

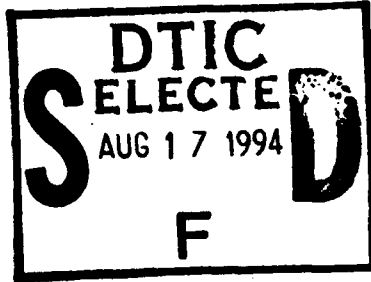
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Heliport/Vertiport MLS Precision Approaches

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July 1994

Final Report

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Dear Colleague:

Enclosed for your information is a copy of the recently published report **FAA/RD-94/23, Heliport/Vertiport MLS Precision Approaches**.

In the early 1990's, the Federal Aviation Administration initiated an effort to answer certain questions on precision approaches to heliports and vertiports. Of particular interest were issues of economic justification and available airspace.

At the time this task was begun, the microwave landing system (MLS) appeared to be the only near-term option for a precision landing at a heliport or vertiport. Since that time, tremendous progress has been made on the development of the global positioning system (GPS) and MLS has been rejected. The first GPS nonprecision approach at a heliport has been commissioned in Chattanooga Tennessee and three more are planned. Plans are also being made to develop GPS precision approaches to heliports.

The expense of MLS would have limited the number of heliports and vertiports where MLS instrument approaches could have been economically justified. In contrast, due to the low life cycle costs of GPS instrument approaches, such procedures are likely to be implemented at hundreds of heliports. Early implementation at hospital heliports can provide tremendous benefits to the nation in terms of lives saved.

This effort was focused on MLS. The implementation of GPS instrument approaches has required us to re-focus our thinking. This re-focusing is now well underway as evidenced with the commissioning of the Chattanooga GPS nonprecision approach. The publication of this report is not likely to have broad implications regarding the implementation of GPS instrument approaches. However, some portions of the work may have application to GPS instrument approaches and this document is published with this in mind.

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1.0 INTRODUCTION

The 1990 version of the Federal Aviation Administration's (FAA) Rotorcraft Master Plan (RMP) (reference 1) sets forth, as one of its goals, the need for "an adequate system of public use...heliports." At the present time, no approved criteria or process is available to define precisely what steps need be taken to develop an instrument flight rules (IFR) heliport or vertiport. As one means of supporting such development, the FAA has sponsored this study program to investigate the criteria needed and the steps necessary to plan for and develop an IFR heliport or vertiport. The study effort is divided into the six tasks described in the following paragraphs.

1. Develop a model of criteria necessary to establish an IFR heliport or vertiport facility. (At the present time, there is no single document, advisory circular (AC), or FAA order that can be considered an IFR heliport or vertiport standard. Where data is available, the model will contain elements of IFR facility requirements from a number of official FAA sources. Where data is not available, the model will consist of reasonable assumptions and extensions of existing FAA standards and policies.)
2. Develop a selection process to qualify potential IFR heliport and vertiport candidates.
3. Identify and conduct a survey of potential heliport and vertiport candidates supplying the criteria developed in task 1 and the qualifying process developed in task 2.
4. At six candidate sites, evaluate the sites and recommend changes, as necessary, to the current heliport or vertiport facility and to current FAA procedures and support facilities with regard to the IFR heliport or vertiport design, development, and operation.
5. Evaluate the candidate heliports and vertiports for instrument approach procedure compatibility by using SIMMOD simulation analysis software.
6. Provide to the FAA a prioritized list of candidate IFR heliport and vertiport facilities based on the application of the criteria and processes developed in tasks 1 through 5.

Two approaches were used in the investigative process. First, a literature search was conducted of applicable ACs, reports, and FAA orders that address IFR heliport certification, construction, and instrument procedure development. Second, interviews were conducted with various FAA personnel who deal with heliport and IFR issues from both regulatory and operational points of view. From the literature and the interviews, data were collected on prior and on-going analysis activities, simulations, and test results that define the current state of IFR heliport requirements to the maximum extent possible.

This report is an interim report presenting the results of the first two tasks. A second interim report will be prepared at the completion of tasks 3 and 4, and a final technical report will be prepared at the conclusion of the study effort. Periodic briefings will be presented to cognizant FAA offices during the course of the study. These briefings are for the dual purpose of informing the various FAA organizations on the progress of the study and receiving direction or redirection for the remaining work.

1.1 BACKGROUND

The RMP identifies the potential for 200 IFR-capable heliports/vertiports by 2010. To achieve this goal and to effectively integrate vertical flight aircraft into the National Airspace System (NAS), full IFR precision approach all-weather facilities are necessary.

The only two freestanding precision IFR heliports operating in the United States are the test facility at the FAA Technical Center (FAATC) in Atlantic City, New Jersey and the private heliport at United Technologies Sikorsky Aircraft in Stratford, Connecticut. Helicopters can use IFR approaches to airports, but must follow fixed-wing procedures. This decreases the efficiency of the air traffic system and can intrude upon fixed-wing traffic which must accommodate the helicopter's slower speed.

Attempts to find locations for all-weather heliports were made under the 1983 National Prototype Demonstration and Development Program sponsored by the FAA. The prototype heliports developed in Indianapolis, Indiana; New York City, New York; and New Orleans, Louisiana were to be IFR. A fourth prototype heliport was to be developed in Los Angeles, California, but for various reasons it was never constructed. Operational difficulties were encountered at the New Orleans Downtown Heliport, and problems also developed at both of the most favorable sites, Indianapolis and New York City.

A close-in obstruction problem caused the Indianapolis Downtown Heliport to be dropped from the microwave landing system (MLS) site list. The Downtown Manhattan Heliport in New York City also had obstruction problems, and a point-in-space approach was developed which proved to be a feasible answer. However, local issues have caused continued delay in implementation of the point-in-space approach procedure.

The establishment of an all-weather heliport has been of concern to the helicopter industry. A joint FAA/industry effort was put forth to refine IFR heliport airspace requirements for New York City. The Port Authority of New York and New Jersey (PANYNJ) requested an MLS demonstration in the "real environment" when they heard the FAA was to test MLS IFR helicopter procedures. This effort was to support an IFR approach to the New York City prototype heliport, then under renovation. The local pilots' organization, the Eastern Region Helicopter Council (ERHC), and MLS manufacturers demonstrated the approach to a pier-side helipad just north of the Downtown Manhattan Heliport. With the success of the demonstration, the PANYNJ approved installation of the MLS approach and

the procedures were approved. Unfortunately, there were problems obtaining the necessary equipment and local issues have caused continuing delays in implementation.

1.2 PURPOSE OF THE RESEARCH EFFORT

The purpose of this research effort is to develop a process that allows the FAA to identify locations that are potential IFR heliport and vertiport sites. In addition, this process will rank the sites in order of most suitable to least suitable. Included in the overall effort is a definition of those criteria and factors used to produce this ranking.

This IFR heliport and vertiport selection and ranking process will be applied to a number of potential sites in the United States. Application of the process will serve two purposes. First, it will test the selection process and the analytical models used in the selection process. This test will identify areas where the process needs refinement. Second, the application will produce a ranked list of potential IFR heliports and vertiports that the FAA can use for future planning purposes.

1.3 ASSUMPTIONS

In developing analytical tools and methods for IFR heliport and vertiport selection, it is sometimes necessary to make some assumptions regarding the likely outcomes of future criteria and policies. To date, two assumptions have been made to facilitate the development of the IFR heliport and vertiport model.

First, the development of the selection process is based primarily on the analysis of heliports, but it is assumed that much of the heliport selection process will apply to vertiports also. Because vertiport terminals are only a very recent development, there is only limited data on which to base specific selection criteria for vertiports.

The second assumption involves the airspace requirements for heliports and vertiports. The selection process assumes an airspace model based on MLS criteria. MLS criteria was chosen for two reasons; they are:

- o IFR heliports and vertiports will likely be required in city center congested areas where airspace is a scarce resource. MLS criteria requires a minimum of airspace as compared to other approved precision and nonprecision approach criteria.
- o In order to achieve maximum benefits at a heliport or vertiport, the vertical flight aircraft must provide safe and reliable service. In order to provide this service, a precision approach capability utilizing the vertical flight aircraft's steep approach capability will be needed. At present, the only approved precision landing system that can support steep angle approaches in city center environments is MLS. (the differential global positioning system (dGPS) may provide this capability in the future at a

fraction of the cost of MLS, but currently there are no approved criteria for dGPS. Therefore, MLS criteria is currently the only current option for supporting steep angle approaches to heliports and vertiports.)

As the study progresses, other assumptions may be required. If so, these assumptions will be described in subsequent reports for the IFR heliport airspace project.

1.4 SUPPLEMENTAL - TERMINAL AIRSPACE RECONFIGURATION

On December 17, 1991, the final rule for Airspace Reclassification was published (56 FR 65638). The new airspace classes are effective September 16, 1993. The final rule amends 14 Code of Federal Regulations (CFR) 71, to reclassify U.S. airspace in accordance with the airspace classes adopted by the International Civil Aviation Organization (ICAO). Reclassification will affect all control zones and transition areas by modifying their lateral and vertical dimensions. Specific terminal control areas (TCAs) and airport radar service areas (ARSAs) revisions will readjust surface areas and amend the language in their airspace descriptions.

Under the amended 14 CFR 71 effective September 15, 1993, positive control areas (PCAs), Jet routes, and area high routes will be classified as Class A airspace areas; TCAs will be classified as Class B airspace areas; ARSAs will be classified as Class C airspace areas; control zones and airport traffic areas for airports with operating control towers that are not associated with the primary airport of a TCA or an ARSA will be classified as Class D airspace areas; all other controlled airspace areas will be classified as Class E airspace areas; and airspace that is not otherwise designated as a controlled airspace area as Class G airspace.

The above designated airspace reclassification will effect various aspects of this report. This report retains the current airspace classifications because explicit depiction of the new airspace must be investigated and revised on an individual case-by-case basis, pending final changes to the appropriate Federal regulations and FAA Orders and is therefore not yet available.

2.0 DATA COLLECTION

2.1 REVIEW OF APPLICABLE DOCUMENTATION

The basic documents investigated dealing with IFR heliport requirements are AC 150/5390-2, "Heliport Design;" 150/5390-3, "Vertiport Design;" and FAA Order (FAAO) 8260.37, "Heliport Civil Utilization of Collocated Microwave Landing Systems (MLS)." These documents embody both the physical and airspace requirements for IFR heliports/vertiports. Other documents significant to this investigation include: FAAO 8260.3B, "United States Standard for Terminal Instrument Procedures (TERPS);" AC 90-45A, "Approval of Area Navigation Systems for Use in the U.S. National Airspace System;" FAAO 7400.2C, "Procedures for Handling Airspace Matters;" and FAAO 7031.2C., "Airway Planning Standard Number One Terminal Air Navigation Facilities and ATC Services." A complete bibliography can be found at the end of this report.

2.1.1 Interviews

Data was collected from interviews with the FAA offices and personnel shown in table 1.

TABLE 1
FAA COORDINATION

FAA OFFICE	PRIMARY AREA OF RESPONSIBILITY
AAS-100	DESIGN AND OPERATIONS CRITERIA DIVISION
AFS-420	FLIGHT PROCEDURES STANDARDS BRANCH
AVN-540	STANDARDS DEVELOPMENT BRANCH
ATM-100	AIR TRAFFIC SYSTEM MANAGEMENT
ATP-120*	TERMINAL PROCEDURES BRANCH
ATR-120*	AIR TRAFFIC PLANS AND REQUIREMENTS
ACD-330**	FAA TECHNICAL CENTER

* OFFICE NOTIFIED OF PROJECT

** MEETING PLANNED

3.0 IFR HELIPORT OPERATIONAL CONCEPTS AND REQUIREMENTS MODEL

Many interconnecting elements of the aviation system must be considered when identifying the components of an IFR heliport facility. These elements are: the physical aspects of the heliport itself, such as the size of the landing area and other parts of the heliport; airspace requirements for IFR approach, departure, missed approach, and obstacle avoidance; air traffic control (ATC) procedures and facilities; the effects of adding IFR traffic to existing procedures; the potential impact on traffic operating under visual flight rules (VFR) that may operate to and from that facility and facilities nearby; and communications. How the heliport may affect the surrounding environment with regard to noise, economic impact, and community attitude also must be evaluated in the site selection process to determine neighborhood compatibility and long-term value of the heliport to the community. This section describes all of the basic criteria needed to define a requirements model for an IFR heliport.

Separate FAA branches have developed the criteria for each category of data. Although the FAA branches coordinate efforts, as yet one comprehensive source document on IFR heliport/vertiport development has not been generated. Through the investigative process, this project will endeavor to define the criteria required for IFR heliport and vertiport installation and operation. Due to the limited data available for vertiports, this study will concentrate its efforts mainly on heliports. Current initiatives under the FAA's Vertical Flight IFR Terminal Area Procedures (VERTAPS) program is attempting to address civil tiltrotor (CTR) airspace requirements and to verify published criteria in AC 150/5390-3, "Vertiport Design." Investigative results from the VERTAPS program will be incorporated as appropriate.

This section first examines physical design aspects of the heliport. Design and development requirements necessary to support IFR vertical flight in a terminal area within the NAS are discussed. In the terminal environment, the activity level requires a precise blending of aircraft movements, ATC procedures, airspace policies, procedural qualifications, and terminal instrument procedures (TERPS). Further examination explores the impact and operability of each of the key elements through discrete subsections: airspace utilization, ATC, MLS precision instrument procedures, and heliport data requirements.

It must be noted that in defining and assessing these elements, a practical, common sense approach must be taken. The operational parameters of a viable IFR heliport must be defined before basic elements of an IFR heliport can be determined. In other words, the elements need to be assessed within the context of the current aviation system and with rational expectations of what the characteristics of a vertical flight facility will entail.

For example, in defining precision approach capability, the need for aircraft parking space is not a critical issue. However, if no parking space is provided separate from the takeoff and landing area in which to

discharge or enplane passengers or cargo, the facility will be restricted to one operation at a time, precluding any substantive benefit. One operation at a time would not meet the demands of a heliport whose characteristics qualify it for IFR capability. Therefore, the question of available aircraft parking, although by itself inconsequential to IFR arrival and departure planning, becomes a basic concern in designing and planning an IFR heliport or vertiport. Using this logic, design elements fall into one of two categories, *fundamental* or *supplemental*, depending on whether they are essential to simple operation or necessary due to the operational concept of a basic IFR heliport within the framework of the current system. ATC requirements for an IFR facility also help define basic facility specifications and real estate needs.

To define the operational concept of a specific heliport, certain assumptions must be made regarding the heliport or vertiport's location, missions expected to use the facility, size of the largest aircraft expected to use the facility (design helicopter), number of operations it can accommodate, and its relationship to other nearby vertical flight facilities including airports, etc. Then, each element's interrelationship with other elements must be examined to ensure that the interactional aspects required to support a IFR facility are appropriately incorporated to provide the most serviceable model. The operational concept of an IFR facility is discussed in section 3.1. The significance of each element's interaction with other elements is presented in sections 3.2 through 3.6.

3.1 IFR HELIPORT/VERTIPOINT OPERATIONAL CONCEPT

The prime consideration in defining an operational concept for an IFR heliport/vertiport is to provide a level of service that is safe, reliable, and cost effective. With this in mind, an operational concept for *realistic* IFR operations must be defined.

Many vertical flight missions require visual capability as a function of their purpose, such as power line patrol, real estate sales, sight-seeing, construction, etc. Due to their visibility requirements, a landing facility catering to these types of missions does not require IFR capability. The type of facility that would require IFR is one that serves missions that provide transportation or other services and must meet deadlines regardless of weather conditions: scheduled commuter, air taxi, corporate/executive, small package delivery, etc. These deadline-oriented missions require a high degree of reliability to satisfy customer needs and to justify the rotorcraft's cost to the company (in the case of corporate/executive), or to remain in business (in the case of air taxi or scheduled commuter operations). To justify the cost of developing an IFR facility, a high percentage of operational availability (97 to 99 percent, or better) to support this type of service must be provided. The basic operational concepts for both groundside and airside considerations are discussed in sections 3.1.1 and 3.1.2, respectively.

The preliminary assessment of the operational concept must be coordinated with various agencies and organizations who participate in the NAS. These include, but are not limited to, those listed below:

- o FAA Headquarters,
- o FAA regional offices,
- o key airlines,
- o other helicopter operators,
- o air package express carriers,
- o local and state government bodies, and
- o the private sector.

The foundation of this effort centers on a systematic approach to determine each important design consideration from both the airside and groundside. Prior to final conclusions, communications and dialogue with these organizations will greatly assist in refining the operational concept.

3.1.1 Groundside Assessment

An IFR facility must be economically competitive (i.e., with enough demand) from a marketing and operating standpoint to justify the expense of establishing IFR capability. This type of heliport/vertiport would most likely be located in a metropolitan area where demand for transportation and communication services would be highest. Within this setting, adequate demand can be anticipated in either a city-center or a suburb.

Demand, or the numbers of annual operations and/or enplaned passengers, must be at a level that IFR capability is warranted, as well as cost-effective. Precise levels of activity that would provide adequate cost-effectiveness for an IFR facility are not defined.

In addition, there are no requirements on which to base eligibility for various navigational or other types of equipment for heliports. Therefore, this study must attempt to define a reasonable level of activity to appraise demand for a successful IFR heliport. One method is to start with criteria that the FAA uses to allocate funding. Public-use heliports can receive up to 90 percent funding under the "Airport and Airway Improvement Act of 1982" (AIP). To receive the funding, the heliport must be included in the National Plan of Integrated Airport Systems (NPIAS). The NPIAS describes certain criteria for funding. Public-use heliports are included "in the plan if they have at least 4 based rotorcraft or 800 annual itinerant [emphasis added] operations, or 400 annual operations by air taxi rotorcraft." Heliports that are also included in a state or regional system plan are preferred. If public-use heliports cannot meet these criteria, they can also be included if they "make a significant contribution to public transportation." The criteria may provide the flexibility to establish realistic levels of demand in terms of current vertical flight systems.

Another approach to determining eligibility is to examine the benefit/cost relationships of IFR heliport systems. A recently completed

study, "Rotorcraft Low Altitude Benefit/Cost Analysis: Conclusions and Recommendations," DOT/FAA/DS-89/11 (reference 43) has evaluated these relationships based on the percentage of instrument meteorological conditions (IMC) at a given location. For example, consider a location that has weather minimums that are typical of an average location in the United States. (For this purpose, average weather minimums will be between a 466 foot ceiling - 3/4 mile visibility and an 800 foot ceiling - 1 mile visibility.) Table 2 shows, for various helicopter missions, the number of annual operations by IFR-capable helicopters needed to justify: 1) the purchase of a remote communications outlet to support IFR operations at a heliport/vertiport, and 2) the development of a nonprecision approach procedure that requires only existing navigation equipment (e.g., an existing very high frequency omni range (VOR), non directional beacon (NDB), LORAN-C, or global positioning system (GPS)).

TABLE 2
ANNUAL OPERATIONS BY IFR-CAPABLE HELICOPTERS TO UNDERWRITE PURCHASE OF IFR EQUIPMENT OR FINANCE DEVELOPMENT OF IFR PROCEDURES

ANNUAL OPERATIONS BY IFR-CAPABLE HELICOPTERS		
HELICOPTER MISSION	TERMINAL COMMUNICATIONS	NONPRECISION APPROACH
AIR TAXI	13,111	368
BUSINESS	15,019	640
CORPORATE/EXECUTIVE	13,629	400
COMMUTER	11,689	256

Latent demand must also be considered when determining expected annual operations or passengers enplaned. Latent demand is demand that is there if a facility becomes available, or if a facility introduces improvements. For instance, there may already be a certain number of IFR-certified rotorcraft in a metropolitan area that would use an IFR-capable landing area if it became available. Or, a rotorcraft airline may begin service at that location once an IFR facility is in place.

The types of aircraft expected to use an IFR facility would be those that are IFR-certifiable and involved in transportation service. This does not necessarily mean an extremely large aircraft. Although some rotorcraft airlines do use helicopters as large as a Sikorsky S-61 (26 passengers), some have been quite successful with Bell 206 Jet Rangers (4 passengers). However, in general, the types of helicopters employed for transportation services range from medium to large.

3.1.2 Airside Assessment

Operational traits as defined in the groundside assessment (section 3.1.1) establish the foundation for specific heliport or vertiport requirements. Airspace requirements must also be defined and addressed

along with groundside issues. The most important concern when introducing a facility with IFR capability into an existing system is to ensure that overall operational risk to safety does not increase.

Projected increases in traffic volume must be carefully evaluated against existing route structures to guarantee that equivalent levels of safety will continue to be provided. The aim is to adapt the existing air traffic system to capitalize on rotorcraft capabilities rather than to apply fixed-wing procedures that are restrictive to rotorcraft. This will entail developing an innovative and efficient strategy for airside design. It will further require a careful appraisal of the terminal environment by the various Federal, state, and local officials involved.

Section 3.1.1 stated that a heliport or vertiport with enough activity to warrant IFR capability would most likely be located in an urban area. In such a setting, precise airspace concerns must be addressed. For example, heliports or vertiports in such locations, city-centers in particular, may be surrounded by an obstacle-rich environment and due to the lack of flexibility in airspace requirements, IFR operational potential may be nonexistent. The converse may also be true. Locations that offer no restraint to airspace requirements may experience groundside restrictions that limit the physical space needed for IFR operations and eliminate that location from consideration.

ATC issues must be addressed with regard to airspace considerations. When in the public interest or otherwise justified, an instrument procedure must be designed within controlled airspace. This normally dictates that a control zone be designated at the specific landing site. In some cases, an existing heliport may be a satellite facility to an operational control zone but has been excluded due to its VFR-only operations. Appropriate provisions can be initiated to incorporate these types of facilities into the controlled environment. At other locations where this situation does not exist, an independent control zone may be required. Here, as in route structures, the unique operating characteristics of rotorcraft offer the potential for control zone configuration alterations to support distinctive heliport operations under IFR. New control zone configuration alterations would most likely be first implemented by exception to a rule. As an exception became standardized the Federal Aviation Regulations (FARs) and FAAOs would be changed.

The introduction of a new IFR facility presents another concern with regard to ATC. All control authority for the management of IFR air traffic is delegated to specific ATC facilities. Varying levels of ATC authority exercise jurisdiction over specific portions of arrival and departure airspace associated with IFR operations, air route traffic control centers (ARTCC) for en route, approach control facilities for terminal, and control towers for the local vicinity. Numerous airports throughout the United States operate effectively without a control tower to directly handle IFR air traffic because they do not have traffic levels that meet the eligibility requirements for a tower. Establishment criteria for towers at heliports and vertiports have not yet been

investigated. This is an research and development (R&D) effort that needs to be examined. However, an IFR heliport or vertiport operating within congested airspace may warrant an exception to these eligibility requirements. The unique operational characteristics of heliports and vertiports in urban and city-center locations should not disqualify them as equal participants in the IFR structure.

3.1.3 Airport Airspace Analysis

The preliminary application of the criteria developed in this study will be employed for in-place, operational heliports. Any heliport upgrade from VFR to IFR will be in accordance with 14 CFR 157. Accordingly an airport airspace analysis derived from an aeronautical study must be completed for each facility in question. The results of this study are used to advise those persons who propose modification to the heliport. This is accomplished by a determination regarding the effect of the operational alternation on the safe and efficient use of the navigable airspace. A complete study consists of an airspace analysis, a flight safety review, and a review of the potential effect on air traffic control and air navigation facilities. Each of these phases of the heliport aeronautical study requires complete and accurate data to enable the FAA to provide the best possible advice regarding the merits of the proposed alterations on the NAS.

The authority to conduct the airport program is delegated to the appropriate regional Airports Office. This office must maintain direct coordination with Air Traffic, Airway Facilities, and Flight Standards personnel.

3.2 PHYSICAL REQUIREMENTS OF IFR HELIPORTS

The basic physical design requirements for all public-use heliports are the same whether the facility is VFR or IFR. The differences are focused in the physical configuration of a potential site to allow for obstacle avoidance and approach/departure route protection for IFR procedures. The basic sources for physical design standards for heliports and vertiports are FAA ACs 150/5390-2, "Heliport Design,"¹ and 150/5390-3, "Vertiport Design." Although the recommendations are only advisory, they represent the acceptable standards for vertical flight landing facility construction and development in the United States.

AC 150/5390-2 is divided into several categories of heliports: private-use, public-use, heliports at airports, VFR, nonprecision instrument, and precision instrument. The basic design elements germane to this project are delineated primarily under two chapters: chapter 3, Public-Use Heliports, and chapter 7, Precision Instrument Heliports. References

¹AC 150/5390-2, "Heliport Design," is currently (12/92) under revision and will be reissued in the future as AC 150/5390-2A. Heliport requirements described in this study are based on that document as it currently stands. If the revision is issued before the end of the study period, relevant changes will be made in subsequent reports.

pertinent to data delineated in sections of additional chapters and ACs are provided where relevant.

AC/150/5390-3, "Vertiport Design," is structured somewhat differently under the assumption that there will be few, if any, private vertiports. The categories in this document are: airside design; airspace; VFR; IFR, marking, lighting, and NAVAIDS; landside design; tiltrotor facilities at airports; and design examples. References pertinent to data delineated in sections of additional chapters and ACs are provided where relevant.

There are many elements that make up the physical requirements for heliports. The size or measurement of some design elements vary depending on the size of the helicopters using the heliport, operational requirements, use of the heliport, services provided, etc. Because of this, there are no precise physical requirements that are ideal for every situation. In other words, a complete set of criteria that may be perfect for an IFR public-use heliport in one location may not be right for another. Therefore, the physical requirements can only be defined within a framework of variables when formulating an IFR heliport requirements model.

This also holds true for landing facility amenities. Although an "ideal" heliport may include every amenity, some elements for which guidance is furnished may not be necessary for an acceptable IFR facility candidate or for a successful IFR heliport. For example, fuel and/or maintenance services may be inappropriate at a specific location, or a city-center facility may provide appropriate space for helicopter requirements but may only have room for a few automobile parking spaces, etc.

When evaluating a potential site for an IFR facility, certain elements are more critical than others with regard to the appropriateness of location. For instance, the elements that define the necessary real estate requirements, such as the takeoff and landing area² and the final approach and takeoff area² (FATO), are of higher priority than elements such as lights for night operations or navigation equipment. In other words, if a facility is too small to accommodate the high priority

²The revision of "Heliport Design," AC 150/5390-2A changes the application of certain terms to be consistent with both AC 150/5390-3, "Vertiport Design," and International Civil Aviation Organization (ICAO) standards. The changes are as follows:

ELEMENT	CURRENT DOCUMENT 150/5390-2	REVISED DOCUMENT 150/5390-2A
FINAL APPROACH AND TAKEOFF AREA (FATO)	LOAD BEARING SURFACE FROM WHICH A HELICOPTER MAY TAKEOFF/LAND	THE CLEAR AREA AROUND THE LOAD BEARING SURFACE
TAKEOFF AND LANDING AREA	THE CLEAR AREA AROUND THE LOAD BEARING SURFACE	---
TOUCHDOWN AND LIFT-OFF AREA (TLOF)	---	LOAD BEARING SURFACE FROM WHICH A HELICOPTER MAY TAKEOFF/LAND

elements, it would not qualify as a potential site. The priority of specific requirements is discussed in section 4.0, Candidate IFR Heliport/Vertiport Qualifying Factors.

The remainder of section 3.2 defines each physical element and the range of variations required for an IFR public-use heliport. Section 3.3 presents airspace utilization, section 3.4 presents ATC requirements, section 3.5 presents TERPS, and 3.6 presents heliport data requirements.

3.2.1 Heliport Takeoff and Landing Area

The heliport takeoff and landing area is the area within which the rotorcraft maneuvers for takeoff and landing (refer to footnote 2 on page 13). The FATO is located within the heliport takeoff and landing area (see section 3.2.2). In other words, the heliport takeoff and landing area defines the basic size of the heliport. A basic heliport would consist of just a heliport takeoff and landing area including the FATO. The heliport takeoff and landing area may be located at ground level, on a rooftop of a building, on an elevated platform, or over water (when the FATO is located on a solid surface).

The minimum dimensions of the heliport takeoff and landing area are determined by the size of the design helicopter. Different measurements apply for single rotor helicopters and tandem rotor helicopters. At high altitudes and/or in hot climates, a longer heliport takeoff and landing area is recommended. The longer takeoff and landing area provides additional maneuvering room so that a helicopter can operate more efficiently under high or hot conditions. AC 150/5390-2 recommends that a public-use heliport expecting 10 or more operations per hour have more than 1 heliport takeoff and landing area.

In addition to the basic size requirements, a horizontal clearance or safety area is required between the edge of the heliport takeoff and landing area and any vertical object. This area is to avoid main or tail rotor strikes with any vertical object that may be near the heliport takeoff and landing area. Depending on the design helicopter, the safety area can add 10 to 24 feet to the space required for the landing area of a heliport.

For a vertiport, the takeoff and landing area is referred to as the FATO. It can be any shape but "must be capable of circumscribing a square with 250 foot sides (75 m)." It is recommended that the size of the square increase with altitude by 50 feet (15 m) per 1,000 foot elevation above mean sea level (MSL).

3.2.2 Final Approach and Takeoff Area (FATO)

A FATO is defined as an "area over which the final phase of the approach maneuver to hover or landing is completed and from which the takeoff maneuver is commenced" (refer to footnote 2 on page 13). In the current version of "Heliport Design," it is considered the load bearing area, normally located within the heliport takeoff and landing area, from which

a helicopter may touch down or lift off. Under certain circumstances, FATOs can be located apart from the takeoff and landing area if that area is designated over water or some other non-solid surface. Different measurements apply for single rotor helicopters and tandem rotor helicopters for determining minimum FATO size. The FATO does not have to be centered within the heliport takeoff and landing area. If it is not centered it must be at least the length of one rotor diameter of the design helicopter from the edge of the heliport takeoff and landing area. The surface must be capable of producing ground effect.

If there is more than one FATO where simultaneous, same-direction, diverging operations are to take place, there is a minimum center-to-center separation distance requirement. If sequential operations are to be conducted, the heliport takeoff and landing areas surrounding the FATO may overlap; AC 150/5390-2 specifies the requirements for this condition.

Where the FATO is contained within the heliport takeoff and landing area, its size requirements would not affect the physical land requirements for the heliport.

3.2.3 Parking Areas

During the time a helicopter remains on the FATO or within the heliport takeoff and landing area, no other helicopter may use the facility. The number of parking spaces required for a particular heliport would depend on the number of helicopters expected to use the heliport at a specific time (day, hour) and the length of time each is expected to remain parked. This need would vary with the type of operations being conducted.

The number of parking spaces required would have a definite effect on the amount of land needed and the operational capacity of the heliport. Since a candidate IFR facility must have enough potential operations to warrant the expense of establishing IFR capability, it is logical that the site would need one or more parking areas. Two types of parking areas are defined in AC 150/5390-2, *helipads* and *helidecks*;³ the first is at ground level, and the second is elevated.

3.2.4 Taxi Routes and Taxiways

Taxi routes provide clear access between the heliport takeoff and landing area and parking positions. The taxiway is the hard surface area of a taxi route provided for wheeled rotorcraft. The width requirement for these routes is different based on whether the aircraft are to hover or ground taxi.

³In the draft revision of "Heliport Design," 150/5390-2A, the term *helideck* will be defined as a heliport located on a floating or an off-shore structure.

If the taxi route connects the heliport takeoff and landing area and the parking area within the normal boundary of the heliport, it should not have any effect on its size. However, in certain circumstances the taxi routes may have to be located in peripheral areas to avoid objects such as buildings, trees, etc. If this is the case, the placement of the taxi route may increase the size requirement of the heliport.

3.2.5 VFR Approach/Departure Routes

No heliport is exclusively an IFR facility. Even with a published precision instrument procedure, there is an IFR visual segment beyond the decision height (DH) that must be flown by visual reference. IFR and VFR approach/departure routes must be carefully planned for all heliports to ensure operational compatibility.

Consideration must be made to avoid objects and noise sensitive areas. Curved routes can be used. If available and feasible, routes can be located over major highways, railroad tracks, rivers, etc., so that the impact on the surrounding area is reduced. 14 CFR 77 criteria for transitional surfaces must be met.

Hazards to navigation must be removed or marked depending on the circumstances. Hazards are anything penetrating the imaginary surfaces⁴ of the heliport, including parked helicopters. IFR approach and departure routes may follow the same ground track, but IFR obstruction avoidance requirements differ and must be evaluated separately.

3.2.5.1 VFR Approach/Departure Protection Areas

The VFR approach/departure protection area underlies the routes from the edge of the primary surface (14 CFR 77, Subpart C, heliport imaginary surface) that overlies the designated takeoff and landing area at the heliport elevation on an 8:1 slope out to a point where its height is 35 feet (10.5m) above the elevation of the landing surface. It is desirable that this area be reasonably free of terrain irregularities or objects in order to best protect approach/departure routes. Ownership by the heliport of that portion of land beneath the innermost surface should be considered. It offers the best means of regulating and protecting persons and property on the ground. The necessity of owning or controlling these areas may affect the size and cost of the heliport.

3.2.6 Heliport Facilities

The type and number of facilities can significantly increase the overall land requirements of the heliport. Fuel dispensing areas need to be located away from the operating areas. Maintenance services may require hangars and/or larger apron areas. Terminal buildings can be small or

⁴The routes locate the 14 CFR 77 Subpart C heliport approach and transitional surfaces emanating from the primary surface. They are called "imaginary" because, although unseen, they exist within the airspace around the heliport.

quite elaborate. The size of the heliport would increase when large parking facilities are constructed for automobiles or alternate forms of transportation.

3.2.6.1 Fuel

As an added service to customers and to augment income, fuel is sold at some heliports. The only guidance that AC 150/5390-2 provides is that fuel storing and dispensing must conform to Federal, state, and local requirements.

3.2.6.2 Maintenance

Some larger heliports provide maintenance service. There is no specific guidance provided for these facilities in the FAA heliport and vertiport design ACs.

3.2.6.3 Terminal Facilities

Facilities for passengers and pilots can range from none to a complete terminal building with waiting room, pilot lounge, restaurant, etc. Specific guidance is found in AC 150/5360-9, "Planning and Design of Airport Terminal Facilities at Non-Hub Locations."

3.2.6.4 Alternative Transportation

Research in previous studies on the demand for IFR capability at heliports has indicated that provisions for alternative transportation are necessary at heliports where the primary function is to provide transportation, whether for corporate/executive transport, charter operation, or scheduled service. Heliports supporting the community or regional transportation infrastructure would need to provide alternative transportation at the heliport. These transportation alternatives could include taxi cab access; car rental agencies; existing public transportation such as subways, buses, etc.; and automobile parking.

3.2.6.5 Automobile Parking

Currently, few persons who currently employ helicopter transportation can be expected to commute to and from the heliport in public transportation. As rotorcraft expand into the urban transportation infrastructure that may change. However, the automobile is the current dominant mode of private transportation in the United States, and most people will use cars. Automobile parking therefore is highly recommended at any heliport supporting community or regional transportation services. Minimum parking facilities should provide enough space for customer and employee needs. Larger heliports may provide curb-side discharge and pickup areas.

3.2.7 Heliport Marking

Requirements for marking for heliport takeoff and landing areas, FATOs, parking areas, and for identification, weight limit, and taxi route/ways would be the same for both a VFR and an IFR heliport. Guidance is found in ACs 150/5390-2 and 3, and specific requirements in AC 150/5345-39, FAA Specification L-853, "Runway and Taxiway Retro-Reflective Markers."

3.2.8 Basic Heliport Lighting

Basic requirements for lighting at heliports where night operations occur or where the owner/operator wishes to provide lighting are the same for both VFR and IFR heliports. Basic lighting includes, perimeter lights, flood lights, taxi route/way lighting, and obstruction marking and lighting.

For an IFR heliport the perimeter lights must be enhanced with additional edge and wing bar lights to meet standards for a heliport instrument lighting system (HILS) (see section 3.5.9.2). Specific requirements are found in ACs 150/5390-2 and 3. In addition, heliport approach lighting systems (HALS), are required to support IFR precision approaches at heliports, (see section 3.5.9.1). These configurations may dictate visibility minima as discussed in section 3.2.12, NAVAIDS (navigation aids).

Detailed requirements for landing facility lighting are found in AC 150/5340-18B, "Standards for Airport Sign Systems;" AC 150/5345-46A, "Specification for Runway and Taxiway Light Fixtures;" AC 150/5340-24, "Runway and Taxiway Edge Lighting Systems;" and AC 150/5345-44D, "Specification for Taxiway and Runway Signs."

3.2.9 Visual Aids

Visual aids include wind indicators, landing direction lights, visual glide path indicator, and an identification beacon. Specific requirements for these items are found in ACs 150/5390-2 and 3. IFR heliports would not require landing direction lights of the type required for VFR heliports since the IFR lighting requirements would be applicable. Additional guidance on visual aids is found in AC 150/5345-27C, "Specification for Wind Cone Assemblies," and AC 150/5345-12C, "Specification for Airport and Heliport Beacons."

3.2.10 Safety Features

Safety features are critical to all aviation facilities. Specific items pertaining to heliports include approach/departure path alignment, fences, fire protection, walkways, and snow and ice removal. The requirements of AC 150/5390-2 apply. AC 150/5200-30, "Airport Winter Safety & Operations" provides specific guidance. For IFR heliports, particular care needs to be applied when siting fences to avoid interference with IFR operation. In addition, specific critical areas are associated with MLS equipment. These areas require protection from

unlimited movement of surface traffic to ensure continuous integrity of radiated signals.

3.2.11 Weather Observation and Reporting Requirements

Weather observation and reporting is not required to support visual flight operations. Despite this, most VFR facilities normally provide a limited level of weather related information as a safety feature to enhance operability.

For IFR operations, FAA regulations require that hourly and special weather observations be taken during the hours and dates when instrument activity is conducted. It further requires that these observations be "expeditiously" provided to the ATC authority having jurisdiction over the airspace associated with a particular heliport or vertiport. The introduction and approval of automated weather devices is one way of satisfying this requirement. Guidance can be found in AC 150/5220-16A, "Automated Weather Observing Systems (AWOS) for Non-Federal Applications," as well as AC 150/5390-2. IFR weather reporting requirements are discussed in section 3.3.2.1.3.

3.2.12 Precision NAVAIDS Requirements

Availability of approved navigation and landing systems that can effectively provide precision approach/departure guidance information for heliports is very limited. Currently the only system that can adequately meet these requirements is the MLS. The MLS is normally comprised of three basic components. These are:

- o course guidance (azimuth),
- o vertical guidance (elevation), and
- o distance measuring equipment/precision (DME/P) or conventional (DME/N).

Limitations associated with other terminal NAVAIDS, such as the instrument landing system (ILS), prevent them from being used in confined conditions often associated with heliports. The GPS has great potential to satisfy heliport precision approach requirements when generated in the dGPS mode. However, dGPS has not yet been fully developed for this purpose. Using criteria specifically developed for heliports, MLS provides all of the navigation essentials for precision approach capability.

3.2.12.1 MLS Installation Requirements and Basic Siting Concept

Specific site requirements must be satisfied to ensure proper MLS operability. Each candidate heliport must be evaluated through a site survey to guarantee MLS installation criteria can be attained. Such a survey should include, but may not be limited to, examination of the following items:

- o obstruction clearance charts,

- o area topographical charts,
- o heliport master plan,
- o description of existing nav aids and lighting,
- o heliport electrical conduit and cable information,
- o proposed MLS type equipment and characteristics,
- o run-up areas,
- o ground traffic patterns,
- o heliport property lines,
- o noise abatement regions, and
- o restricted airspace.

Due to limited available real estate at most current and proposed heliports, it is necessary to collocate the MLS azimuth (AZ) and elevation (EL) equipment. Figure 1 displays the positioning array for the AZ and the EL antennas under the collocation concept. The DME antenna is usually located with the AZ antenna.

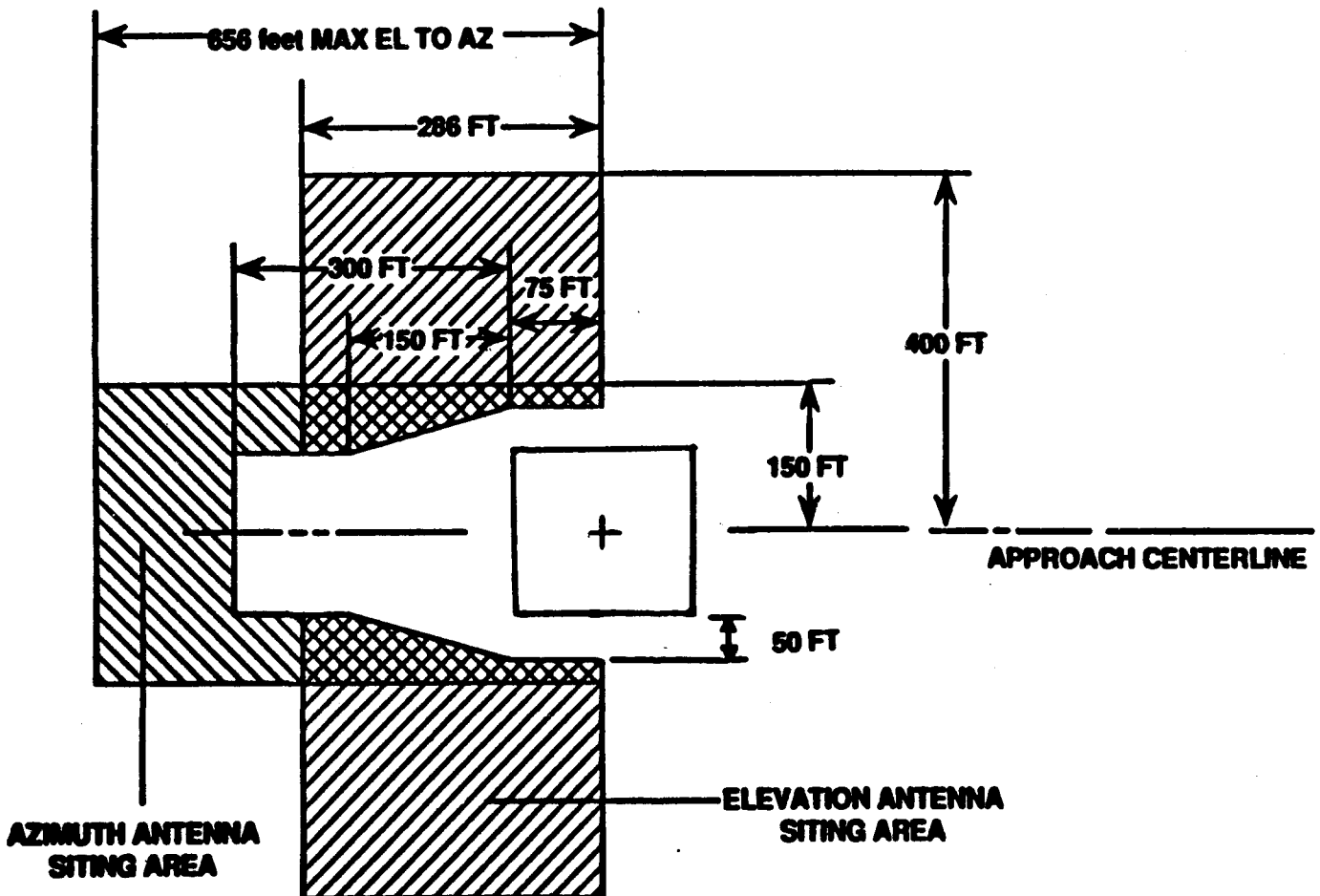


FIGURE 1 POSITIONING ARRAY FOR THE AZ AND THE EL ANTENNAS

In parallel with the siting requirements, it is necessary to have object-free MLS critical areas. Vehicles and other aircraft in close proximity to an MLS component transmitter can cause signal blockage or reflection.

This can seriously degrade system performance that could adversely affect an aircraft executing an IFR procedure. Without question, in developing heliport selection criteria, the MLS critical areas must be considered and surveyed. Any object that is determined to cause signal interference must be removed. Figure 2 and 3 illustrate the typical MLS critical area configuration for the collocated sited systems.

3.2.12.2 Functional Coverage Requirements

Optimum collocated siting of the MLS can provide category I minima standards. In addition, the potential for positive course guidance during the missed approach segment also exists by including a back azimuth station. When compared to the present precision ILS, MLS offers a wider coverage volume of positive course guidance for both azimuth and elevation as shown in figure 4.

3.3 AIRSPACE UTILIZATION

Effective airspace utilization is very important in the development of an instrument procedure for any IFR facility. The more complex the air traffic movements, the more restrictive aircraft and pilot requirements may be. However, despite procedure complexity, an efficient, productive, and useful airspace designation is required to accommodate safe and expeditious air traffic flow. Each final candidate heliport will require an FAA Regional Air Traffic Division review. The review will assess the existing and/or proposed en route and terminal airspace structures to ensure that they satisfy the needs of the users and ATC.

The following sections provide a precursory outline of distinctive issues and concerns that must be addressed with the introduction of an IFR facility into the existing system. Each section provides an examination into what specific actions must be accomplished to develop an operational plan to allow the incorporation of IFR heliports or vertiports in an airspace environment.

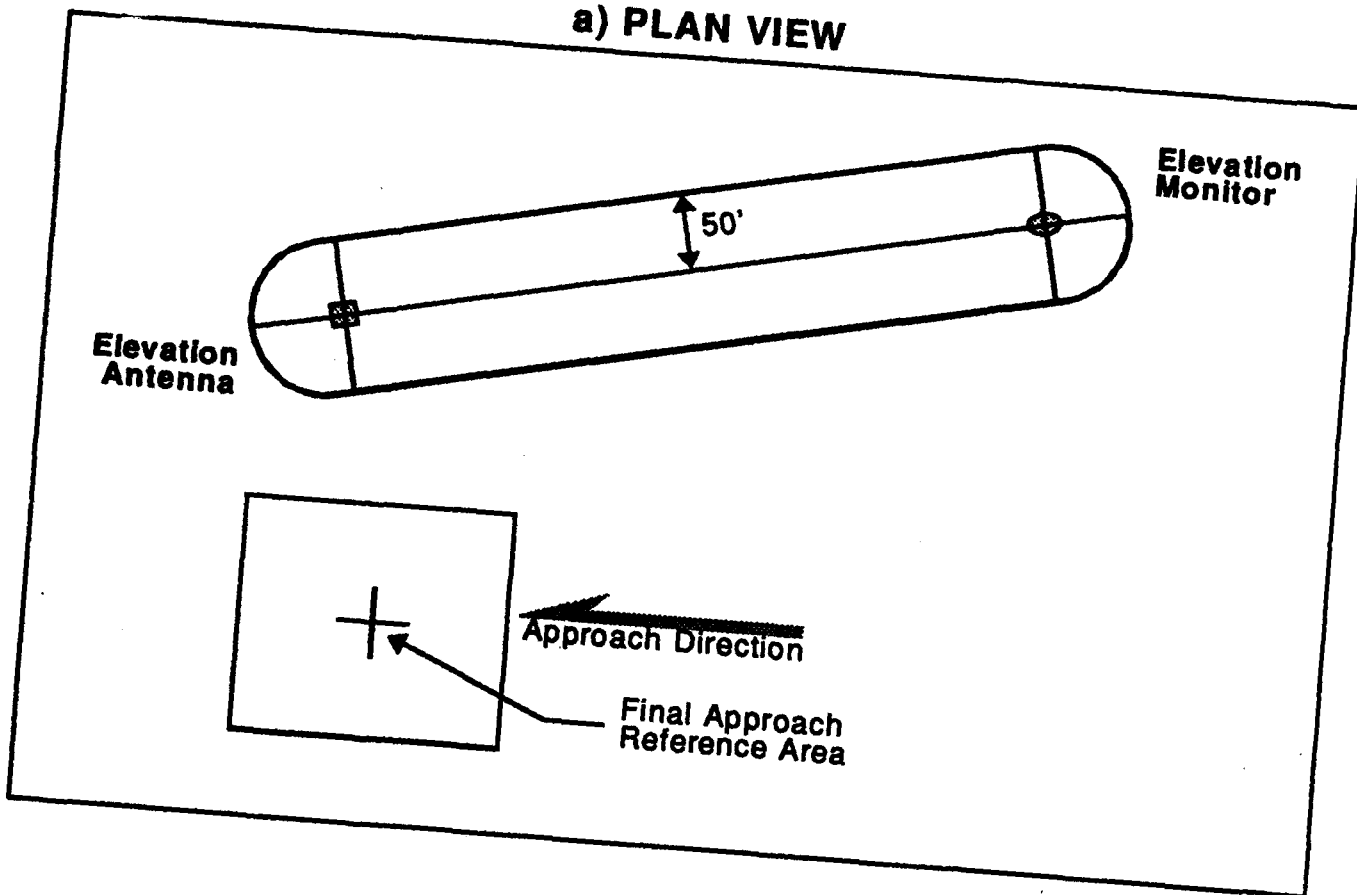
3.3.1 En Route Airspace Structure

The en route airspace structure of the NAS consists of three basic strata:

- o airways (low altitude),
- o jet routes (medium altitude), and
- o random operations (high altitude).

The lower stratum or "airway" structure extends from the base of controlled airspace up to but not including 18,000 feet above MSL. This low altitude regime is where the flow patterns for both the arrival and departure routes for an IFR heliport must be constructed. If the heliport is to be located in an existing terminal area, a blending of fixed-wing and rotorcraft operations must be established. Most terminal areas have well-defined route structures that satisfy users needs. The introduction of a new IFR facility will dictate the need to modify or

a) PLAN VIEW



b) PROFILE VIEW

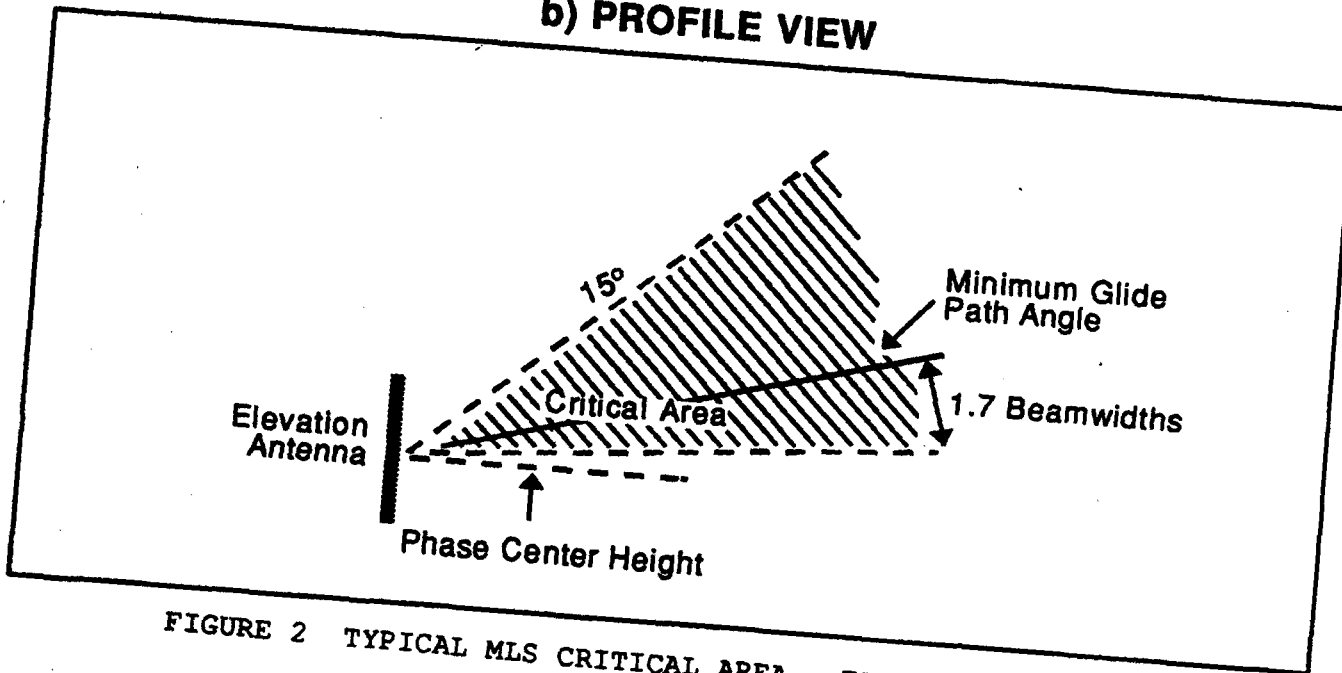
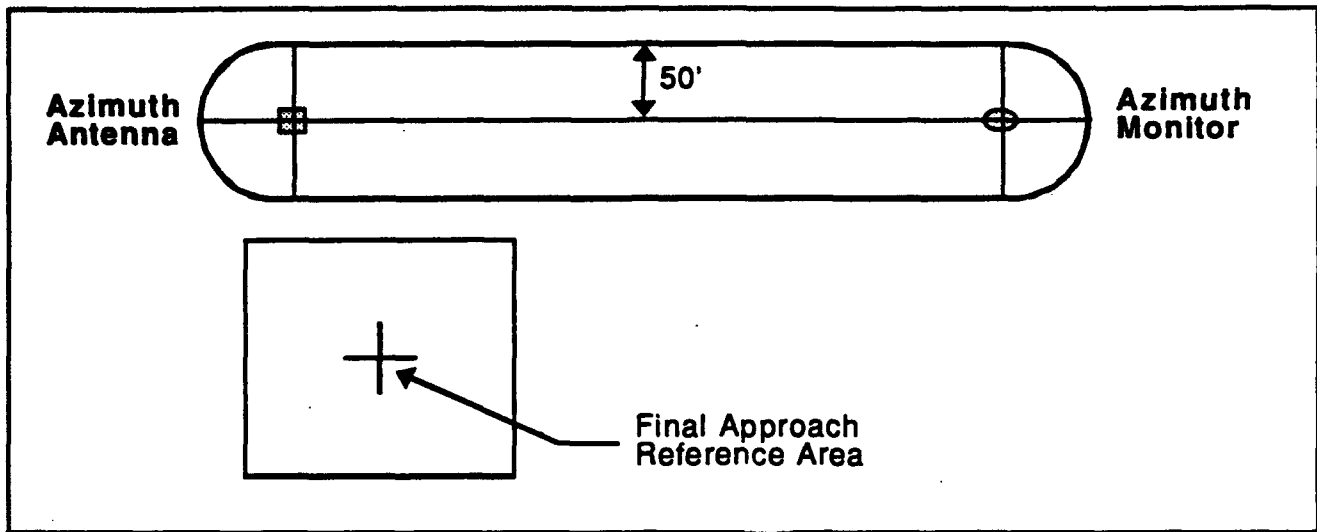


FIGURE 2 TYPICAL MLS CRITICAL AREA - ELEVATION ANTENNA

a) PLAN VIEW



b) PROFILE VIEW

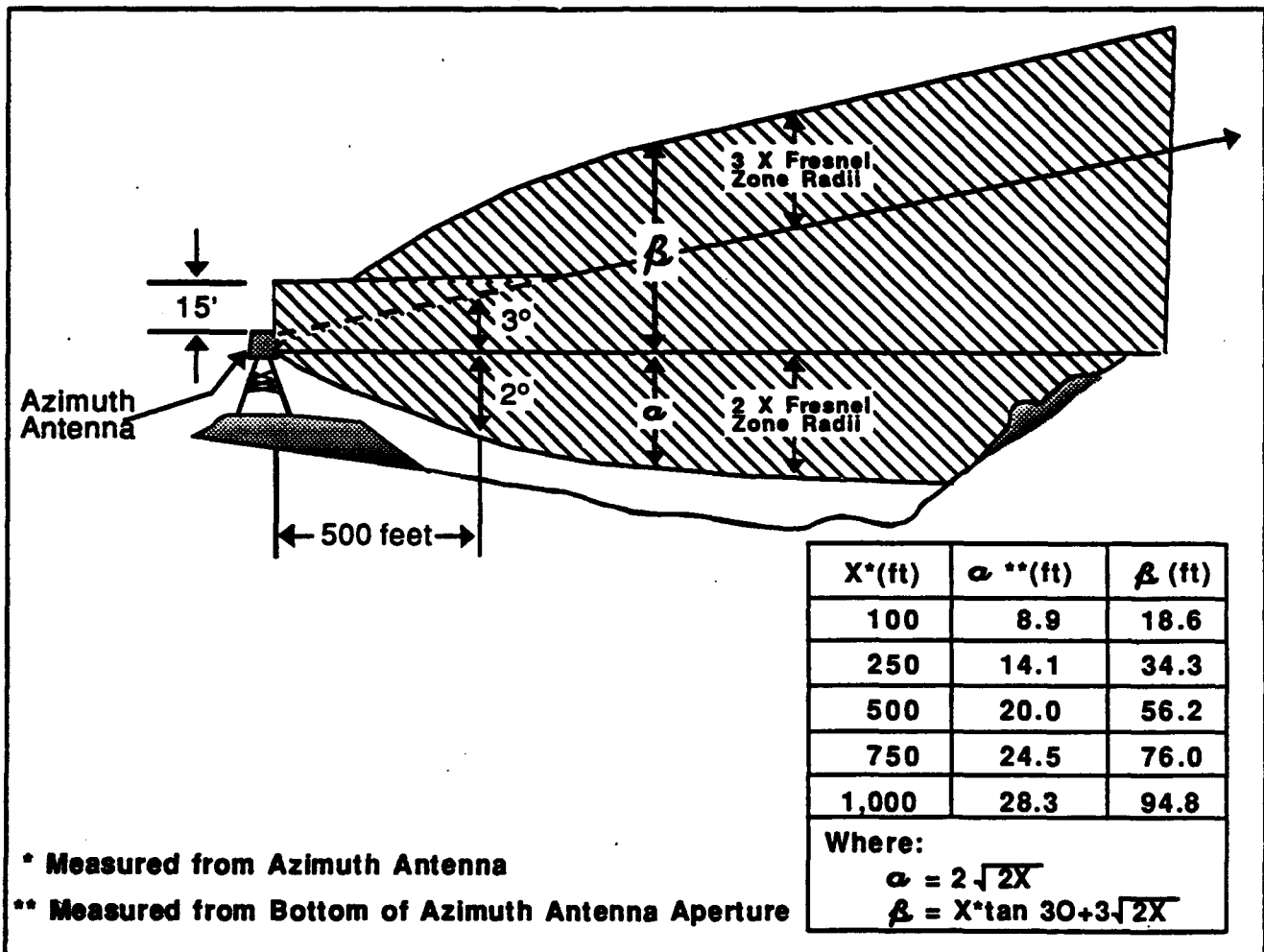


FIGURE 3 TYPICAL MLS CRITICAL AREA - AZIMUTH ANTENNA

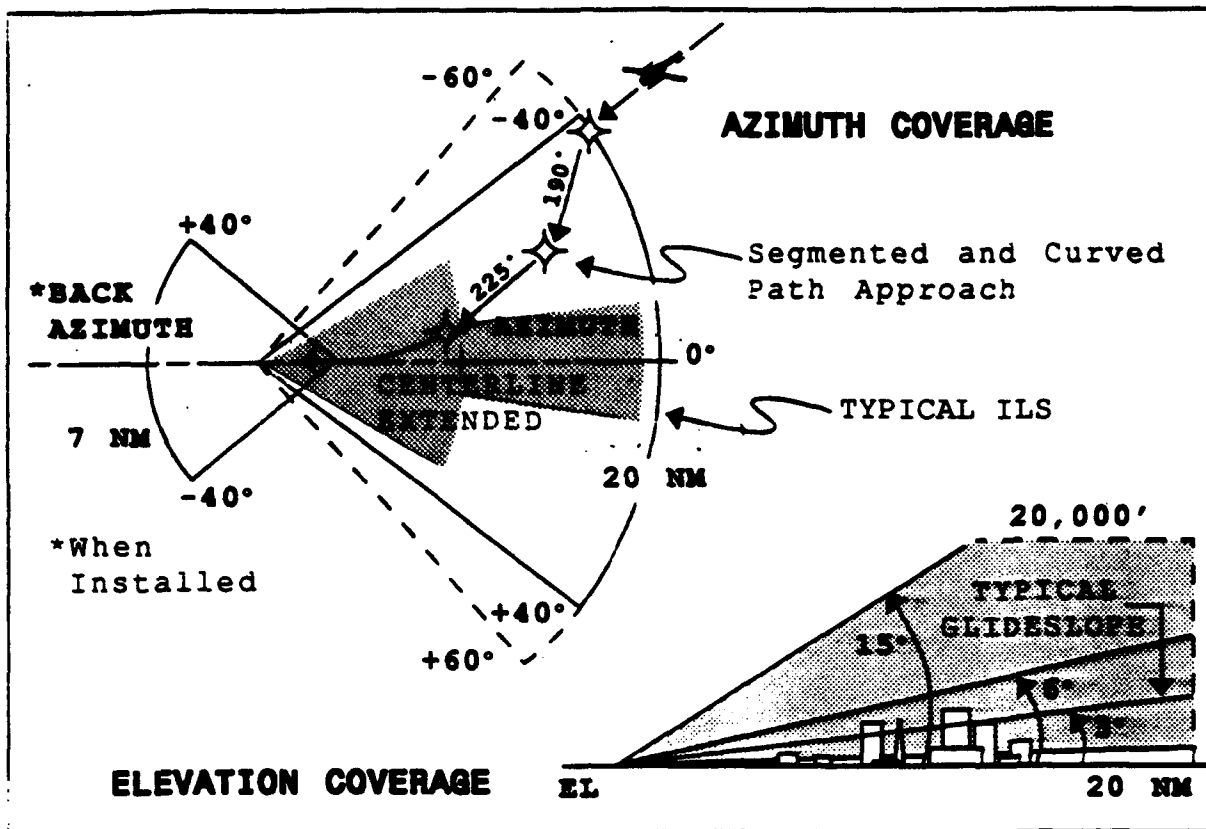


FIGURE 4 AZIMUTH AND ELEVATION COVERAGE WINDOWS

amend existing flow configurations in order to handle the arrival and departure of vertical flight aircraft. Because airspace is finite, some terminal areas experience persistent fixed-wing air traffic saturation offering little, if any, room for further usage. This is a critical consideration, since any addition of rotorcraft activity must be integrated with current and projected levels of aircraft movement.

3.3.1.1 Route Identification

Direct coordination with the regional FAA Air Traffic Division is necessary to explore the methodology needed to develop or modify a designated route structure. The route criteria must satisfy lateral and vertical protection, as prescribed for ATC procedures and TERPS.

3.3.1.2 Processing Channel

Appropriate coordination must be accomplished through FAA Flight Operations and Flight Standards to handle the necessary routing. Specific attention will be directed toward FAO 8260.19, "Flight Procedures and Airspace Handbook."

3.3.1.3 Criteria

All developed routing must be manually validated to ensure that required navigational tolerances are satisfied. This includes the placement of operational fixes, waypoints, or essential reporting points required for ATC.

3.3.1.4 Development and Construction

A review of in-place route systems is the initial step in airway and/or route construction. Correlation with appropriate levels within the FAA Air Traffic and Flight Standards Office must be vigorously maintained during this initial development phase. Blending existing fixed-wing systems with heliport IFR arrival and departure requirements will be the primary consideration.

3.3.1.5 Flight Inspection

Final development of selected airways and/or specified routes will be provided to the appropriate FAA Flight Standards Office for comment, review, and validation. The appropriate Flight Standards Office will be responsible for the required notice of proposed rule-making (NPRM) and for the actual flight inspection when required. Flight inspection data concerning airway and/or routing operability shall be documented as required by the FAA.

3.3.2 Terminal Airspace Structure

The FAA has the responsibility for establishing instrument procedures used for terminal operations at civil airports and heliports within the United States and its possessions. Procedures published in 14 CFR 97 are identified as standard instrument approach procedures (SIAPs). These procedures are available to all users. Public-use procedures should not be established without the designation of controlled airspace according to FAA Handbook 7400.2C, "Procedures for Handling Airspace Matters." This requires direct coordination between all controlling agencies within any terminal airspace structure to ensure all procedures and policies are satisfied. Review of terminal airspace structures falls directly under the jurisdiction of each FAA regional Air Traffic Division. Of primary concern are control zones, transitions areas, terminal control areas, and airport radar services areas.

3.3.2.1 Control Zones

A control zone provides controlled airspace from the surface of the earth to the base of the continental control area. The development of initial IFR heliport procedures warrants the designation of a control zone to accommodate projected IFR air traffic movement. An IFR heliport may justify a new type or modified definition of a control zone, as discussed in section 3.3.2.1.5.

3.3.2.1.1 Designation

FAA Handbook 7400.2C, chapter 23, paragraph 6101 states that, "a control zone shall be designated to accommodate instrument procedures if such action is justified and/or in the public interest." The introduction of public-use IFR heliports that will operate in less than visual meteorological conditions (VMC) and the regulatory nature associated with controlled airspace substantiates the need for a designated control zone.

3.3.2.1.2 Communications

Communications capability for aircraft operating in a control zone must exist down to the landing surface. Communications may either come directly from the ATC facility having jurisdiction over the control zone or from rapid relay through other communications facilities that are acceptable to that ATC facility.

3.3.2.1.3 Weather Observation and Reporting

FAA regulation requires that Federally certified weather observers take hourly and special weather observations at the primary facility during the hours and dates the control zone is designated. It further requires this weather observation be transmitted expeditiously to the ATC facility having jurisdiction over the control zone. Where the weather duties are conducted by other than Federal employees, the appropriate FAA office must notify them about the reporting and dissemination requirements and the applicable National Weather Service (NWS) and FAA publications.

3.3.2.1.4 Loss of Communication or Weather Reporting Capability

If the requirements of paragraphs 3.3.2.1.2 and 3.3.2.1.3 cannot be continually met, appropriate action must be initiated. A notice to airmen (NOTAM) will be issued detailing the affected control zone service (communication or weather).

3.3.2.1.5 Configuration of Control Zones

The dimensions of control zones to support heliport operations will require further investigation. The unique operational characteristics of urban/city-center heliports may create a need for a separate category of control zone, not yet defined in FAA regulations or orders. The current 5 statute mile (sm) circular radius and vertical distance standard goes well beyond the projected requirement for controlled airspace for urban/city-center heliports in most cases. Modification of the current control zone dimensions to those appropriate for vertical flight aircraft will be required.

3.3.2.1.6 Control Zone Extensions for Arrival and Departure

At certain locations extending the control zone along specific or random routes may be necessary to ensure containment of IFR procedures within the required designed controlled airspace. Extension lengths and widths

for arrival and departure operations will require special consideration due to the limitations imposed by an urban heliport environment.

3.3.2.2 Transition Areas

Transition areas are extensions of controlled airspace constructed to contain and protect those portions of the terminal operations that transit between the terminal and en route environments. Transition areas extend upward from 700 feet or more above the surface when designated with an airport for which an instrument procedure has been prescribed, or from 1,200 feet or more above the surface when designated with airway route structures or segments. The upper vertical limits terminate at the base of overlying controlled airspace.

3.3.2.2.1 Designation

If communications requirements are satisfied (see section 3.3.2.2.2), the transition area must be designated to perform three primary functions: initially, to contain IFR arrival, departure, holding, and en route operations not protected by other controlled airspace; second, to accommodate prescribed instrument approach procedures; and third, to accommodate special (unpublished) procedures in the public interest.

3.3.2.2.2 Communications

Communications capability must exist with IFR aircraft that normally operate within the transition area. This communication may be either direct from the ATC facility having jurisdiction or from rapid relay through other communication facilities.

3.3.2.2.3 General Criteria

There are two base levels from which a transition area may extend, either 700 or 1,200 feet. A target IFR altitude of 1,500 feet with an above the surface altitude of 1,200 feet defines the floor of controlled airspace.

3.3.2.2.4 Transition Area Criteria for Arrival and Departure

As with a control zone, the transition area has unique applications when it is designated to support arrival or departure operations. Arrival extensions are designed to protect IFR procedures from a point where an IFR flight leaves an altitude of 1,500 feet above the surface on approach. This criteria is directly linked with TERPS to maintain a consistent standard for aircraft protection while operating within controlled airspace. This same perspective is true for the departure phase of flight.

3.3.2.3 Terminal Control Area Requirements

Terminal control areas (TCAs) offer controlled airspace from the surface to a specified altitude. A TCA often encompasses airspace for more than one airport. Within this area all aircraft are subject to specific

regulations regarding pilot qualifications and aircraft equipment. This program was developed to reduce midair collision potential in the congested airspace surrounding an airport with high density air traffic. At some locations, IFR heliport candidates must satisfy requirements to support operations in a TCA.

3.3.2.4 Airport Radar Service Area Requirements

Airport radar service areas (ARSAs) normally center on a single airport environment. They also provide controlled airspace extending upward from the surface or higher to specified altitudes within which aircraft are subject to the operating rules and pilot/equipment requirements detailed in 14 CFR 91.

3.4 AIR TRAFFIC CONTROL

The primary purpose of the ATC system is to promote the safe, orderly, and expeditious flow of air traffic. The infrastructure of a terminal environment is an interconnecting system of sectorized parcels of airspace. Each parcel contributes to the overall separation standards and procedural agreements that generate an efficient flow of air traffic.

To accomplish this sectorization of airspace, there are many variables involved. Each set of circumstances must be evaluated on its own merit. When more than one action is required, an in-depth matrix must be developed to accurately depict flow pattern tracks for aircraft movement. From a safety standpoint, a matrix provides the best tool for judging the modification of procedures to support a new IFR facility.

Service levels of the ATC system are regulated by many factors, including the volume of traffic, frequency of congestion, quality of radar, controller workload, and controller duty priority. As stated previously, it is acknowledged that direct coordination with ATC is necessary to ensure existing and planned modifications to terminal airspace structures are sufficient to satisfy all user needs.

3.4.1 Mission Profile

Currently, an IFR helicopter mission profile is considered to be the following:

An IFR departure from a heliport via an established helicopter standard instrument departure; a cruising altitude during the en route phase in the lower altitude stratum at or below 5,000 feet; a descent via a precision instrument approach to visual conditions and finally, continuation of the approach in visual conditions to the destination heliport or vertiport.

The introduction of a new facility that adds a precision IFR capability will require the utmost coordination between all agencies involved. Each candidate heliport will require a review from the FAA Regional and local air traffic offices. The existing and proposed arrival and departure

routing infrastructure must also be assessed to see that it is sufficient to satisfy the needs of the users and of ATC.

3.4.2 Control Zone

Consideration must be exercised to ensure compliance with the appropriate Federal regulations. The development of instrument procedures requires that if such action is justified and/or in the public interest, these operations must be contained within controlled airspace. Specific control zone design parameters and dimensions are outlined in section 3.3.2.1.

3.4.3 Separation Standards/Procedures

Separation standards and operational procedures as they will apply to the candidate IFR facility must be clearly defined. The ATC facility responsible for providing air traffic services must be directly involved. Efforts must be expanded to design and develop specific terminal procedures for the rotorcraft community. Coordination with the appropriate ATC authority is necessary to provide a standard for procedural precedence and operational priority. Review of ATC separation standards and procedures contained in FAAO 7110.65G, "Air Traffic Control," is necessary.

3.4.4 Arrival and Departure

The arrival and departure routes and procedures of each potential location must be studied independently to match the operability of that new location as it relates to the overall air traffic situation. An effective balance must be attained to permit a smooth transition between facilities and to define prescribed transfer control points within designated areas of responsibility.

3.4.5 Communications and Control

As heliports and vertiports are certified and activated as IFR-capable, it will be necessary to maintain communications throughout the mission profile. Communication with ATC will be mandatory, considering the environment in which these facilities are expected to be located. Moreover, the need to place an air traffic controlled environment at the heliport may be necessary. The placement of an ATC facility is based on traffic volume, considering both documented and projected levels. As these facilities become active participants in the IFR realm, it may necessitate the development of new standards for the establishment of a control tower at heliports.

3.5 TERMINAL INSTRUMENT PROCEDURES

The rationale behind TERPS criteria is to formulate a safeguard composed of specific obstacle clearance surfaces for arriving and departing instrument procedures. These criteria are predicated on normal aircraft

operations, with emphasis directed toward assessment of three basic factors that contribute to overall system accuracy:

- o ground elements,
- o airborne elements, and
- o flight technical (pilotage) elements.

Credits are allowed for technological advances to ensure safe use of existing controlled airspace. The design and development of instrument procedures to government specifications falls into three distinct classifications: arrival, departure, and en route. The nature of this study limits the discussion to the arrival and departure stages.

The arrival phase consists of four basic segments: initial, intermediate, final, and missed approach. In addition, an area for circling the heliport under visual conditions is considered. Each segment normally begins and ends at designated fixes. The fixes are named to coincide with the segment. For example, the intermediate segment begins at the intermediate fix and ends at the final approach fix, where the final approach segment begins. In constructing a procedure, the final approach course should be identified first, because it is usually the least flexible and most critical of all the segments.

The departure phase specifies obstacle clearance requirements to be applied to either diverse departures, departure routes, or standard instrument departures (SIDs). Each of these departure applications provides obstacle clearance surfaces to satisfy defined climb gradients along a designated departure flight path. When the approach and departure courses have been determined, they blend to produce an orderly maneuvering pattern that is responsive to the local traffic flow.

3.5.1 MLS Precision Instrument Procedures Requirements

FAAO 8260.37 defines the development criteria for helicopter precision instrument approach procedures using collocated MLS facilities at heliports. These criteria are applicable for all heliports served by collocated MLS facilities. Procedures to runways served by non-collocated MLS facilities are not discussed in this document. Fundamental considerations in determining the requirements for procedural design and development include:

- o system components,
- o routes and approach segments,
- o missed approach segments,
- o obstacle clearance surfaces, and
- o appropriately assessed visual and instrument minima.

The range of possibilities for the necessary requirements are discussed in the following sections. The dialogue that follows is limited to an overview of the necessary elements of TERPS development. To ensure that operational access to the candidate facilities can be met during IMC, a common standard must be defined. Protection from obstacle intrusion into

operational areas must be furnished through trapezoidal areas and clearance surfaces. The framework presented here of the required components provides an awareness of parameter standards that planners can use to assess candidate heliports. For more detailed procedural development beyond the dimensional criteria contained in this report, refer to FAAO 8260.3B.

3.5.2 Initial and Intermediate Segments

The initial segment is where an instrument approach normally commences. Here, an aircraft departs the en route phase of flight and maneuvers to enter a terminal environment. The transitional or intermediate segment connects the initial segment with the final segment, aligning the aircraft with the final segment in preparation for landing. It is in the intermediate segment that adjustments in aircraft configuration, speed, and positioning are made in preparation for the final approach. The minimum lengths of both the initial and intermediate segments can vary. The length of each is dependent on specific procedural design requirements, as shown in figure 5.

3.5.3 Final Approach Segment

The final approach segment is a trapezoidal area that originates from the azimuth antenna. It is coincident with the final approach reference area (FARA) (see section 3.5.4.1), extended centerline and is normally aligned with the 0 degree azimuth. It begins at a point back from the FARA and extends to the precision final approach fix (PFAF), the point at which the approach begins. The length and width of the final approach segment is defined by two sections, the final approach primary area and the transitional surfaces. A vertical perspective is added by defining an obstacle clearance plane within the length and width of the final approach segment. The slope ratio of this plane is solely dependent on the approach glidepath angle. Transition surfaces are attached at right angles and extend outward and upward from the edge of the primary area at a gradient of 7:1. Collectively, these define a three dimensional protection zone for helicopters from obstacles on approach in the final segment, as shown in figure 6.

3.5.3.1 Final Approach Primary Area

The final approach primary area is centered on the final approach course and has a standard length of 25,000 feet. This length may vary under certain circumstances, but cannot be less than 2 miles. Its width at the beginning edge is 1,000 feet, from where it evenly expands to 6,000 feet at the 25,000 foot point. Dimensional widths are adjusted with any changes in the length.

Within the lateral limits defined above, an inclined plane is created to provide designated clearance above obstacles. This is the obstacle clearance plane. It begins at the FARA elevation, extends outward at a slope ratio dependent on the designated approach glidepath angle. The associated missed approach surface, which normally begins beyond the

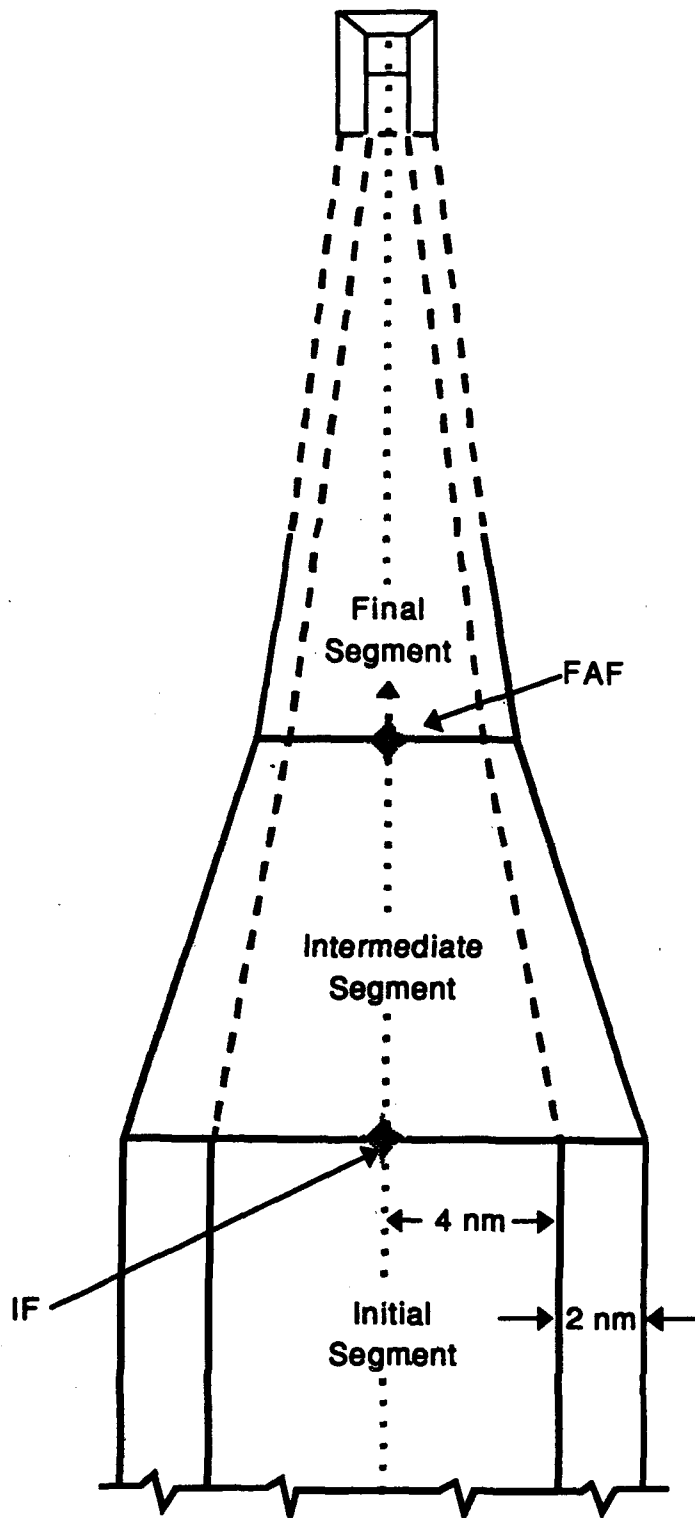


FIGURE 5 INITIAL AND INTERMEDIATE SEGMENTS

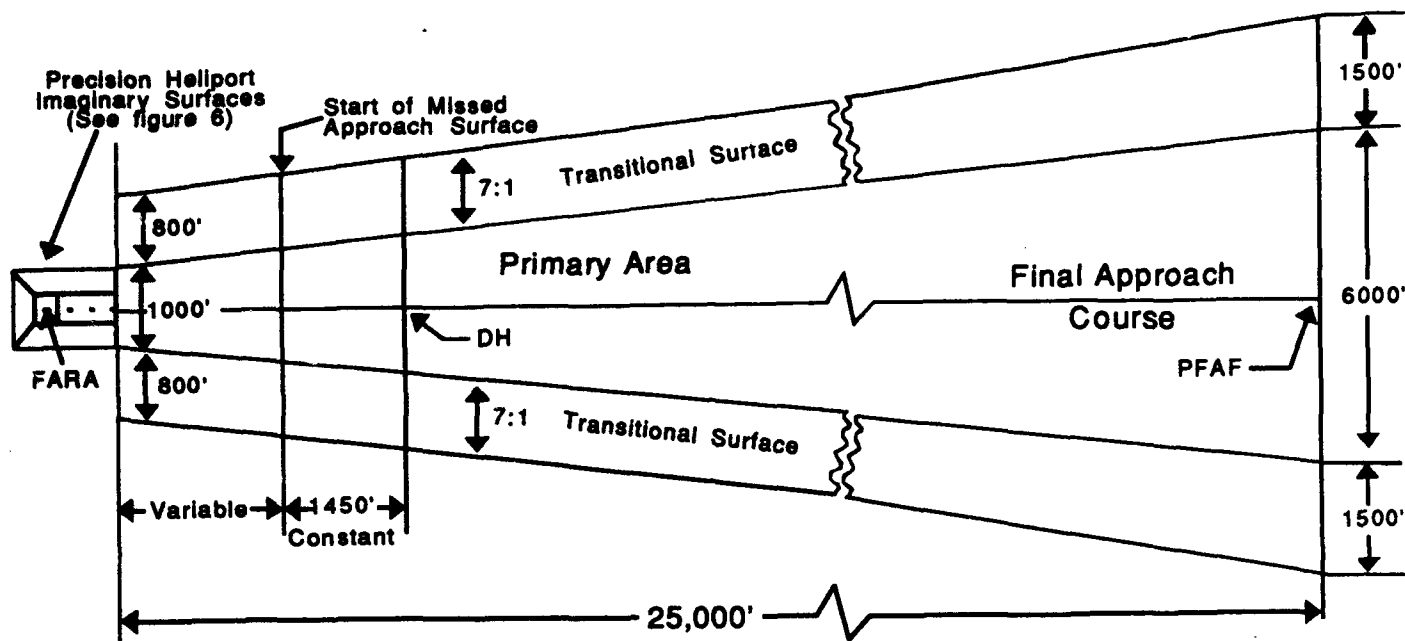


FIGURE 6 FINAL APPROACH PRIMARY AREA AND TRANSITIONAL SURFACES

DH, provides an additional obstacle clearance plane throughout the remainder of the procedure, see figure 6.

3.5.3.2 Transitional Surfaces

Transitional surfaces are areas measured at right angles from the outer edges of the final approach course. At the origin, these surfaces are 600 feet wide and increase evenly to 1,500 feet at the 25,000 foot point. They begin at the height of the final approach obstacle clearance surface and extend outward and upward at a gradient of 7:1 at right angles to the final approach course (FAC). The dimensions of these surfaces vary with the length of the final approach segment and adjustments are made accordingly. Figure 6 also depicts these surfaces.

3.5.4 Precision Heliport Imaginary Surfaces

The connection between the final approach area and the heliport surfaces is made through five elements:

- o the FARA,
- o the approach obstacle free zone (OFZ),
- o the inner-transitional surfaces OFZ,
- o the obstacle assessment surface (OAS) area, and
- o surface extensions.

Each of these elements is designed to restrict the type and height of obstacles in close proximity to the FARA. Specific dimensions and

inclined slopes are provided for each, as depicted in figure 7. Only essential (required by function) frangible heliport visual aids are permitted to penetrate the surfaces.

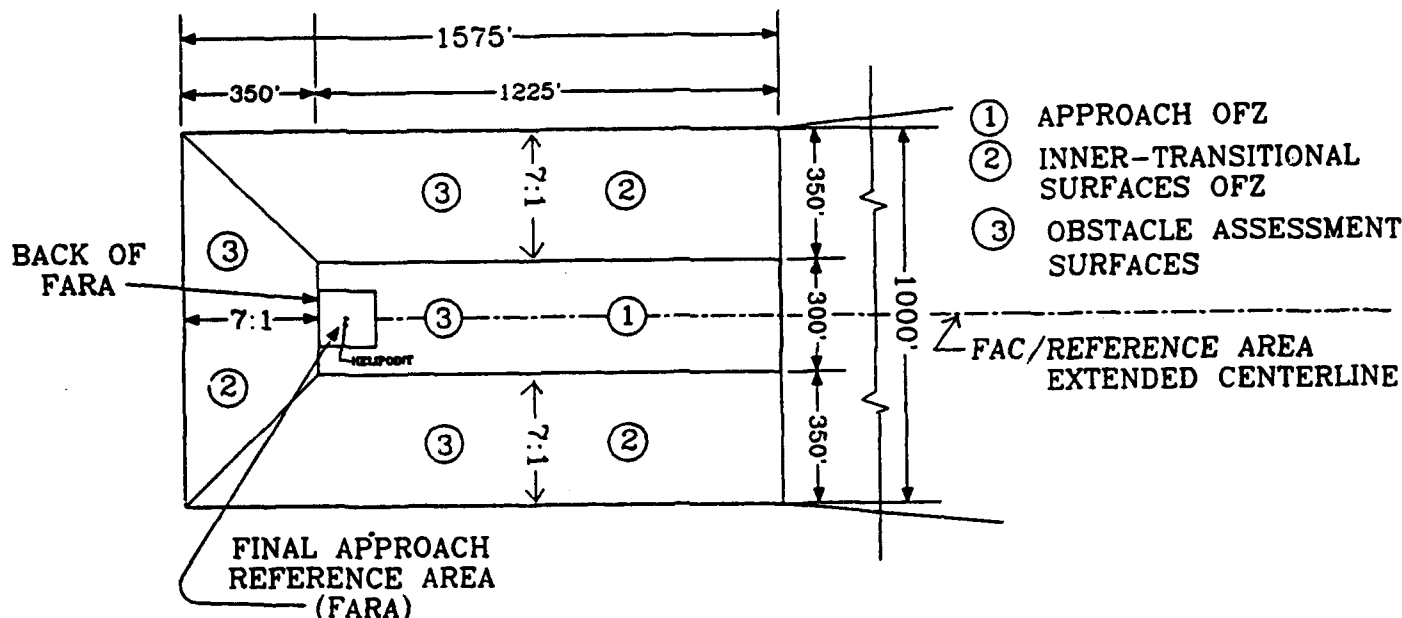


FIGURE 7 PRECISION HELIPORT IMAGINARY SURFACES

3.5.4.1 FARA

The FARA is an area surveyed by location and elevation, and approved for instrument operations where hover or touchdown is authorized and is normally associated with the FATO. It provides a 150 foot obstacle-free square where instrument procedures may terminate or begin. The center point, or heliport, is aligned with the FAC and designated as an arrival and/or departure point for reference and control of instrument arrival and departure operations of helicopters.

3.5.4.2 Approach OFZ

The approach OFZ starts at the back edge of the FARA at the same elevation as the heliport, the dimensional center of the FARA. At that point, the OFZ is 300 feet wide and centered on the FAC. Routinely, the OFZ extends outward in the direction of the final approach segment and rises at a slope of 20:1 until it is 8 feet above the heliport elevation.

3.5.4.3 Inner-Transitional Surfaces OFZ

The inner-transitional surface areas are 350 feet wide and composed of two side surfaces and one end surface. The total length of the inner-

transitional side surfaces is 1,575 feet. These surfaces begin at the side edge of the approach OFZ surface and extend upward at a slope of 7:1.

The end surface is 350 feet long. It is 300 feet wide at the back of the FARA end of the OAS and extends out to a width of 1,000 feet and upward at a slope of 7:1 measured perpendicular to the OFZ back edge.

3.5.4.4 Obstacle Assessment Surface (OAS) Area

The OAS area is 1,000 feet wide and centered on the FAC. It begins 350 feet beyond the back edge of the FARA and extends to the beginning of the final approach area. The OAS consists of the OFZ and the 7:1 surfaces defined in sections 3.5.4.2 and 3.5.4.3.

3.5.4.5 Surface Extensions

Where the takeoff and landing area with a HILS (see section 3.5.9.2) is not the FARA, the heliport surfaces shall provide extensions for additional obstacle protection. These extensions are shown in figure 8. These extensions must meet the same obstacle-free criteria as the FARA.

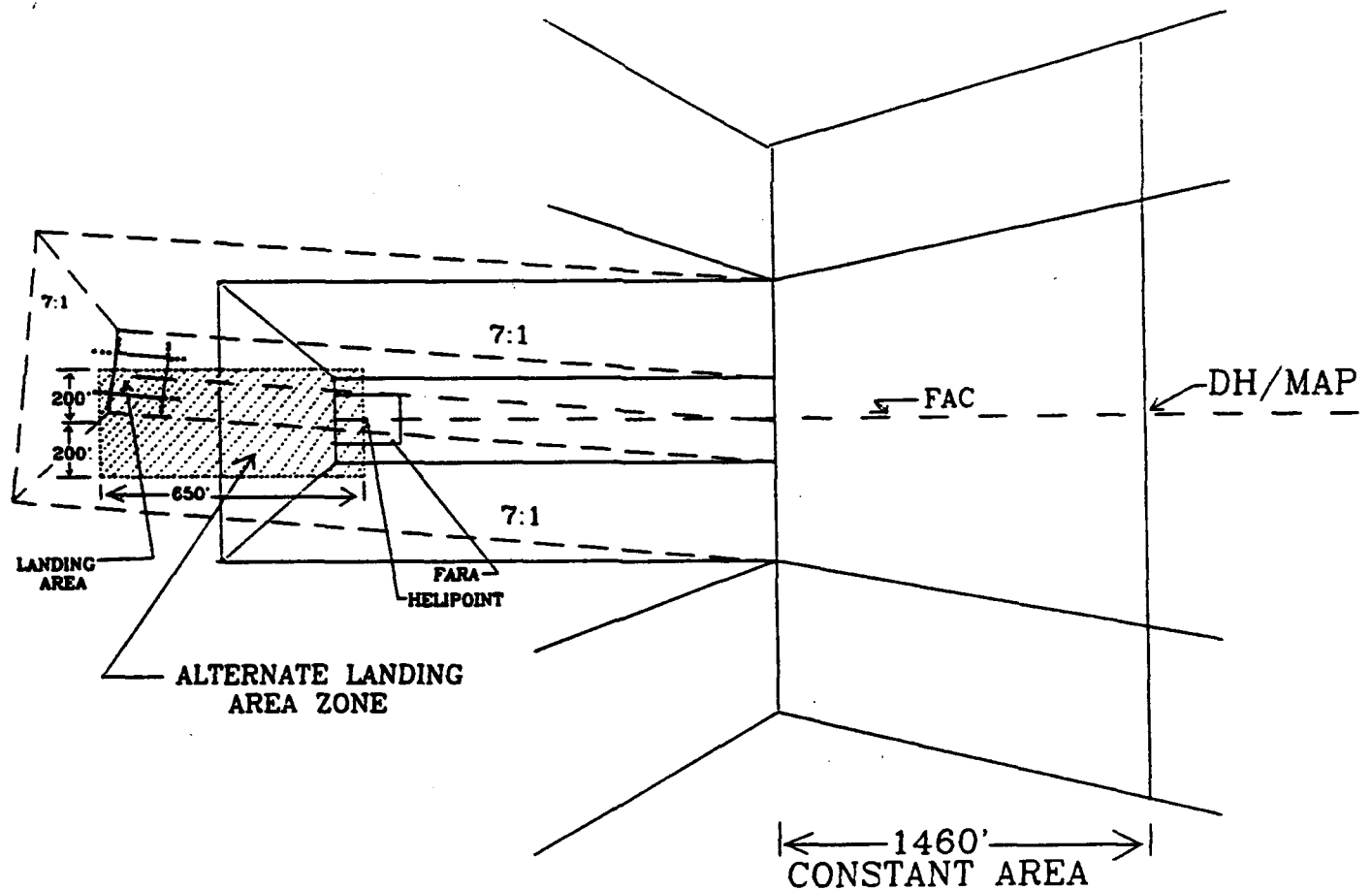


FIGURE 8 SURFACE EXTENSIONS

3.5.5 Glidepath Angle

In addition to the required obstacle clearance (ROC), there are other criteria that apply to selection of a glidepath angle and antenna location. MLS facilities should be commissioned with the lowest glidepath angle possible to allow the lowest minimums. Angles below 3 degrees or above 6 degrees will not be established without an approved waiver from the Flight Standards Service, FAA Headquarters, Washington, D.C.

The elevation antenna will be located in accordance with appropriate siting requirements, except it shall not penetrate approach or inner transitional OFZ surfaces. The optimum heliport crossing height (HCH) for the glidepath angle is 8 feet. When the optimum cannot be achieved, the height will not be less than 8 feet or greater than 20 feet above the heliport.

3.5.6 Missed Approach Segment

The missed approach segment begins at the DH or missed approach point (MAP) and ends at a point or fix where initial approach or en route obstacle clearance is provided. The width at this point is the same as the final approach primary area. Its edges splay 20 degrees relative to the missed approach course until reaching its maximum width, 4 nm each side of the missed approach track. Secondary areas for the missed approach segment join at the edges of the final approach transitional surfaces. The edges splay 30 degrees relative to the missed approach course until reaching a constant width of 2,500 feet measured perpendicular to the edge of the primary area. Positive course guidance should be provided wherever possible. Where no positive course guidance is provided, the total area defined by the 30 degree splay is also considered part of the primary area, as shown in figure 9. The 20:1 missed approach obstacle clearance surface and splay begin beyond the DH/MAP toward the missed approach area. Its height above the surface is coincident with the elevation of the final approach obstacle clearance surface.

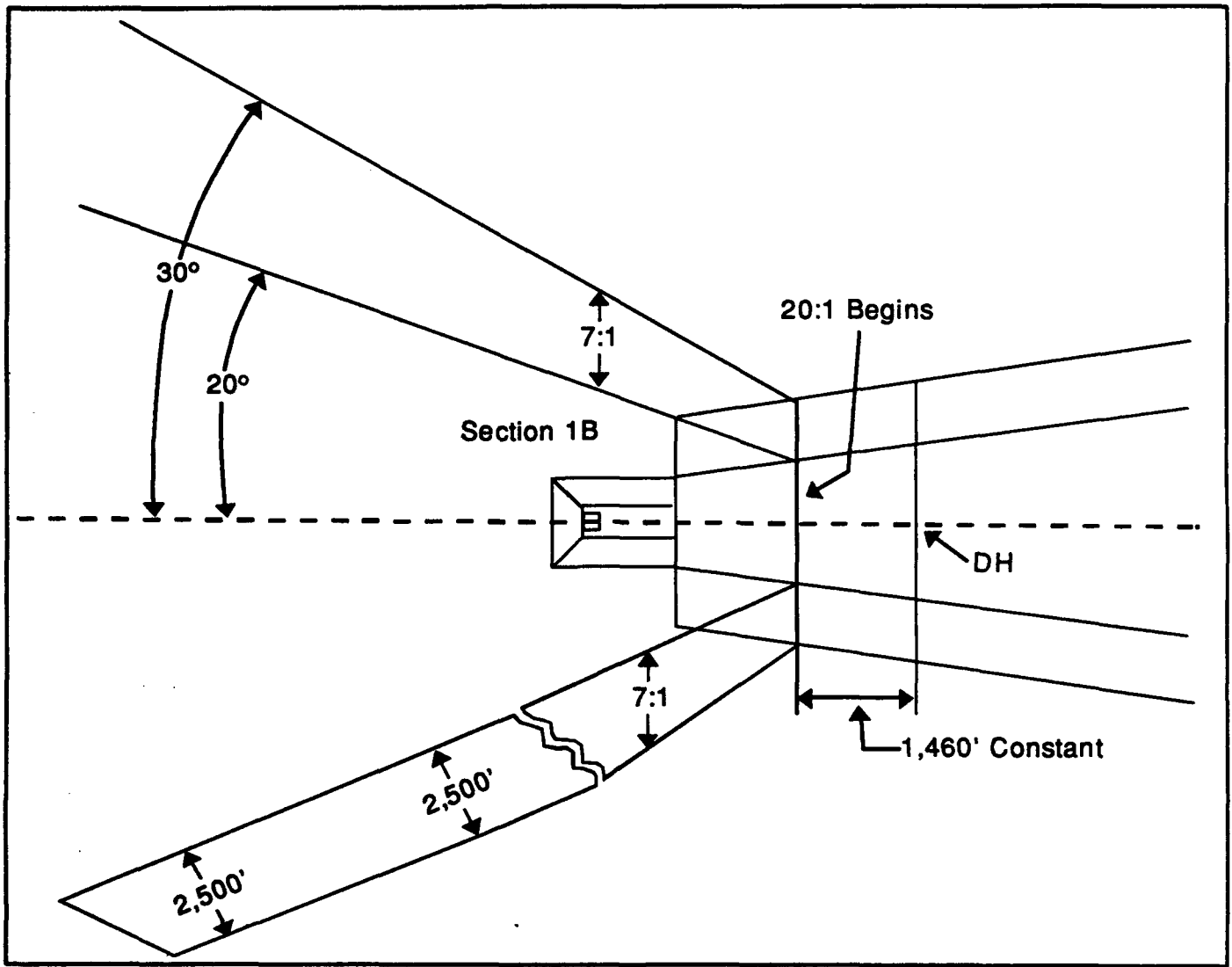
3.5.6.1 Straight Missed Approach Area

The straight missed approach (maximum turn of 15 degrees from the final approach course) area is centered on the missed approach course. It is composed of two sections with different slope ratios. The first section begins at the MAP and is equal to the width of the final approach primary and secondary areas. The second begins at the end of the first section and extends to the end of the missed approach segment.

3.5.6.2 Turning Missed Approach Area

Turning missed approach criteria apply when a turn of more than 15 degrees from the final approach course is required. Two separate turning missed approach areas must be evaluated. Each is used to determine if publication of speed category minimums (61 to 90 knots, or

a) PLAN VIEW



b) PROFILE VIEW

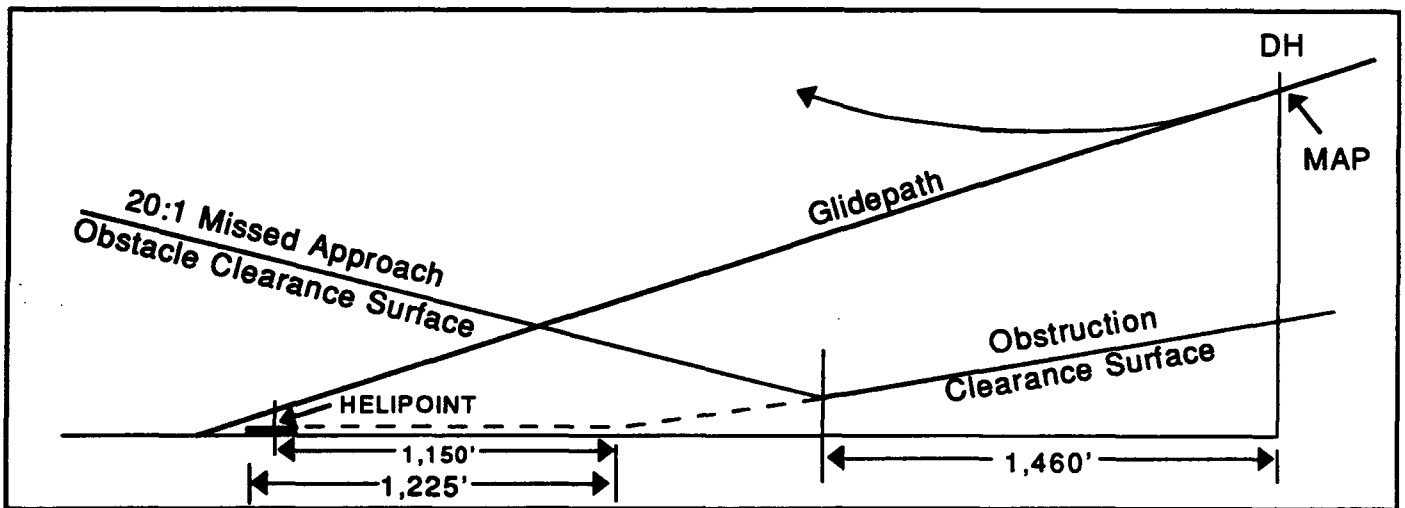


FIGURE 9 MISSED APPROACH SEGMENT

60 knots or less, based on flight track turning radii) are necessary. Where obstacle evaluations determine separate minimums for the two areas, speed categories must be published.

Turning missed approaches may commence at an altitude, a fix, or a point to intercept a course, but not at an altitude of less than 400 feet above heliport elevation.

3.5.6.2.1 Straight Segment

All turning missed approach areas must have a straight segment for a specified distance from the MAP that aligned with the final approach course to the turn commence point. The minimum segment must not be less than 0.5 nm in length or not less than the distance required to achieve a 352 foot-per-nautical mile climb gradient from the height above heliport (HAH) to an altitude of 400 feet above the heliport elevation.

3.5.6.2.2 Flight Track Turning Radius

A reference center vertex for the turning missed approach is formed by measuring perpendicular to the final approach course at the end of the straight segment, as shown in figure 10. A series of flight track turning radii are drawn from the vertex, and the protected airspace is measured along these radii. The resulting airspace is shaped like a spiral. Each flight track turning radius must be evaluated independently to determine if separate minimums must be published for different helicopter speed categories.

3.5.6.3 Specific Airspace Boundaries

Depending on the projected flight track and airspeed, unique trapezoidal airspace boundaries are created. These boundaries provide the primary and secondary areas as they relate to degree of turn, altitude, or fix to intercept a selected course, bearing, or radial as the missed approach is executed. Each location's airspace is site-specific and requires evaluation based on the individual heliport environment.

3.5.6.4 Missed Approach Obstacle Clearance

For a straight missed approach, a 20:1 primary obstacle surface is provided for helicopters. It is predicated upon airspeeds not exceeding 90 knots until the helicopter reaches missed approach altitude. For turning missed approaches, an aircraft being operated to the lower minimums, based on speed category, must not exceed 60 knots until turn completion. This is to insure that a helicopter remains within the obstacle clearance area based on the associated turn radius evaluation.

3.5.6.4.1 Straight Missed Approach Area

For the straight missed approach area, the obstacle clearance surface slopes outward and upward at a rate of 20 feet horizontally for each foot

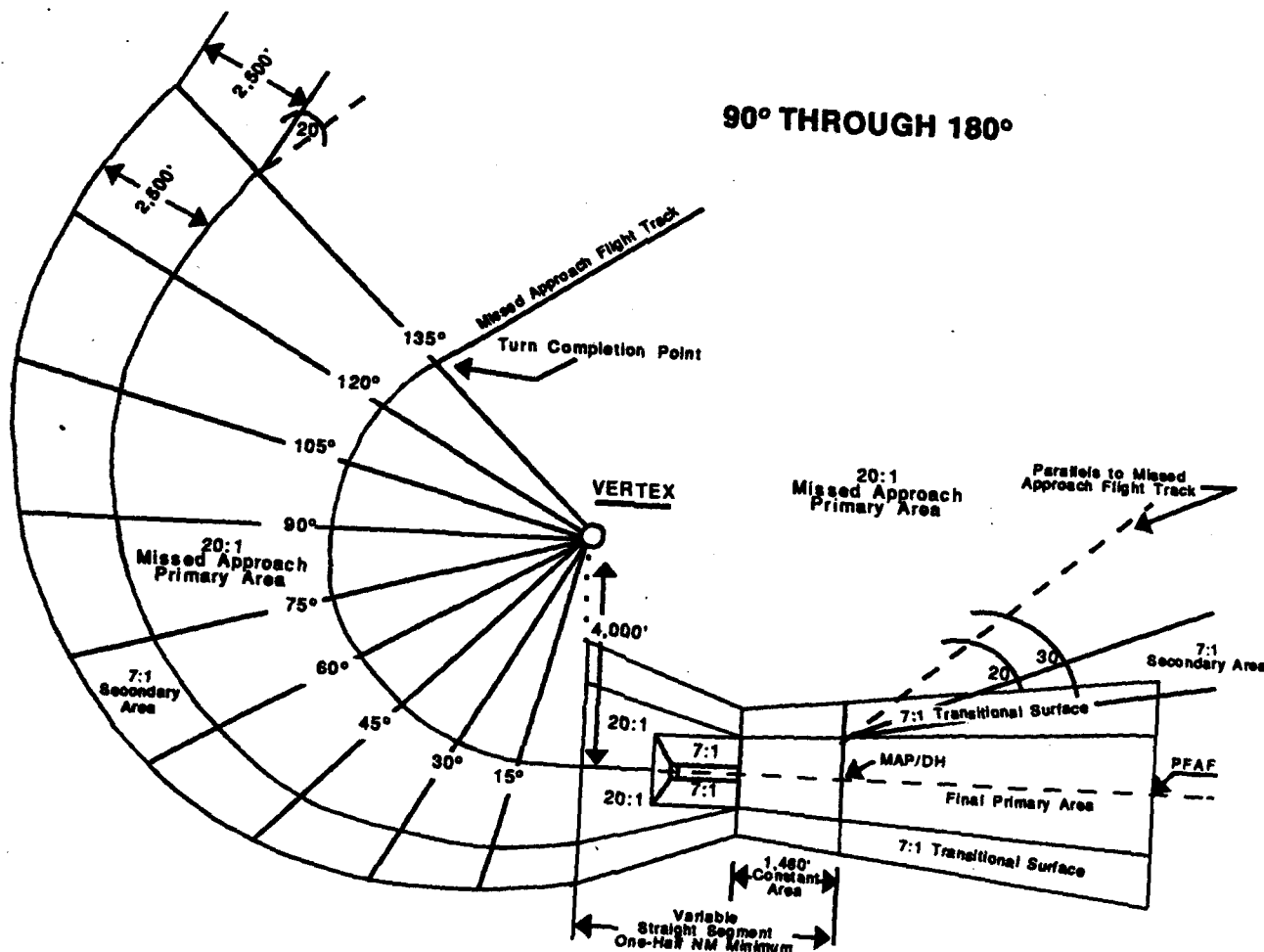
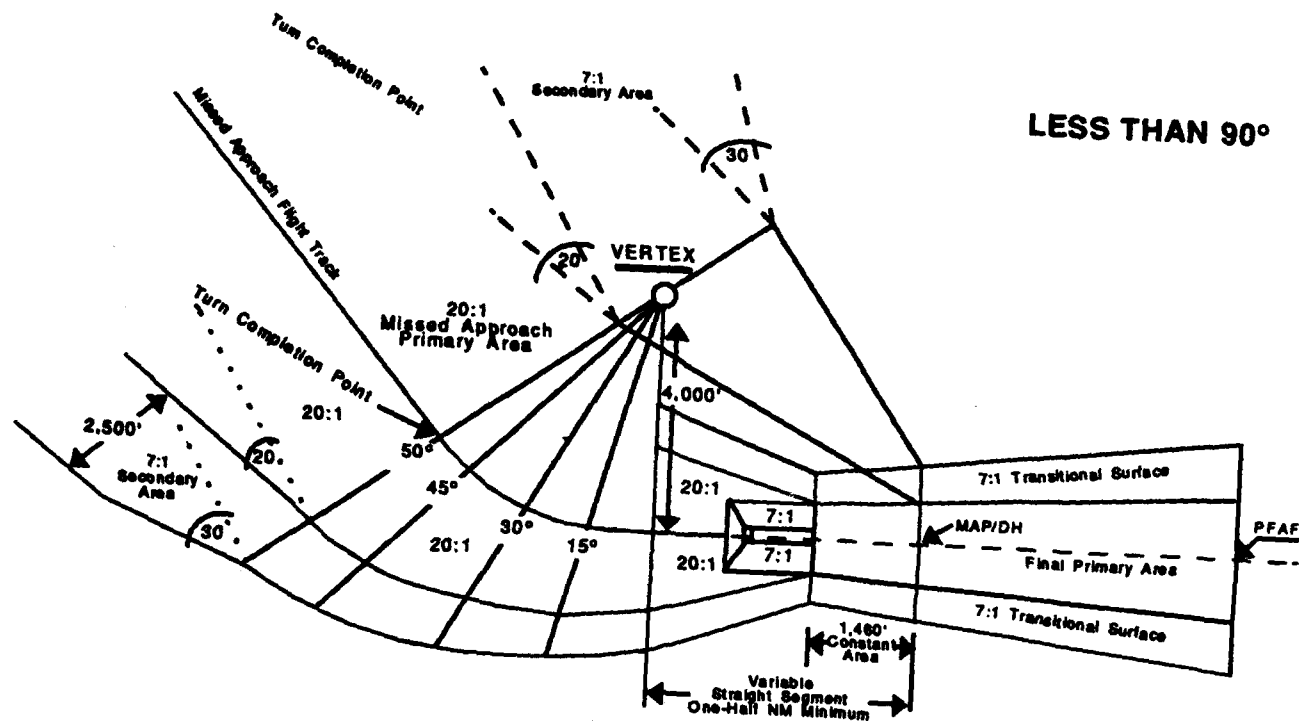


FIGURE 10 TURNING RADII

GREATER THAN 180°

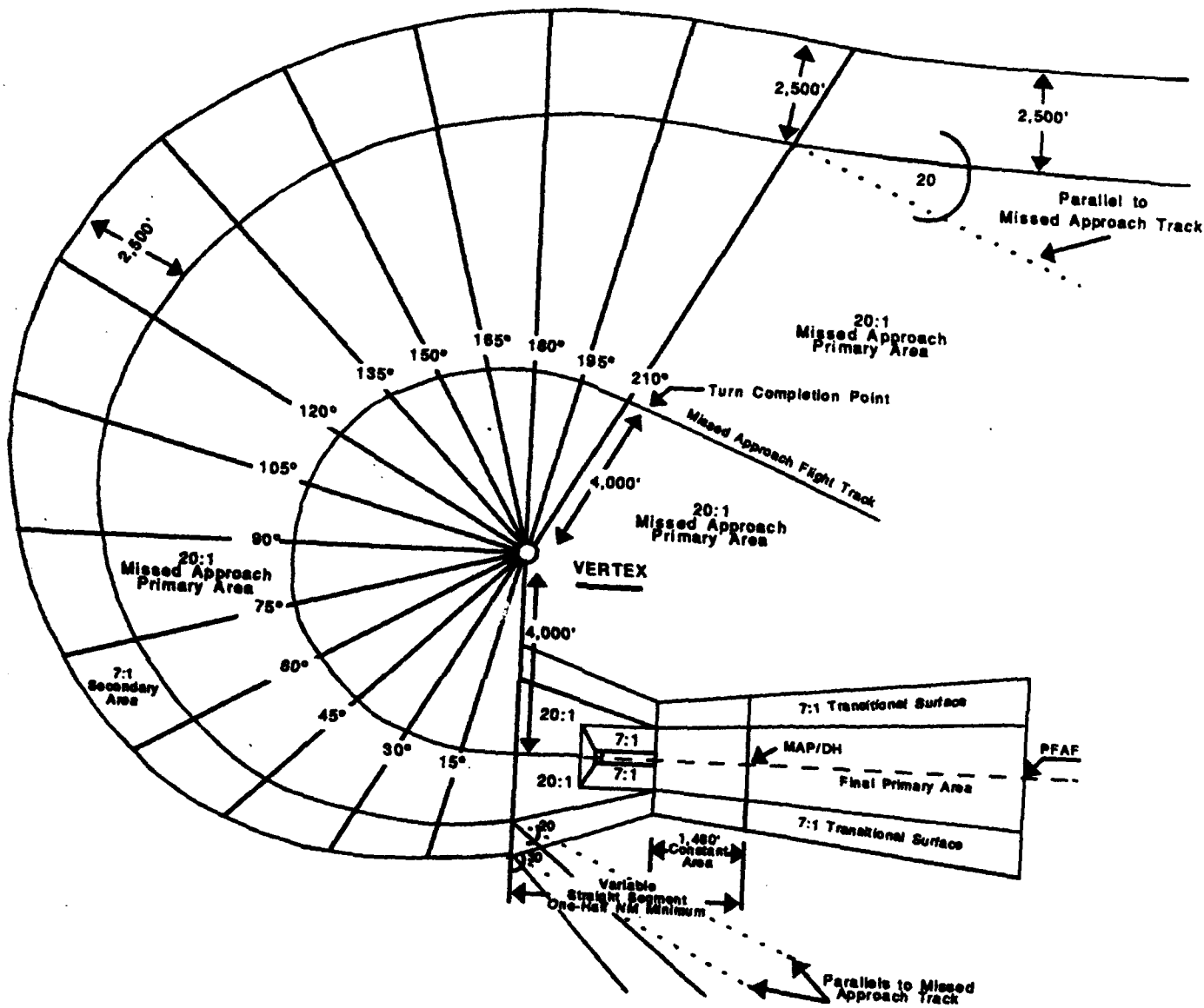


FIGURE 10 TURNING RADII (continued)

vertically (20:1). No obstacle may penetrate the obstacle clearance surface (see figure 10).

3.5.6.4.2 Turning Missed Approach Area

At the end of the straight segment where a turn commences, the associated flight turning radius will be developed. This defines a turning missed approach area with a 20:1 surface for obstacle protection (see figure 10).

3.5.6.4.3 Secondary Areas

Additional protection is provided in a secondary surface that slopes outward and upward at a ratio of 7:1 from the missed approach surfaces (see figure 10). No obstacle may penetrate this surface. Where no positive course guidance is provided, the same criteria used for the primary surface (see 3.5.6.4) must be applied in the secondary areas.

3.5.7 Discontinuance

Discontinuance of the procedures occurs when the aircraft is capable of re-entering the en route system or holding at a point to await further instruction from ATC. The missed approach procedure must be simple and must specify an altitude and, where practical, a clearance limit that allows an aircraft to proceed to a designated location or point, while awaiting further ATC instructions. As in all aspects of instrument procedures design, explicit obstacle clearance criteria must be satisfied. To achieve this, a missed approach altitude is chosen that is sufficient to permit holding or en route flight. Obstacle clearance criteria requires that a minimum obstacle clearance of 1,000 feet above the highest obstacle be provided. To ensure that a missed approach procedure achieves this clearance, the missed approach surface must continue to be applied until it reaches a vertical distance of 1,000 feet below the designated missed approach altitude. At this point, holding and en route obstacle clearance compliance requirements have been satisfied and further application of the missed approach surface is not required.

3.5.8 Minimums

Based on the fundamental application of procedural development, operating in an instrument environment imposes certain restrictions to guarantee obstacle avoidance. The principal elements associated with "minimums" are altitude and visibility. This translates to DH, minimum descent altitude (MDA), and weather criteria. Minimums established for any particular heliport are published to the lowest value permitted by the TERPS criteria.

Weather criteria are divided into two primary areas: initially, the visibility (lateral distance) required to execute a procedure, and a ceiling value (height above the ground to the overcast cloud layer) which is equal to or greater than the height of the DH or MDA above heliport elevation. Each procedure will specify minimums for the various conditions stated in the procedure, i.e., straight-in, circling, alternate, and takeoff, as required. Takeoff minimums may be stated as visibility only, except where the need to see and avoid an obstacle makes it necessary to specify a ceiling value.

3.5.8.1 Minimum Descent Altitude (MDA)

The MDA is the lowest altitude to which descent is authorized on procedures not using a glide slope. Helicopters are not authorized to

descend below the MDA until the heliport environment is in sight, and the helicopter is in position to descend for normal landing. The MDA is expressed in feet above MSL. It is determined by adding the required obstacle clearance to the MSL height of the controlling obstacle in the final approach segment and circling approach area for circling approaches.

3.5.8.2 Decision Height

The DH applies only where an electronic glide slope provides the reference for descent as provided by the MLS. The DH is the height, specified in feet MSL, above the heliport elevation at which a missed approach can be initiated if the required visual reference has not been established. DHs will be established with respect to the approach obstacle clearance requirements as specified in section 3.5.3.

3.5.9 Visibility

The minimum visibility standard is that distance required for a pilot to establish visual reference in time to descend safely from the DH or MDA and maneuver to the heliport. Actual minimums are determined by aircraft category, height above heliport, and accuracy of the navigation system.

3.5.9.1 Heliport Approach Lighting System (HALS)

Approach lighting systems can aid the approaching pilot by making the landing environment more apparent. Therefore, an approach lighting system allows the pilot to see the landing environment sooner, thereby requiring less visibility than when such lighting is not available. Certain lighting systems and operational conditions must exist in order to reduce straight-in visibility minimums. A standard HALS is mandatory for heliport MLS precision approach operations and optional for nonprecision approach operations. This system provides an extended 1,000 foot lighted approach with light bars spaced every 100 feet as shown in figure 11. Specific visibility credits are provided if the system is installed for nonprecision approaches.

3.5.9.2 Heliport Instrument Lighting System (HILS)

Certain operational conditions must exist to establish straight-in heliport MLS approaches. A HILS is the minimum lighting system required for all MLS instrument approaches to a heliport. This system includes the elements discussed below and shown in figure 11.

Perimeter lights. A minimum of five omnidirectional yellow lights on each side are spaced equidistantly and used to mark the edges of the FARA and/or the landing area. The front and back row of lights are augmented with an additional light between each fixture to provide enhanced brilliance in the direction of approach.

Edge Bar Lights. Three unidirectional white lights are used to extend the right and left line of perimeter lights forward and

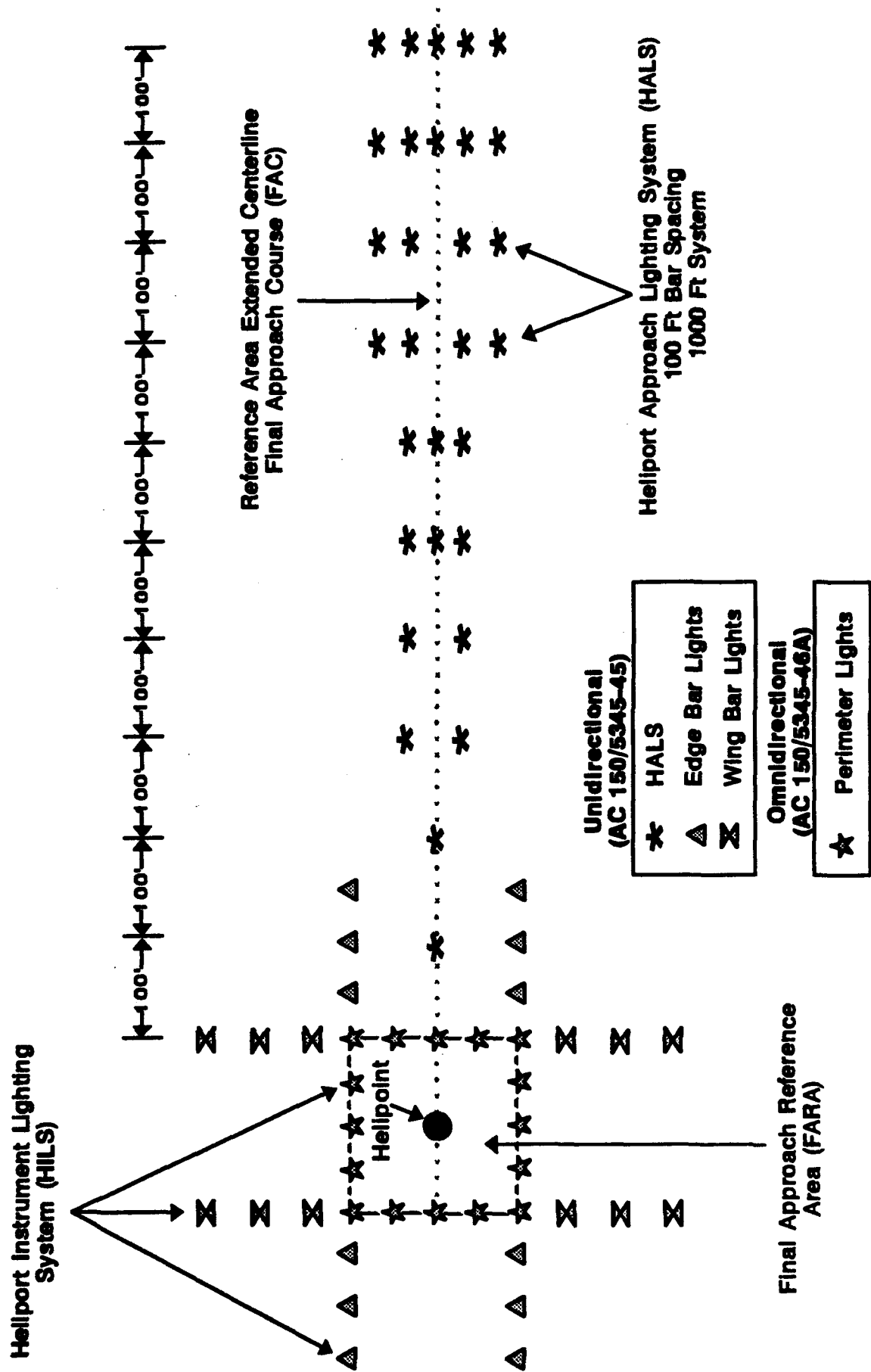


FIGURE 11 HILS AND HALS

rearward on each side of the FARA and/or the landing area. These lights are spaced at 50 foot (12.5 m) intervals as measured from the line of perimeter lights.

Wing Bar Lights. Three unidirectional white lights are used to extend the front and rear line of perimeter lights outward on each side of the FARA and/or the landing area. These lights are spaced at 15 foot (4.5 m) intervals as measured from the line of perimeter lights.

3.5.10 Standard Minimums

The development of an instrument procedure under the standards outlined in this report will prescribe the lowest civil minimums which may be published for an MLS. Lower minimums based on additional equipment or aircrew qualifications may be authorized, but are not addressed.

3.5.11 Alternate Minimums

The development of an instrument procedure under the standards contained in this report will satisfy the requirements for an alternate heliport facility. Minimums authorized when a heliport is to be used as a precision alternate must not be less than a 600 foot ceiling and 2 miles visibility.

3.5.12 Departures

Where applicable, civil standard takeoff minimums can be specified by the number of engines on the helicopter. Takeoff minimums are stated in terms of visibility only, except where the need to see and avoid an obstacle makes a ceiling value necessary. In this case, the published procedure will identify the location of the controlling obstacle.

3.6 HELIPORT DATA REQUIREMENTS

To construct and publish a public-use instrument procedure, detailed cartographic data for the heliport and surrounding area must be available to support this project. The various fundamental elements necessary to perform a procedural study to support the design and development of instrument approach procedures and/or departures are discussed in the following sections.

3.6.1 Obstruction Charting

The location of obstructions and terrain features are paramount to the design and development of any instrument procedure. TERPS is founded on providing obstacle clearance. Without charted documentation that identifies specific geographical or topographical references by type, elevation, and location, an instrument procedure can not be produced. Normally, a current National Ocean Service (NOS) obstruction chart (OC), and an approved heliport layout plan, as specified in 14 CFR 151, subpart A, or a heliport drawing will satisfy this prerequisite.

3.6.2 Accuracy Standard

Both heliport and obstruction data is required for procedural development. FAAO 8260.29A, "Obstacle Data Accuracy Coding Standards for Instrument Procedures," provides the accuracy standard. The order recognizes that obstacle data accuracy is not absolute. Accuracy depends upon the source of data provided. Inaccuracies do not preclude the use of these data, provided it is identified and taken into account. In some cases, upgrading the accuracy of the controlling obstacle could provide relief from operational restrictions in an instrument procedure. Therefore, the accuracy codes established in FAAO 8260.29A will be used as the minimum coding standard for procedural development.

3.6.2.1 Geodetic Position

All geodetic positions should be determined according to North American Datum of 1983. This is effective October 15, 1992 and is a change from the North American Datum of 1927.

3.6.2.2 Coordinates

Coordinates should be determined and submitted to the nearest one-hundredth of a second for any designated reference point or obstacle. The most important site location is the heliport (section 3.5.4.1). This is the primary ground reference site within the FARA. It is used to control and develop instrument arrival/departure procedures for helicopters at heliports.

3.6.2.3 Elevations

All elevations will be given in MSL.

3.6.2.4 Obstacles in Approach/Missed Approach Areas

An obstacle assessment of the generalized arrival, departure and missed approach areas must be accomplished. The principle behind TERPS is to provide minimum clearance above the designated controlling obstacles for any segment of a procedure. Available obstacle data files for most locations are maintained by the National Flight Data Center (NFDC).

3.6.3 Off-Heliport Data

The requirement for off-heliport obstruction data varies significantly with the type of procedure in development. Each segment's dimensional surfaces vary and require different clearance elevations.

3.6.4 Altimeter Setting Source

To execute a public-use instrument procedure, a current altimeter setting must be available and provided to the helicopter during the operating hours of the particular instrument procedure.

3.6.5 Weather Observation and Reporting

Public-use instrument procedures require that weather information be available during the operating hours of the particular instrument procedure. At non-tower and non-flight service station locations where instrument procedures are being conducted, the ATC authority must be able to provide the altimeter setting source, and weather observation and reporting capabilities. Current weather observing programs being used by the NWS and FAA could adequately satisfy this prerequisite requirement. Either manual observations, automated observations, or an aggregate of both systems could provide required weather observation criteria to support IFR operations.

3.6.6 Existing Navigation Facilities

To fully develop an instrument procedure, all available navigational information must be compiled. This includes, but is not limited to, locations of supplemental navigational aids that can support procedure development. Data will include latitude and longitude to the nearest tenth of a second and an azimuth/bearing relation to the heliport on the heliport.

3.6.7 Environmental Considerations

All new instrument approach and associated departure procedures must be evaluated under specific environmental considerations. In accordance with FAAO 1050.1D, "Policies and Procedures for Considering Environmental Impacts," an environmental assessment must be accomplished for all new or revised ATC procedures. Appendix 3 of that order lists the specific parameters requiring evaluation. The prime concern focuses on procedures which predictably route air traffic over noise sensitive areas at less than 3,000 feet above ground level (AGL). Coordination with the appropriate Federal and local agencies is required.

3.6.8 Processing and Procedure Development

The FAA flight inspection field offices (FIFO) are the designated aviation standards national field offices with the responsibility and authority for actual development of instrument procedures. Direct coordination with the specific FIFO and regional flight procedures branch is required.

4.0 CANDIDATE IFR HELIPORT/VERTIPOINT QUALIFYING FACTORS

The purpose of this task is to develop recommendations for a preliminary selection standard to qualify potential IFR heliport facilities. This section develops rational characteristics/criteria necessary to evaluate heliport environments (airside, groundside, and the community in which it will be located) to determine which existing facilities are the most likely candidates for IFR implementation. The results will be used to develop an FAA IFR heliport selection policy.

The actual selection must be accomplished on two levels. First, a preliminary selection will be made in task 3 to identify and survey candidate sites at a national level using the criteria developed here. That task will develop a preliminary list of candidate sites from which the FAA will select six. Final selection will be undertaken based on an on-site evaluation outlined in task 4. The requirements and products of tasks 3 and 4 will be presented in the second letter report.

4.1 SELECTION CRITERIA

A systematic approach must be formulated to discriminate between those heliport elements that are critical to initial site selection and those that are not. Using this approach, a classification strategy based on weighted measures can be applied to produce a pragmatic and realistic selection system. Key to this strategy is recognizing and understanding what is essential in developing a heliport capable of handling operations under IMC. Each element must be prioritized in a logical sequence based on its significance in siting a facility. This priority assessment, shown in figure 12, is based on experience in developing heliport system planning requirements and produces distinctive tiers for evaluation.

The critical or "must have" tier is divided into two functional layers, the primary being categorized as essential and the secondary being categorized as requisite. At the essential level, immediate focus centers around two specific elements, meteorological conditions and physical size requirements. Does a heliport have those climatic conditions that warrant an IFR capability and the necessary real estate to support minimum IFR operational dimensions? This initial filtering will eliminate several facilities. For those that remain, the requisite level investigates the supportive aspects of individual heliport operational characteristics, airspace factors, location and environmental concerns, and local governmental attitudes. If the requisite evaluation demonstrates significant merit or potential within the above elements, then a definitive tier of detailed analysis must be accomplished.

The definitive tier must include an in-depth assessment that closely scrutinizes the operational aspects or characteristics of the heliport under consideration. These criteria elements would include current number of operations, number of potential IFR operations, mission types using or expected to use the heliport, TERPS requirements, airspace, and ATC compatibility. The final selection criteria would weigh location and

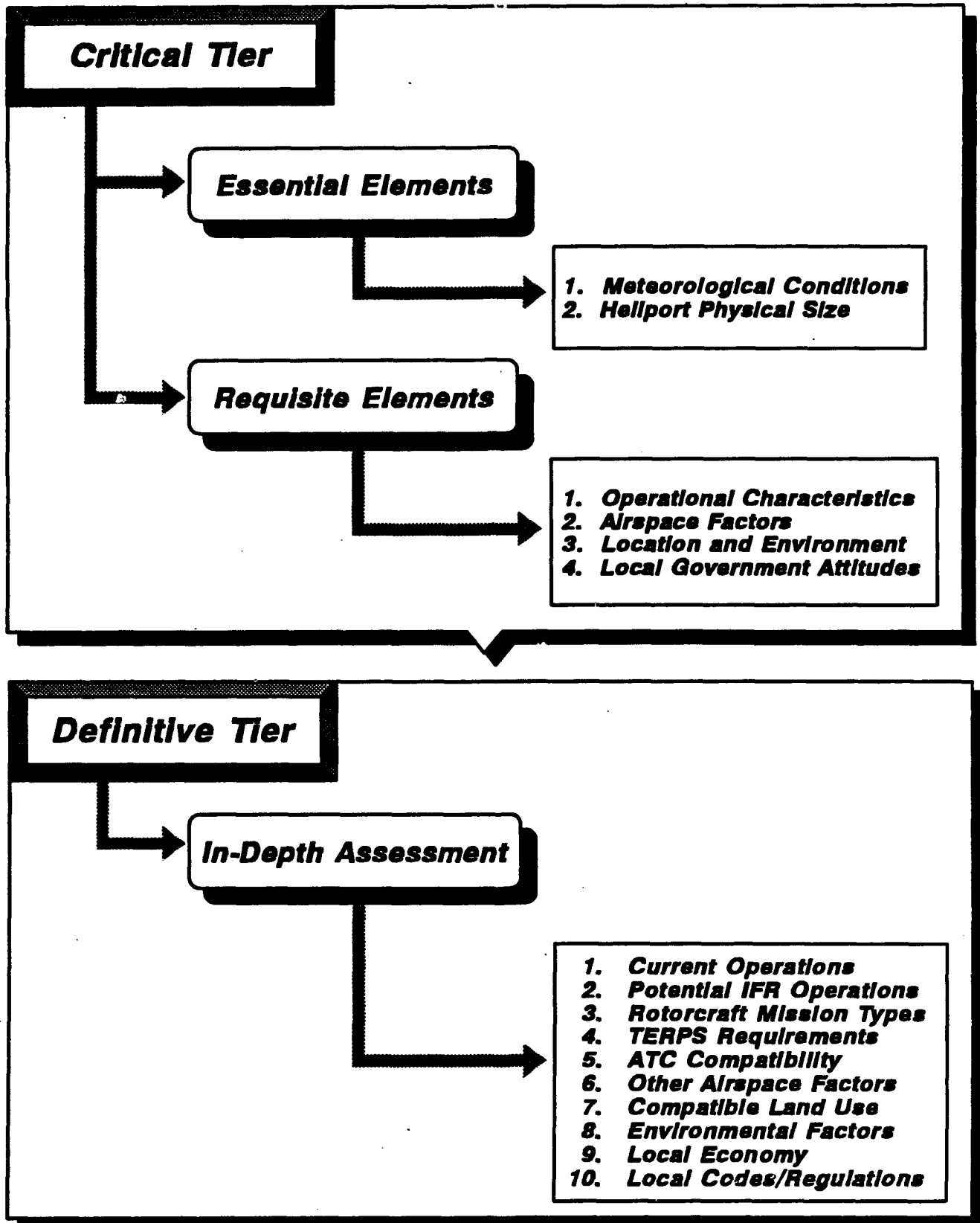


FIGURE 12 IFR HELIPORT CRITERIA ORDER OF INVESTIGATION

environmental elements, including compatible land use, local economy, environment concerns, and local government attitudes.

The elements in these tiers are not necessarily listed by their importance in heliport development but by the required order of investigation. In other words, although local government attitude may affect the final decision on whether the heliport is developed, land use compatibility must be established before the proposal can be presented to the local government.

4.1.1 Meteorological Conditions

In determining the optimum sites for installation of IFR capability, the most important factor is to establish need. In addition, the expense incurred with IFR support equipment installation must substantiate a defined public benefit. A balance must be struck from an operational and cost/benefit perspective.

The primary element in determining need is meteorological conditions. The first criterion that must be considered in screening potential IFR heliport sites is climate and weather. The IFR candidate heliports must be located where the weather can be expected to be in IMC enough days of the year to warrant IFR landing facility installation. A full service IFR heliport located where there are only a few periods below minimums per year would be pointless. Once weather screening is completed, additional operational criteria can be applied.

4.1.2 Physical Size Requirements

The next most important criterion for heliport candidates is the availability of real estate to support the critical elements discussed in section 3.0. Is the facility currently large enough or, if not, is there available land for expansion? The candidate heliport must have the space necessary for all elements critical for basic IFR equipment operation and for meeting the operational concept criteria. The elements discussed in section 3.0 that directly influence the amount of land required are shown in table 3 by heliport design element.

Additional criteria discussed in section 3.0 also determine, to some extent, the amount of land necessary in terms of the obstacle-free areas adjacent to the heliport needed for TERPS and airspace procedures and requirements. These criteria have more effect on determining the suitability of the heliport location rather than the amount of real estate needed to be under the control of or purchased by the owner. The secondary IFR heliport design elements, subelements, and their significance are shown in table 4.

Each of these criteria must be investigated at each potential site during the site selection for IFR heliport development.

TABLE 3
DEVELOPMENT CRITERIA AFFECTING SIZE OF HELIPORT

ELEMENT	SUBELEMENTS	SIGNIFICANCE
HELIPORT TAKEOFF AND LANDING AREA	SIZE/NUMBER REQUIRED	BASIC SIZE OF OPERATIONAL AREA DETERMINED BY DESIGN HELICOPTER AND THE NUMBER OF TAKEOFF AND LANDING AREAS REQUIRED.
PARKING SPACES	NUMBER REQUIRED	SIZE OF HELIPORT WOULD INCREASE DEPENDENT ON THE NUMBER OF PARKING SPACES REQUIRED.
TAXI ROUTES AND TAXIWAYS	HOVER OR GROUND TAXI	WOULD INCREASE SIZE OF HELIPORT IF LOCATED OUTSIDE AREA DEFINED BY TLOF AND PARKING SPACES.
PROPERTY TO PROTECT INNER APPROACH AND DEPARTURE SURFACES	---	IF PURCHASED TO PROTECT APPROACH AND DEPARTURE SURFACES, WOULD INCREASE AMOUNT OF LAND THAT MUST BE HELD BY OWNER OF HELIPORT.
TYPE AND SIZE OF HELIPORT FACILITIES	FUEL MAINTENANCE HANGARS TERMINAL BUILDINGS	WOULD INCREASE SIZE OF HELIPORT DEPENDING ON NUMBER, DESIGN, AND ARRANGEMENT OF THESE FACILITIES.
ALTERNATIVE TRANSPORTATION ACCESS	TAXI STAND CAR RENTAL OFFICE METRO STATION TRAIN ACCESS LIMOUSINE WAITING AREA	WOULD INCREASE SIZE OF HELIPORT DEPENDING ON NUMBER, DESIGN, AND ARRANGEMENT OF THESE FACILITIES.
AUTOMOBILE PARKING	EMPLOYEES PASSENGERS	WOULD INCREASE SIZE OF HELIPORT DEPENDING ON NUMBER, DESIGN, AND ARRANGEMENT OF THESE FACILITIES.
COLLOCATED MLS FACILITIES	AZIMUTH EQUIPMENT ELEVATION EQUIPMENT DISTANCE MEASURING EQUIPMENT (DME)	SATISFY COLLOCATION STANDARDS TO PROVIDE ADEQUATE MLS SIGNAL COVERAGE.
FARA	MLS PRECISION TERPS	SPECIFIED 150 FT X 150 FT, WOULD AFFECT SIZE IF NOT CENTERED OVER THE TAKEOFF AND LANDING AREA.

TABLE 4
SECONDARY SITING CONSIDERATIONS

ELEMENT	SUBELEMENTS	SIGNIFICANCE
FINAL APPROACH SEGMENT	FINAL APPROACH PRIMARY AREA TRANSITIONAL SURFACES GLIDE PATH ANGLE FINAL APPROACH OBSTACLE CLEARANCE SURFACES	SPECIFIC MINIMAL DIMENSIONS THAT RESTRICT OR PROHIBIT OBSTACLE INTRUSION. LATERALLY SLOPED EXTENSIONS TO THE PRIMARY AREA THAT ALSO RESTRICT OR PROHIBIT OBSTACLE INTRUSION. DICTATES THE ASSOCIATED OBSTACLE CLEARANCE SLOPES. DETERMINES LOCATION PROCEDURAL DEVELOPMENT CAPABILITY BY DISALLOWING OBSTACLE PENETRATION OF THIS SURFACE.
PRECISION HELIPORT IMAGINARY SURFACES	FARA APPROACH OFZ INNER-TRANSITIONAL SURFACES OFZ OBSTACLE ASSESSMENT SURFACE OAS SURFACE EXTENSIONS	OBSTACLE-FREE 150 FOOT SQUARE. REQUIRES VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES DURING INSTRUMENT FLIGHT OPERATIONS. REQUIRES VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES DURING INSTRUMENT FLIGHT OPERATIONS. REQUIRES VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES DURING INSTRUMENT FLIGHT OPERATIONS. ADDITIONAL AREA REQUIRING VERTICAL AND LATERAL CLEARANCE WHEN THE LANDING AREA WITH HILLS IS NOT THE FARA.
MISSED APPROACH SEGMENT - STRAIGHT	MISSED APPROACH PRIMARY AREA MISSED APPROACH SECONDARY AREA MISSED APPROACH OBSTACLE CLEARANCE DISCONTINUANCE	SPECIFIC VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES. LATERALLY SLOPED EXTENSIONS TO THE PRIMARY AREA REQUIRING SPECIFIC VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES. DETERMINES LOCATION PROCEDURAL DEVELOPMENT CAPABILITY BY DISALLOWING OBSTACLE PENETRATION OF THIS SURFACE. THE POINT WHERE THE MISSED APPROACH SURFACE IS NO LONGER REQUIRED.
MISSED APPROACH SEGMENT - TURNING	MISSED APPROACH PRIMARY AREA MISSED APPROACH SECONDARY AREA FLIGHT TRACK RADII DEGREE OF TURN MISSED APPROACH OBSTACLE CLEARANCE DISCONTINUANCE	SPECIFIC VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES MUST BE PROVIDED. LATERALLY SLOPED EXTENSIONS TO THE PRIMARY AREA REQUIRING SPECIFIC VERTICAL AND LATERAL CLEARANCE FROM OBSTACLES. FACTOR USED TO COMPUTE SPEED CATEGORY FOR RADIUS OF TURN BASED OBSTACLE OR LOCATION. DICTATES THE TURN RADII AREA REQUIRING ADDITIONAL OBSTACLE CLEARANCE INVESTIGATION. DETERMINES LOCATION PROCEDURAL DEVELOPMENT CAPABILITY BY DISALLOWING OBSTACLE PENETRATION OF THIS SURFACE. THE POINT WHERE THE MISSED APPROACH SURFACE IS NOT REQUIRED.

4.1.3 Helicopter Operational Characteristics

Operational characteristics are a major determinant in selecting an IFR helicopter candidate. Characteristics that would have significant impact on selection include the numbers of operations and the types of missions using or expected to use the helicopter. A certain threshold of operations is required before a facility can apply for and obtain IFR equipment.

4.1.3.1 Number of Operations

As previously stated, a helicopter or vertiport that would qualify for IFR capability would have to have a large number of operations. There are no current standards for this determination. The draft AC 150/5390-2A allows for two types of public-use helicopters, utility and commercial service. The distinction between the two is that the commercial service helicopter has 2,500 or more annual enplaned passengers and receives scheduled passenger service while the utility helicopter is more for corporate or private aircraft. The enplanement figure will be used as a preliminary requirement for each helicopter candidate. The limited number of scheduled commercial services currently operating in the United States eliminates this requirement from consideration at this time.

4.1.3.2 Mission Types

It was determined in a survey performed for "Rotorcraft Low Altitude IFR Benefit/Cost Analysis: Operations Analysis" (DOT/FAA/DS-89/10) that only certain types of rotorcraft missions create a need or desire for IFR helicopters. These missions include, but may not be limited to, air taxi, corporate executive, scheduled commuter, business, and small package delivery. In other words, only those missions that must meet strict deadlines (i.e., where delays are detrimental to the service provided or threaten the existence of the operation itself) are of significance in determining the need for an IFR helicopter.

The types and mix of missions that currently use each candidate helicopter must be determined during the selection process. Selection rank would also be affected if it could be established that with IFR capability, appropriate missions would be drawn to use the helicopter in question during a reasonable time frame in the future, such as a 15-year life cycle.

4.1.4 Airspace Factors

4.1.4.1 TERPS

The basic development of all SIAP imposes a predetermined level of safety with regard to obstacle avoidance. This translates into specific airspace design parameters based on the navigation system that supports the SIAP. Design and development of an MLS SIAPS provides the aviation community with an accurate, flexible, and versatile precision approach and landing system. The constraints of each segment (initial, intermediate, final, and missed approach) of the procedures requires a

significant effort to ensure that prescribed mandatory vertical and lateral obstacle clearances are met to satisfy the required level of safety. Each candidate site must accommodate the associated trapezoid to provide the mandatory obstacle clearance, signal integrity, and system siting requirements. For specific criteria elements, see table 4.

4.1.4.2 Airspace

In conjunction with the TERPS initiative, the placement of arrival and departure corridors must be examined. The installation and operation of additional facilities in congested or encumbered airspace can restrict and reduce that airspace's overall operational effectiveness. The initial effort should focus on establishing separate and independent access routes to and from the heliport that do not conflict or interfere with existing structures. Special consideration must address the unique capabilities of rotorcraft to safely operate at lower altitudes and airspeeds than conventional fixed-wing aircraft. The evolution of vertical flight technology can also complement existing route structures due to the capability of newer aircraft to maintain fixed-wing airspeeds and associated altitudes. Airspace is finite, and equal access for vertical flight aircraft must be explored in an attempt to reduce terminal area congestion and resolve associated airport capacity issues. For specific criteria elements, see table 4.

4.1.4.3 Air Traffic Service

Specific coordination with various levels of air traffic (regional and local) personnel must be foremost in this investigation. As a precursor to any development effort, individual area assessments by the local air traffic division must be initiated. Each area is distinctive and must be evaluated to appraise the placement of this facility from a traffic standpoint. As stated previously, the introduction of a new IFR facility will have a significant influence on the way air traffic is managed within any en route or terminal environment. The unique operating characteristics of rotorcraft offer the potential to employ innovative control techniques with regard to developing an efficient and effective flow pattern for these facilities. A close working relationship must be in place between all concerned parties to create practical and productive air traffic policies and procedures.

4.1.5 Location and Environmental Concerns

The FAA AC 150/5050-6, "Airport-Land Use Compatibility Planning," states that:

The airport and the community exert a number of important influences upon each other. Those influences may be generally classified as economic, social, and environmental; and they must be taken into consideration during the process of developing a compatibility plan...

Not only does this statement apply to heliports, but it may be even more consequential due to the nature of their operations. Metropolitan heliports bring aircraft activity into a community rather than diverting it to the outskirts. This is because heliports need to be located close to the center of demand for their services, usually in a downtown, suburban, or industrial area. In addition, the public generally sees less value in heliports than they do in airports.

4.1.5.1 Compatible Land Use

A heliport that has been developed into an IFR facility must be viable for a sufficient length of time to realize a return on investment (ROI) and to also achieve a contribution to the transportation system. In order to select a potentially viable heliport it is vital to consider the compatibility of surrounding land uses, both existing and future. A heliport that, at the present time, is considered by its neighbors as a nuisance cannot be counted on to remain in operation for an acceptable amount of time. Plans for future land use in the area must be determined through an investigation of planning documents at the appropriate levels (city, county, regional, etc.). As a general guide, table 5 shows the various types of land uses considered noise compatible for heliports based on FAA AC 150/5050-6. Although based on noise compatibility in general, this table is representative of compatible land use for heliports.

TABLE 5
HELIPORT NOISE COMPATIBLE LAND USES

COMPATIBILITY	LAND USE
COMPATIBLE BY DEFINITION	MANUFACTURING, TRADE, RESOURCE PRODUCTION AND EXTRACTION, WATER AREAS (RIVERS, LAKES, ETC.) AND UNDEVELOPED LAND USES
COMPATIBLE (AMBIENT NOISE MASKING)	RETAIL SALES, SERVICES AND OTHER BUSINESS AND COMMERCIAL USES, E.G., OFFICE BUILDINGS, SHOPPING CENTERS, HOTELS OR RECREATIONAL AREAS
NOISE SENSITIVE	RESIDENTIAL NEIGHBORHOODS OR LAND NEAR CHURCHES, SCHOOLS, CONCERT HALLS, OPEN-AIR THEATER

SOURCE: AC 150/5050-6 "AIRPORT-LAND USE COMPATIBILITY PLANNING."

However, compatibility planning must work both ways. It must take into account the future needs of the surrounding area. As AC 150/5050-6 states, "...achieve an acceptable balance between the needs and tolerances of both the airport [heliport] and its neighbors."

4.1.5.2 Local Economy

The condition of the local economy also plays a significant role in determining the most appropriate location for an IFR capable heliport.

4.1.5.3 Environmental Concerns

Environmental concerns are becoming increasingly important when siting all aviation facilities. Noise is always the primary concern in these cases. A candidate site must be compatible with its surroundings. Compatibility must include any increase in activity resulting from IFR capability. Additional issues that citizens and municipalities are concerned about include air pollution, water pollution, ground access, and safety flight operations. Air pollution by helicopters is negligible although this issue may be brought up by concerned citizens and communities. However, no tests on this issue have been undertaken for advanced vertical flight (AVF) aircraft. Frequent AVF aircraft operations to a large heliport or vertiport may have more impact. Water pollution caused by fueling or maintenance facilities at a heliport or vertiport is coming under greater scrutiny. The ability to deal with all these public issues must be addressed during final site selection and community standards must be upheld.

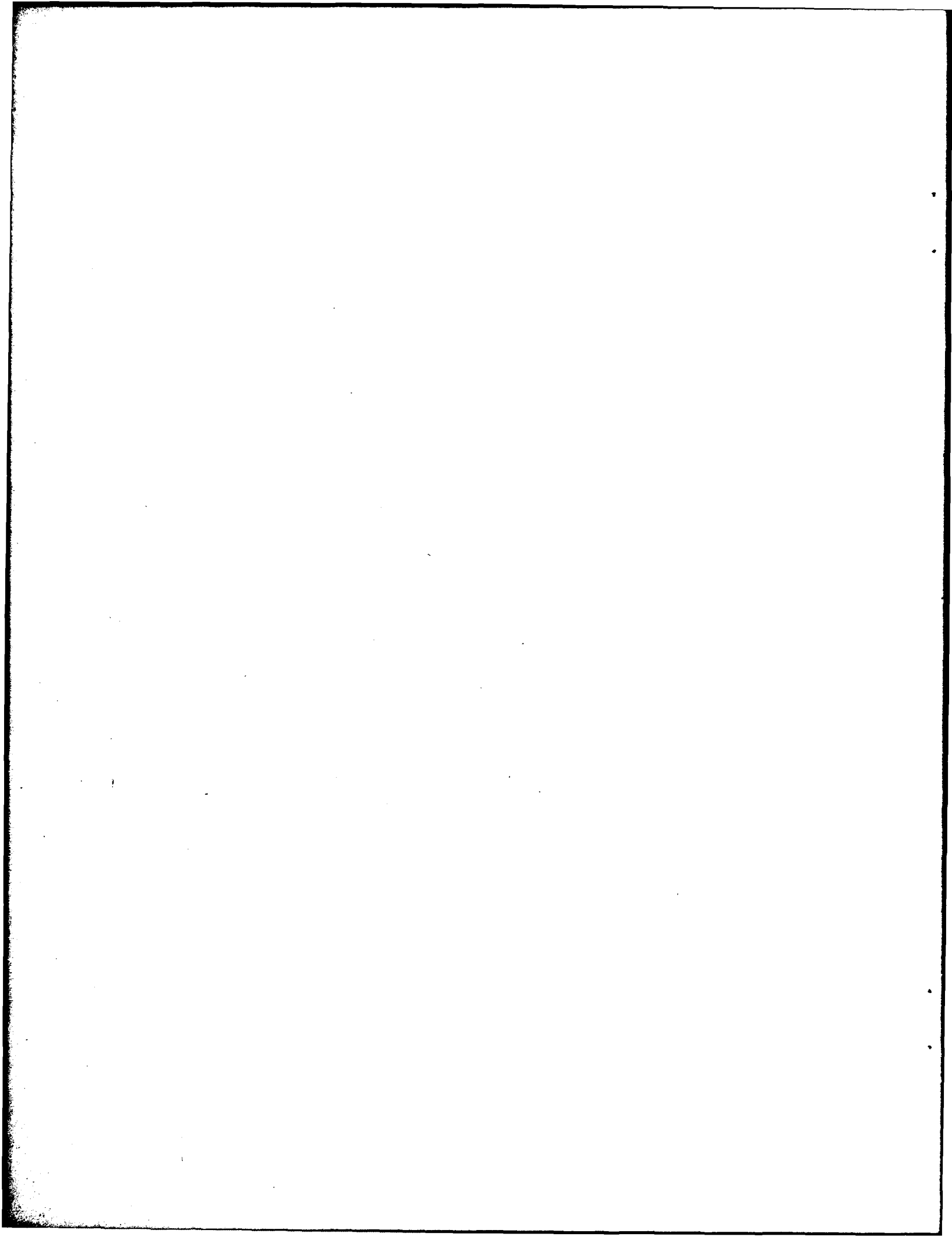
Ground access to a new transportation mode may increase traffic at and en route to that location and create a potential increase in noise and air pollution. These concerns must be dealt with in the design of ground access to the facility and by incorporating the individual community's standards, regulations, and goals. The receptivity of community leaders to work with the vertical landing facility to solve these problems should be measured in the final site selection process.

Beyond the direct benefit of affecting the environment as little as possible, addressing environmental issues is an additional, albeit indirect tool, in obtaining and keeping good relations with the local government and its citizens.

4.1.6 Local Government Attitudes

The attitude of the local government may be the most important aspect of heliport development and continuance. "Four Urban Heliport Case Studies," DOT/FAA/PM-87/32 - DOT/FAA/PP-88/2, determined that even successful heliports can be closed if the local government receives pressure from its constituents or if city planning goals do not include a heliport at a specific location.

To the extent possible, an investigation must be made into the local attitudes at heliport candidate sites. This should include all governments whose jurisdiction may impact the heliport and the local population near the heliport. The investigation into local attitudes must become increasingly more detailed at each level of the heliport selection process.



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LIST OF ACRONYMS

AC	Advisory Circular
AGL	Above Ground Level
AIP	Airport Improvement Plan
ARSA	Airport Radar Service Area
ATC	Air Traffic Control
AVF	Advanced Vertical Flight
AWOS	Automatic Weather Observation System
AZ	Azimuth
CFR	Code of Federal Regulations
CTR	Civil Tiltrotor
dGPS	Differential Global Positioning System
DH	Decision Height
DME	Distance Measuring Equipment
DME/N	Distance Measuring Equipment (conventional)
DME/P	Distance Measuring Equipment (precision)
EL	Elevation
ERHC	Eastern Region Helicopter Council
FAA	Federal Aviation Administration
FAAO	Federal Aviation Administration Order
FAATC	Federal Aviation Administration Technical Center
FAC	Final Approach Course
FAR	Federal Aviation Regulation
FARA	Final Approach Reference Area
FATO	Final Approach and Takeoff Area
FIFO	Flight Inspection Field Office (FAA)
GPS	Global Positioning System
HAH	Height Above Heliport
HALS	Heliport Approach Lighting System
HCH	Helipoint Crossing Height
HILS	Heliport Instrument Lighting System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
m	Meters
MAP	Missed Approach Point
MDA	Minimum Descent Altitude
MLS	Microwave Landing System
MSL	Mean Sea Level
NAS	National Airspace System
NAVAID	Navigation Aid(s)
NDB	Non Directional Beacon
NFDC	National Flight Data Center
NFPA	National Fire Protection Agency
nm	Nautical Mile
NOS	National Ocean Service
NOTAM	Notice To Airmen
NPIAS	National Plan of Integrated Airport Systems
NPRM	Notice of Proposed Rule Making
NWS	National Weather Service

OAS	Obstacle Assessment Surface
OC	Obstruction Chart
OFZ	Obstacle Free Zone
PANYNJ	Port Authority of New York and New Jersey
PCA	Positive Control Areas
PFAF	Precision Final Approach Fix
R&D	Research and Development
RMP	Rotorcraft Master Plan
ROC	Required Obstacle Clearance
ROI	Return on Investment
SIAPS	Standard Instrument Approach Procedures
SID	Standard Instrument Departures
sm	Statute Miles
TCA	Terminal Control Area
TERPS	Terminal Instrument Procedures
TLOF	Touchdown and Lift-off Surface
VERTAPS	Vertical Flight IFR Terminal Area Procedures
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omni Range