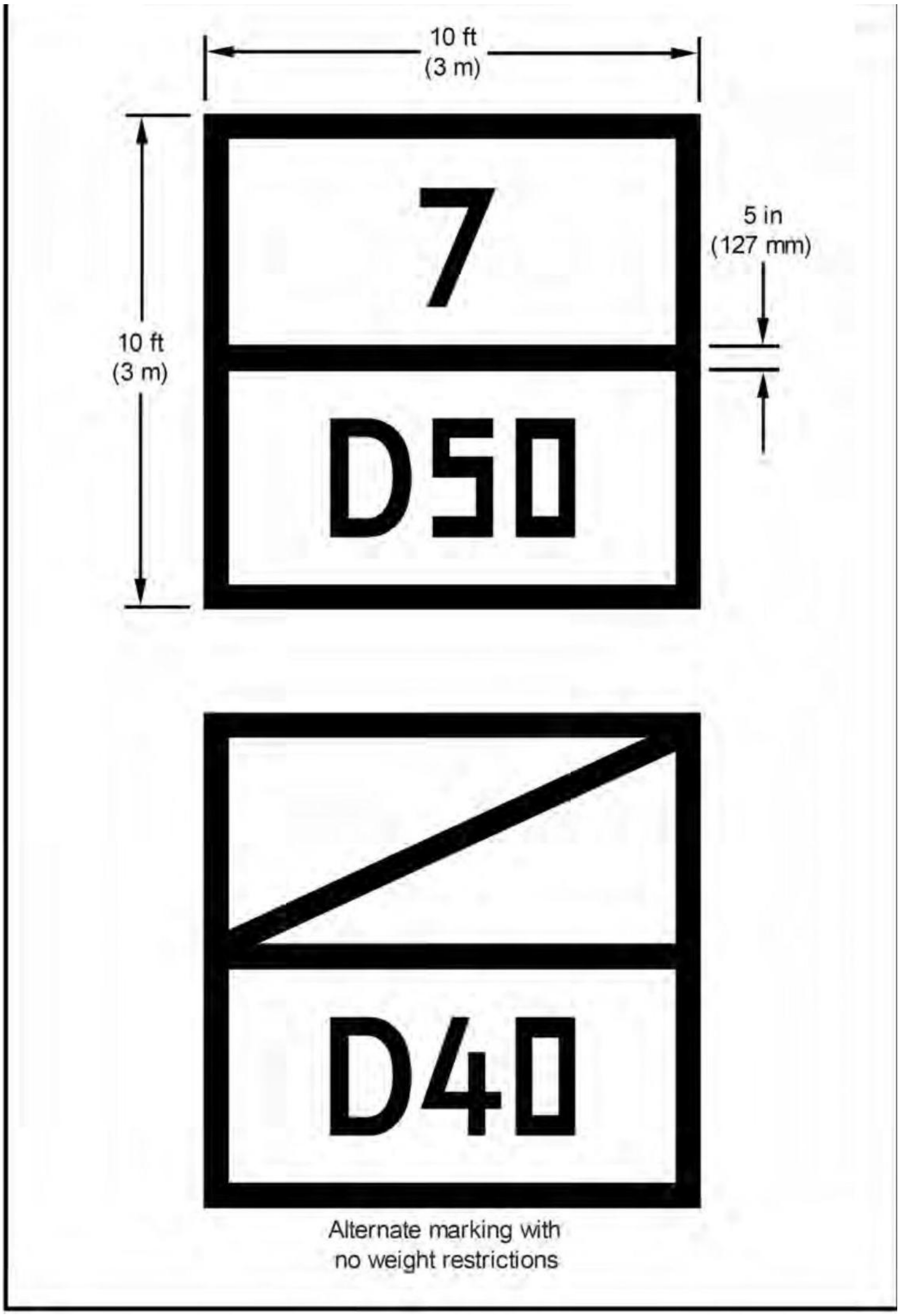
4. 下面的数字是设计垂直起降飞机的控制尺寸，位于框的下半部分中央，前面有字母“D”。

5. An existing TLOF without a weight limit is marked with a diagonal line extending from the lower left-hand corner to the upper right-hand corner in the upper section of the TLOF size/weight limitation box.

5. 在 TLOF 尺寸/重量限制框的上方部分，用一个从左下角延伸到右上角的斜线标记一个没有重量限制的现有 TLOF。

See Figure 3-3 for details on the TLOF size/weight limitation box, and Figure 3-4 and Figure 3-5 for details on the form and proportions of the numbers and letters specified for these markings. 3.4. Flight Path Alignment Optional Marking and Lighting.

参见图 3-3 了解 TLOF 尺寸/重量限制框的详细信息，以及图 3-4 和图 3-5 了解这些标记指定的数字和字母的形状和比例。3.4. 航路对齐可选标记和照明。



Note: Make the minimum size of the box 5ft (1.5 m) square. Where possible, increase this dimension to a 10ft (3 m) square for improved visibility.

注意: 使框的最小尺寸 5ft (1.5 m) 为正方形。在可能的情况下，将此尺寸增加到 10ft (3 m) 正方形以提高可见性。

Figure 3-4: Form and Proportions of 36-inch(914mm)Numbers for Marking Size
图 3-4:36 英寸 (914 毫米) 标记尺寸的数字形状和比例
and Weight Limitations
以及重量限制

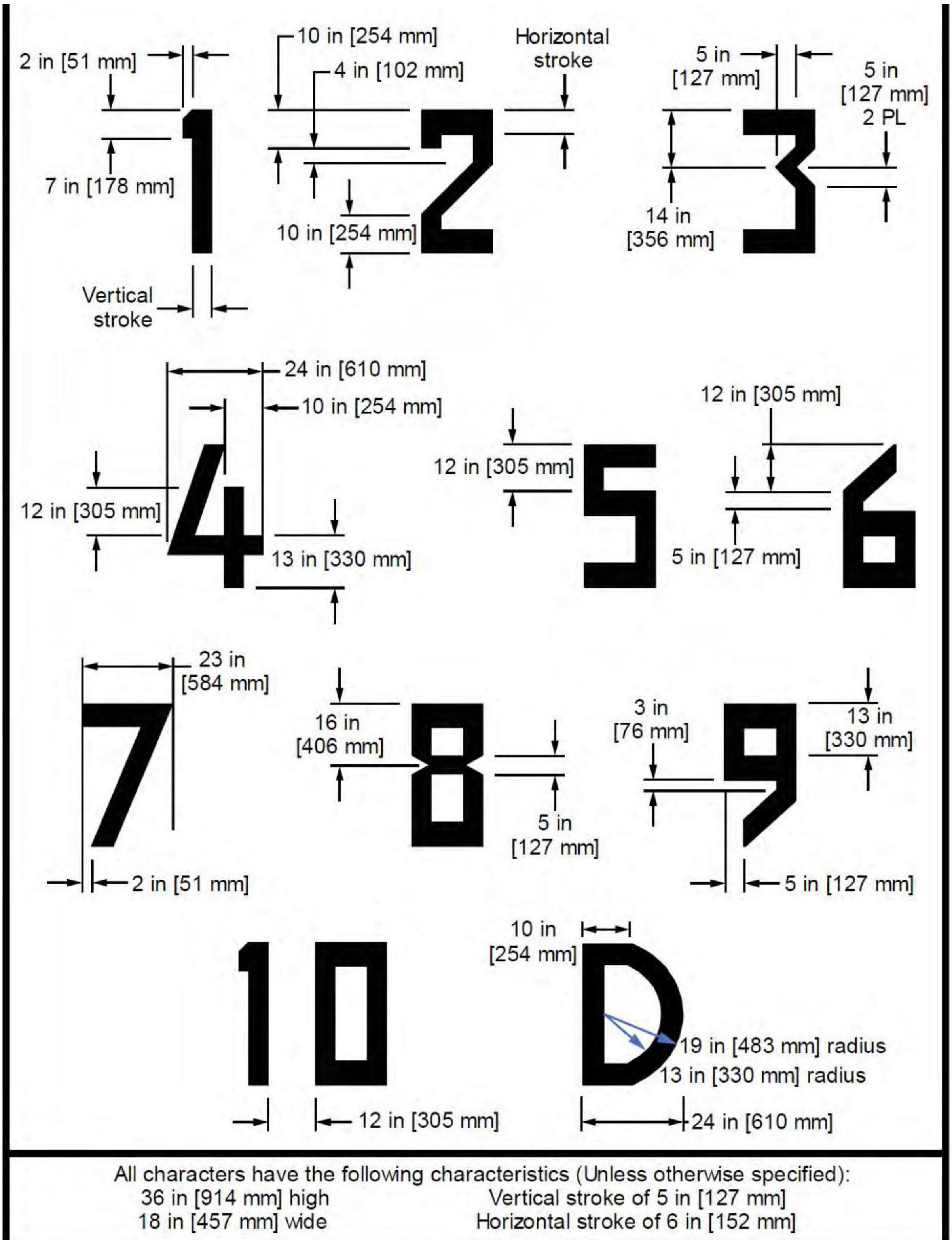
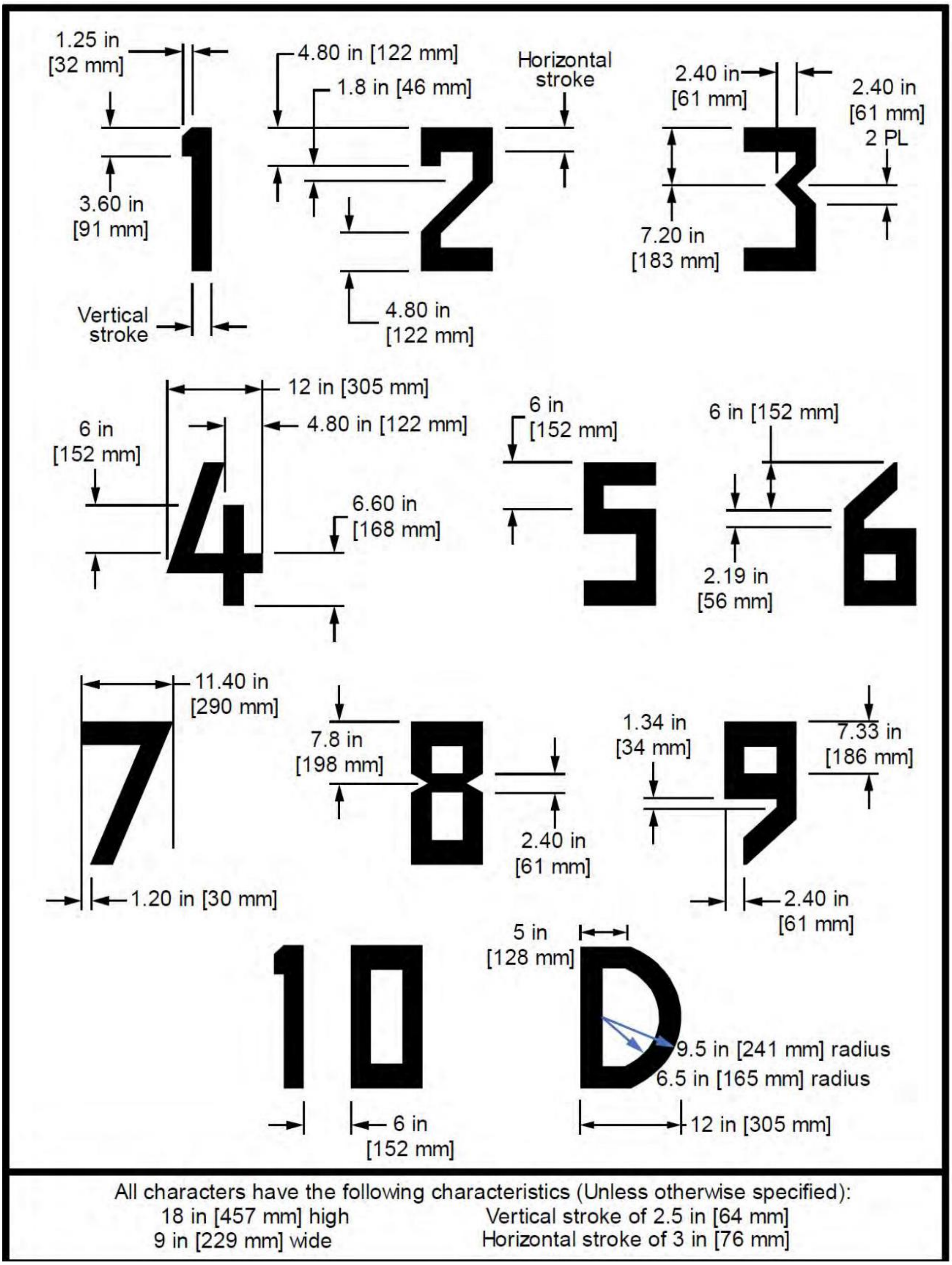


Figure 3-5: Form and Proportions of 18-inch(457mm)Numbers for Marking Size and Weight Limitations
图 3-5:18 英寸 (457 毫米) 标记尺寸和重量限制的数字形状和比例



Flight path alignment marking and lighting is optional and includes markings and/or lights when it is desirable and practicable to indicate available approach and/or departure flight path direction(s). Guidance for optional flight path alignment marking and lighting includes:

航路对齐标记和照明是可选的，包括在需要且实际可行的情况下指示可用的进近和/或起飞航路方向标记和/或灯光。可选航路对齐标记和照明的指导包括:

1. The shaft of each arrow is 1.5ft (0.5 m) wide and at least 10feet (3 m) long.

1. 每个箭杆的宽度为 1.5ft (0.5 m) ，且至少长度为 10feet (3 m) 。

2. The arrow heads are 5 feet(1.5m)wide and 5 feet(1.5m)tall.

2. 箭头宽度为 5 英尺 (1.5 米)，高度为 5 英尺 (1.5 米)。

3. The color of the arrow must provide good contrast against the background color of the surface. Provide a contrasting border around the arrows if needed to increase visibility for the pilot.

3. 箭头的颜色必须与表面的背景颜色形成良好的对比。如果需要提高飞行员的可见性，请在箭头周围提供对比边框。

4. An arrow pointing toward the center of the TLOF depicts an approach direction.

4. 指向 TLOF 中心的箭头表示进近方向。

5. An arrow pointing away from the center of the TLOF depicts a departure direction.

5. 一个指向 TLOF 中心之外的箭头表示出发方向。

6. In-pavement flight path alignment lighting is recommended. See paragraph 3.5 for additional guidance. For elevated lights, if the TLOF light conflicts with a flight path alignment light, remove the conflicting flight path alignment light fixture.

6. 建议使用路面飞行路径对齐照明。参见第 3.5 节以获取更多信息。对于升高灯具，如果 TLOF 灯光与飞行路径对齐灯光冲突，则移除冲突的飞行路径对齐灯具。

7. For a vertiport with a flight path limited to a single approach direction or a single departure path, the arrow marking is unidirectional (i.e., one arrowhead only). For a vertiport with only a bidirectional approach/takeoff flight path available, the arrow marking is bidirectional (i.e., two arrowheads).

7. 对于飞行路径仅限于单一进近方向或单一出发路径的垂直机场，箭头标记是单向的 (即只有一个箭头)。对于只有双向进近/起飞飞行路径可用的垂直机场，箭头标记是双向的 (即有两个箭头)。

See Figure 3-6 for additional guidance.

参见图 3-6 以获取更多信息。

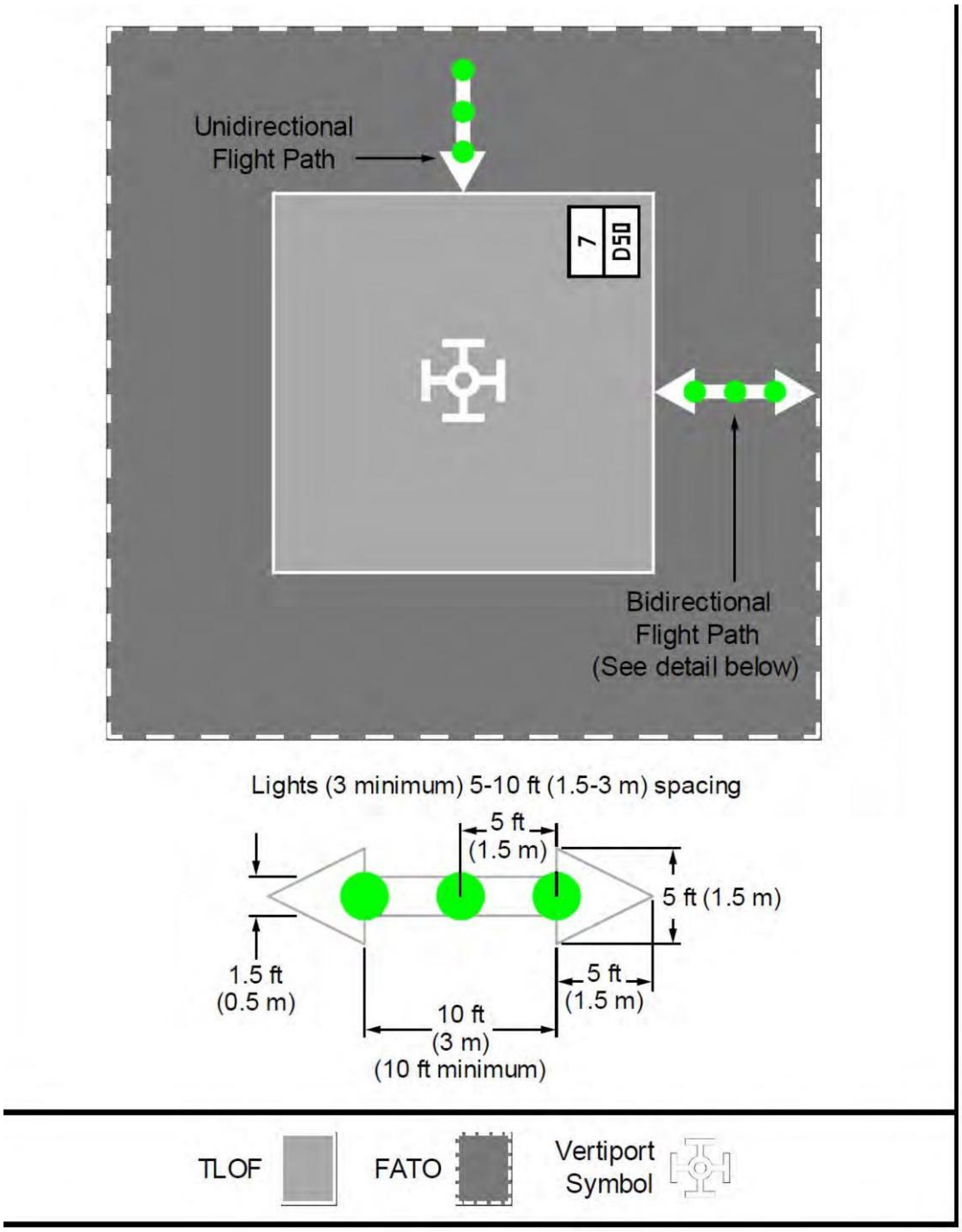


Figure is configured for 50 -foot(15.2m)TLOF
图形配置适用于 50 英尺 (15.2 米)TLOF。
Note 1: Arrowheads have constant dimensions.
注意 1: 箭头具有恒定的尺寸。
Note 2: If necessary, adjust stroke length to match length available. Minimum length = 10ft (3 m) .
注意 2: 如有必要，调整笔划长度以匹配可用长度。最小长度 = 10ft (3 m) 。
Note 3: Light type: omnidirectional green lights, Type L-861H or L-852H.
注意 3: 灯光类型: 全向绿色灯光，类型 L-861H 或 L-852H。
Note 4: If necessary, locate the lights outside of the arrow.
注意 4: 如有必要，将灯光置于箭头之外。
Note 5: In-pavement flight path alignment lighting is recommended.
注意 5: 建议使用路面飞行路径对齐照明。
Note 6: See paragraph 3.4 for guidance on flight path alignment markings.
注意 6: 参见第 3.4 节以获取关于飞行路径对齐标记的指导。

3.5. Lighting.

3.5. 照明。

Lighting is required for vertiports that support night operations. The lighting should enable the pilot to both establish the location of the vertiport and identify the perimeter of the operational area.

In-pavement lighting is preferred to elevated lighting. The following guidelines apply to lighting:

对于支持夜间运行的垂直起降场，照明是必需的。照明应使飞行员能够确定垂直起降场的位置并识别操作区域的边界。与升高照明相比，地面嵌入式照明更为首选。以下指导原则适用于照明:

3.5.1. General.

3.5.1. 一般规定。

1. The FAA type L-861H omnidirectional perimeter light fixture supports all possible directions of approach. AC 150/5390-2 provides the standards for the FAA type L- 861H light fixture.

1. FAA 型号 L-861H 全方位边界照明灯具支持所有可能的接近方向。AC 150/5390-2 提供了 FAA 型号 L- 861H 灯具的标准。

2. For reference, the light fixtures are listed in AC 150/5390-2 as FAA type L-861H, elevated heliport perimeter light, and Type L-852H, in-pavement heliport perimeter light.

2. 作为参考，灯具在 AC 150/5390-2 中被列为 FAA 型号 L-861H，升高式直升机起降场边界灯和型号 L-852H，地面嵌入式直升机起降场边界灯。

3. With light fixture FAA type L-861H as the base, elevated (FAA type L-861H) and in-pavement (FAA type L-852H) fixtures will be established in the next update of AC 150/5345-46, Specification for Runway and Taxiway Light Fixtures. Use FAA type L-861H for TLOF and FATO perimeter applications and for Flight Path Alignment Lights and Landing Direction Lights. See AC 150/5390-2 and AC 150/5345-46 for additional information.

3. 以 FAA 型号 L-861H 灯具为基础，升高式 (FAA 型号 L-861H) 和地面嵌入式 (FAA 型号 L-852H) 灯具将在下一次更新的 AC 150/5345-46 中设立，该规范适用于跑道和滑行道灯具。在 TLOF 和 FATO 边界应用以及飞行路径校准灯和着陆方向灯中使用 FAA 型号 L-861H。有关更多信息，请参见 AC 150/5390-2 和 AC 150/5345-46。

4. The elevated light emitting diode (LED) vertiport fixture and LED in-pavement fixtures are identified as L-861H (L) and L-852H (L), respectively.

4. 升高式发光二极管 (LED) 垂直起降场灯具和 LED 地面嵌入式灯具分别被标识为 L-861H (L) 和 L-852H (L)。

5. Perimeter light fixtures must meet chromaticity requirements for "aviation green" per SAE AS 25050, Colors, Aeronautical Lights and Lighting Equipment, General Requirements, when using incandescent lights. For light fixtures that use LEDs, see the standards in EB 67, Light Sources Other Than Incandescent and Xenon For Airport and Obstruction Lighting Fixtures.

5. 周边照明设备必须符合 SAE AS 25050 标准中规定的“航空绿色”色度要求，该标准为《航空灯光和照明设备颜色、一般要求》。当使用白炽灯时，应符合此要求。对于使用 LED 的照明设备，请参见 EB 67 标准中的规定，该标准涉及机场和障碍照明设备中除白炽灯和氙灯外的光源。

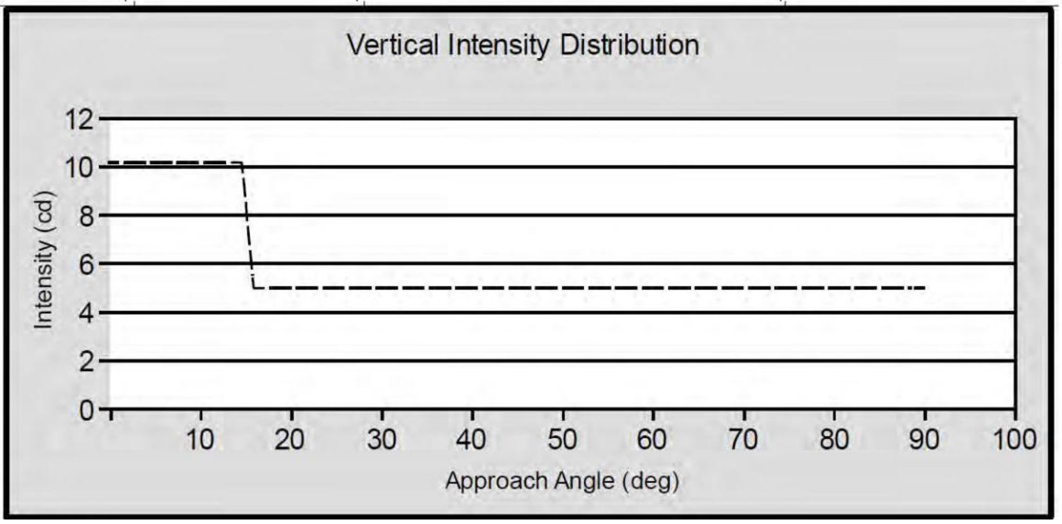
6. Photometric standards for perimeter light fixtures are included in Table 3-1. See AC 150/5345-46, paragraph 3.3, Photometric Requirements, for detailed measurement methods and standards.

6. 周边照明设备的光度标准包含在表 3-1 中。详细测量方法和标准请参见 AC 150/5345-46 文档第 3.3 节“光度要求”。

Table 3-1: Perimeter Lighting Intensity and Distribution

表 3-1: 周边照明强度和分布

	Approach Angle 0 to 15 degrees		Approach Angle 16 to 90 degrees
Color	Minimum	Minimum average intensity	Minimum
Green	10 cd	15 cd	5 cd



7. Elevated perimeter light fixtures will be installed in a load-bearing light base (L- 868, Size B) or non-load-bearing light base (L-867, Size B) per AC 150/5345-42, Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories. Shallow base type light bases will not be used.

7. 提升的周边照明设备将安装在承重灯座 (L-868，B 型) 或非承重灯座 (L-867，B 型) 上，具体按照 AC 150/5345-42 文档《机场灯座、变压器外壳、接线盒及附件规范》。不得使用浅基型灯座。

8. Installation of vertiport lighting is to be in accordance with AC 150/5340-30, Design and Installation Details for Airport Visual Aids.

8. 机场起降区照明设备的安装应遵循 AC 150/5340-30 文档《机场视觉助航设备设计和安装细节》的规定。

3.5.2. In-Pavement Perimeter Lights on TLOF and FATO.

3.5.2. TLOF 和 FATO 上的嵌入式周边照明。

1. TLOF perimeter lights are green and FAA type L-861H (AC 150/5345-46) or FAA type L-852H. LED versions of FAA type L-861H and L-852H are per AC 150/5345-46 and EB 87.

1. TLOF 周边照明为绿色，符合 FAA 类型 L-861H(AC 150/5345-46) 或 FAA 类型 L-852H。LED 版本的 FAA 类型 L-861H 和 L-852H 按照 AC 150/5345-46 和 EB 87 标准执行。

2. A square TLOF has:

2. 方形 TLOF 有:

a. One light in each corner.

a. 每个角落安装一盏灯。

b. Lights uniformly spaced between the corners with no less than five lights on each side.

b. 灯光均匀分布在角落之间，每边至少有五盏灯。

c. Lights spaced no more than 25 feet(7.6m)apart.

c. 灯光间隔不超过 25 英尺 (7.6 米)。

d. A light along the centerline of the approach.

d. 接近中线上的灯光。

3. A circular TLOF has:

3. 圆形 TLOF 具有:

a. An even number of lights

a. 灯光数量为偶数

b. Minimum of eight lights uniformly spaced.

b. 最少八个灯光，均匀分布。

4. TLOF lights are within 1 foot(0.3m)inside or outside of the perimeter line.

4. TLOF 灯光在边界线内外 1 英尺 (0.3 米) 范围内。

5. TLOF lights are installed in accordance with AC 150/5340-30.

5. TLOF 灯光的安装符合 AC 150/5340-30 规定。

6. Flight path alignment arrow lighting is recommended for night operations and includes a minimum of three lights spaced 5-10 feet (1.5 to 3 m) apart. These lights may extend across the TLOF, FATO, Safety Area, or any suitable surface in the immediate vicinity of the FATO or Safety Area, if necessary.

6. 飞行路径对齐箭头照明在夜间运行中推荐使用，并包括至少三个灯光，间隔 5-10 英尺 (1.5 至 3 m) 距离。这些灯光可根据需要延伸至 TLOF、FATO、安全区域或 FATO 或安全区域附近的任何合适表面。

7. FATO perimeter lights are optional.

7. FATO 边界灯光是可选的。

8. If installed, FATO perimeter lights are green and FAA type L-861H (AC 150/5345- 46) or FAA type L-852H. LED versions of FAA type L-861H and L-852H are per AC 150/5345-46 and EB 87.

8. 如果安装，FATO 边界灯光为绿色，符合 FAA 类型 L-861H(AC 150/5345-46) 或 FAA 类型 L-852H。FAA 类型 L-861H 和 L-852H 的 LED 版本符合 AC 150/5345-46 和 EB 87。

9. A square FATO has:

9. 方形 FATO 具有:

a. One light in each corner.

a. 每个角落有一个灯光。

b. Lights uniformly spaced between the corners with no less than five lights on each side.

b. 角落之间均匀分布的灯光，每侧至少有五盏灯。

c. Lights spaced no more than 25 feet(7.6m)apart.

c. 灯光间隔不超过 25 英尺 (7.6 米)。

d. A light along the centerline of the approach.

d. 接近中心线上有一盏灯。

10. A circular FATO has:

10. 圆形 FATO 具有:

a. An even number of lights

a. 偶数个灯光

b. Minimum of 8 lights uniformly spaced.

b. 至少 8 个灯光均匀分布。

11. FATO lights are within1foot(0.3m)of the inside or outside of the perimeter line.

11. FATO 灯光在内部或外部边界线 1 英尺 (0.3 米) 范围内。

12. Approach lights are optional. When installed they include a line of five green, omnidirectional lights located on the centerline of the preferred approach/departure path. The first light is 30 to 60 feet (9.1 to 18.3 m) from the TLOF. Remaining lights are spaced at15-foot(4.6m)intervals aligned on the centerline of the approach path.

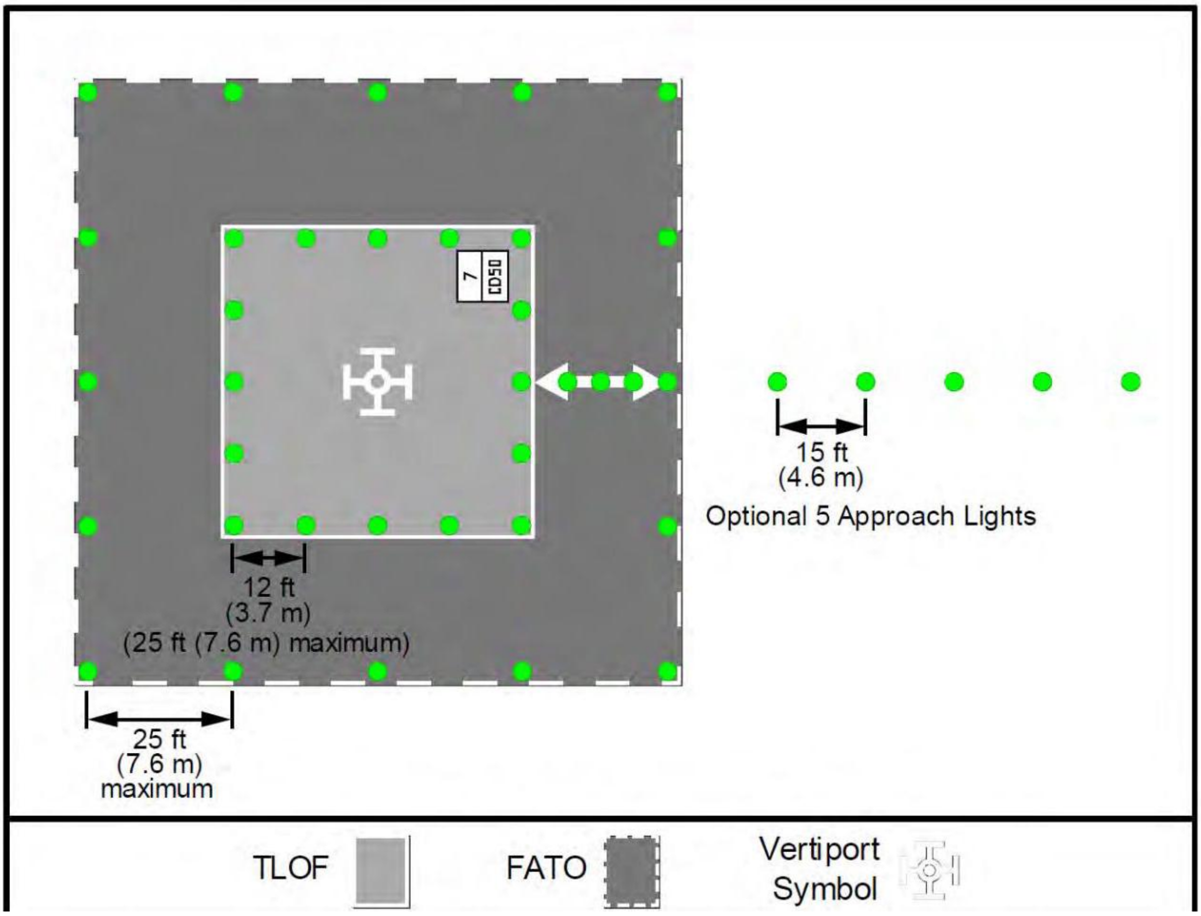
12. 接近灯光是可选的。当安装时，它们包括一条由五个绿色、全向性的灯光组成的线，位于首选的接近/离开路径的中心线上。第一盏灯距离 TLOF 30 至 60 英尺 (9.1 至 18.3 m)。其余灯光以 15 英尺 (4.6 米) 间隔均匀分布在接近路径的中心线上。

See Figure 3-7 for additional guidance on perimeter lighting for surface level vertiports. See Figure 3-8 and Figure 3-9 for guidance for lighting for elevated vertiports.

参见图 3-7，获取关于地表水平起降场的围栏照明附加指导。参见图 3-8 和图 3-9，获取关于升高起降场的照明指导。

Figure 3-7: TLOF/FATO Perimeter Lighting

图 3-7:TLOF/FATO 围栏照明



Note 1: In-pavement lights are within 1 foot(0.3m)of the inside or outside of the TLOF and FATO respective perimeters.

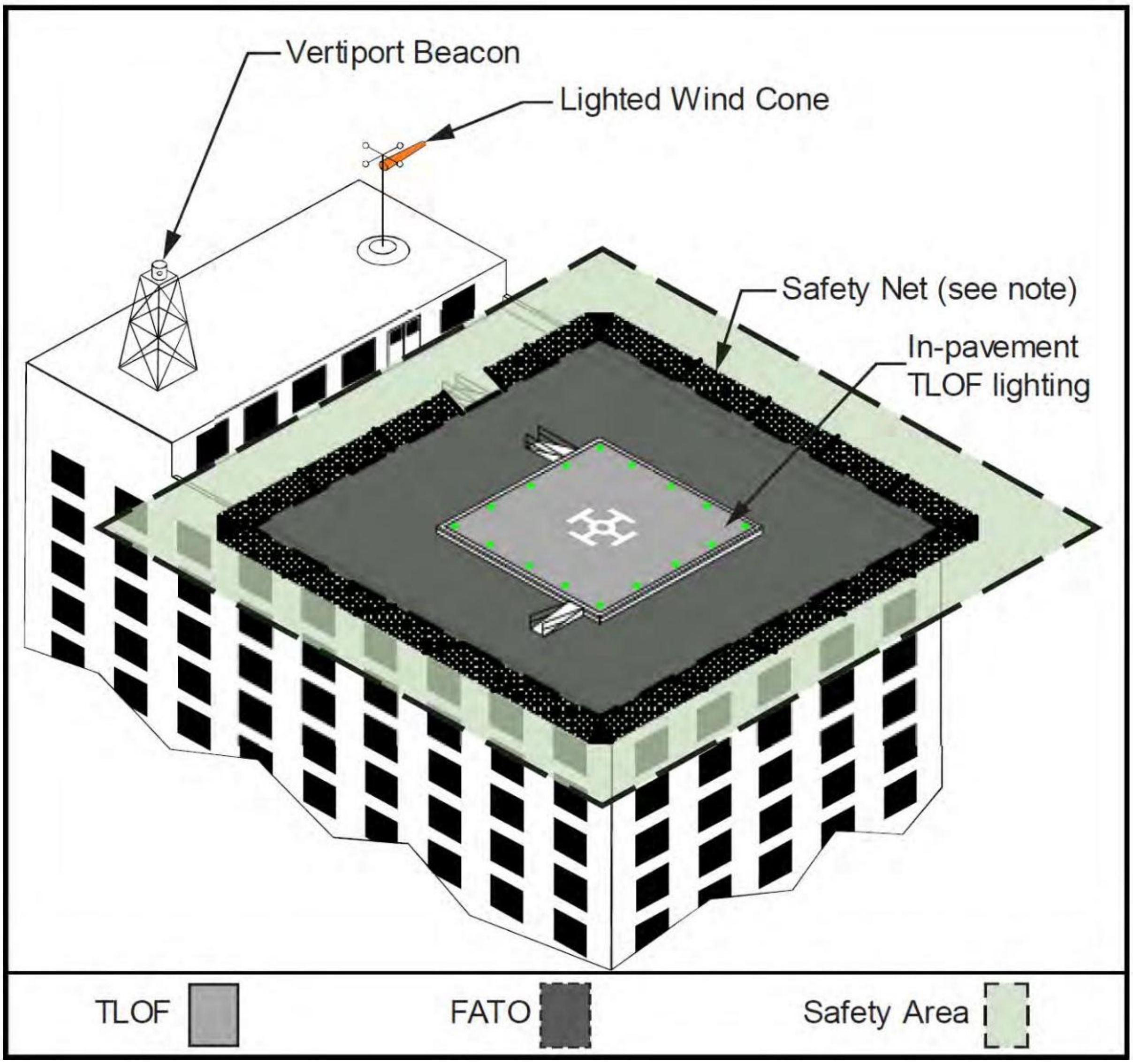
备注 1: 嵌入式灯光在 TLOF 和 FATO 各自的边界线内部或外部 1 英尺 (0.3 米) 范围内。

Note 2: Elevated lights are outside and within 10feet (3 m) of TLOF and FATO respective perimeters.

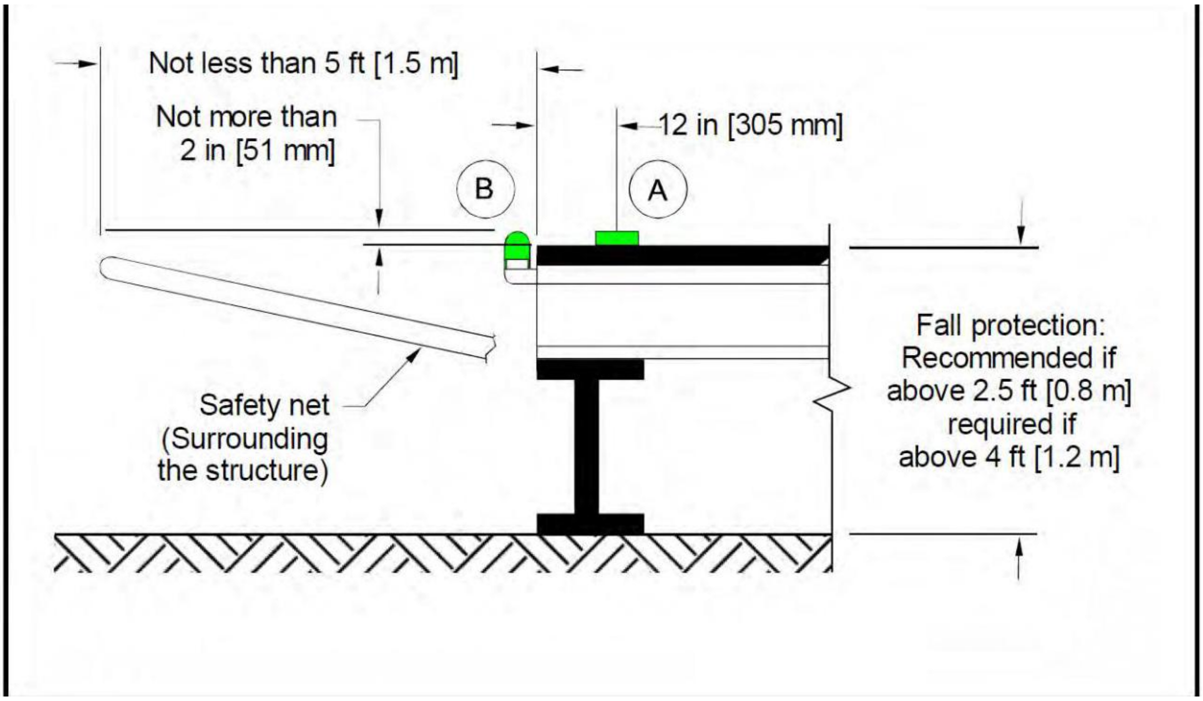
注释 2: 升高照明灯位于 TLOF 和 FATO 各自边界的 10feet (3 m) 外部和内部。

Note 3: Exhibit is configured for 50-foot (15.2 m) TLOF.

注释 3: 展示配置适用于 50 英尺 (15.2 米) 的 TLOF。



Note: See Figure 3-9 for safety net and lighting details.
注释: 见图 3-9，了解安全网和照明的详细信息。
Figure 3-9: Elevated FATO Perimeter Lighting
图 3-9: 升高 FATO 边界照明



Note 1: Install either "A" Type L-852H, or "B" Type L-861H.
注释 1: 安装 "A" 型 L-852H 或 "B" 型 L-861H。
Note 2: In-pavement edge light fixture (A (Type L-852H).
注释 2: 嵌入式边缘照明灯具 (A 型 L-852H)。
Note 3: Omnidirectional light (B), mounted off the structure edge (Type L-861H).
注释 3: 全方位照明 (B 型)，安装在结构边缘之外 (L-861H)。
Note 4: Ensure elevated lights do not penetrate a horizontal plane at the TLOF elevation by more than 2 inches(51mm).
注释 4: 确保升高照明灯在 TLOF 高度处穿透水平面的距离不超过 2 英寸 (51 毫米)。
Note 5: For TLOF and FATO lighting standards, see EB 87.
注释 5: 关于 TLOF 和 FATO 照明标准，见 EB 87。
Note 6: A safety net's supporting structure should be located below the safety net.
注释 6: 安全网支撑结构应位于安全网下方。

3.5.3. Elevated Perimeter Lights on TLOF and FATO.
3.5.3. TLOF 和 FATO 的升高边界灯。

The same standards for in-pavement lights apply to raised lights except for the following:
与嵌入式照明标准相同，以下情况除外:
1. Lights are omnidirectional.
1. 照明为全方位的。
2. Lights are on the outside edge of the TLOF and FATO.
2. 照明位于 TLOF 和 FATO 的外边缘。
3. Lights are on frangible elevated light fixtures, no more than 8 inches(203mm) high, and no more than 10feet (3 m) out from the TLOF and FATO, respective, perimeters.
3. 照明位于易碎升高照明装置上，高度不超过 8 英寸 (203 毫米)，并且从 TLOF 和 FATO 各自的边界向外不超过 10feet (3 m) 。
4. Lights do not penetrate a horizontal plane at the TLOF edge elevation by more than 2 inches(51mm), as shown in Figure 2-2.
4. 照明不得穿透 TLOF 边缘水平面超过 2 英寸 (51 毫米)，如图 2-2 所示。

See Figure 3-7 for additional information.
参见图 3-7 获取更多信息。

3.5.4. Visual Glideslope Indicators (VGSI).
3.5.4. 视觉下滑道指示器 (VGSI)。

A VGSI provides pilots with visual vertical course and descent cues. Install the VGSI such that the lowest on-course visual signal provides a minimum of one degree of clearance over any object that lies within ten degrees of the approach course centerline.

VGSI 为飞行员提供视觉垂直航向和下降提示。安装 VGSI，使得最低的航向视觉信号至少提供 1 度的间隙，超出任何位于进近航向中心线 10 度范围内的物体。

3.5.4.1. Siting.

3.5.4.1. 选址。

1. The optimum location of a VGSI is on the extended centerline of the approach path at a distance that brings the VTOL to a hover with the undercarriage between 3 and 8 feet (0.9 to 2.4 m) above the TLOF.

1. VGSI 的最佳位置是在进近路径的延长中心线上，距离能够使 VTOL 悬停在距 TLOF 3 至 8 英尺 (0.9 至 2.4 米) 高的位置。

2. To properly locate the VGSI, estimate the vertical distance from the undercarriage to the pilot's eye.

2. 为了正确放置 VGSI，估算从起落架到飞行员眼睛的垂直距离。

3.5.4.2. Control of the VGSI.

3.5.4.2. VGSI 的控制。

Design the VGSI to be pilot controllable such that it is ”on” only when needed as an option.

设计 VGSI 以便于飞行员控制，使其仅在需要时作为选项“开启”。

3.5.4.3. VGSI Needed.

3.5.4.3. 需要 VGSI。

A VGSI is an optional feature. However, install a VGSI if one or more of the following conditions exist, especially at night:

VGSI 是一个可选功能。然而，如果满足以下一个或多个条件，尤其是在夜间，则应安装 VGSI:

1. Obstacle clearance, noise abatement, or traffic control procedures necessitate a slope to be flown.

1. 需要飞行斜坡以清除障碍物、降低噪音或控制交通程序。

2. The environment of the VTOL provides few visual surface cues.

2. VTOL 的环境提供的视觉表面线索很少。

3.5.4.4. Additional Guidance.

3.5.4.4. 额外指导。

Additional guidance is provided in AC 150/5345-52, Generic Visual Glideslope Indicators (GVGI), and AC 150/5345-28, Precision Approach Path Indicator (PAPI) Systems.

额外指导可在 AC 150/5345-52，《通用视觉下滑道指示器 (GVGI)》和 AC 150/5345-28，《精密进近路径指示器 (PAPI) 系统》中找到。

3.5.5. Floodlight Option.

3.5.5. 滑行灯选项。

The FAA has not evaluated floodlights for effectiveness in visual acquisition of a vertiport. Guidelines for the use and installation of floodlights include:

FAA 尚未评估滑行灯在视觉获取垂直机场方面的有效性。滑行灯的使用和安装指南包括:

1. Install floodlights to illuminate the TLOF, the FATO, and/or the parking area if ambient light does not suitably illuminate markings for night operations.

1. 如果环境光线不足以照亮夜间运行的标记，则安装滑行灯以照亮 TLOF、FATO 和/或停车场。

2. Mount these floodlights on adjacent buildings to eliminate the need for tall poles, if possible. Place floodlights clear of the TLOF, the FATO, the Safety Area, the approach/departure surfaces, and transitional surfaces and ensure floodlights and their associated hardware do not constitute an obstruction hazard.

2. 如有可能，将这些泛光灯安装在相邻建筑物上，以消除对高杆的需求。确保泛光灯远离 TLOF、FATO、安全区域、起飞/降落面以及过渡面，并确保泛光灯及其相关硬件不构成障碍物危险。

3. Aim floodlights down to provide adequate illumination on the apron and parking surface.

3. 调整泛光灯向下照射，以在停机坪和停车面上提供足够的照明。

4. Ensure floodlights that might interfere with pilot vision during takeoff and landings are capable of being turned off by pilot control or at pilot request.

4. 确保在起飞和降落过程中可能干扰飞行员视线的泛光灯能够通过飞行员控制关闭或应飞行员请求关闭。

Note 1: Floodlights do not replace TLOF or FATO lighting recommendations.

注意 1: 泛光灯不能替代 TLOF 或 FATO 照明建议。

Note 2: White lighting for heliport applications should not be activated until the aircraft has landed and deactivated prior to takeoff.

注意 2: 直升机机场的白光照明应在飞机着陆后激活，在起飞前关闭。

3.6. Identification Beacon.

3.6. 识别信标。

An identification beacon is required for night operations. The identification beacon is flashing white/yellow/green with a rate of 30 to 45 flashes per minute. On-airport vertiports are not required to have a vertiport identification beacon. Install beacons per the heliport guidance below:

夜间运行需要识别信标。识别信标为白色/黄色/绿色闪烁，频率为每分钟 30 至 45 次。机场内的直升机场不需要设置直升机场识别信标。按照以下直升机场指导安装信标:

1. AC 150/5345-12, Specification for Airport and Heliport Beacons, provides specifications for a beacon.

1. AC 150/5345-12，《机场和直升机场信标规范》，提供了信标的规格。

2. AC 150/5340-30 provides guidelines for installing a beacon. 3.7. Wind Cone.

2. AC 150/5340-30 提供了安装信标的指导。3.7. 风向袋。

Wind cones provide the direction and magnitude of the wind. The following guidelines apply to wind cones:

风向袋提供了风向和风力的大小。以下指南适用于风向袋:

1. Minimum of one wind cone conforming to AC 150/5345-27, Specification for Wind Cone Assemblies.

1. 至少有一个符合 AC 150/5345-27，《风向袋组件规范》的风向袋。

2. Orange in color to provide the best possible contrast to its location's background.

2. 采用橙色以提供与所在位置背景的最大可能对比度。

3. Locate to provide valid wind direction and speed information near the vertiport under all wind conditions.

3. 安置于能够提供在所有风向条件下，靠近直升机场的有效的风向和风速信息的位置。

4. Visible to pilots on the approach path when the aircraft is 500feet (152 m) from the

4. 当飞机从 500feet (152 m) 处接近时，对飞行员可见。TLOF.

5. Visible to pilots from the TLOF.

5. 从 TLOF 对飞行员可见。

6. Located within 500 feet(152m)horizontal of the TLOF.

6. 位于 TLOF 水平距离 500 英尺 (152 米) 以内。

7. If one location does not provide for all the above, multiple locations may be necessary to provide pilots with all the wind information needed for safe operations.

7. 如果一个位置无法提供以上所有条件，可能需要多个位置来为飞行员提供进行安全操作所需的所有风信息。

8. See AC 150/5345-27 and AC 150/5340-30 for primary and secondary wind cones for multiple wind cone requirements.

8. 参见 AC 150/5345-27 和 AC 150/5340-30 了解关于多个风锥要求的主要和次要风锥。

9. Located outside the Safety Area and does not penetrate the approach/departure or transitional surfaces.

9. 位于安全区域外，且不穿透进近/起飞或过渡面。

10. Follows installation details specified in AC 150/5340-30.

10. 遵循 AC 150/5340-30 中指定的安装细节。

11. Lighted internally or externally for night operations.

11. 为夜间操作内部或外部照明。

4.0 Charging and Electric Infrastructure.

4.0 充电与电气基础设施。

Most early concepts of operation for AAM activity indicate the use of electric propulsion by VTOL aircraft. The electrical needs for these aircraft vary based on design and manufacturer. This EB addresses battery driven technologies. Future guidance will be provided on other emerging energy concepts (e.g., hydrogen).

大多数早期关于 AAM 活动的操作概念表明使用电动推进的垂直起降飞机。这些飞机的电力需求根据设计和制造商的不同而有所差异。本 EB 文件讨论了电池驱动技术。关于其他新兴能源概念 (例如，氢能) 的未来指导将另行提供。

Electrification of aviation propulsion systems is an evolving area with few industry-specific standards. In addition to relevant national, state, and local building codes, the following sections provide a partial list of relevant standards that may assist when specifying charging systems and facility layout for this emerging industry. Current charging standards for light duty vehicle charging (up to 350 kw) align with multiple light electric aircraft currently applying for certification. However, for meeting operational characteristics of higher capacity batteries and novel systems, manufacturers and operators may implement, along with fixed-charger equipment, alternate charging methods including mobile charging systems, fixed battery storage, cable and/or on-board battery cooling, battery swapping, or other concepts.

航空推进系统的电动化是一个不断发展变化的领域，目前行业内缺乏特定的标准。除了相关的国家、州和地方建筑法规外，以下部分提供了可能有助于在为这一新兴行业指定充电系统和设施布局的相关标准的不完全列表。目前针对轻型车辆充电的标准 (高达 350 kw) 与多个正在申请认证的轻型电动飞机相符合。然而，为了满足大容量电池和新型系统的操作特性，制造商和运营商可能会实施固定充电设备以外的替代充电方法，包括移动充电系统、固定电池储存、电缆和/或车载电池冷却、电池更换或其他概念。

At the time of this publication, consensus has not been achieved regarding classes of charging or connection standards and could vary based on the aircraft duty cycle, charging speed, battery chemistry, charging system, and battery cooling system, etc. Charging infrastructure design for vertiports should consider adapting to multiple aircraft specific systems. Additional guidance is currently being developed as the AAM industry continues to evolve.

在本出版物发布之时，关于充电类别或连接标准的共识尚未达成，并且可能会根据飞机的工作周期、充电速度、电池化学性质、充电系统和电池冷却系统等因素而有所不同。垂直机场的充电基础设施设计应考虑适应多种特定飞机系统。随着 AAM 行业的持续发展，额外的指导目前正在进行开发。

Battery charging must be done in a safe and secure manner. Any aircraft batteries stored on site should be stored safely away from TLOF, FATO, and Safety Areas. As additional research is developed, further recommendations will be released.

电池充电必须以安全和可靠的方式进行。任何现场存储的飞机电池都应安全地远离 TLOF、FATO 和安全区域存储。随着额外研究的开展，将进一步发布推荐意见。

4.1. Standards.

4.1. 标准。

4.1.1. Airport/Vertiport Fire Fighting and Safety Considerations.

4.1.1. 机场/垂直机场消防和安全考虑。

- 2021 International Fire Code (IFC): To implement alternative energy vectors, there is the need for general precautions, emergency planning and preparedness, and storage of hazardous materials.

- 2021 年国际消防法规 (IFC): 为了实施替代能源矢量，需要采取一般性预防措施、应急计划和准备，以及危险材料的储存。

- NFPA 110, Standard for Emergency and Standby Power Systems: To ensure the continuity of electric aircraft operations, uninterrupted power supply is needed thus creating a need for guidelines on emergency and backup power supply systems.

- NFPA 110，应急和备用电源系统标准: 为确保电动飞机操作的连续性，需要不间断电源，因此产生了关于应急和备用电源系统指导方针的需求。

- NFPA 70, NEC Article 625 - Electric Vehicle Charging System: Covers the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means, and the installation of equipment and devices related to electric vehicle charging. It also addresses scenarios that would allow the use of load balancing functions on electrical supply systems.

- NFPA 70，NEC 第 625 条-电动汽车充电系统: 涵盖了连接电动汽车与电源的导电体和设备，以及与电动汽车充电相关的设备和装置的安装。它还解决了允许在电力供应系统上使用负载平衡功能的场景。

- NFPA 70, Article 706 - Energy Storage Systems: This article applies to all energy storage systems (ESS) having a capacity greater than 3.6MJ (1kWh) that may be standalone or interactive with other electric power production sources. These systems are primarily intended to store and provide energy during normal operating conditions.

- NFPA 70，第 706 条-能量存储系统: 本文适用于所有容量大于 3.6MJ (1kWh) 的能量存储系统 (ESS)，这些系统可能是独立运行的，也可能是与其他电力生产源互动的。这些系统主要旨在在正常操作条件下储存和提供能量。

- NFPA 400, Hazardous Materials Code: Covers the minimum NFPA standards for the storage and handling of hazardous materials such as lithium batteries.

- NFPA 400，危险材料代码: 涵盖了处理和储存危险材料 (如锂电池) 的最低 NFPA 标准。

- NFPA 418, Standard for Heliports: This standard establishes fire safety standards for operations of heliports and rooftop hangars for the protection of people, aircraft, and other property. Future editions of this standard will include electric mobility asset considerations.

- NFPA 418，直升机机场标准: 本标准为直升机机场和屋顶机库的操作制定了消防安全标准，以保护人员、飞机和其他财产的安全。该标准的未来版本将包括电动移动资产考虑。

- NFPA 855, Standard for the Installation of Stationary Energy Storage Systems: Covers the minimum NFPA standards established for design, installation, and maintenance of a stationary energy storage system including battery storage systems.

- NFPA 855，固定式能量存储系统安装标准: 涵盖了设计、安装和维护固定式能量存储系统的最低 NFPA 标准，包括电池存储系统。

4.1.2. Occupational Safety and Health Administration Considerations.
4.1.2. 职业安全与健康管理局考虑因素。

- 29 CFR Section 1910.176, Handling Materials - General: This standard provides the minimum requirements for the storage and handling of hazardous materials such as lithium batteries.

- 29 CFR 第 1910.176 节，物料处理-一般: 本标准为储存和处理危险材料 (如锂电池) 的最低要求。

4.1.3. Power Quality Considerations.
4.1.3. 电能质量考虑。

- IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems: The grid impact of high wattage charging stations needs to be considered when designing and adopting charging stations. This standard provides guidance in the design and compliance of power systems with nonlinear loads.

- IEEE 519-2014，IEEE 关于电力系统中谐波控制的推荐实践和要求: 在设计和使用充电站时，需要考虑高功率充电站对电网的影响。该标准为设计符合非线性负载的电力系统及其合规性提供了指导。

- IEEE 1826-2020, IEEE Standard for Power Electronics Open System Interfaces in Zonal Electrical Distribution Systems Rated Above 100kW : Airports require power, monitoring, information exchange, control, and protection of interfaces that are based on technological maturity, accepted practices, and allowances for future technology insertions such as the integration of electric aircraft.

- IEEE 1826-2020，IEEE 关于区域电气分配系统中额定电压超过 100kW 的电力电子开放系统接口的标准: 机场需要基于技术成熟度、公认实践以及对未来技术植入 (如电动飞机的集成) 的考虑，对电力、监控、信息交换、控制以及接口保护的需求。

4.1.4. Underwriter's Laboratories (UL) Certifications Considerations. The following standards focuses on certifying the components and safety of the systems.
4.1.4. 保险商实验室 (UL) 认证考虑。以下标准专注于对系统的组件和安全进行认证。

- UL 2202, Standard for Safety of Electric Vehicle (EV) Charging System Equipment: Covers conducting charging system equipment (600 volts or less) for recharging batteries in surface electric vehicles.

- UL 2202，电动汽车 (EV) 充电系统设备安全标准: 涵盖了用于为地面电动汽车充电的导电充电系统设备 (600 伏特或以下)。

- UL 2251, Standard Testing for Charging Inlets and Plugs: Covers plugs, receptacles, vehicle inlets, and connectors rated up to 800 amperes and up to 600 volts AC or DC, and intended for conductive connection systems, for use with electric vehicles.

- UL 2251，充电接口和插头测试标准: 涵盖了额定电流高达 800 安培和额定电压高达 600 伏特交流电或直流电的插头、插座、车辆接口和连接器，以及用于导电连接系统的电动汽车。

- UL 2580, Batteries for Use in Electric Vehicles: Covers electric equipment storage assemblies in electric powered vehicles.

- UL 2580，电动汽车用电池: 涵盖了电动车辆中的电气设备储能组件。

- UL 9540, Energy Storage System (ESS) Requirements - Evolving to Meet Industry and Regulatory Needs: This key standard encompasses the design, commissioning, operation, decommissioning, and emergency operations for all energy storage systems.

- UL 9540，储能系统 (ESS) 要求 - 不断发展以满足行业和监管需求: 这一关键标准涵盖了所有储能系统的设计、调试、运行、停用和紧急操作。

- UL 9540a, Test Method.

- UL 9540a，测试方法。

4.1.5. Vehicle to Infrastructure Considerations.
4.1.5. 车辆与基础设施考虑。

- SAE J1772, SAE Electric Vehicle and Plugin Hybrid Electric Vehicle Conductive Charge Coupler: This standard was developed to define the fit and function of a conductive coupler for use in charging electric vehicles. It was later expanded to include direct current (DC) charging through combined alternating current/direct current (AC/DC) physical connector referred to as the Combined Charging Standard (CCS).

- SAE J1772，SAE 电动汽车和插电式混合动力电动汽车导电充电耦合器: 该标准旨在定义用于电动汽车充电的导电耦合器的配合和功能。后来该标准扩展到包括通过称为组合充电标准 (CCS) 的交流/直流 (AC/DC) 物理连接器进行直流 (DC) 充电。

- SAE AIR7357, MegaWatt and Extreme Fast Charging for Aircraft (under development): This standard is a work in progress under SAE leadership and intended to provide a charging interface for battery packs from 150kWh – 1MWh within aircraft.

- SAE AIR7357，飞机兆瓦级和极速充电 (开发中): 该标准是在 SAE 领导下进行的工作，旨在为飞机内的电池组提供充电接口 150kWh – 1MWh 。

- Megawatt Charging System (MCS): The MCS is intended to extend the capabilities of the CCS to accommodate the charge rate demands of larger vehicles and thus serve the trucking and aviation sectors. Ratings should exceed 1MW (Max 1,250 volt and 3,000 ampere (DC)) while also addressing communication and controls using ISO/IEC 15118 and meeting UL 2251 touch safe standards.

- 兆瓦级充电系统 (MCS):MCS 旨在扩展 CCS 的功能，以满足更大车辆的充电速率需求，从而服务于卡车和航空领域。额定功率应超过 1 兆瓦 (最大 1250 伏特和 3000 安培 (直流))，同时解决使用 ISO/IEC 15118 进行通信和控制，并符合 UL 2251 触摸安全标准。

- ISO/IEC 15118-1:2019, Road Vehicles: Vehicle to Grid Communication Interface: This standard defines the digital communications protocol to be used for the charging of high voltage electric vehicle batteries from a charging station. Beyond the basic handshakes and charge control between a vehicle and a charging station, this standard also includes convenience and security layers that support the ”plug and charge” experience. Additionally, it offers the potential to schedule and coordinate the charging demands with the grid conditions.

- ISO/IEC 15118-1:2019，道路车辆: 车辆到电网通信接口: 该标准定义了用于从充电站为高压电动汽车电池充电的数字通信协议。除了车辆和充电站之间的基本握手和充电控制之外，该标准还包括支持“即插即充”体验的便利性和安全层。此外，它还提供了根据电网条件安排和协调充电需求的可能性。

5.0 On-Airport Vertiports.

5.0 机场垂直起降场。

To support AAM operations, certain OEMs and operators are interested in developing vertiports on airports and modifying existing on-airport helicopter landing facilities. All federally obligated airport sponsors are required to ensure the safety, efficiency, and utility of the airport and to provide reasonable and not unjustly discriminatory access to all aeronautical users.

为了支持先进空中交通 (AAM) 运营，某些原始设备制造商和运营商对在机场开发垂直起降场和修改现有的机场直升机着陆设施感兴趣。所有联邦有义务的机场赞助商都要求确保机场的安全、效率和实用性，并为所有航空用户提供合理且非歧视性的接入。

This chapter addresses design considerations for separate vertiport facilities on airports. VTOLs can operate on airports without interfering with airplane traffic and operations. Operations can occur on existing airport infrastructure for its intended purpose or on dedicated vertiport facilities.

本章节讨论了在机场设置独立垂起降设施的设计考虑因素。VTOL(垂直起降飞机) 可以在不影响飞机交通和运营的情况下在机场运行。运行可以发生在现有机场基础设施上，用于其预定目的，或者在专用的垂起降设施上进行。

Separate vertiport facilities and approach/departure procedures may be needed when the volume of airplane and/or VTOL traffic affects operations. Airports with interconnecting passenger traffic between VTOLs and fixed wing aircraft should generally provide access between the respective terminals for boarding with applicable security measures in place.

当飞机和/或 VTOL 的交通量影响运营时，可能需要独立的垂起降设施和进近/起飞程序。具有 VTOL 与固定翼飞机之间联程旅客的机场，通常应提供各自航站楼之间的登机通道，并采取适当的安全措施。

Any new vertiport infrastructure or fixed equipment must be depicted on the ALP and submitted for FAA review prior to development and operation. For projects subject to FAA approval, an appropriate level of environmental review under the National Environmental Policy Act (NEPA) is required. These on-airport vertiport facilities must follow all guidance detailed in this EB.

任何新的垂起降基础设施或固定设备都必须在机场布局图 (ALP) 上标明，并在开发和运营前提交给 FAA(美国联邦航空局) 审查。对于需要 FAA 批准的项目，根据《国家环境政策法》(NEPA) 需要进行适当级别的环境审查。这些机场内的垂起降设施必须遵循本 EB 中详细的所有指导。

For facilities being built on non-federally obligated airports, in compliance with Part 157, the sponsor or proponent must submit Form 7480-1 at least 90 days in advance of the day that construction work is to begin on the vertiport takeoff and landing area. 5.1. On-Airport Location of TLOF.

对于正在非联邦资助的机场上建设的设施，为符合第 157 部分的规定，发起人或提案人必须在垂起降设施的起飞和着陆区域施工开始前至少 90 天提交 7480-1 表格。5.1. 机场内 TLOF(起飞和着陆设施) 的位置。

Locate the TLOF to provide ready access to the airport terminal with applicable security measures in place or to the VTOL user's origin or destination. If needed, locate the TLOF away from but with access to fixed-wing aircraft movement areas (the runways, taxiways, and other areas of an airport that are used for taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and aircraft parking areas). 5.2. On-Airport Location of FATO.

确定 TLOF 的位置，以便在采取适当安全措施的情况下方便地通往机场航站楼，或者通往 VTOL 用户的出发地或目的地。如有必要，将 TLOF 设置在固定翼飞机活动区域 (跑道、滑行道以及机场用于飞机滑行、起飞和着陆的其他区域，不包括装卸区和飞机停放区) 之外，但要有通往这些区域的通道。5.2. 机场内 FATO(最终起飞和着陆区) 的位置。

See Table 5-1 for standards of the distance between the centerline of an approach to a runway and the centerline of an approach to a vertiport's FATO for simultaneous, same-direction VFR operations. Figure 5-1 depicts an example of an on-airport Vertiport location. The FATO should be located outside of all object free areas (OFAs), Safety Areas, runway protection zones, and safety critical navigational aid areas.

参见表 5-1，了解跑道接近中心线与竖直机场 FATO 中心线之间的距离标准，以便进行同时、同向的 VFR 运行。图 5-1 展示了一个机场内竖直机场位置的示例。FATO 应位于所有无障碍区域 (OFAs)、安全区域、跑道保护区以及关键导航辅助设施区域之外。

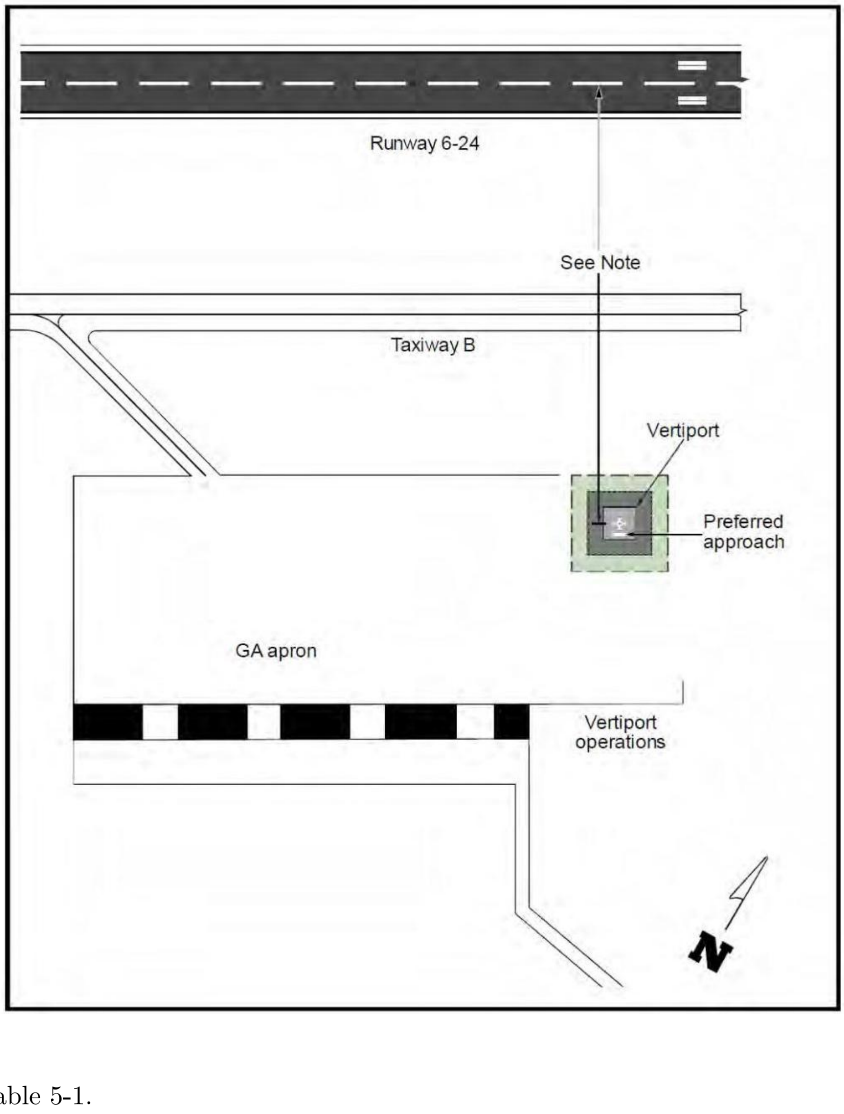
Table 5-1: Recommended Minimum Distance between Vertiport FATO Center to Runway Centerline for VFR Operations

表 5-1:VFR 运行推荐的竖直机场 FATO 中心到跑道中心线的最小距离

Reference VTOL Aircraft MTOW	Airplane Size	Distance From Vertiport FATO Center to Runway Centerline
12,500 pounds (5,670 kg) or less	Small Airplane (12,500 pounds (5,670 kg) or less)	300 feet (91 m)
12,500 pounds (5,670 kg) or less	Large Airplane (12,500-300,000 pounds (5,670- 136,079 kg))	500 feet (152 m)
12,500 pounds (5,670 kg) or less	Heavy Airplane (Over 300,000 pounds (136,079 kg))	700 feet (213 m)

参考垂直起降飞机最大起飞重量	飞机尺寸	垂直机场 FATO 中心到跑道中心线的距离
12,500 磅 (5,670 千克) 或以下	小型飞机 (12,500 磅 (5,670 千克) 或以下)	300 英尺 (91 米)
12,500 磅 (5,670 千克) 或以下	大型飞机 (12,500-300,000 磅 (5,670-136,079 千克))	500 英尺 (152 米)
12,500 磅 (5,670 千克) 或以下	重型飞机 (超过 300,000 磅 (136,079 千克))	700 英尺 (213 米)

Figure 5-1: Example of an On-airport Vertiport
图 5-1: 机场内竖直机场示例



Note: See Table 5-1.
备注: 见表 5-1。
Note: Figure does not reflect every type of configuration.
备注: 图形未反映每种配置类型。

6.0 Site Safety Elements.

6.0 站点安全要素。

6.1. Fire Fighting Considerations.

6.1. 消防考虑。

The procedures to put out a battery system fire on an aircraft may differ from one VTOL to another. Previous FAA research with small lithium battery cells found that water and other foam fire extinguishing agents were more effective for suppressing lithium battery fires and preventing thermal runaway than gas or dry powder extinguishing agents during experiments within a 4-foot(1.2m)by 4-foot(1.2m)by 4-foot(1.2m)test chamber [§8] . The cooling effect of the extinguishing agent was the key factor in preventing the fire from spreading. Although this method was found to be effective for small battery packs, it is yet to be determined if similar results would be achieved with large battery packs.

熄灭飞机上电池系统火灾的程序可能因不同的 VTOL 而异。先前 FAA 对小锂离子电池单元的研究发现，在 4 英尺 (1.2 米)x 4 英尺 (1.2 米)x 4 英尺 (1.2 米) 的测试室内的实验中，水和其他泡沫灭火剂抑制锂离子电池火灾和防止热失控比气体或干粉灭火剂更有效 [§8] 。灭火剂的冷却效果是防止火势蔓延的关键因素。尽管这种方法对小型电池组被证明是有效的，但尚未确定是否会对大型电池组产生类似的结果。

The firefighting techniques for VTOL aircraft are still unknown and may differ from model to model. Providing adequate fire protection for VTOL aircraft on vertiports will require a full understanding of the hazards related to the specific aircraft that will be using the vertiport. This also applies to the utility infrastructure needed to charge the VTOL aircraft.

VTOL 飞机的消防技术仍然未知，且可能因型号而异。为了在竖直机场为 VTOL 飞机提供足够的消防保护，需要完全了解将与竖直机场一起使用的特定飞机相关的危险。这也适用于为 VTOL 飞机充电所需的公用设施基础设施。

Vertiport operators may need to comply with applicable local fire, environmental, and zoning regulations. Vertiport operators will need the means to control VTOL aircraft fires. Firefighting personnel, including local first responders, should be trained and equipped to manage the specific needs associated with electric aircraft such as lithium battery fires, electrical fires, toxic gas emissions, and high voltage electrical arcing.

机场运营商可能需要遵守适用的当地消防、环保和规划法规。机场运营商将需要有能力控制垂直起降飞机的火灾。消防人员，包括当地的第一反应者，应接受培训并配备设备，以应对与电动飞机相关的特定需求，如锂电池火灾、电气火灾、有毒气体排放和高电压电弧。

Firefighting equipment should be adjacent to, but outside, the TLOF and FATO area. Fire safety equipment should be clearly marked for conspicuousness from anywhere within or outside the FATO. For elevated sites, fire equipment may be located below the level of the FATO but must be fully accessible under all circumstances and clearly marked to anyone on the TLOF and FATO.

消防设备应放置在 TLOF 和 FATO 区域旁边，但不在这些区域内。消防安全设备应明显标记，以便从 FATO 内部或外部的任何位置都能看到。对于高层场地，消防设备可以位于 FATO 以下水平，但在所有情况下都必须完全可进入，并且对 TLOF 和 FATO 上的任何人都明显标记。

The current NFPA 418, Standard for Heliports (2021), is based on conventional liquid fuel and its dangers and risks. This standard is currently under revision to account for electrical hazards and fire safety standards for vertiports, which is expected to be published on or before January 2024. NFPA 855-2020, Standard for Stationary Energy Storage Systems, provides safety standards for stationary and mobile energy storage systems. Chapters on emergency response provide relevant guidance for fire protection engineers, system designers, code officials, and emergency responders.

现行的 NFPA 418 标准，即直升机机场标准 (2021 年)，基于传统的液态燃料及其危险和风险。该标准目前正在修订中，以考虑电气危害和垂直机场的消防安全标准，预计将在 2024 年 1 月或之前发布。NFPA 855-2020 标准，即固定式能源存储系统标准，为固定式和移动式能源存储系统提供了安全标准。关于紧急响应的章节为消防工程师、系统设计师、法规官员和紧急响应人员提供了相关指导。

6.2. Security and Safety.

6.2. 安全与保障。

For vertiports located in secured airport environments, unless screening was carried out at the VTOLs passengers' departure location, Transportation Security Administration regulations may require that a screening area and/or screening be provided before passengers enter the airport's secured areas. If necessary, airports should establish multiple VTOL parking positions and/or locations in the terminal area to service VTOL passenger screening and/or cargo needs. General information about passenger screening is available on the Transportation Security Administration website, www.tsa.gov/public/.

对于位于受保护机场环境中的垂直机场，除非在 VTOL 乘客出发地点进行了安检，否则运输安全管理局的法规可能要求在乘客进入机场受保护区域之前提供安检区域和/或进行安检。如有必要，机场应设立多个 VTOL 停车位和/或在航站楼区域内设立位置，以服务 VTOL 乘客安检和/或货运需求。关于乘客安检的一般信息可在运输安全管理局的网站上找到，网址为 www.tsa.gov/public/。

Controlling vertiport access and keeping operational areas clear of people, animals, equipment, debris, and vehicles is important for safety and security. The following guidance apply to safety barriers and access control measures:

控制垂直机场的入口并保持作业区域无人、无动物、无设备、无碎片和车辆，对于安全和保障至关重要。以下指导适用于安全屏障和入口控制措施:

1. For ground-level vertiports, erect a safety barrier around the VTOL aircraft operational areas in the form of a fence or a wall outside of the Safety Area and below the 8:1 elevation of the approach/departure surface.

1. 对于地面层垂直机场，在安全区域外且低于进近/起飞面 8:1 升高线的位置，围绕 VTOL 飞机作业区域设置安全围栏或墙壁。

2. If necessary, near the approach/departure paths, install the barrier well outside the outer perimeter of the Safety Area and below the elevation of the approach/departure and transitional surfaces described in paragraph 2.5.

2. 如果需要，在进近/起飞路径附近，将屏障安装在安全区域外侧边缘之外且低于第 2.5 段描述的进近/起飞和过渡表面的升高线。

3. Safety barriers must be high enough to present a positive deterrent to persons inadvertently or maliciously entering an operational area, but at a low enough elevation to be non-hazardous to all aircraft operations.

3. 安全屏障必须足够高，以对无意或恶意进入作业区域的人员形成有效威慑，但高度又必须足够低，以免对所有飞机作业造成危害。

4. Provide control access to airport airside areas with adequate security measures as required or recommended by the Transportation Security Administration.

4. 根据运输安全管理局的要求或推荐，为机场空侧区域提供带有足够安全措施的入口控制。

5. Display a vertiport caution sign like that shown in Figure 6-1 at all vertiport access points.

5. 在所有垂直机场入口处展示如图 6-1 所示的垂直机场警示标志。

For on-airport vertiports, proponents should work with their local Transportation Security Administration security representative.

对于机场内的垂直机场，提议者应与当地运输安全管理局的安全代表合作。

Figure 6-1: Vertiport Caution Sign

图 6-1: 垂直机场警示标志

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§ Maloney, Thomas. DOT/FAA/TC-13/53, Extinguishment of Lithium-Ion and Lithium-Metal Battery Fires. Federal Aviation Administration, 2014.

§ Maloney, Thomas. DOT/FAA/TC-13/53, 锂离子和锂金属电池火灾的扑灭. 联邦航空管理局，2014 年。

6.3. Downwash/Outwash.

6.3. 下降洗流/外洗流。

The downwash and outwash impacts of VTOL are still being researched. However, the impacts of the ground geometry, surrounding infrastructure, and the re-circulatory flow impact on rotor/propeller aerodynamics performance and vehicle flight dynamics should still be considered in vertiport siting.

VTOL 的下降洗流和外洗流影响仍在研究之中。然而，在确定垂直机场位置时，应考虑地面几何形状、周围基础设施以及对旋翼/螺旋桨气动性能和飞行器飞行动力学影响的再循环流动。

If downwash and outwash of the VTOL will create safety issues for people or property, other aircraft operators, or if the VTOL aircraft aerodynamic performance will be impacted by how the downwash and outwash interacts with the surrounding ground or infrastructure, then the TLOF, FATO, and Safety Areas should be adjusted appropriately, or alternative mitigations should be taken.

如果垂直起降飞机的向下洗流和侧向洗流会对人员或财产、其他航空运营商造成安全问题，或者垂直起降飞机的气动性能会受到向下洗流和侧向洗流与周围地面或基础设施相互作用的影哪些因素会影响垂直起降飞机的气动性能，那么应该相应调整 TLOF、FATO 和安全区域，或者采取其他替代缓解措施。

6.4. Turbulence.

6.4. 湍流。

Air (e.g., wind) flowing around and over buildings, stands of trees, terrain irregularities, and elsewhere can create turbulence on ground-level and rooftop vertiports that may affect VTOL operations. The following guidelines apply to turbulence:

空气 (例如，风) 绕过和吹过建筑物、树木丛、地形不规则处以及其他地方，可能在地面和屋顶垂直起降场产生湍流，这可能会影响垂直起降飞机的运行。以下指南适用于湍流:

1. When possible, locate the TLOF away from buildings, trees, and terrain to minimize air turbulence near the FATO and the approach/departure paths.

1. 在可能的情况下，将 TLOF 位于建筑物、树木和地形之外，以最小化 FATO 和进近/起飞路径附近的空气湍流。

2. Assess the turbulence and airflow characteristics near and across the surface of the FATO to determine if a turbulence mitigating design measures are necessary (e.g., air gap between the roof, roof parapet, or supporting structure).

2. 评估 FATO 附近和表面的湍流和气流特性，以确定是否需要采取湍流缓解设计措施 (例如，屋顶、屋顶女儿墙或支撑结构之间的空气间隙)。

3. A minimum six-foot(1.8m)unobstructed air gap on all sides above the level of the top of a structure (e.g., roof) and the elevated vertiport will reduce the turbdulent effect of air flowing over it.

3. 在建筑物 (例如，屋顶) 顶部水平以上至少六英尺 (1.8 米) 的四周无障碍空气间隙，可以减少空气流过其上方的湍流效应。

4. Where an air gap or other turbulence-mitigating design measures are not taken on elevated structures, operational limitations may be necessary under certain wind conditions. 6.5. Weather Information.

4. 在高层结构上未采取空气间隙或其他湍流缓解设计措施的情况下，在特定风速条件下可能需要实施运行限制。6.5. 天气信息。

An optional automated weather observing system (AWOS) measures and automatically broadcasts current weather conditions at the vertiport site. When installing an AWOS, locate it at least 100feet (30.5 m) and not more than 700feet (213 m) fromtheTLOF and such that its instruments will not be affected by rotor/propeller wash from VTOL operations. Find guidance on AWOS systems in AC 150/5220-16, Automated Weather Observing Systems (AWOS) for Non-Federal Applications, and FAA Order 6560.20, Siting Criteria for Automated Weather Observing Systems (AWOS). Other weather observing systems will have different siting criteria.

一个可选的自动气象观测系统 (AWOS) 测量并自动播报竖直机场现场的当前天气条件。安装 AWOS 时，应将其放置在至少 100feet (30.5 m) 远且不超过 700feet (213 m) fromtheTLOF 远的位置，并确保其仪器不会受到 VTOL 操作中的旋翼/螺旋桨气流的影响。关于 AWOS 系统的指导，请参见 AC 150/5220-16，《面向非联邦应用的自动气象观测系统 (AWOS)》以及 FAA 指令 6560.20，《自动气象观测系统 (AWOS) 选址标准》。其他气象观测系统将有不同的选址标准。

6.6. Winter Operations.

6.6. 冬季运行。

Swirling snow dispersed by an VTOL's rotor/propeller wash can cause the pilot to lose sight of the intended landing point and/or obscure objects that need to be avoided. Elevated heliports may use a resistive heating system.

VTOL 的旋翼/螺旋桨气流分散的旋转雪可能会使飞行员失去对预定着陆点的视线，并/或遮蔽需要避开的物体。升高的直升机机场可能会使用电阻加热系统。

1. Design the vertiport to accommodate the methods and equipment to be used for snow removal.

1. 设计竖直机场以适应用于除雪的方法和设备。

2. Design the vertiport to allow the snow to be removed sufficiently so it will not present an obstruction hazard.

2. 设计竖直机场以允许雪被清除得足够彻底，从而不会造成障碍危险。

3. For vertiports in winter weather, an optional dark TLOF surface can be used to absorb more heat from the sun and melt residual ice and snow.

3. 对于冬季天气下的竖直机场，可以使用可选的深色 TLOF 表面以吸收更多的太阳热量并融化残留的冰和雪。

4. Find guidance on winter operations in AC 150/5200-30, Airport Field Condition Assessments and Winter Operations Safety.

4. 关于冬季运行的指导，请参见 AC 150/5200-30，《机场场地条件评估与冬季运行安全》。

6.7. Access to Vertiports by Individuals with Disabilities.

6.7. 残疾人士使用竖直机场的通道。

Congress has passed various laws concerning access to airports. Since vertiports are a type of airport, these laws are similarly applicable. Find guidance in AC 150/5360-14, Access to Airports by Individuals with Disabilities.

国会已经通过了关于机场通道的各种法律。由于竖直机场是机场的一种类型，这些法律同样适用。关于指导，请参见 AC 150/5360-14，《残疾人士使用机场的通道》。

Acronym List

缩略词列表

AAM advanced air mobility

AAM 高级空中移动性

AC Advisory Circular

AC 咨询通告

AC alternating current

AC 交流电

AGL above ground level

AGL 地面以上高度

ALP Airport Layout Plan

ALP 机场布局计划

AWOS automated weather observing system

AWOS 自动气象观测系统

CCS combined charging standard

CCS 组合充电标准

CFR Code of Federal Regulations

CFR 联邦法规典

Dcontrolling dimension

D 控制尺寸

direct current

直流电

EB Engineering Brief

EB 工程简报

ESS energy storage system

ESS 能量存储系统

ETL effective translational lift

ETL 有效翻译提升

EV electric vehicle

EV 电动汽车

eVTOL electric vertical takeoff and landing

eVTOL 电动垂直起降

FAA Federal Aviation Administration

FAA 联邦航空管理局

FATO final approach and takeoff area

FATO 最终进近和起飞区域

FC failure condition

FC 故障条件

GA general aviation

GA 通用航空

HOGE hover out of ground effect

HOGE 地效外悬停

IEC International Electrotechnical Commission

IEC 国际电工委员会

IEEE Institute of Electrical and Electronics Engineers

IEEE 电气和电子工程师学会

IFC International Fire Code

IFC 国际消防规范

IFR instrument flight rules

IFR 仪表飞行规则

ISO International Organization for Standardization

ISO 国际标准化组织

LAP Landing Area Proposal
LAP 着陆区域提案
LDR landing distance required
LDR 所需着陆距离
LED light emitting diode
LED 发光二极管
LOB line of business
LOB 业务线
MCS megawatt charging system
MCS 兆瓦充电系统
MSL mean sea level
MSL 平均海平面
MTOW maximum takeoff weight
MTOW 最大起飞重量
NEC National Electric Code
NEC 国家电气规程
NEPA National Environmental Policy Act
NEPA 国家环境政策法案
NEMSPA National EMS Pilots Association
NEMSPA 国家紧急医疗服务飞行员协会
NFPA National Fire Protection Association
NFPA 国家消防协会
OEM original equipment manufacturer
OEM 原始设备制造商
OFA object free area
OFA 无障碍区域
RTODR rejected takeoff distance required
RTODR 所需的拒绝起飞距离
SAE SAE International
SAE SAE 国际
TDP takeoff decision point
TDP 起飞决策点
TLOF touchdown and liftoff area
TLOF 着陆和起飞区域
TODR takeoff distance required
TODR 所需的起飞距离
Transportation Security Administration
交通安全管理局
Underwriters Laboratories
保险商实验室
VFR visual flight rule
VFR 视觉飞行规则
VGSI Visual Glideslope Indicator
VGSI 视觉下滑道指示器
visual meteorological conditions
视觉气象条件
vertical takeoff and landing
垂直起降