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PLANNING AND DESIGN CRITERIA FOR METROPOLITAN STOL PORTS

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Airports Service

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: PLANNING AND DESIGN CRITERIA FOR METROPOLITAN STOL PORTS

1. PURPOSE.

This advisory circular provides the criteria recommended for the planning and design of STOL ports in metropolitan areas.

2. HOW TO OBTAIN THIS PUBLICATION.

Obtain additional copies of this advisory circular from the Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

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Director, Airports Service

Initiated by: AS-560

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Chapter 1. INTRODUCTION

1. GENERAL.

One of the major functions of the FAA is to encourage and foster the development of civil aeronautics. This advisory circular is a step in this continuing effort, and contains guidance for the planning and design of metropolitan STOL (Short Take Off and Landing) ports. It is also intended to provide an understanding of the need for STOL ports and to encourage their development as a part of the national transportation system.

2. SCOPE.

a. The advisory circular outlines the basic physical, technical, and public interest factors which should be considered in planning and establishing metropolitan STOL ports. The information is based on STOL aircraft performance and research studies conducted by both industry and Government.

b. The criteria provided are advisory in nature and do not establish requirements except where Federal funds are used for the development of a STOL port. Further, the specific recommendations presented are for the average or usual situation and may not be appropriate in every case. To assist in the interpretation of the criteria, it is recommended that technical advice be obtained from appropriate industry representatives and FAA technical personnel. Through consultations, the community can be assured of professional assistance in developing a STOL port that is safe, efficient, and compatible with its environment.

c. Further information about the reference material mentioned throughout the advisory circular is contained in Appendix 1, Bibliography.

3. BACKGROUND.

a. The term STOL has been widely used without having an official definition beyond Short Take Off and Landing. The FAA has recognized the necessity for a definition, but believes the definition should cover the STOL transportation system rather than the aircraft alone.

b. As is apparent, a STOL port will also accommodate VTOL (Vertical Take Off and Landing) aircraft.

c. The recommended design criteria are subject to change as further evaluation and operational experience dictate. In this regard, flight tests are currently being conducted at NAFEC (National Aviation Flight Evaluation Center). Significant future changes to the existing criteria will be accomplished by appropriate revision to this advisory circular.

4. POTENTIAL ROLE.

The greatest potential of STOL aircraft is in the role of short-haul transportation (up to 500 miles). The use of STOL for city-center to city-center and intracity air passenger traffic would serve two prime purposes—provide better service to the passenger, and relieve airspace and ground congestion at larger airports. Most of our large and medium hub airports are becoming congested, in regard to both available airspace and to passenger facilities. In some cases, surface accessibility is in shorter supply than air accessibility. If the trend continues as forecast, the problem will worsen. In view of this, when developing a metropolitan STOL system, it is important to recommend site locations which are accessible to users and compatible with airspace use. Such a system should provide relief for large and medium hub airports and benefit both long and short-haul passengers.

a. *CAB Northeast Corridor Investigation.* The Civil Aeronautics Board (CAB) examiner in this case determined that air service by STOL equipment is technically and economically feasible between New York, Boston, Hartford, Newark,

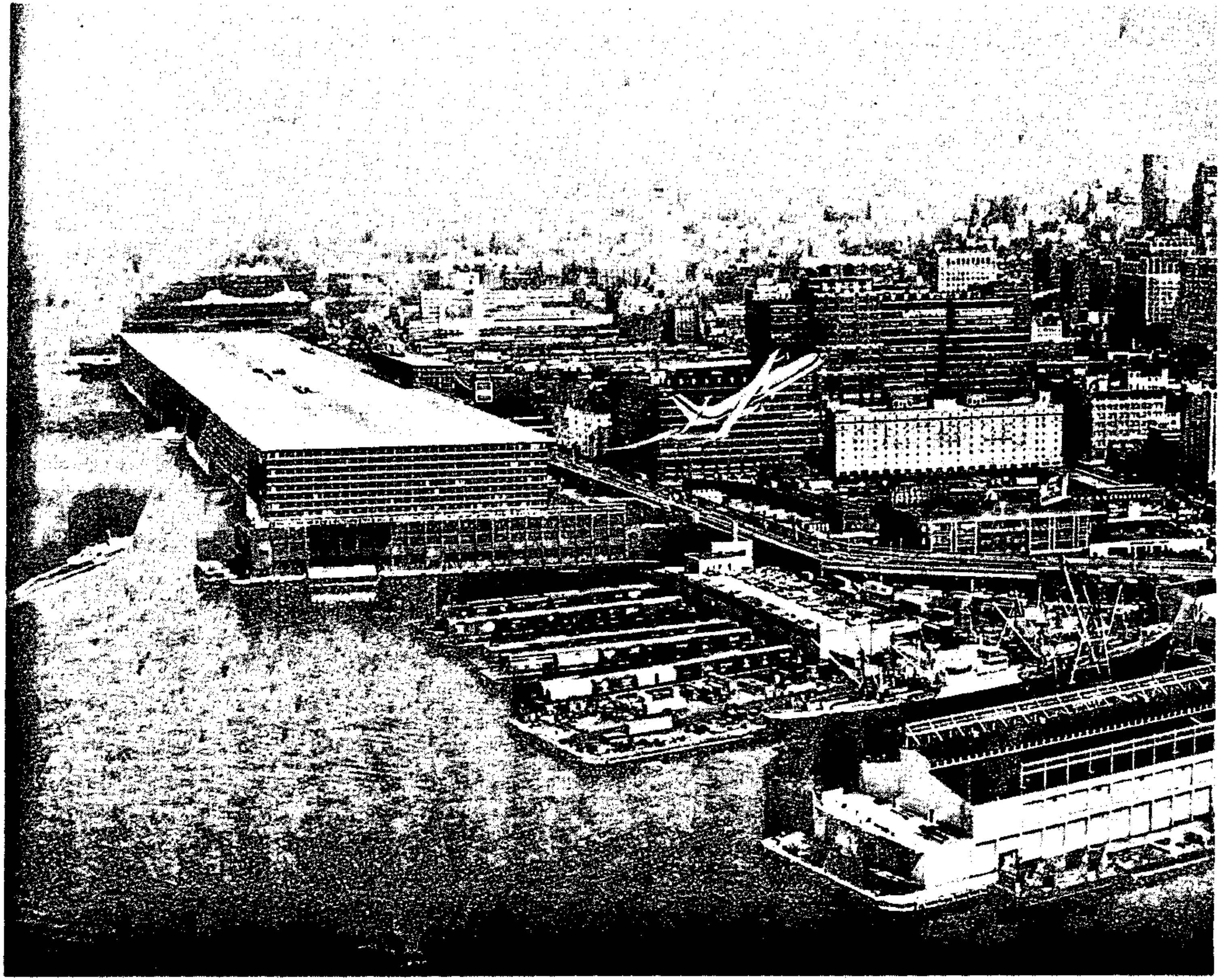


FIGURE 1. Potential New York STOL Port

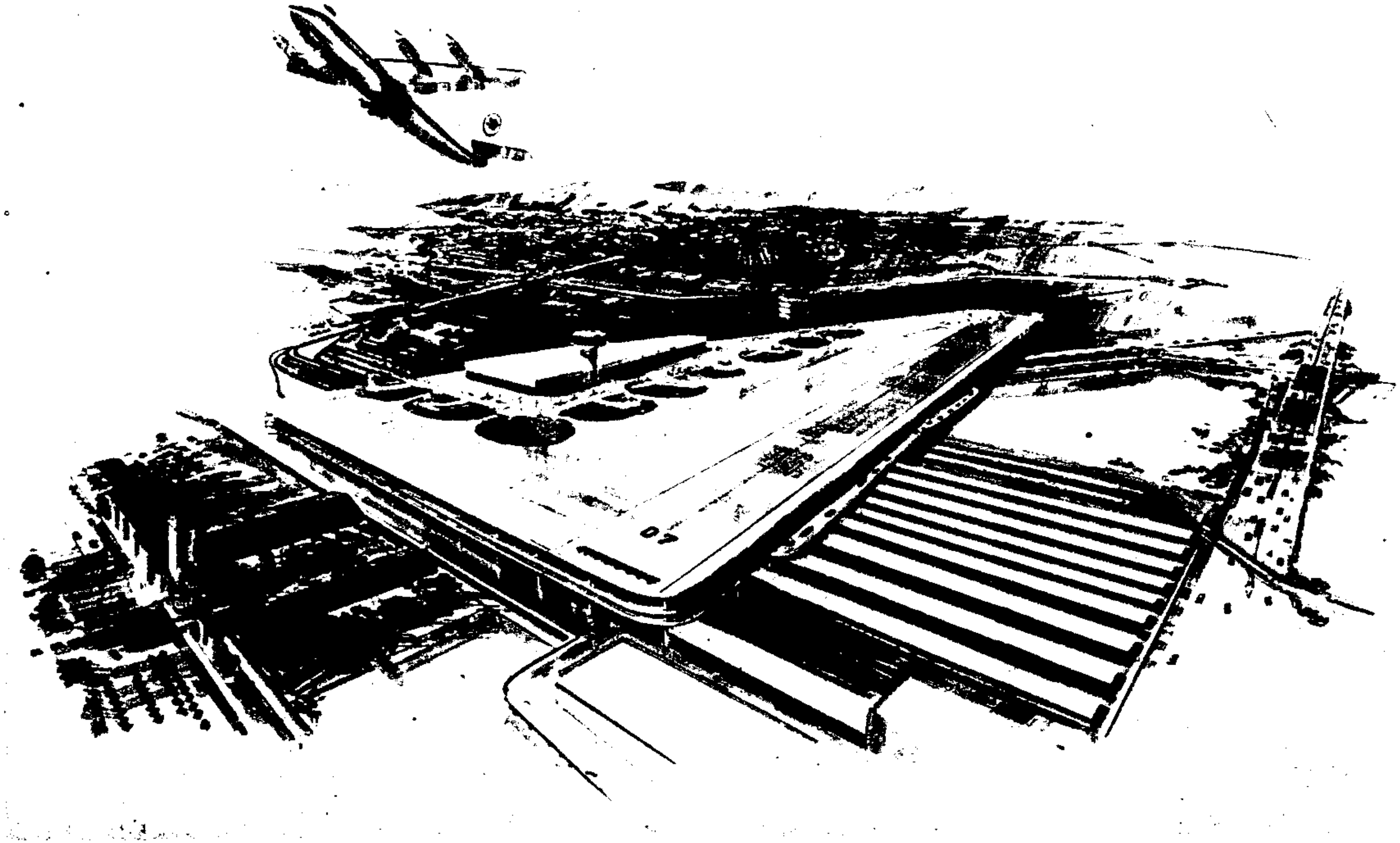


FIGURE 2. Potential Los Angeles STOL Port

Trenton, Philadelphia, Wilmington, and Washington, D.C. The examiner also found that the public convenience and necessity require the institution of this service in order to reduce congestion and delay in air transportation and to improve the quality of air transportation in these markets. The Civil Aeronautics Board concurred on 9 September 1970 with the Examiner's findings and initiated phase two of the investigation.

b. *Congestion.* One airline recently estimated that air traffic congestion will result in an annual loss to New York City's economy of $54 million in 1970, $205 million in 1975, and $589 million by 1980. No estimate can be given for the amount of time lost by the passenger during his total trip; that is, by surface congestion, getting to the airport, and by air traffic congestion circling to land or waiting to takeoff.

c. *Passenger Market.* Studies submitted in the CAB Northeast Corridor case forecast a STOL market of 5 to 10 million passengers in 1973, and 14 to 28 million passengers in 1978. If these figures were realized, a significant number of peak hour flights could be diverted from the major conventional airports in the Northeast Corridor.

5. DEMAND.

In the last few years, an increasing amount of publicity has been given to STOL aircraft. Several large cities and some regional entities, such as the Western Council of State Governments, have studied the feasibility of and the need for establishing STOL ports in metropolitan areas. In the New York City area, for example, more than six sites have been analyzed as potential STOL ports. Accordingly, these has been an increasing demand for FAA criteria to assist in such studies.

6. EVOLUTION.

Creation of an optimum, operational STOL system will not be done in one step. It must be recognized that development will be evolutionary. The interaction among acceptable vehicles, navigational systems, air traffic control procedures and hardware, heliports, STOL ports, community acceptance, and other factors requires a step-by-step approach. STOL service may, of necessity, be initiated at an existing general aviation airport. However, the optimum system may require a separate STOL port closer to the city center. Planning for the STOL system should proceed with the goal of evolving to the optimum by reserving necessary airspace and ground areas. This is particularly critical for metropolitan STOL port sites.

7. TERMINOLOGY.

The following are definitions of terms as they are used herein:

a. *Approach/Departure Surface.* An imaginary plane extending outward and upward from the ends of the primary surface at a slope of 15 feet horizontally to 1-foot vertically (15:1).

b. *Metropolitan Area.* An area intended to denote a built-up or urban area, and not a Standard Metropolitan Statistical Area (SMSA).

c. *Metropolitan STOL Port.* An airport designed to accommodate STOL aircraft and located in or near major activity centers of a metropolitan area.

d. *Primary Surafce.* An imaginary plane centered on the runway. Its width is 300 feet. Its length coincides with the length of the runway safety area.

e. *Runway Safety Area.* An area symmetrically located about the runway which is constructed to support (without major damage) aircraft which might inadvertently traverse it. Its width extends 50 feet beyond each runway edge. Its length extends 100 feet beyond each runway end.

f. *STOL Runways.* A runway specifically designated and marked for STOL aircraft operations.

g. *Transitional Surface.* An imaginary surface adjacent to each side of the primary surface and a portion of the approach surfaces. It extends outward and upward at a slope of 4 feet horizontally to 1-foot vertically (4:1).

h. *STOL Aircraft.* An aircraft which has the capability of operating from a STOL runway in accordance with applicable airworthiness and operational regulations.

i. *VTOL Aircraft.* An aircraft which has the capability of vertical takeoff and landing. These aircraft include, but are not limited to, helicopters.

8. AIRCRAFT DATA.

Several concepts of large STOL aircraft have been studied and developed to the prototype stage. None, however, has to date been placed in production. Appendix 2 lists the physical characteristics of proposed STOL aircraft, as provided by manufacturers.

Chapter 2. DESIGN CRITERIA

9. GENERAL.

During the process of developing these design criteria, certain assumptions had to be made because of the lack of commitment of large STOL aircraft to civil production. Therefore, these standards represent considered judgment of what constitutes a practical set of criteria considering available data, safety, noise, environment, and economics. It is apparent that the shorter the runway the easier it will be to locate a STOL port site, and the greater will be its compatibility with the local environment. On the other hand, the criteria cannot be so restrictive that aircraft manufacturers will be unable to produce a vehicle which can operate safely and economically from the STOL port.

10. DESIGN CRITERIA.

The following criteria have been developed based on STOL aircraft, bidirectional runway operations, and a precision instrument approach. See Figures 3 and 4 for illustration of specific dimensions.

DESIGN CRITERIA[1] FOR METROPOLITAN STOL PORTS

Design Item	*Recommended Criteria*	*Comment*
a. Runway Length at Sea Level & 90° F.	1,500 feet to 1,800 feet	Correction for elevation and temperature to be made on the basis of individual aircraft performance.
b. Runway Width	100 feet	Widening may be desirable if wind coverage is less than 95%.
c. Runway Safety Area Width	200 feet	Widening may be desirable if wind coverage is less than 95%. If elevated, a 300-foot width is recommended for the structure.
d. Runway Safety Area Length	1,700 feet to 2,000 feet	If elevated, the structure would be within this range.
e. Taxiway Width	60 feet	Based on expected configuration of second generation aircraft.
f. Runway C_L[2] to Taxiway C_L	200 feet	Based on expected configuration of second generation aircraft.
g. Runway C_L to Edge of Parked Aircraft	250 feet	Based on expected configuration of second generation aircraft.
h. Runway C_L to Building Line	300 feet	Height controlled by transitional surface.
i. Taxiway C_L to Fixed Obstacle	100 feet	Based on second generation aircraft.
j. Runway C_L to Holding Line	150 feet	Based on second generation aircraft.
k. Separation Between Parallel Runways		See paragraphs 15 and 16.

[1] The criteria are subject to change as further experience is gained.
[2] C_L = Centerline

Design Item	Recommended Criteria	Comment
l. Protection Surfaces:		
1) Primary Surface Length	Runway length plus 100 feet on each end.	
2) Primary Surface Width	300 feet	Based on the use of microwave instrument approach equipment.
3) Approach/Departure Surface Length	10,000 feet	
4) Approach/Departure Surface Slope	15:1	
5) Approach/Departure Surface Width at:		Approach/departure surface is 765 feet wide at 1,500 feet from beginning.
Beginning	300 feet	
10,000 feet	3,400 feet	
6) Transitional Surface Slope	4:1	
7) Transitional Surface Maximum Height	100 feet	
m. Clear Zone:		
1) Length	750 feet	
2) Inner Width	300 feet	Begins at end of primary surface
3) Outer Width	532 feet	
n. Pavement Strength	150,000 pounds gross weight on dual tandem gear.	Based on second generation aircraft. Also see paragraph 30.
o. Runway Marking		See paragraph 35.
p. Runway Lighting System		See paragraph 37.

11. RUNWAY LENGTH DETERMINATION.

A discussion of takeoff and landing runway lengths is needed to establish a common understanding of the terms used. This is particularly necessary for the case of the elevated STOL port, where reference to FAR field length cannot be considered in the same context as the conventional airport. Refer to Appendix 3.

12. MICROWAVE ILS.

Microwave instrument landing systems for STOL operation are currently being evaluated by the FAA. The type of equipment has been designed specifically for steep gradient approaches. The siting of the microwave system may be relatively simple since the localizer and glide slope functions may be collocated. (See Figure 3.) Offset ILS approaches would be advantageous under certain site conditions and are under study. Nevertheless, an offset approach should be considered only where obstructions in the approach would prevent a straight-in ILS procedure.

13. OBSTRUCTION CLEARANCE.

The imaginary surfaces for protection of the STOL port are shown in Figure 5. A future amendment of FAR Part 77 will incorporate these surfaces for STOL ports.

a. *General.* The surfaces have been defined on the basis of operational tests with the microwave ILS. The 15:1 slope for the approach/departure surface is predicated on adequate obstruction clearance for steep gradient approaches and also for takeoff climb.

b. *Curved Paths.* For VFR (Visual Flight Rules) operations, a curved path for approach or departure is quite practical and may be necessary in some cases to provide a suitable route. For example, an IFR (Instrument Flight Rules) procedure may be feasible from only one direction. Under adverse wind conditions, it would

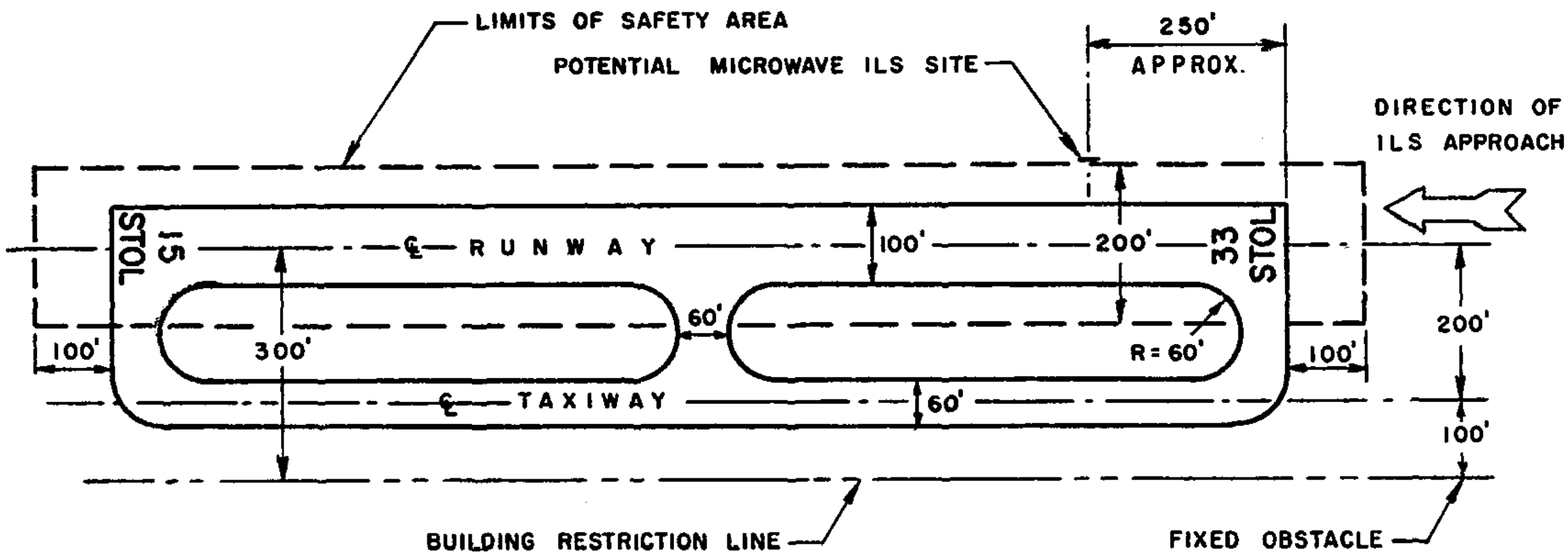


FIGURE 3. Dimensional Criteria

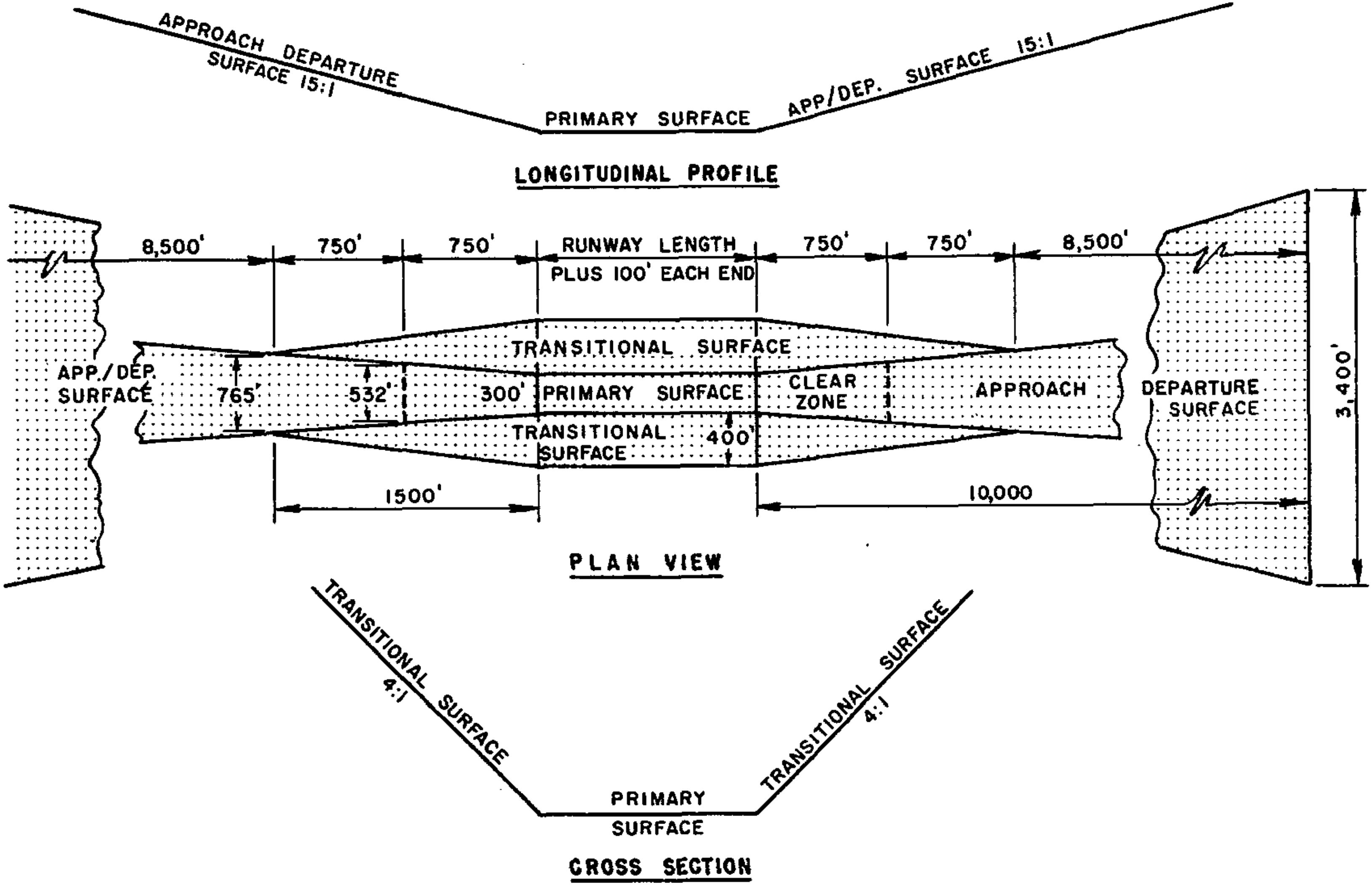


Figure 4. Protection Surfaces

be desirable and perhaps necessary to complete the IFR approach, transition to VFR and land from the opposite direction. The radius of the curved path will vary according to the performance of individual aircraft and the angle of bank used. For planning purposes, a radius of 1,500 feet may be used.

14. RUNWAY ORIENTATION.

One of the primary factors influencing runway orientation is wind. Ideally, the runway should be aligned with the prevailing winds. It is recognized that the limited number of STOL port sites will minimize the opportunity for the runway to have optimum wind coverage. On the other hand, it is also recognized that the availability of a crosswind runway on a metropolitan STOL port will be rare. Accordingly, the designer should attempt to obtain maximum wind coverage. The minimum desirable wind coverage is 95 percent based on the total hours of available weather observations. In other words, the objective is to attain more than 95 percent usability (preferably 98 percent). The allowable crosswind component will be determined by the crosswind capabilities of the most critical aircraft expected to operate at the STOL port.

15. PARALLEL RUNWAYS—STOL PORT.

For simultaneous VFR operations on a STOL port, the minimum separation between the centerlines of parallel runways should be 700 feet. Minimum IFR separation between parallel STOL runways is to be determined.

16. STOL RUNWAY AT AN EXISTING AIRPORT.

In order not to adversely affect capacity at a metropolitan airport, STOL aircraft should be segregated to the extent feasible from conventional aircraft. To accomplish this, a separate runway for STOL operations should be provided with separate approach and landing aids for IFR conditions. The minimum lateral separation between a STOL runway centerline and a conventional runway centerline for simultaneous VFR operations should be 700 feet. Minimum IFR separation between parallel STOL and CTOL runways is to be determined.

17. RUNWAY CAPACITY.

The capacity of a runway is the number of aircraft operations (landings and takeoffs) that the runway can accommodate in a limited period of time. The operational capacity of a STOL runway will be lowest during IFR conditions. To obtain maximum IFR capacity, the STOL runway should be equipped with a microwave ILS and radar surveillance (including an air traffic control tower). A method for calculation of capacity values is given in Advisory Circular 150/5060-1A. This publication discusses the numerous factors which must be considered in a capacity analysis. However, as a general guideline, with current procedures, the IFR capacity of a single STOL runway will be approximately 45 operations per hour. It is expected that this capacity will be considerably expanded when adequate data have been collected and analyzed.

18. AREA NAVIGATION.

Area navigation provides a means of overcoming many of the constraints of the present VOR system (See Advisory Circular 90-45). By eliminating the requirement to fly along radials that lead directly to or from the ground station, it is possible to design routes and procedures that better facilitate the movement of traffic. For air access to STOL ports, this can achieve the following benefits:

a. Straight-line, point-to-point navigation without establishing ground navaids on the centerline of the route.

b. Segregation of STOL traffic from conventional aircraft.

c. Rapid transition from enroute to ILS procedures.

d. Construction of routes compatible with congested areas.

e. Increased flexibility for air traffic control.

19. CONSTRUCTION.

Criteria for construction of a STOL runway; i.e., pavement slopes, vertical curves, and sight distances should follow the existing criteria for a general utility airport (see AC 150/5300-4A). One exception is the longitudinal grade which should not exceed 1 percent.

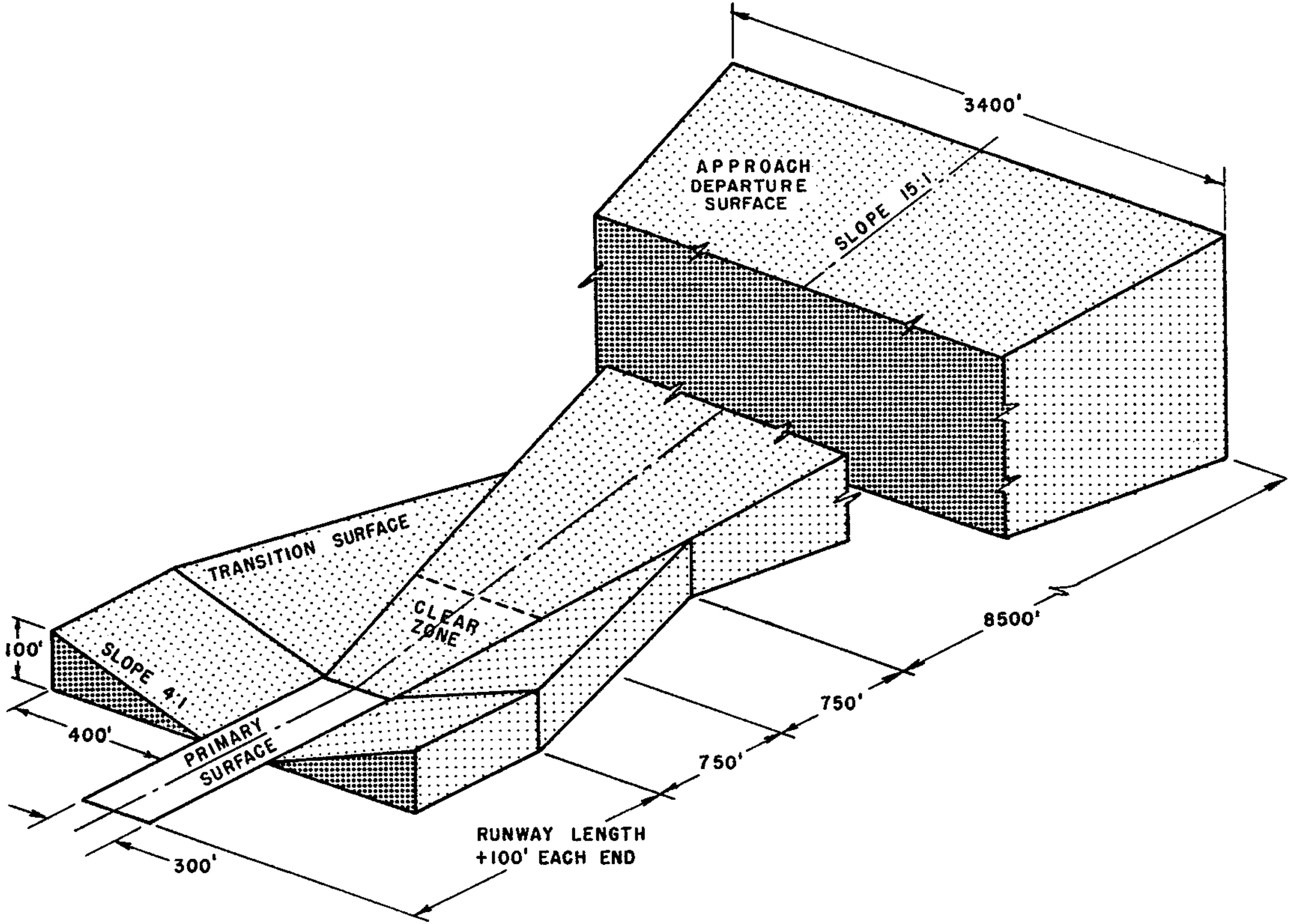


FIGURE 5. Isometric of Protection Surfaces

a. Particular attention must be given to the texture of the runway surface in order to reduce the possibility of an accident when the runway is wet. The stopping distance on a wet runway can be considerably improved by grooving the runway or by use of a rough-textured surface course.

b. By following FAA construction standards, a good texture can be achieved in either bituminous concrete or portland cement concrete without sacrificing stability or durability. Upon completion of construction, the pavement surface qualities should be conducive to effective braking action.

c. Recent traction studies have proved that under wet or flooded conditions, runway grooving provides airplane stopping performance comparable to that on a dry runway. Accordingly, if hydroplaning is anticipated, grooving should be an integral part of the construction project to preclude the aircraft from hydroplaning.

d. For detailed information on construction, refer to Advisory Circulars 150/5320-5A, 150/5320-6A, and 150/5370-1A. It is recommended that all STOL port pavement be considered "critical area" for thickness design.

Chapter 3. METROPOLITAN PLANNING

20. DISCUSSION.

a. *The primary potential* for STOL transportation lies in the short-haul markets in and between large metropolitan areas and between these areas and outlying communities. The concentration of a high percentage of the Nation's aeronautical activity in these areas, when related to the acute shortage of available real estate and airspace, results in the need to look to STOL air transportation as a viable means of accommodating the potential demand.

b. *In analyzing a metropolitan airport system*, it is apparent that aviation demand is resulting in constraints at major conventional airports in regard to:

(1) the saturation of the airspace used by conventional aircraft;

(2) landing area and terminal congestion at conventional airports; and

(3) congestion of ground access to conventional airports.

Establishment of STOL air transportation can alleviate these problems by diverting the short-haul traveller from the major conventional airports.

c. *Thus, the planner* of the metropolitan airport system should, upon identifying the current and potential constraints, plan for a system of STOL ports, with the timing of the establishment of the individual STOL ports paralleling the projected shift of a portion of the short-haul market from conventional air transportation to STOL transportation. STOL ports should be planned for early development near the principal centers of short-haul passenger origins and destinations. Many of the large- and medium-hub airports would benefit from STOL transportation. In this regard, FAA is currently studying the market potential for STOL transportation.

d. *Examples* of areas now experiencing airspace, airport, and ground access congestion are the Northeast Corridor and the California Corridor. Further, it is emphasized that the STOL port or STOL runway must be planned from the standpoint of how it will function in the system. For example, a STOL port which is recommended for Manhattan Island in New York City should be related to the potential STOL system for the area.

e. *The recent ruling* by the CAB examiner in the Northeast Corridor Investigation determined that STOL service is technically and economically feasible between the following cities: New York City, Boston, Hartford, Philadelphia, Trenton, Newark, Wilmington, and Washington, D.C. (See Figure 6.)

21. SITE INVESTIGATION.

The investigation of a site for a STOL port will require close coordination between all levels of government and the aviation community. Among the factors to be considered are:

a. Both VFR and IFR traffic procedures.

b. Relationship to other airports and airspace utilization, current and proposed.

c. Aircraft operational performance.

d. Compatibility of the STOL port with surrounding land uses, particularly as relates to noise.

e. Effect of existing and proposed obstacles on aircraft operations.

f. Operational usability of the site related to climatological conditions including crosswinds, temperatures, precipitation, ceiling, and visibility.

A STOL port does have certain advantages which allow more flexibility in locating it in a metropolitan area. The short runway, the need for less airspace due to the inherent maneuverability of a STOL aircraft in the terminal area and the steeper obstruction clearance planes, allow

FIGURE 6. Map of Northeast Corridor

greater flexibility in siting. Additionally, because of the shortness of the STOL runway, in some cases, it may be feasible to site a STOL port on an elevated structure; perhaps on a waterfront or over a railroad yard. However, the fact that a waterfront site may be available does not mean that the STOL port should automatically be sited there. The site should be located as near as feasible to the primary origin/destination of passengers and still not cause disruption of activities adjacent to the STOL port. In many cities, this site may be near the central business district. In others, a number of STOL ports may be needed, dispered in outlying areas and forming a STOL network. Often, such locations will be limited to industrial areas due to land use compatibility factors.

22. INTEGRATED TRANSPORTATION CENTER.

From a system standpoint, the investigation must also recognize the relationship of STOL

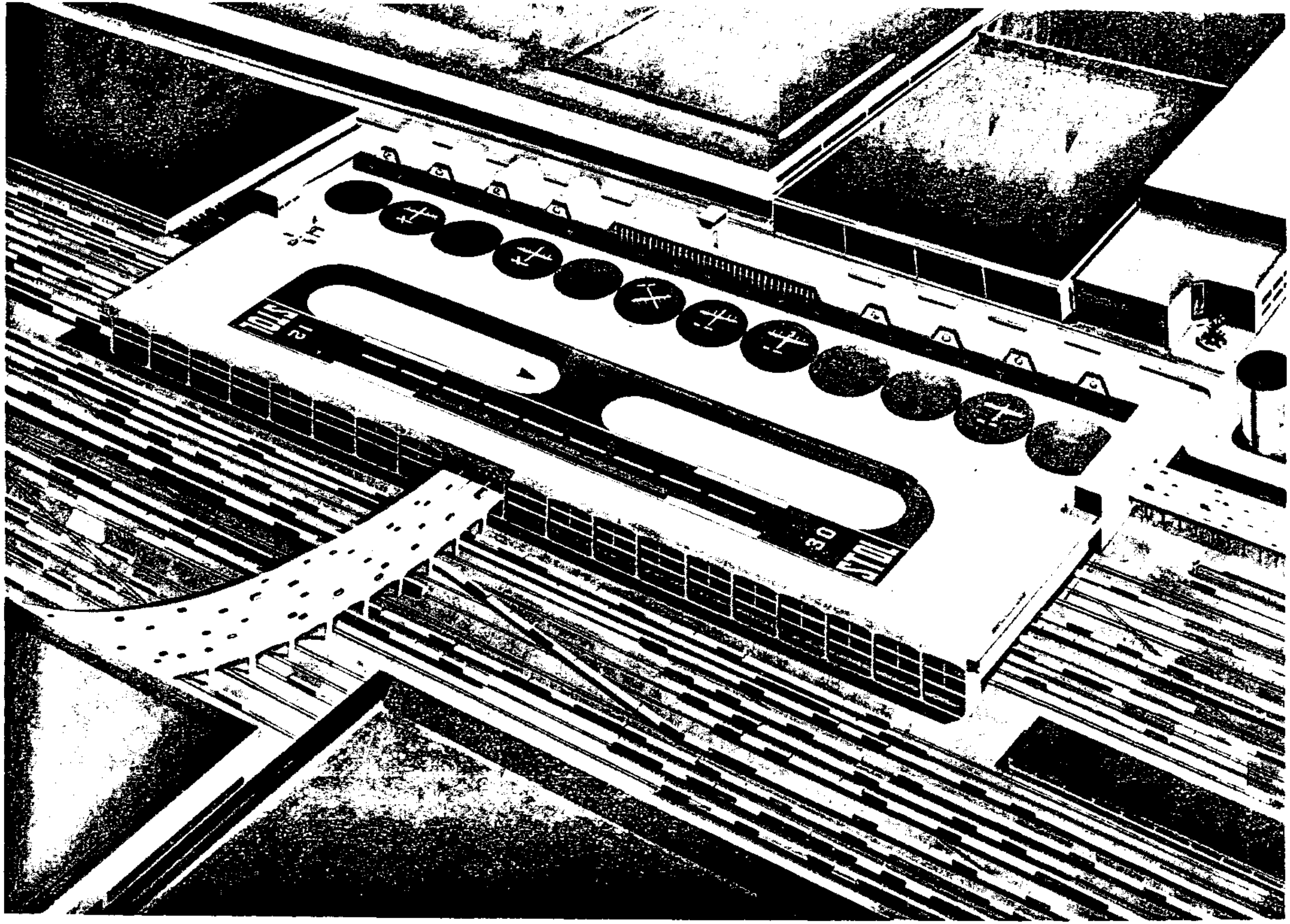


FIGURE 7. Hypothetical Transportation Center

air transportation to all other transportation modes. The ideal STOL port should provide the passenger with air service integrated with convenient surface transportation. Such a facility, therefore, should be planned to allow rapid interchange between the maximum number of transportation modes feasible at that point. Several cities are studying the feasibility of an integrated transportation center as part of their urban renewal plans. Combination of transportation and post office facilities is another possibility. Figure 7 illustrates a proposed transportation center.

23. POTENTIAL CONFIGURATIONS.

In many metropolitan areas, siting of a STOL port may necessitate an elevated structure. At such sites, the designer should strive to achieve vertical loading and unloading of passengers and cargo; i.e., from one level to another. Such a design will allow an operational area that is virtually free of fixed obstacles. Each STOL port should be designed with due consideration of local conditions, particularly the configuration of the land available and surrounding land uses. Figure 8 shows one possible layout of the staggered runway concept. One runway is used primarily for landing and the other for takeoff. This configuration allows a considerable reduction in the total operational area by eliminating parallel taxiways. Also, the flow of traffic is optimized, since no aircraft backout or turning around is involved. Figure 9 shows the tandem runway concept. Again, one runway is used for landing and the other for takeoff, but not simultaneously. Spacing must be provided for taxiing past parked aircraft and aircraft backout for turning around. The figures are intended to illustrate the new approach which must be taken in the planning and design of STOL ports; they are not intended to require a parallel runway configuration.

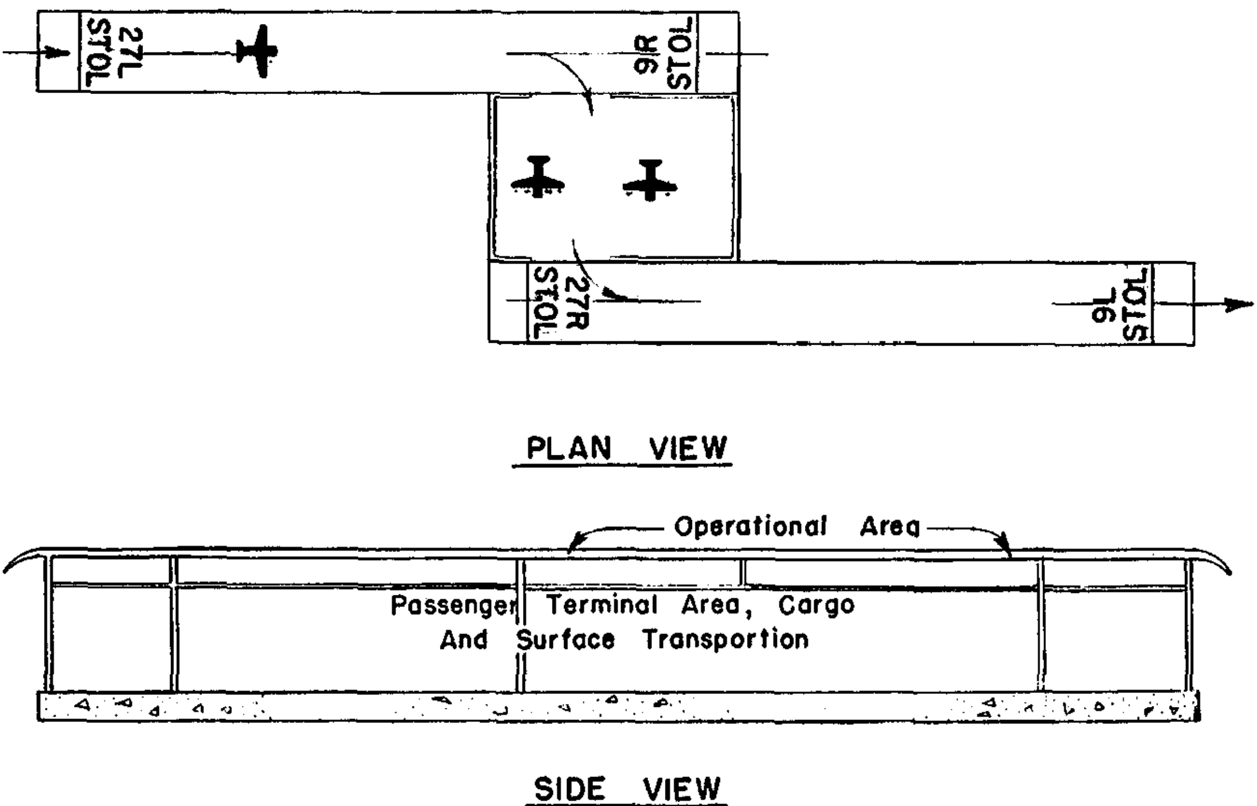


FIGURE 8. Potential Layout

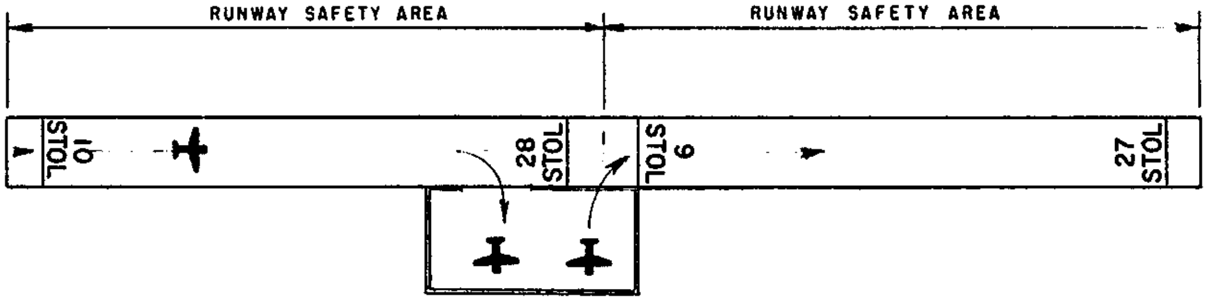


FIGURE 9. Potential Layout

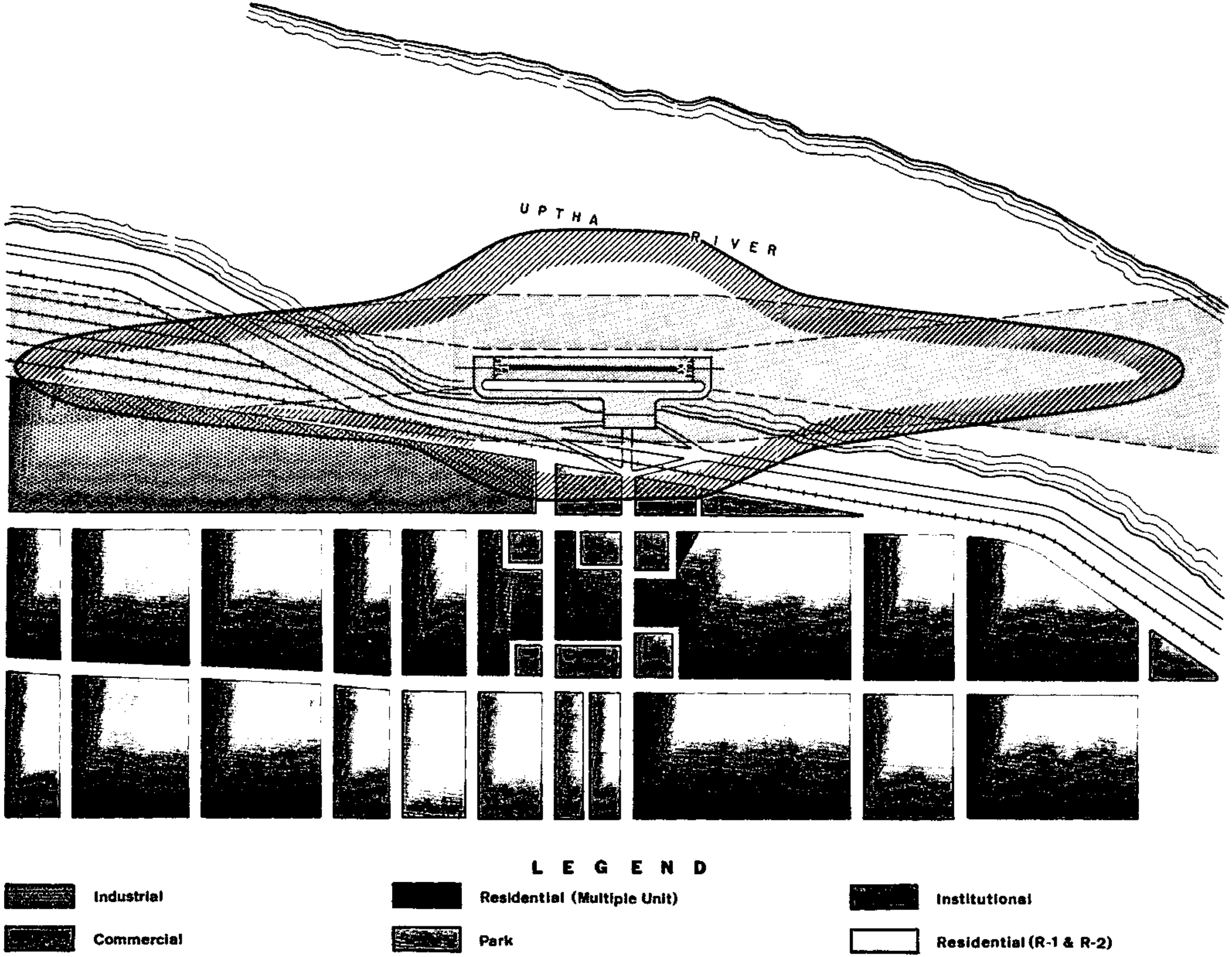
24. AIRSPACE PROTECTION.

To adequately protect the STOL port, the imaginary surfaces shown in Figure 5 should be controlled by the local airport authority. An airport zoning ordinance can be an effective method of preventing the establishment of structures which would constitute an obstruction to aircraft. To provide guidance in the preparation of such an ordinance, AC 150/5190-3, has been published. It is recommended that this publication be used to assist in the adoption of a STOL port zoning ordinance. Height restriction zoning should suffice for some portions of these surfaces. However, the innermost area of the approach is critical and should ideally be owned by the airport authority. To encourage control of this area, "clear zones" have been designated for the inner-most 750 feet of the approach area. This distance is predicated on the approach surface attaining a height of 50 feet above the elevation of the STOL port. The airport authority should acquire control of the land in the clear zone by fee title or by easement. In the case of an elevated STOL port, "airspace rights" may be adequate if control equal to an easement is obtained.

25. LAND USE AND NOISE.

The surrounding land uses have a very important effect on a STOL port and, of course, the STOL port itself will have an important effect on these land uses. Also, aircraft noise will undoubtedly be a primary factor in siting a STOL port. Site selection studies should always include an examination, by qualified acoustical personnel, of the potential impact of noise exposure on the use of land surrounding the prospective STOL port. This is important because each particular location often has its own set of unique circumstances which affects questions of noise sensitivity apart from that which would be predicted by the application of simple noise exposure descriptors. Land uses that should be avoided are: residential, schools, hospitals, and noise-sensitive commercial land uses. On the other hand, land uses that are considered compatible are transportation ways; that is, railroads, highways, rivers, lakes; industrial, so long as they do not interfere with the airport through production of smoke or electronic signals, and also commercial and recreational uses to a certain extent.

a. *NEF.* To evaluate the effects of noise on land use, a methodology has been developed called NEF (Noise Exposure Forecast). See Bibliography. NEF provides a mechanism for calculating a single number rating of the cumulative aircraft noise exposure intruding into a community. Factors in the NEF calculation procedure include the noise of various aircraft types, flight profiles, frequency of operations, operating procedures, runway utilization, and time of day operations. Based on the resulting calculations, NEF contours can be constructed. These contours permit the land areas enclosed within them to be evaluated for various types of uses compatible with the noise exposure. Not the least important is the information provided to the building designer for providing appropriate sound insulated structures. As a rule of thumb, it is generally accepted that land areas exposed to less than 30 NEF will not have major noise problems. However, there are exceptions. For example, building structures such as schools, churches, hospitals, and auditoriums, which are used for sensitive activities, might require extra



METROPOLITAN STOL PORT

FIGURE 10. Example of NEF Contours

noise insulation considerations. If these structures are being designed in the context of zoning regulations promulgated with noise control in mind, noise reduction methods can be applied in a relatively straightforward manner. However, the problem of providing for sound insulation of existing structures can be quite complex.

b. *Example.* To illustrate the extent to which noise exposure from hypothetical STOL aircraft operations from a hypothetical STOL port might affect nearby land uses, Figure 10 has been drawn up. As can be seen, the 30 NEF contour is centered on the runway. In constructing the contour, one of the primary assumptions was that there would be an equal number of landings and takeoffs in each direction. The NEF contour extends mainly over an uninhabited area: the railroad yard, the river, and only to the south in the commercial area and part of the industrial area does the noise affect land use. However, for the location and land use described and for the STOL aircraft operations assumed, no obvious siting problem would be anticipated due to adjacent land use.

c. *Rule Making.* An industry-government task force has been working on possible rule making for noise certification of STOL transport aircraft. An advance notice of proposed rule making is in process and is scheduled to be released in the near future.

Chapter 4. ELEVATED STOL PORTS

26. GENERAL.

The siting of a STOL port involves a series of tradeoffs. One of these is the optimum site for the origin/destination of passengers versus availability of a practical and economic site. In metropolitan areas, this causes a detailed look at elevated STOL ports. For example, in New York City, several waterfront sites on Manhattan Island have been studied. In Los Angeles and San Francisco, sites have been analyzed over railroad yards. All are intended to provide air transportation integrated with surface transportation. Such a facility appears to have a great potential for accommodating the short-haul air passenger demand. However, since it is elevated, there are some unique design problems which must be recognized.

27. OPERATIONAL SURFACE.

Essentially, the same standards are used for elevated STOL ports as surface facilities. Nevertheless, the question arises as to what is the recomended minimum.

a. *Length of Structure.* The length of structure recommended is a range between 1,700 feet and 2,000 feet. FAA and the National Aeronautics and Space Administration (NASA) are presently studying potential operational problems of an elevated STOL port.

b. *Width of Structure.* The width of the structure recommended is 300 feet for the runway operational area. However, this is dependent upon the emergency arresting system selected for lateral containment, the degree of wind coverage, and the need for a parallel taxiway. The lateral arresting system may require a greater or lesser area width, adjacent to the runway. Also, if the runway is not aligned with prevailing winds, it may be appropriate to have a wider runway. For most STOL ports, a parallel taxiway will be needed. In this case, the structure should be at least 400 feet wide.

c. *Terminal Area.* Vertical flow of passenger and cargo may eliminate the need for a terminal building on the operational area. See Chapter 6.

28. AIRCRAFT EMERGENCY ARRESTING SYSTEMS.

The FAA considers some type of emergency arresting system or barrier to be a mandatory requirement for elevated STOL ports. The aircraft cannot be allowed to roll off the structure; it must be contained. However, the FAA, in conjunction with industry, has not yet developed standards for the design and installation of such a system. The following discussion represents the latest thinking for emergency arresting systems on the ends of the runways and also on the sides of the runway. (It should be noted here that only emergency systems are discussed.)

a. *General.* Arresting systems have been developed to a high degree of reliability by industry. The majority of the systems in operation are rotary energy absorbers using either pendant or net engagements. For operation on a STOL port, the arresting system should be a simple device which seldom requires maintenance. No individual adjustment should be needed to arrest the range of weight and speeds of aircraft which will use the STOL port. The system should operate unattended and have a high degree of reliability (more than 99 percent).

b. *Runway End Arrestment.* Runway end arrestment can be considered an emergency situation, brought on by a combination of factors which prevent the aircraft from decelerating to a safe turn-off speed prior to the exit taxiway. To the extent feasible, the arrestment system should be flush mounted, and when needed, should actuate in less than 2 seconds. To allow for a reasonable G-loading, the system should have a runout of from 300 feet to 350 feet. No injuries to passengers and only minor aircraft damage would be expected. In this regard, it appears feasible to adapt hook and pendant equipment for STOL ports within certain limitations. However, further study of this and other systems is required.

c. *Lateral Arrestment.* Using the minimum STOL port width of 300 feet, the distance from the runway edge light to the edge of the structure is 90 feet. It appears that no emergency arresting system available now can meet this criterion. Accordingly, various concepts are being studied, including hook and pendant, net, sloped sides, and barriers.

29. WIND CONSIDERATIONS.

Structures and buildings can have a dramatic effect on air currents. Studies of elevated heliports have shown that considerable turbulence and strong wind shears can be developed by air flowing over and around buildings under certain conditions. It is, therefore, recommended that an in-depth analysis be made of each proposed elevated STOL port to determine the wind effects under various conditions. Assistance in collecting necessary climatological data can be obtained by contacting the local NOAA (National Oceanic and Atmospheric Administration).

a. *NASA Studies.* Recently, the FAA asked NASA to investigate what kind of turbulence and crosswind factors might be expected on elevated STOL ports. Subsequently, NASA has been conducting wind tunnel investigations of building designs incorporating STOL ports to determine wind flow patterns. So far this study has revealed that turbulence could be reduced with curved overhangs on the edges of the STOL port. A second portion of these studies is the examination of the reduction of crosswinds through the use of fences and screens.

30. STRUCTURAL DESIGN.

The landing area should be designed for the largest aircraft expected to use it. The maximum weight aircraft anticipated by 1985 is 150,000 pounds. Other types of loads, such as snow, freight equipment etc., should be considered in the design of the area and the structures as appropriate.

a. *Design Loadings.* The designer must base his design on the aircraft's dynamic and static gear loads and its landing gear configuration. Appendix 2 lists the maximum gross weight and the maximum static gear load for each type of aircraft. Normal landings and takeoffs impose vertical loads on the landing surface that are not significantly more than the static loads of the aircraft at rest. In addition to these vertical loads imposed on the landing surface, the designer must consider the horizontal forces resulting from the deceleration of the aircraft as the wheel brakes are applied in order to bring the craft to a stop from its maximum landing velocity. In the case of hard landings, however, loads higher than static, but of short duration may be imposed on the landing surface. Dynamic (or impact) loading represents the maximum loads that can be expected under service conditions that could develop if an aircraft makes a hard landing. The landing surface should be designed so that it will not fail under impact loads. The impact load and horizontal braking loads for a specific aircraft must be obtained from the manufacturer and are listed for some aircraft in Appendix 2. These loads will be applicable over the footprint area of the tire required to support the load for any given tire pressure. The designer should recognize that the greatest stresses on the landing platform may be the punching or shear stresses in the area of impact. The forces of the aircraft emergency arresting system will have to be resisted by the landing surface support structure. These arresting system forces can be obtained from the equipment manufacturer. For operational areas outside of the touchdown area, the design loading can be the maximum static weight listed in Appendix 2. Consideration should be given to pavement stresses developed by locked-brake turns.

b. *Other Loads.* Live loads due to snow and traffic of personnel and equipment will be accounted for in accordance with local building codes. Judgment must be exercised in deciding whether these loads are applied simultaneously with the concentrated load due to the aircraft. It is recommended that heavily snow-laden roofs be cleared prior to operations to eliminate extra weight and guard against reduced visibility due to the blowing of snow. Also, it may be feasible to install a heating system in the surface of the STOL port.

31. EMERGENCY EQUIPMENT.

Provison should be made for equipment on the operational area to handle emergency medical and fire situations. Refer to AC 150/5210-6A. Consideration should also be given to some type of built-in hydrant system.

32. AIRCRAFT MAINTENANCE AND FUELING.

Due to the limited parking space available, it appears logical to plan only for emergency maintenance. The decision to install an aircraft fueling system will depend on several factors, among which is the requirement of the local building code.

33. FLOATING STOL PORTS.

A STOL port located on water (floating or semi-submersed) is not truly an elevated facility. However, many of the operational problems associated with a floating STOL port are the same as for an elevated STOL port. For example, emergency arresting systems should be provided to insure that the aircraft does not fall into the water. On the other hand, wind flow should be considerably less of a problem. In many metropolitan areas, a floating facility, on either an interim or permanent basis, may provide the best solution to establishing STOL service. For example, an interim floating STOL port might be established for a short time (say 3 years), at one location and then moved to another location.

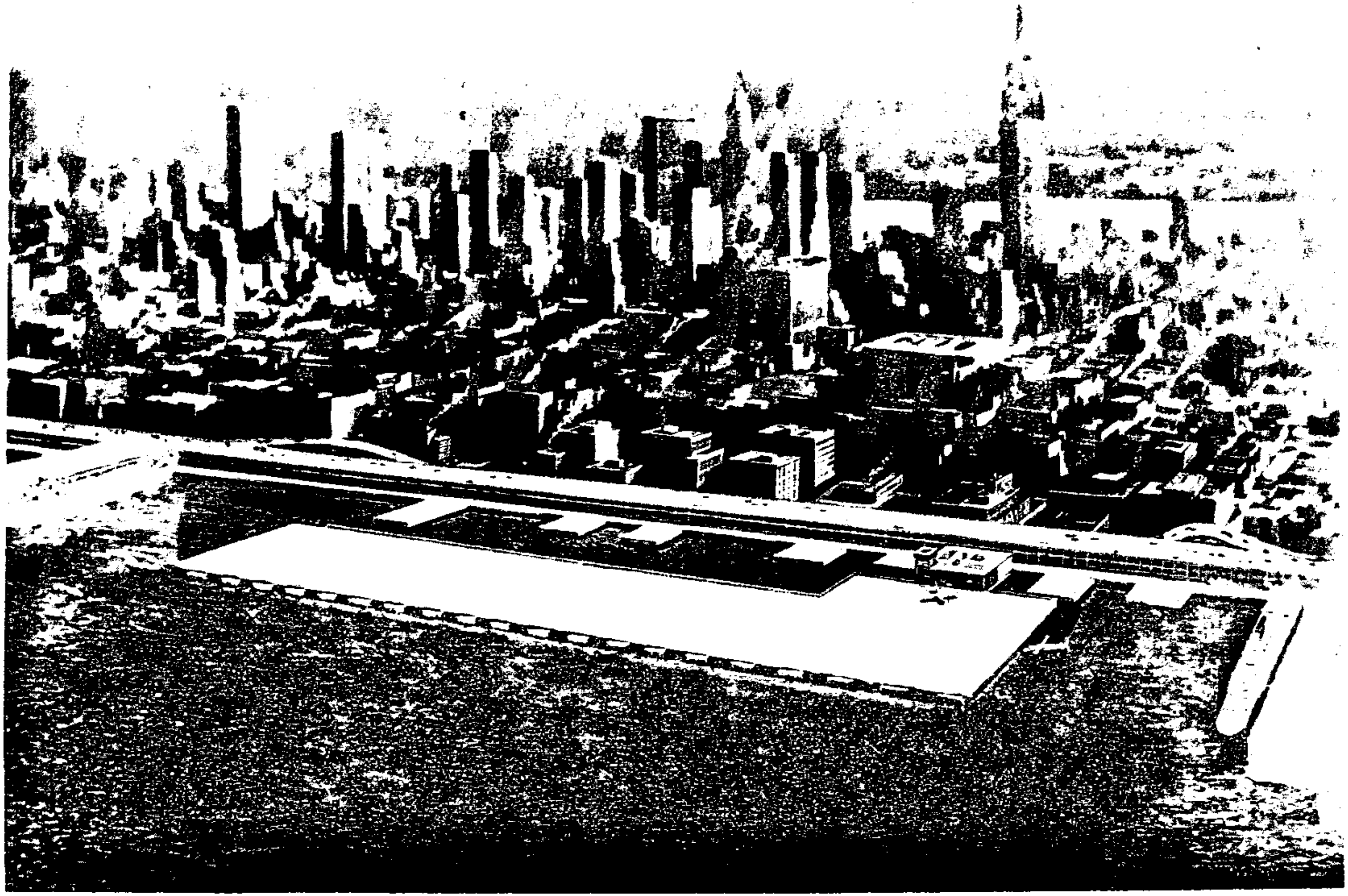


FIGURE 11. Hypothetical Floating STOL Port

Chapter 5. VISUAL AIDS

34. GENERAL.

The recommendations for marking and lighting outlined here are based on flight tests conducted at NAFEC, and on operational experience at Washington National and Dulles International Airports. Accordingly, the criteria given are subject to change upon future evaluation of additional data.

35. RUNWAY MARKING.

The following markings should be installed on the STOL runway using white nonskid paint (see Figure 12).

a. *Threshold markings* consist of the letters "STOL" 60 feet in length, as shown in Figure 13. A 3-foot wide transverse stripe marks the beginning of the runway.

b. *Runway direction number* is above the threshold marking in accordance with AC 150/5340-1C, except that the size and stroke is one-half the size shown in the advisory circular. The location is that shown in Figure 13.

c. *Runway centerline marking* is 3 feet wide and placed in accordance with AC150/5340-1C.

d. *Runway edge marking* is as shown for the allweather runway in AC 150/5340-1C, except that no edge markings are installed in the first 120 feet of the runway.

e. *Tounchdown aim point marking* is the beginning of a solid block 20 feet wide, 200 feet long on either side of the runway centerline, including the runway edge marking, and 300 feet from the beginning of the runway.

f. *For light colored surfaces*, the markings should be outlined with black paint.

g. *For elevated STOL ports* where the runway safety area outboard of the threshold is utilized for takeoff, the displaced threshold marking should be installed in the runway safety area in accordance with AC 150/5340-1C (see Figure 15).

NOTE: All Markings Are White.
Four Aim Point Markings As Shown To Be Provided For Either Bidirectional Or Unidirectional Operation.

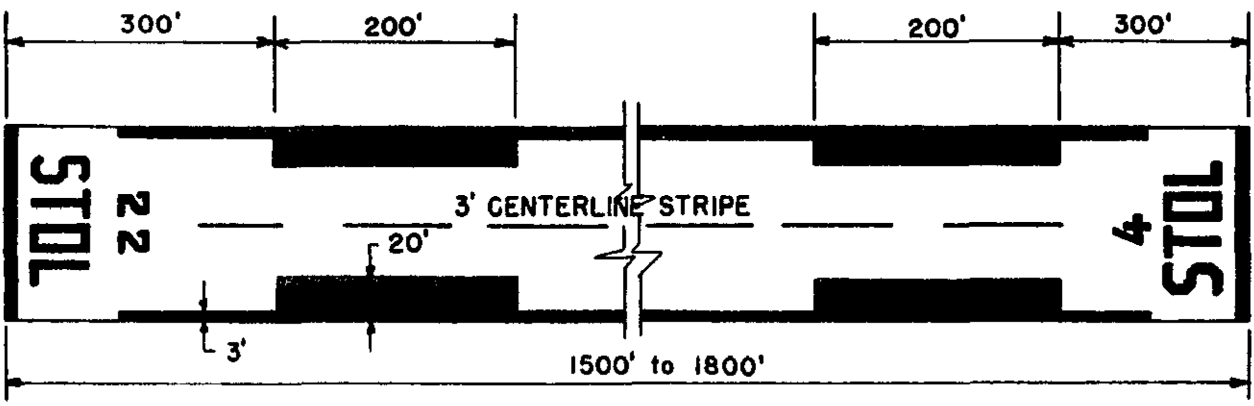


FIGURE 12. STOL Runway Marking

NOTE: All Other Markings To Be
The Same As Figure 12.

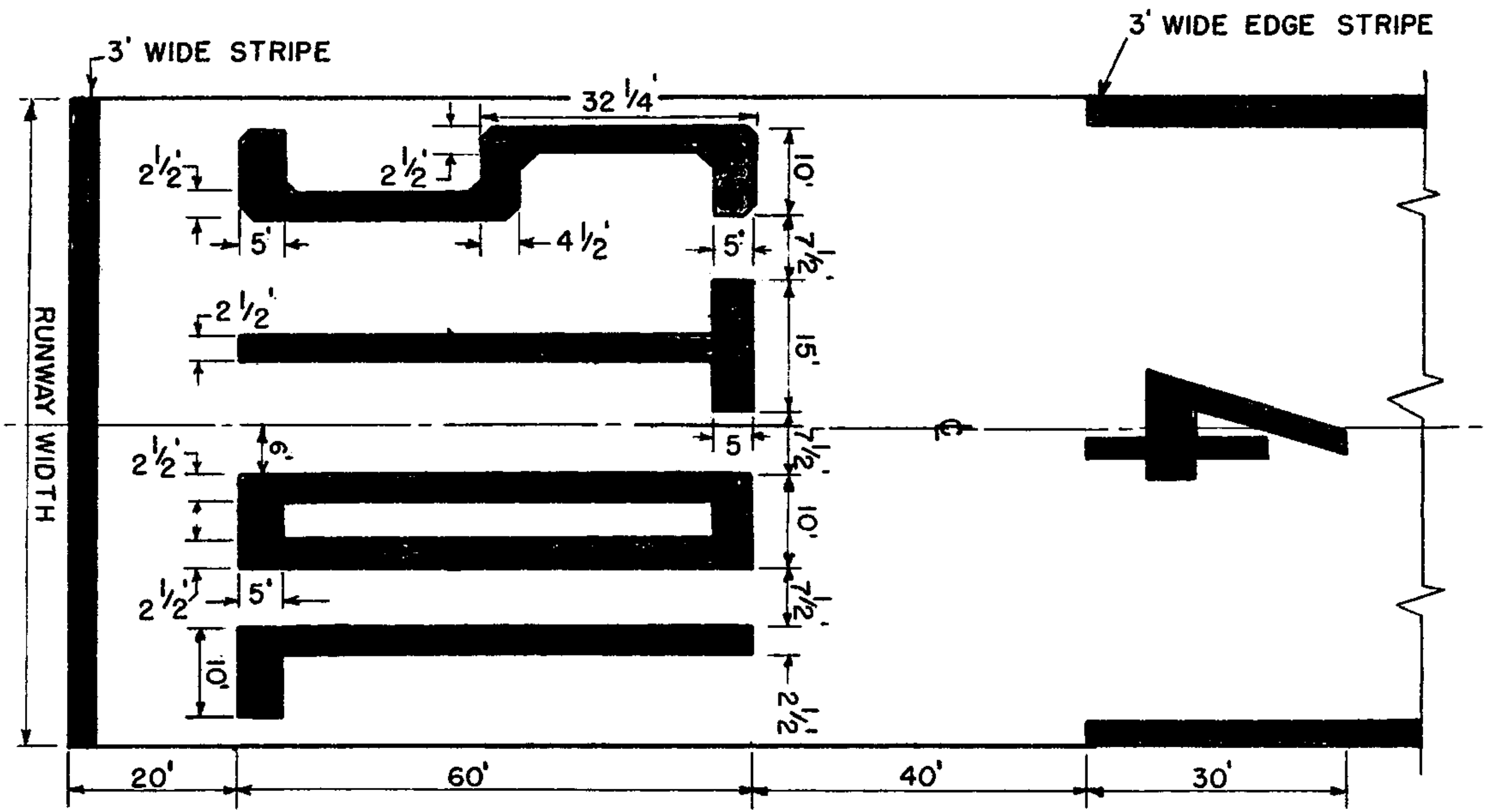


FIGURE 13. STOL Runway Marking

36. MIXED OPERATIONS.

At a conventional airport, where conventional aircraft and STOL aircraft operate on the same runway, only conventional markings should be applied to that runway.

37. RUNWAY LIGHTING.

The following lighting system should be installed on STOL runways where instrument or night operations are contemplated (see Figure 14). All above-ground lights are frangibly mounted and provided with at least three steps of brightness control.

a. *Threshold lighting* consists of two groups of four L-819 light fixtures forming wing bars symmetrically located about the runway centerline. The innermost light is in line with the runway edge lights. The lights are alternate yellow and green in the direction of approach. They are red in the opposite direction. The lights do not exceed 14 inches in height above the runway edge. In the case of single-direction operations, only the appropriate lights are shown.

b. *Runway edge lighting* consists of alternate yellow and white L-819 or L-802 light fixtures spaced at even intervals, at least 100 feet apart but not more than 200 feet apart. The lights do not exceed 14 inches in height above the runway edge and are not placed more than 10 feet from the edge of the full-strength pavement. The L-802 fixture light uses 45-watt lamps with the yellow filter, and 30-watt lamps with the white lens.

c. *Runway end lights* consist of a bar of seven L-850B lights with red filters symmetrically placed about the runway centerline spaced five feet apart and on line with the runway threshold lights. The center light is on the extended runway centerline. In the event of bidirectional operation, L-850A lights with red filters to mark the runway end and alternate yellow and green filters to mark the runway threshold are installed.

d. *Runway distance remaining lights* consist of four L-850B lights with red filters installed on the runway centerline, beginning 50 feet from the runway threshold in the direction of the roll-out and blanked out on the other side. The lights are 50 feet apart (see Figure 14).

e. *Visual approach slope indicators (VASI-2)* are in accordance with AC 150/5340-14B except that:

(1) The spacing between the upwind and downwind units is 150 feet.

(2) The downwind bar is located 175 feet from the runway threshold.

(3) The glide path angle is 6 to 8 degrees and the optimum appears to be 7.5 degrees.

(4) The spread between the upwind and downwind units is 0.7 of a degree.

(5) The system is energized continuously and provided with day-night intensity control by means of a photocell.

(6) It should be noted that the VASI guidance accuracies close to the STOL port are not acceptable unless used in conjunction with another aid. This aid could be airborne (such as a heads-up display) or ground based (such as the Navy mirror system). Studies are currently underway to determine a solution to this problem.

f. *Runway End Identifier Light System (REILS)* is in accordance with AC 150/5340-14B and consists of two flashing lights located in line with the runway threshold lights. The system provides early runway identification and is beneficial in metropolitan areas where a preponderance of lighting exists (see Figure 14).

38. STOL PORT BEACON.

In lieu of the conventional airport beacon, a new beacon is being developed for STOL ports. The intensity will be sufficient to identify it from a distance of 3 miles.

39. WIND DIRECTION INDICATOR.

A wind indicator adjacent to the landing area is recommended. This should be located so that it will be prominent but will not be a hazard to flight. In addition, the wind indicator should be located to preclude the possibility of spurious effects from a nearby building or structure. The wind cone fabric color should contrast with its surroundings. The wind indicator should be lighted.

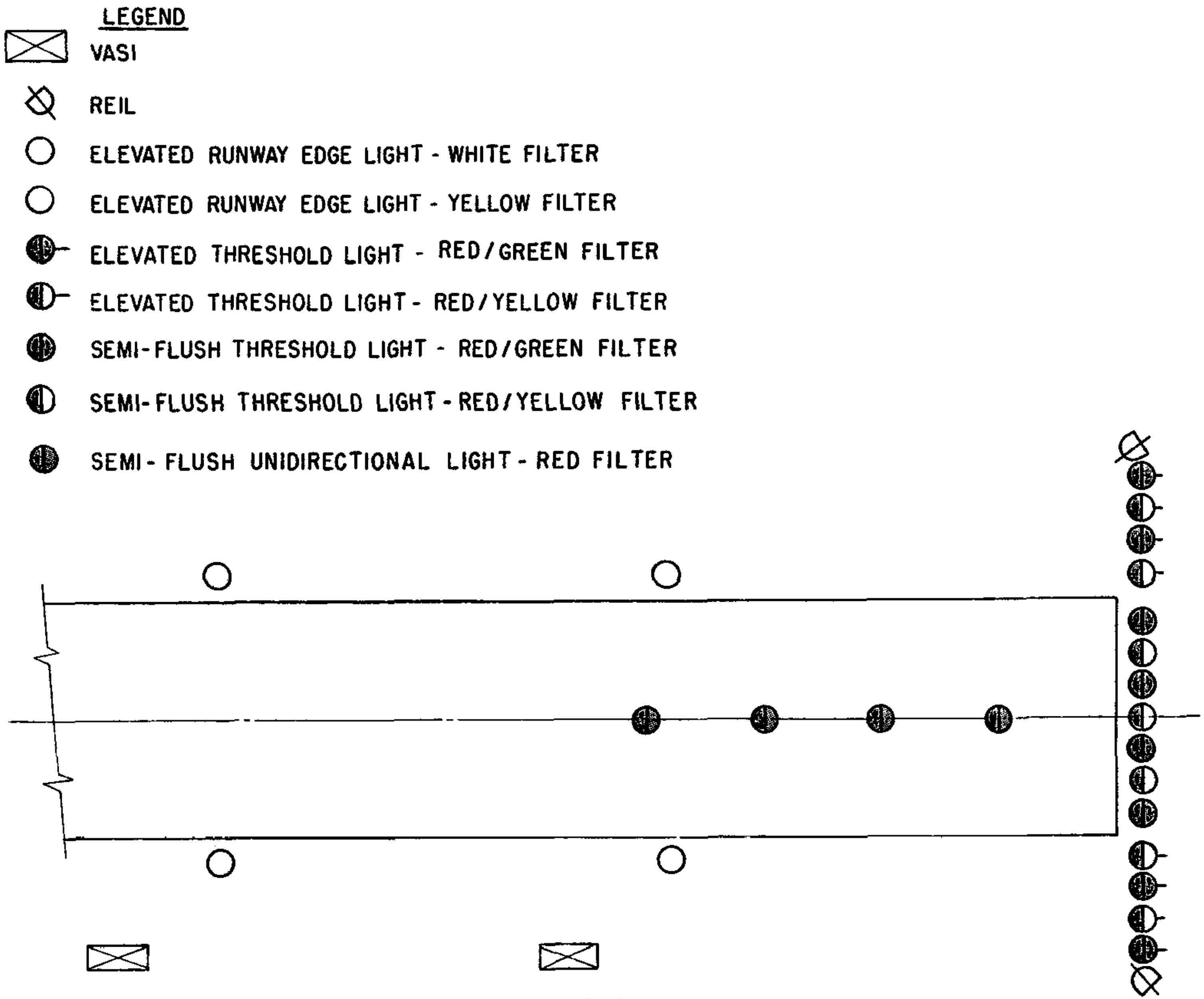


FIGURE 14. Lighting Configuration

40. OTHER STOL PORT LIGHTING.

a. On surface STOL ports, taxiways should be lighted with standard blue edge lights. On elevated STOL ports, taxiways should be lighted by green centerline lights.

b. Parking aprons should be lighted by floodlights. However, the lights should be mounted and aimed to avoid interference with the pilot's vision.

c. Approach lighting for STOL ports is under study as part of the instrument landing system. Conventional approach lighting systems are not considered feasible for a STOL port.

41. OBSTRUCTION LIGHTING.

Where it is not feasible to remove an obstruction, that object should be marked and lighted in accordance with AC 70/7460-1. Isolated structures not penetrating the obstruction clearance surfaces may require special consideration.

Chapter 6. TERMINAL AREA

42. GENERAL.

The primary purpose of the terminal area on a STOL port is the same as the terminal area on a conventional airport—to provide for the transfer of passengers and cargo from one mode of transportation to another. However, due to the specialized function of the STOL system, attention should be given to possible innovations in the terminal area, such as gate processing and vertical movement of passengers. The STOL system, which is aimed at short-haul, high-density air transportation, must be efficient in every aspect.

43. TERMINAL BUILDING.

The terminal building should be designed to accommodate a steady flow of passengers rather than long-term holding of passengers. This means secondary features of the terminal, such as concessions and eating facilities, should be minimized. To aid in efficient passenger handling, consideration should be given to passenger processing at the gate. Since the majority of short-haul passengers are business-oriented, time-conscious, and carry relatively little baggage, gate processing should be quite feasible. Also, mutual-use (or common use) gates appear to be a requirement.

44. VERTICAL MOVEMENT.

On elevated STOL ports, it may not be feasible to locate the terminal on the same level as the operational area. This would, of course, require vertical movement of passengers and baggage. Several methods of accomplishing this have been studied. Among these are escalators, elevators, and loading bridges. The escalators would involve the least cost but would create a fixed obstacle in the aircraft maneuvering area. The elevators can be located on the side of the structure but are expensive and preclude a steady flow of passengers to the aircraft. The loading bridges completely protect the passenger from the weather but are expensive and create an obstacle. At surface STOL ports, vertical movement of passengers may be feasible between mass transit vehicles and the aircraft gate area. This should be given careful evaluation during the initial planning of the terminal.

45. CAPACITY.

The size of the terminal is determined by the peak-hour volume of passengers and cargo. The forecast of the peak-hour volume must be made recognizing the maximum capacity of the runway (in VFR conditions), the aircraft passenger capacity, the aircraft load factor, and the frequency of service. Further, an analysis must be made of the maximum capacity of the surface access systems. Surface congestion has a direct effect on the efficiency of the air transportation system.

46. FALLOUT SHELTER.

Guidance for the planning and design of fallout sheters is contained in AC 150/5355-2, dated April 1, 1969, *Fallout Shelters in Terminal Buildings*. The same provisions contained in this circular are applicable to STOL ports. Elevated STOL ports, by the nature of their inherent construction, should provide adequate protective shelter spaces for employees and the public if fallout shelter is considered in the initial concept of the design. Plans for construction of STOL ports should include fallout protection. Local civil defense agencies can arrange to have a nearby university provide professional advisory services to the STOL port designers to achieve optimum shelter.

Chapter 7. ROLE OF GOVERNMENT

47. FEDERAL AND LOCAL GOVERNMENTS.

Federal and local governments have similar objectives in the field of airport development, not only to insure that public interests are protected but also to assist the public in understanding aviation as an important part of the transportation system. The Federal Government, through the FAA, has established safety rules for airplane and helicopter operations. These regulations concern such matters as minimum safe altitudes, ceiling and visibility weather limitations, right-of-way, and related standards needed for safety of persons and property both in the air and on the ground. The Federal safety regulations are comprehensive. The purpose for such broad Federal regulation of the navigable airspace is to achieve safety through uniform and centralized control of aviation operations. Most state and local jurisdictions find their safety-of-flight requirements covered by the Federal regulations. It is quite common, however, for state and local authorities to have detailed rules governing the establishment and licensing of airports.

48. FEDERAL AVIATION REGULATIONS (FAR's).

The FAA does not license airports or STOL ports; however, in the future, the agency will certificate all airports serving air carriers certificated by the CAB. This will be done through regulations. Specific matters of interest in current regulations are as follows:

a. *FAR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports.* The Federal Aviation Act of 1958, Section 309, states in part that no airport or landing area, *not involving* expenditure of Federal funds, shall be established, or constructed, or any runway layout substantiallly altered unless reasonable prior notice thereof is given the Administrator, pursuant to regulations prescribed by him, so that he may advise as to the effects of such construction on the use of airspace by aircraft. FAR Part 157 was promulgated to carry out the intent of this section.

b. *FAA Form 7480-1, Notice of Landing Area Proposal.* This is used for reporting those airport projects subject to the notice requirements for provisions of FAR Part 157. Forms may be obtained from any FAA regional office.

c. *FAR Part 77, Objects Affecting Navigable Airspace.* This sets forth the requirements for notice to the FAA Administrator for certain proposed construction or alteration of structures that would affect the navigable airspace. Part 77 requires persons intending to erect certain structures to notify the FAA of their intentions. The FAA then conducts an aeronautical study of the proposed structure to determine whether or not it would be a hazard to air navigation. The FAA advises all interested parties of its findings.

d. *Airworthiness.* FAR Parts 23, 25, and 29 and the Tentative Airworthiness Standards for powered lift transport category aircraft set forth the requirements for the manufacture of STOL and VTOL transport category aircraft.

e. *Operating Regulations.* FAR Part 91 prescribes general operating rules for all aircraft. FAR Parts 121, 133, and 135 set forth the requirements for various types of commercial operations; and FAR Part 127 contains the operating rules for scheduled air carrier service by helicopters. FAR Part 61 pertains to certification requirements of pilots and flight instructors.

f. *FAR Part 152, Federal-Aid to Airports.* This sets forth the policies and procedures for administering the Airport Development Air Program (ADAP) under the Airport and Airway Development Act of 1970. This program assists in the development of public airports (including STOL ports) through grants of funds to public agencies, referred to as "sponsor." The sponsor must be a public agency such as a state, territory, municipality, or other political subdivision, or a tax-supported organization such as an airport authority or transportation authority. A project for STOL development may be approved by the FAA only if it is reasonably necessary and consistent with existing plans of public agencies for the development of the area in which the facility is to be located, and provided it is within the scope of the current National Airport System Plan (NASP). Federal participation in the allowable cost of such development is about 50 percent. To be eligible, the land comprising the site of the STOL port must be publicly owned and under the control of a public agency. However, this requirement does not in any way preclude a floating or elevated structure from consideration. Additionally, the site must be evaluated by the FAA from an airspace utilization standpoint and must be found compatible.

49. STATE REQUIREMENTS.

The establishment of an airport usually will require prior approval, or the issuance of a license, from the appropriate state aeronautics commission or similar authority. In some states, the licensing requirements apply only to airports open to the public; in others, however, they apply to all airports within the state.

50. LOCAL REQUIREMENTS.

Some local jurisdictions have rules and regulations governing the establishment of an airport. Zoning laws and the related provisions of building codes, fire regulations, and similar ordinances should be taken into account by the STOL port planner.

51. GOVERNMENT ASSISTANCE.

In view of the preceding, it is apparent that STOL port developers should seek the cooperation and assistance of the FAA, state, and local authorities in the early stages of planning in order to proceed with full knowledge of both the regulatory and economic needs. The FAA is prepared to give technical advice and assistance on request. Preliminary coordination may be accomplished with the local FAA Airports Office. Most state aviation authorities have established procedures for handling airport applications. Local government authorities often do not have an established procedure for handling airport applications, and it may be necessary to explain the special nature of STOL aircraft operations. In some communities, education of the public, particularly the immediate neighbors of a STOL port, may be needed to point out the advantages of STOL services to a community and to clarify any misunderstandings related to the services.

Appendix 1. BIBLIOGRAPHY

1. FAA PUBLICATIONS.

a. Some FAA publications may be obtained free of charge from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590. Other "for sale" documents are obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Make checks or money orders payable to the Superintendent of Documents. No c.o.d. orders are accepted. As an aid in obtaining the "for sale" documents, listed below are the regional addresses of the Government Printing Office Bookstores:

(1) Government Printing Office Bookstore, Federal Office Building, Room 1463, 14th Floor, 219 South Dearborn Street, Chicago, Illinois 60604.

(2) Government Printing Office Bookstore, Federal Bulding, Room 135, 601 East 12th Street, Kansas City, Missouri 64106.

(3) Government Printing Office Bookstore, Federal Building, Room 1023, 405 Golden Gate Avenue, San Francisco, California 94102.

(4) Government Printing Office Bookstore, Federal Building, 300 North Los Angeles Street, Los Angeles, California 90012.

(5) Government Printing Office Bookstore, John F. Kennedy Federal Building, Room G25, Sudbury Street, Boston, Massachusetts 02213.

b. The following Federal Aviation Regulations (FAR's) are available on a subscription basis from the U.S. Government Printing Office by volume number for the prices indicated:

(1) *Volume III.* FAR Part 25, Airworthiness Standards: Transport Category Airplanes, $5.50.

(2) *Volume IV.* FAR Part 27, Airworthiness Standards: Normal Category Rotorcraft; FAR Part 29, Airworthiness Standards: Transport Category Rotorcraft, $3.50.

(3) *Volume VI.* FAR Part 91, General Operating and Flight Rules, $5.50.

(4) *Volume VII.* FAR Part 121, Certification and Operations: Air Carriers and Commercial Operators of Large Aircraft; FAR Part 127, Certification and Operations of Scheduled Air Carriers with Helicopters, $6.50.

(5) *Volume VIII.* FAR Part 135, Air Taxi Operators and Commercial Operators of Small Aircraft, $3.50.

(6) *Volume IX.* FAR Part 61, Certification: Pilots and Flight Instructors, $6.00.

(7) *Volume X.* FAR Part 151, Federal Aid to Airports, $4.50.

(8) *Volume XI.* FAR Part 157, Notice of Construction Alteration, Activation, and Deactivation of Airports, $2.75.

c. The following advisory circulars are also available from the Superintendent of Documents at the prices indicated:

(1) AC 70/7460-1, Obstruction Marking and Lighting, $0.60.

(2) AC 150/5300-4A, Utility Airports, $1.75

(3) AC 150/5320-5A, Airport Drainage, $0.45.

(4) AC 150/5370-1A, Standard Specifications for Construction of Airports, $3.50.

e. The following advisory circulars may be obtained free from the Department of Transportation:

(1) AC 90-45, Approval of Area Navigation Systems for Use in the U.S. National Airspace System.

(2) AC 150/5060-1A, Airport Capacity Criteria Used in Preparing the National Airport Plan.

(3) AC 150/5190-3, Model Airport Zoning Ordinance.

(4) AC 150/5210-6A, Aircraft Fire and Rescue Facilities and Extinguishing Agents.

(5) AC 150/5320-6A, Airport Paving.

(6) AC 150/5340-1C, Marking of Paved Areas on Airports.

(7) AC 150/5340-14B, Economy Approach Lighting Ads.

(8) AC 150/5345-1B, Approved Airport Lighting Equipment.

(9) AC 150/5355-2, Fallout Shelters in Terminal Buildings.

2. TECHNICAL REPORTS.

Copies of the following publications may be obtained at $3.00 per copy from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virgnia 22151:

a. STOL-V/STOL City Center Transport Aircraft Study, October 1964, FAA-ADS-26 (McDonnell), AD 614 585.

b. A Systems Analysis of Short-Haul Air Transportation, Northeast Corridor, August 1965, Massachusetts Institute of Technology, PB-169 521.

c. Study of the Feasibility of V/STOL Concepts for Short-Haul Transport Aircraft, March 1966 (Ling-Temco-Vought, Aeronautics Division), N 14938.

d. Study on the Feasibility of V/STOL Concepts for Short-Haul Transport Aircraft, March 1966 (Boeing-Vertol), N68-35177.

e. Study on the Feasibility of V/STOL Concepts for Short-Haul Transport Aircraft, March 1966 (Lockheed-California), N67-38332.

f. An Analysis of Intercity Passenger Traffic Movement Within the California Corridor Through 1980, April 1966, FAA-ADS-75 (Stanford Research Institute), AD 641 611.

g. Technical and Economic Evaluation of Aircraft for Short-Haul Intercity Transportation, April 1966, FAA-ADS-74 (McDonnell), three volumes: AD 641 506, AD 641 507, and AD 641 508.

h. Study of Aircraft in Short-Haul Transportation Systems, August 1967 (Boeing), N67-38582.

i. Conference on STOL Transport Aircraft Noise Certification, January 1969 (FAA), AD-685-610.

j. Offshore Airports, December 1969 (FAA), two volumes: AD 693 172 and AD 693 185.

k. Noise Exposure Forecast Contour Interpretations of Aircraft Noise Tradeoff Studies, May 1969, FAA NO-69-2 (Bolt Beranek and Newman Inc.), AD 695 507.

l. Noise Exposure Forecasts: Evolution, Evaluation, Extensions, and Land Use Interpretations, August 1970, FAA NO-70-9 (Bolt Beranek and Newman Inc.).

3. OTHER PUBLICATIONS.

The following publications may be obtained from the author as noted:

a. Northeast Corridor VTOL Investigation, Civil Aeronautcs Board (CAB), Docket 19078, Initial Decision of Examiner, E. Robert Seaver, 2 February 1970, and CAB Order 70-9-44, 9 September 1970, Washington, D.C. 20428.

b. The Potential Role of V/STOL Aircraft for Passenger Travel in the New York Region, Rand Corporation, Memorandum RM-5816-PA, August 1969, Rand Corporation, 1700 Main Street, Santa Monica, California 90406.

c. Western Region Short-Haul Air Transportation Study, Definition Phase Report, Volumes 1 and 2, July 1970, Aerospace Corporation, 2350 East El Segundo Boulevard, El Segundo, California 90245.

Appendix 2. STOL AIRCRAFT DATA

List of Manufacturers

1. Lockheed Aircraft Corporation
2. McDonnel-Douglas Corporation
3. North American Rockwell Corporation
4. DeHavilland Aircraft of Canada, Ltd.

Data Item	*Aircraft*
	Manufacturer & Model *Lockheed* LG 100-107 D (Turbo prop)
A. Overall Length (ft.)	106.75
B. Wingspan (ft.)	136.6
C. Overall height (ft.)	40.0
D. Type of gear	Dual tandem
E. Wheelbase (ft.)	40.0
F. Tread (ft.)	15.8
G. Wheel spacing (ft.)	23.2
H. Maximum gross weight (lbs.)	114,073
I. Maximum static gear load (lbs.)	49,500
J. Maximum impact gear load (lbs)	142,500
K. Horizontal braking load (lbs.)	79,000
L. Tire footprint area (sq. in.)	180
M. Turning radius (ft.)	43
N. Number of Engines	4
O. Powerplant (type & hp)	Allison 501 D22A 4291 SHP
P. Number seats (crew & pass.)	5 Crew, 80 Pass
Q. Fuel capacity (lbs.)	13,000
R. Maximum cargo capacity (lbs.)	NA
S. Clearance ground to engine (ft.)	5.75
T. Clearance ground to wingtip (ft.)	15.9

Data Item	*Aircraft*
	Manufacturer & Model *McDonnell Douglas* DA-188F (Turbo prop)
A. Overall length (ft.)	80.67
B. Wingspan (ft.)	78.48
C. Overall height (ft.)	33.16
D. Type of gear	Dual wheel
E. Wheelbase (ft.)	23.67
F. Tread (ft.)	20.0
G. Wheel spacing (ft.)	1.5
H. Maximum gross weight (lbs.)	58,422
I. Maximum static gear load (lbs.)	24,600 (main gear/side), 9,222 (nose gear)
J. Maximum impact gear load (lbs)	58,422 (side, main gear)
K. Horizontal braking load (lbs.)	14,600
L. Tire footprint area (sq. in.)	109
M. Turning radius (ft.)	50.75
N. Number of Engines	4
O. Powerplant (type & hp)	General Electric *CT58-16 SHP1600*
P. Number seats (crew & pass.)	4 Crew, 72 Pass
Q. Fuel capacity (lbs.)	15,820
R. Maximum cargo capacity (lbs.)	NA
S. Clearance ground to engine (ft.)	11.25
T. Clearance ground to wingtip (ft.)	16.92

APPENDIX 2. STOL AIRCRAFT DATA—Continued

Data Item	*Aircraft*
	Manufacturer & Model *North American—Rockwell* NR 260 C (Externally-blown flap)
A. Overall length (ft.)	118.0
B. Wingspan (ft.)	126.5
C. Overall height (ft.)	44.1
D. Type of gear	Dual wheel
E. Wheelbase (ft.)	43.3
F. Tread (ft.)	17.3
G. Wheel spacing (ft.)	2.0
H. Maximum gross weight (lbs.)	140,000
I. Maximum static gear load (lbs.)	62,500
J. Maximum impact gear load (lbs.)	94,000
K. Horizontal braking load (lbs.)	42,000
L. Tire footprint area (sq. in.)	223
M. Turning radius (ft.)	44.0
N. Number of Engines	4
O. Powerplant (type & hp,	Tip-driven turbofans at 21,000 pounds thrust
P. Number seats (crew & pass.)	150 Pass, 6 Crew
Q. Fuel capacity (lbs.)	47,000
R. Maximum cargo capacity (lbs.)	20,000
S. Clearance ground to engine (ft.)	6.9
T. Clearance ground to wingtip (ft.)	17.7

Data Item	*Aircraft*
	Manufacturer & Model *DeHavilland Aircraft of Canada* DHC-7 (Turbo prop)
A. Overall length (ft.)	80.3
B. Wingspan (ft.)	93.0
C. Overall height (ft.)	26.25
D. *Type of gear	Dual wheel
E. Wheelbase (ft.)	28.67
F. Tread (ft.)	23.5
G. Wheel spacing (ft.)	Main Wheels: 16 in. centers Nose Wheels: 14.5 in. centers
H. Maximum gross weight (lbs.)	38,500
I. Maximum static gear load (lbs.)	Main Gear: 18,250 per gear Nose Gear: 3,000
J. Maximum impact gear load (lbs)	Main Gear: 36,500 per gear Nose Gear: 12,000
K. Horizontal braking load (lbs.)	Main Gear: 9,125 per gear
L. Tire footprint area (sq. in.)	Main Wheel: 30X10.-00-12, 96 sq. in. per tire Nose Wheel: 6.50-10, 20 sq. in. per tire
M. Turning radius (ft.)	64
N. Number of Engines	4
O. Powerplant (type & hp)	Pratt & Whitney PT6A-50, 1035 SHP
P. Number seats (crew & pass.)	4 Crew, 48 Pass
Q. Fuel capacity (lbs.)	10,000
R. Maximum cargo capacity (lbs.)	12,000 (all cargo)
S. Clearance ground to engine (ft.)	10.75
T. Clearance ground to wingtip (ft.)	13.25

Appendix 3. RUNWAY LENGTH DETERMINATION FOR ELEVATED STOL PORTS

1. GENERAL.

This appendix discusses the parameters which affect runway length determination, as applied to STOL ports. It is intended that a common understanding of "STOL runway length" and how it is derived will be established for an elevated STOL port.

2. TERMS. (For purposes of this discussion.)

a. *Runway Threshold.* A marked and usually lighted line used to indicate the beginning of the area designated for landing of aircraft.

b. *Runway Length.* The distance between the runway thresholds.

c. *Runway.* The pavement or structure which is designated for aircraft landing or takeoff or both.

d. *Takeoff Distance, Landing Distance, and Accelerate-Stop Distance.* These terms vary according to the appropriate airworthiness regulations; i.e., FAR Parts 23 and 25, and the Tentative Airworthiness Standards for Powered Lift Transport Category Aircraft.

3. ASSUMED CONDITIONS.

To provide a common starting point, certain factors must be assumed. These factors include temperature, elevation, wind, and runway gradient.

a. *Temperature.* A normal maximum temperature of 90°F is assumed. This is considered to represent a reasonable maximum for the hottest month at most locations where STOL operations may be initiated.

b. *Elevation.* An airport elevation of sea level is assumed. Further, it is assumed that pressure-altitude is equivalent to the airport elevation for any given locale.

c. *Wind.* The bidirectional runway concept is utilized which means that theoretically no tailwind will be encountered, since runway use would change with change in wind direction. Accordingly, it is assumed that there is zero wind.

d. *Runway Gradient.* Runway gradient is normally referred to as runway slope. For all practical purposes, it is equal to the difference in runway end elevations divided by the length of runway. An uphill slope normally increases the length of runway required for takeoff. For purposes of this discussion, the gradient is assumed to be zero. However, due to the length of a STOL runway and the recommended maximum longitudinal gradient, runway length correction for gradient would be negligible in most cases.

4. AIRCRAFT WEIGHT.

Increasing an aircraft's weight increases its runway length requirements. However, it is not logical to assume that each aircraft will be operated at its maximum gross (structural) weight for either landing or takeoff. Accordingly, the aircraft weight selected should be the weight required to accomplish its design mission. For example, the desgn mission may be a 350 mile route. In order to compute the runway length requirement, the aircraft landing and takeoff weight for the mission would be used.

5. RUNWAY LENGTH DETERMINATION—ELEVATED STOL PORT.

a. *General.* The development of an elevated STOL port may be required in some metropolitan areas due to the scarcity of sites and overall financial feasibility. Such a facility will be unique in many ways, particularly for new aircraft procedures. Accordingly, a process for arriving at landing or takeoff runway lengths is given. It should be noted that this process could be applied equally well to surface (at-grade) STOL ports.

b. *Landing.* The landing threshold is located 100 feet inboard from the edge of the building. The touchdown marking begins 30 feet from the threshold. The VASI-2 and the microwave ILS are sited so that landings will coincide with the beginning of the touchdown marking. The optimum approach angle for the microwave ILS is assumed to be 7.5 degrees. For stopping, the distance from the touchdown to the opposite end of the structure is available. In effect, the entire structure minus 100 feet is used for calculating the landing length. Figure 15 shows a plan view of the landing area configuration. The space between the landing threshold and the building edge is part of the runway safety area and in this case is equivalent to a displaced threshold area. The markings are so configured to insure that there are no significant undershoots. Note the locations of the VASI-2 units.

c. *Takeoff.* As in the landing case, maximum use is made of the structure length available. One assumption is that no portion of the aircraft may extend out over the edge of the building while it is maneuvering for takeoff. Therefore, in computing takeoff runway requirements, the very maximum length available is the length of the structure minus the length designated for aircraft positioning which is 100 feet. Specific takeoff distances and accelerate-stop distances will be determined by appropriate airworthiness standards. Takeoff runway length needed will be dictated by the operations rules based upon the airworthiness data (minimum runway length equal to the takeoff distance or accelerate-stop distance, whichever is longer).

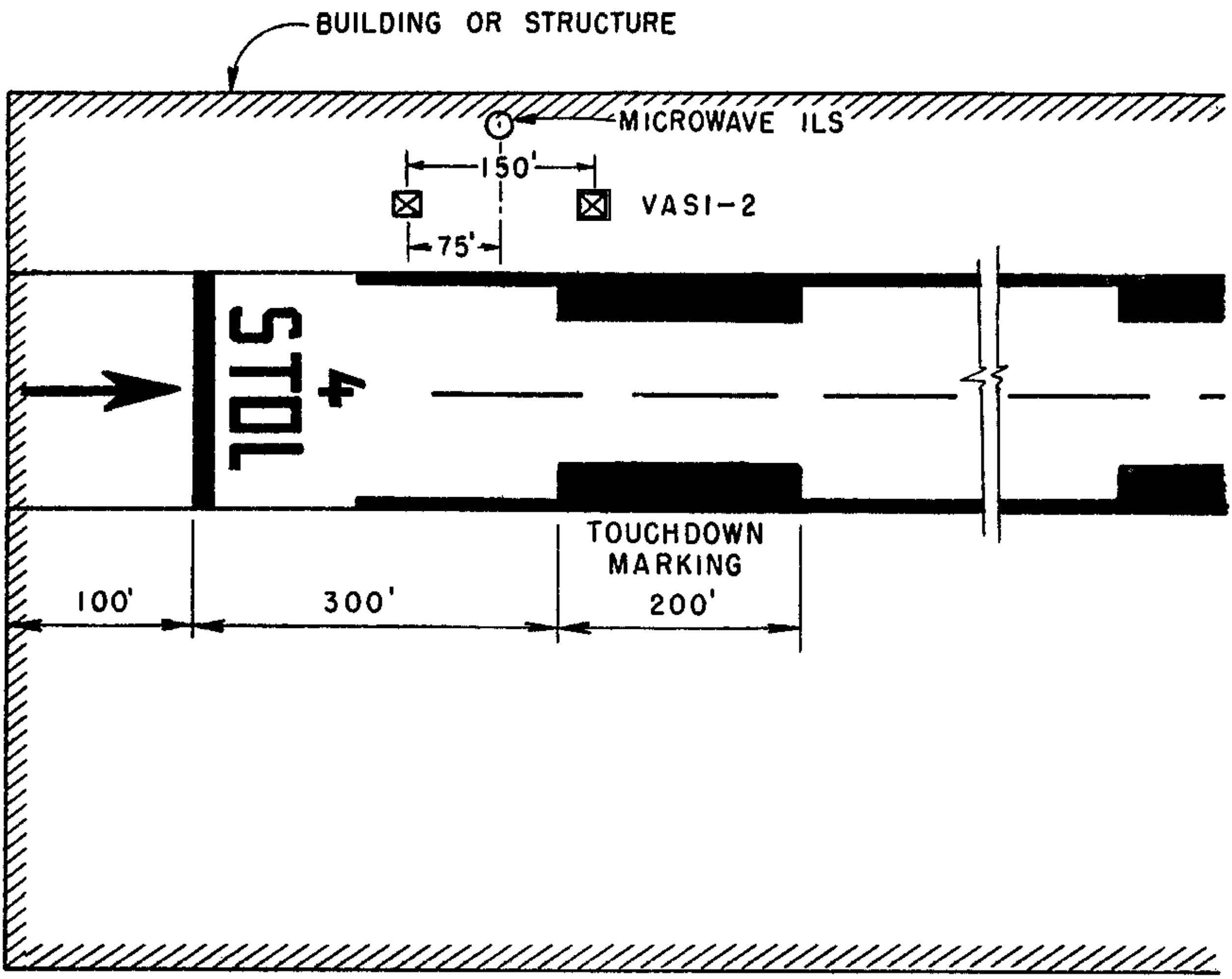


FIGURE 15. Configuration of Elevated STOL Part

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