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AC NO: 150/5300-2C
DATE: September 21, 1973

ADVISORY CIRCULAR

AIRPORT DESIGN STANDARDS

SITE REQUIREMENTS FOR TERMINAL NAVIGATIONAL FACILITIES

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AAS-560

AC NO: 150/5300-2C

DATE: 9/21/73

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIRPORT DESIGN STANDARDS - SITE REQUIREMENTS FOR TERMINAL NAVIGATIONAL FACILITIES

1. PURPOSE. This advisory circular provides airport owners and designers with a general overview of the siting requirements for those air navigational aids and air traffic control facilities located on or in close proximity to an airport. It IS NOT intended that this advisory circular be used to select, design, install, or operate a specific air navigational aid or air traffic control facility.

2. CANCELLATION. Advisory Circular 150/5300-2B, Airport Design Standards - Site Requirements for Terminal Navigational Facilities, dated November 22, 1971, is cancelled.

3. BACKGROUND. Our national reliance upon air transportation (commercial and business fleet, or private aircraft) to move people and high priority cargo is firmly established. To insure dependable operations, the Federal Government installs and operates a system of air navigational aids (NAVAID) and air traffic control (ATC) facilities. Airport owners and designers need to be cognizant of siting requirements of those NAVAID/ATC facilities located on or in close proximity to an airport. This advisory circular provides that overview by extracting and combining siting information on NAVAID/ATC facilities from a number of Federal Aviation Administration (FAA) technical publications not circulated to the public. It is recommended that persons requiring specific guidance pertaining to the selection, design, installation, or operation of a particular NAVAID/ATC facility, contact the appropriate FAA regional office. Technical references are cited in the text and/or Bibliography (Appendix 2).

4. EXPLANATION OF CHANGES. In addition to the editorial changes made to clarify material; to correct dimensional errors or omissions; or to recognize changes in program titles and references, the following technical changes have been made:

   a. All text and drawing dimensions are followed by a metric counterpart. To the extent possible, metric units are those of the International

Civil Aviation Organization (ICAO). In those instances where there were no ICAO values obtainable, an approximate metric conversion was made.

b. The chapter on electronic instrument landing system (ILS) requirements has been revised to reflect FAA preferences in equipment types.

c. The chapter on approach light systems (ALS) has been revised to reflect current length criteria and configurations.

d. The chapter on visual approach slope indicators (VASI) has been revised to reflect current FAA criteria.

5. HOW TO OBTAIN THIS PUBLICATION. Additional copies of this circular, AC 150/5300-2C, Airport Design Standards - Site Requirements for Terminal Navigational Facilities, may be obtained from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

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CHAPTER 1. TERMINAL NAVIGATIONAL AIDS AND AIR TRAFFIC CONTROL FACILITIES

1. GENERAL. This advisory circular describes in general terms the land area, grading requirements, and operational clearances desired for the air navigational aids (NAVAID) and air traffic control (ATC) facilities depicted on Figure 1-1. This advisory circular is issued to alert airport owners and designers to the siting requirements of those NAVAID/ATC facilities located on or in close proximity to the airport. The design, siting, and installation of NAVAID/ATC facilities is a highly complex operation requiring the services of many specialists. Therefore, it is suggested that the airport owner or designer contemplating the installation of a particular NAVAID/ATC facility contact the appropriate FAA regional office for technical guidance. This advisory circular does not cover siting of NAVAIDS used exclusively at heliports or STOL ports nor does it attempt to explain the mechanisms for deciding which NAVAID or ATC facility is to be installed at any airport.

2. CRITERIA SOURCES. The siting criteria contained in this advisory circular have been extracted from a number of FAA technical publications dealing with the establishment of specific terminal navigational aids or air traffic control facilities. These sources are identified in the text and/or are listed in the Bibliography (Appendix 2).

3. METRIC UNITS. To promote an orderly transition to metric units, the text and drawings include both English and metric dimensions. To the extent possible, the metric dimension is the dimensional value promulgated by the International Civil Aviation Organization for the equivalent airport design feature and therefore may not be an exact metric conversion of the English unit. Until an official change over to metric units is effected, the English dimensions shall govern.

4. TERMINAL NAVIGATIONAL AIDS (NAVAIDS). Terminal NAVAIDS are considered to be those facilities and/or equipment installed on or near the airport for the express purpose of providing pilots with electronic guidance and/or visual references to use in executing an approach to land at the airport.

5. AIR TRAFFIC CONTROL (ATC) FACILITIES. The ATC facilities are considered to be those facilities and/or equipment installed on an airport for the express purpose of controlling aircraft operations.

6. AIRCRAFT OPERATIONS. Aircraft operations as used in this advisory circular refer to the established procedures and/or weather conditions under which aircraft may operate.

a. Visual Flight Rule (VFR) Conditions. Weather conditions are at least as good as those prescribed for flight under the visual flight rules specified in Federal Aviation Regulations (FAR) Part 91.

b. Instrument Flight Rule (IFR) Conditions. Weather conditions are below the minimums for flight under visual flight rules.

7. RUNWAYS. A runway is a designated, and usually improved, area on the ground used for the landing and takeoff of aircraft. In the interest of safety, regularity, and efficiency of aircraft operations, runways are marked, in accordance with guidance found in AC 150/5340-1, as a:

a. Basic Runway. Runway markings are those considered necessary to accommodate operations under VFR and circle-to-land instrument procedures.

b. Nonprecision Instrument Runway. Runway markings are those considered necessary to accommodate straight-in nonprecision instrument approaches.

c. Precision Instrument Runway. Runway markings are those considered necessary to accommodate precision instrument approaches.

8. INSTRUMENT APPROACH PROCEDURES. An instrument approach procedure is one that is prescribed and approved for a specific airport by competent authority. United States instrument approach procedures for civil airports are approved by the FAA as prescribed by FAR Part 97. Advisory Circular 90-1 provides additional information on the use of published instrument approach procedure charts. For the purposes of this circular, instrument approaches are identified as:

a. Nonprecision Instrument Approaches. These approaches utilize NAVAIDS that provide course (alignment) guidance and position location information only.

b. Precision Instrument Approaches. These approaches utilize NAVAIDS that provide electronic descent guidance in addition to the course and location guidance of the nonprecision instrument landing system installation.

9. INSTRUMENT LANDING SYSTEM (ILS) CATEGORIES. The ILS's are categorized as:

a. ILS Category I (CAT I). An instrument approach procedure which provides for approaches to a decision height (DH) of not less than 200 feet (60 m.) and visibility of not less than 1/2 mile (.8 km.) or RVR 2400. With operative touchdown zone and runway centerline lights, the runway visual range (RVR) may be reduced to 1800.

b. ILS Category II (CAT II). An instrument approach procedure which provides for approaches to minima of less than DH 200 feet (60 m.)/RVR 2400 to as low as DH 100 feet (30 m.)/RVR 1200.

c. ILS Category IIIa (CAT IIIa). An instrument approach procedure which provides for approaches with no DH limitation, down to and along the surface of the runway with external visual reference during the final phase of the landing and with RVR not less than a value on the order of 700 feet (210 m.).

10. DECISION HEIGHT (DH). With respect to the operation of aircraft, the DH means the height at which a decision must be made during an ILS approach to either continue the approach or to execute a missed approach. This height is expressed in feet above mean sea level.

11. MINIMUM DESCENT ALTITUDE (MDA). The MDA means the lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach where no electronic glide slope is provided or during circle-to-land maneuvering in execution of a standard instrument approach procedure.

12. AIRCRAFT APPROACH CATEGORIES. Aircraft approach categories are a means of grouping aircraft based on speed and weight. The speed used is 1.3 times the aircraft's stalling speed in landing configuration at the aircraft's maximum certificated landing weight. The weight is the maximum certificated landing weight. Both of these values are established by the certificating authority of the country of registry. These categories are utilized in establishing operational limitations in instrument approach procedures. Figure 1-2 illustrates the categories and identifies representative aircraft. (References FAR Part 97 and AC 90-1.)

13. FAA ESTABLISHMENT PROGRAM. The FAA, through its Facilities and Equipment (F&E) Program, installs, operates, and maintains a number of terminal navigational aids and air traffic control facilities. Qualification standards for FAA funded terminal NAVAIDS and ATC facilities may be found in FAA Order 7031.2A.

14. AIRPORT DEVELOPMENT AID PROGRAM (ADAP) ASSISTANCE. In accordance with and subject to the requirements and criteria set forth in FAR Part 152, ADAP financial assistance may be made available to eligible airport sponsors (1) to cover some of the costs of site acquisition and development and (2) for the installation of NAVAIDS designated in FAR Part 152. The appropriate FAA regional office or Airports District Office should be contacted for specific information regarding possible ADAP assistance.

15. PLANNING GRANT PROGRAM (PGP). In accordance with and subject to the requirements and criteria set forth in FAR Part 152, PGP financial assistance may be made available to eligible airport sponsors and planning agencies for the preparation of airport master and airport system plans which include consideration of terminal navigational

facilities needs and siting. Information on the PGP is found in Advisory Circular 150/5900-1. The appropriate FAA regional office should be contacted for specific information regarding possible PGP assistance.

16. PLANNING TERMINAL NAVAIDS AND AIR TRAFFIC CONTROL FACILITIES. It is advisable that airport owners properly anticipate a future need to accommodate IFR operations at the airport or to enhance their IFR capability by the lowering of existing operational minima. Therefore, it is recommended that the airport owner prepare or revise the airport layout plan to accurately depict both existing and planned airport improvements and the different proposed land uses. The airport layout plan should be reviewed by the FAA for potential conflicts/interference with terminal NAVAIDS and air traffic control facilities.

a. Significant Features. Airport design features that could possibly affect NAVAID performance or air traffic control facility siting include:

(1) Airside Features. The location, configuration, and spacing of existing or proposed runway, taxiways, and aprons.

(2) Landside Features. The location, size, and type of construction of existing or proposed above ground structures such as terminal buildings, hangars, liquid storage tanks, overhead powerlines, metallic fences, etc.

(3) Ground Features. The location and size/extent of such ground features as drainage ditches, earth embankments, borrow pits, or similar earthwork.

b. Construction Notice Required. In order for the FAA to review and advise airport owners of the probable adverse effect of a proposed improvement or development on terminal NAVAIDS or air traffic control facilities, the FAA requires that it be notified of any proposed construction/development on or in the vicinity of an existing or proposed public use airport in accordance with the following FAR's:

(1) FAR Part 77. The FAA is to be notified of any proposed construction or alteration that is:

(a) Over 200 feet (60 m.) in height above the ground.

(b) Exceeds an imaginary surface of the following slope and within a specified horizontal distance of the nearest point of the nearest runway.

1 Runways Over 3,200 Feet (960 m.). The slope is 100 to 1 (horizontal to vertical) and the horizontal distance is 20,000 feet (6,000 m.).

2 Runways No More Than 3,200 feet (960 m.). The slope is 50 to 1 (horizontal to vertical) and the horizontal distance is 10,000 feet (3,000 m.).

(c) On an airport that is open to public use and is listed in the Airport Directory Section of the Airman's Information Manual or similar publication.

(2) FAR Part 157. The FAA is to be notified of the construction, alteration, activation, and deactivation of any airport.

17. NONFEDERALLY OWNED NAVAIDS. The FAA's policies regarding nonfederally owned NAVAIDS may be found in FAR Part 171 which explains the information needed with the request for an IFR procedure; the minimum requirements for approval; and the performance, installation, maintenance, and operational requirements that apply.

18. FLIGHT EVALUATION OF NAVAID SITES. In some cases, it is necessary to perform a flight evaluation of a particular site before final approval can be given for the installation of the NAVAID. Flight evaluations are done by installing a portable NAVAID test unit at the proposed site and flight checking the facility to determine electromagnetic performance, adequacy of signal coverage, and any possible interference sources. Flight evaluation of test installations is usually limited to the NAVAID's electronic components associated with precision or nonprecision instrument landing systems. Visual NAVAIDS are normally flight checked after the installation is completed.

19. RESERVED.

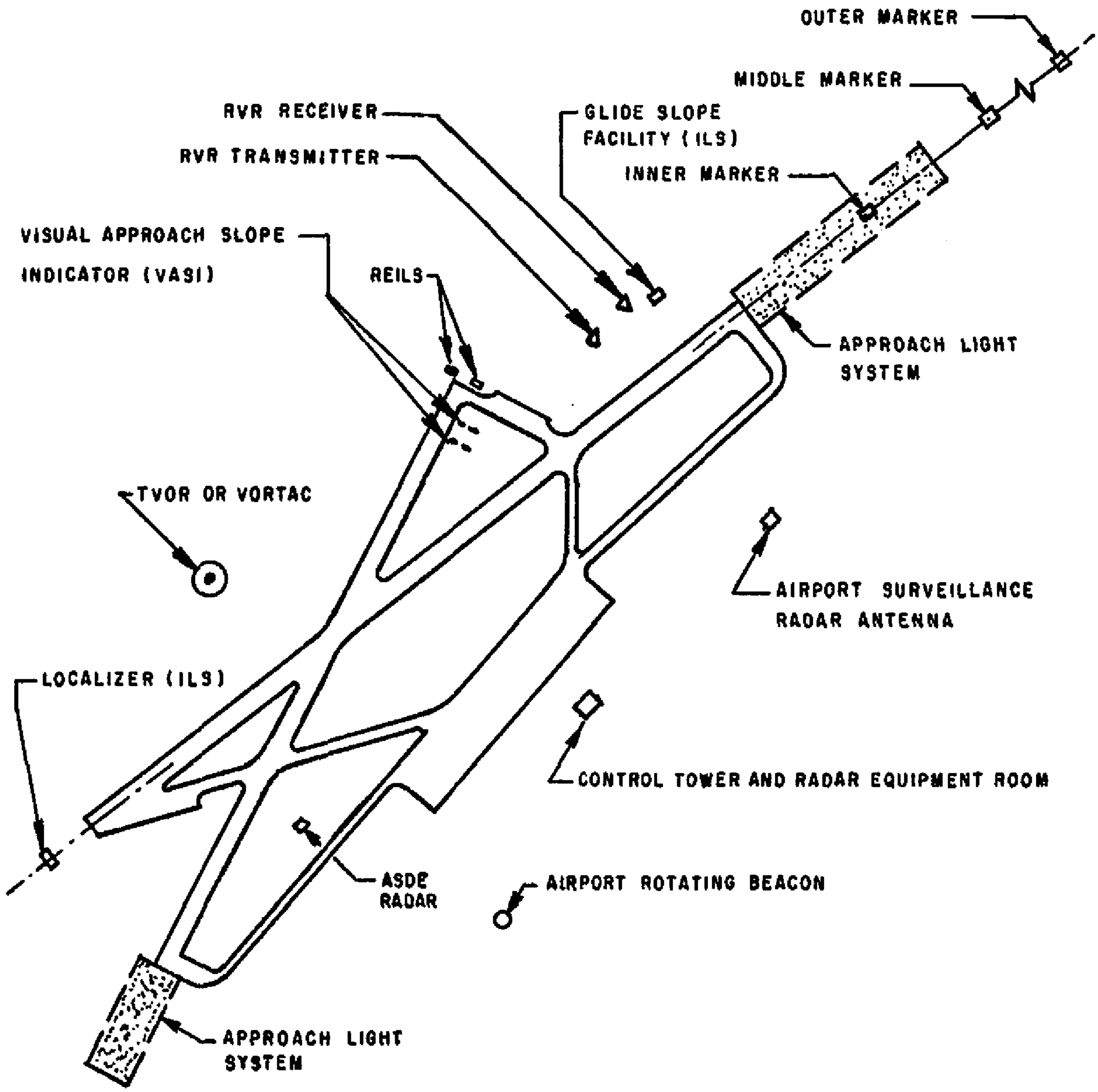


FIGURE 1-1. AIRPORT LOCATION OF NAVIGATIONAL AIDS AND AIR TRAFFIC CONTROL FACILITIES

Approach Category	Speed in Knots	Maximum Landing Weight in Pounds (Kilograms)	Representative Aircraft
A	Less than 91	Less than 30,001 (13,609 kg.)	Single engine Light Twins Aero Commander 680F Beech Queenair 65 Cessna 310 Douglas DC-3
B	91 or more, but less than 121	30,001 (13,609 kg.) or more but less than 60,001 (27,217kg.)	Beech 80, 66-90 Turbo, and Super 18 Cessna 411 Convair 340 and 580 Fairchild F-27 Grand Commander
C	121 or more, but less than 141	60,001 (27,217 kg.) or more but less than 150,001 (68,041 kg.)	Boeing 727-100 and 737 Douglas DC-4, 6, 7, and 9 Jet Commander Gates Learjet 23, 24, and 25 Lockheed 649-1,049, Jetstar, and 188
D	141 or more, but less than 166	150,001 (68,041 kg.) or more	Boeing 707, 720, 727-200, and 747 Convair 880 and 990 Douglas DC-8 and 10 Lockheed L-1011
E	166 or more	Any weight	At this time, there are no civil aircraft in this category.

If any aircraft falls into two categories based on approach speed or landing weight, place it in the higher category. For instance, the Gates Learjet 25 with a maximum landing weight of 13,300 pounds (6,033 kg.) has an approach speed in the 121-140 knot range, so it is included in the "C" category.

FIGURE 1-2. REPRESENTATIVE CIVIL AIRCRAFT APPROACH CATEGORIES

CHAPTER 2. NAVIGATIONAL AIDS FOR PRECISION INSTRUMENT APPROACHES

20. GENERAL. A precision instrument approach procedure to a runway is predicated on the availability of electronic alignment and descent guidance to assist a pilot flying a properly equipped aircraft in landing under conditions of reduced ceiling and lowered visibility. The nation's need for reliable air service is such that the FAA ultimately envisions the establishment of a precision instrument approach procedure at all airports with scheduled air carrier service and at certain airports providing service to general aviation users exclusively. The precision approach procedure is based upon an assemblage of electronic navigational aids and visual aids. This chapter describes the significant siting requirements of the ILS electronic guidance system and its impact upon the design of an airport. Subsequent chapters cover nonprecision electronic approach aids, visual aids, and air traffic control facilities. Design information for ILS electronic guidance systems is found in FAA Order 6750.16.

21. ILS ELECTRONIC GUIDANCE SYSTEMS. The ILS consists of several subsystems that provide a specific piece of the information/guidance needed by the pilot to affect the approach.

   a. Alignment Guidance. The signal used to align the aircraft on the approach path is radiated by the ILS localizer facility. The preferred localizer site is on the extended centerline of the runway beyond the stop end.

   b. Descent Guidance. The signal used to control the descent path is radiated by the ILS glide slope facility. The glide slope facility is located to one side and a short distance down the runway from the landing threshold.

   c. Location Information. The ILS marker beacons are used to inform pilots that they are at a significant point in the approach course. An outer marker (OM) is located at the point where the aircraft should intercept the glide slope signal. A middle marker (MM) is located at the point where an aircraft reaches the decision height (DH) of a CAT I approach. An inner marker (IM) may be installed to indicate the DH of a CAT II approach. In those instances where it is physically or economically impractical to install marker beacons, distance measuring equipment (DME) provides pilots of properly equipped aircraft with a continuous readout of the distance remaining to the ILS touchdown point.

   d. ILS Adjuncts. While they are not considered a specific part of the standard ILS facility, compass locators may be installed at the outer marker site. Compass locators broadcast a low-powered, limited range, nondirectional signal to aid pilots in finding the ILS localizer course.

e. ILS Categories. The ILS installations are designated as CAT I, II, or III facilities in accordance with the minimum visibility conditions in which aircraft are authorized to land. Unless noted otherwise, the criteria contained in this chapter applies to all ILS operational categories.

22. IMPORTANCE OF SITING. The ability of each ILS subsystem to provide a reliable signal depends upon the proper formation of the radiation pattern and the absence of natural or manmade features/objects that cause signal aberrations. Detecting and curing ILS signal problems can be a difficult trial and error process. The more suspect causes of signal interference are: uneven terrain, metal buildings or structures, overhead powerlines, metal fences, dense vegetation, ground vegetation, ground vehicles, and parked or taxiing aircraft. While these problem sources cannot be completely eliminated or avoided, every effort should be made in the original planning of the airport to minimize their potentially adverse effect upon NAVAID operations.

a. ILS Critical Areas. An operationally critical area has been established for the ILS localizer and glide slope facilities. While their location and size usually precludes any permanent "problem" object from being constructed therein, adequate measures should be taken to insure that the area is protected from unlimited and uncontrolled surface traffic movement especially while the facility is in use. It should be noted that the described critical areas are minimal areas that are to be cleared and that signal interference causes may well exist beyond these tracts.

(1) Localizer Critical Area. The localizer critical area is illustrated in Figure 2-1. It is a "keyhole" shaped tract formed by imposing a circle onto a rectangular area. The circle is centered on the antenna array and has a radius of 250 feet (75 m.). The rectangular area begins at the antenna and has a length of 1,000 feet (300 m.) in the direction of the runway. Its width is 400 feet (120 m.) centered on the localizer course line, usually the runway centerline extended.

(2) Glide Slope Critical Area. The glide slope critical area is illustrated in Figure 2-2. It is a rectangular tract beginning at the glide slope antenna and is 1,000 feet (300 m.) in length in the direction of the approaching aircraft. Its width is variable beginning at the near edge of the runway pavement and extending 175 feet (52.5 m.) beyond the glide slope antenna location. A larger rectangular area also associated with the glide slope should be kept clear of parked aircraft. The dimensions of this "no parking" area are also illustrated on Figure 2-2.

b. Jet Blast Protection. In addition to the obvious health hazards to maintenance technicians, prolonged exposure to jet engine exhaust fumes causes a residual buildup to occur on the surfaces of the radiating and monitoring antennas affecting their efficiency. Buildup can be minimized by designing the airport so that no jet aircraft will run-up with its exhaust directed toward an ILS NAVAID unless that aid is at least 300 feet (90 m.) distant.

23. ILS LOCALIZER FACILITIES. The components of the ILS localizer facility are the antenna array with its supporting structure, the transmitting equipment shelter, and the monitor field detectors. The location of the antenna array substantially fixes the location of the equipment shelter and field detectors.

a. Antenna Types. Upon completion of the installation of the presently procured ILS's, the V-ring antenna (Figure 2-3) will not be utilized for future localizer installations. The traveling wave antenna (Figure 2-4) will be procured for all new ILS localizer installations. Location, grading, and clearance requirements are essentially similar for both V-ring and traveling wave antenna systems.

b. Location. The localizer antenna array is symmetrically positioned about the extended runway centerline or the localizer approach azimuth for the "offset" configuration covered in paragraph 25.

(1) Preferred Location. The preferred location of the localizer antenna array is at a distance of 1,000 feet (300 m.) from the stop end of the ILS runway for all ILS categories. See Figure 2-5. The 1,000-foot (300 m.) location is necessary in all instances where an extended runway safety area is required.

(2) Minimal Location. To meet unusual site problems, the antenna array for a CAT I facility may be located no closer than 300 feet (90 m.) from the stop end of the ILS runway. For a CAT II or III facility, the minimal distance is 600 feet (180 m.)

(3) Maximum Location. The maximum distance from the stop end of the ILS runway is 2,000 feet (600 m.) for all facility categories. However, exceptions may be approved on a case-by-case basis if significant operational advantages accrue or if a runway extension is definitely being programmed.

c. Elevation. A ground mounted antenna array is usually adequate. In some instances, it may be necessary to elevate the antenna array to provide the desired signal coverage. The maximum height of the antenna array above the immediate terrain is limited to 35 feet (10.6 m.).

(1) FAR Part 77 Limits. Regardless of the type of antenna used or its distance from the stop end of the runway, the antenna should not penetrate the approach surface as defined in FAR Part 77.

(2) Line-of-Sight. The localizer antenna array shall be mounted so that there will be a clear line-of-sight between the antennas and an aircraft at the appropriate threshold crossing height. Threshold crossing heights are as specified in paragraph 24b(1).

d. Grading. Site grading requirements will depend upon the type of localizer antenna used.

(1) V-Ring or Traveling Wave Antenna. Generally, grading is limited to that required to eliminate signal interference sources in areas A and B as shown on the plan view of Figure 2-5.

(2) Other Antennas. Specific grading requirements for other antenna types should be requested of the appropriate FAA regional office on a case-by-case basis.

(3) Extended Runway Safety Area. An extended runway safety area must be developed at new airports for any runway intended to accommodate air carrier operations of transport category airplanes. Extended runway safety areas are encouraged on any runway accommodating air carrier operations in conjunction with a runway or clear zone improvement/development project. Figure 2-6 illustrates site grading requirements for a localizer installed at the desired 1,000-foot (300 m.) distance. The plus 1 percent slope is necessary to comply with FAR Part 77 requirements. The minus 3-1/2 percent slope is necessary to keep the antenna supporting structure at a reasonable height.

e. Offset Localizer. At some locations, it may be economically unfeasible to site the localizer antenna array on the extended runway centerline. In such cases, the localizer array may be offset (Figure 2-7) so that the azimuth course does not lie on the runway centerline but rather intercepts the centerline at a point determined by the amount of angular offset, the glide path angle, and the decision height. The maximum localizer offset angle is 3.0 degrees. The ILS middle and outer markers are located on the localizer course line. Site clearing and grading requirements are similar to the conventional localizer installation. An offset localizer installation is not acceptable for CAT II or III ILS operations.

24. ILS GLIDE SLOPE FACILITIES. The components of the ILS glide slope facility are the antenna mast, transmitting equipment shelter, and the monitor field detectors. The location of the antenna substantially fixes the location of the equipment shelter and field detectors. Figure 2-8 is a photograph of a typical ILS glide slope facility.

a. Glide Slope Types. The null reference system, which uses the earth in front of the antenna to form the signal, is the basic glide slope system installed by the FAA. The sideband reference and capture effect alterations of the null reference system are installed in difficult site situations. Figure 2-9 summarizes the applicability of the various ILS glide slope systems to typical site conditions.

b. Location. Figure 2-10 illustrates ILS glide slope location criteria.

(1) Longitudinal. The glide slope facility is located to provide a threshold crossing height of:

(a) 37 feet (11.3 m.) to 60 feet (18 m.) inclusive at airports without Category "D" turbojet aircraft operations or programmed operations.

(b) 47 feet (14.3 m.) to 60 feet (18 m.) inclusive at airports with Category "D" turbojet aircraft operations or programmed operations, or at runways 7,000 feet (2,100 m.) long or longer.

(2) Lateral. The glide slope facility is situated about a line that is parallel to the runway centerline and at a distance of 250 feet (75 m.) to 650 feet (195 m.). It is suggested that the glide slope be located on that side of the runway which will result in the least conflict with existing runway/taxiway/apron operations and with least possibility of electronic reflections.

(3) Caution. The ILS glide slope criteria are under constant review and subject to periodic revision to keep abreast of more demanding performance requirements, operational needs of aircraft operators, and growth of airport traffic. Therefore, it is recommended that the appropriate FAA regional office be consulted early in the ILS planning stages.

c. Obstacle Clearance. As a minimum, areas A, B, and C of Figure 2-10 should be cleared of all above ground objects or possible sources of interference which may reflect glide slope signals.

d. Grading Requirements. Transverse grading requirements are shown on Figure 2-11. Conformance to these standards will generally provide for a satisfactory glide slope installation. It should be noted that these requirements represent a compromise between theoretical requirements and practical economic considerations. If terrain irregularities in front of the proposed facility are extremely severe and the cost of meeting these tolerances is not feasible, one of the other glide slope systems should be considered. See Figure 2-9.

e. Special Considerations. Departure from the optimum siting conditions cited in this chapter may be necessary to provide the required obstruction clearance criteria as specified in the United States Standard for Terminal Instrument Procedures (TERPS). The preferred glide slope angle of 3 degrees may need to be adjusted and/or the facility relocated longitudinally to meet obstruction clearance criteria at a particular airport site. The FAA's flight procedures specialists and ILS installation engineers should be consulted for siting guidance.

f. Antenna Height. The height of the glide slope antenna mast is tailored to place the antenna in proper position. Generally, the total mast height for the glide slope systems, allowing an additional 2 feet (.6 m.) for obstruction lights, is as follows:

(1) Null Reference System. Mast height varies from 24 feet (7.2 m.) to 40 feet (12 m.).

(2) Capture Effect System. Mast height varies from 38 feet (11.6 m.) to 60 feet (18 m.).

(3) Sideband Reference System. Mast height varies from 18 feet (5.5 m.) to 32 feet (9.7 m.).

25. ILS MARKER BEACONS (OM, MM, IM). An ILS marker beacon is installed to mark specific points in the ILS approach path (paragraph 21c). The ILS marker beacon location criteria is summarized in Figure 2-12. All future FAA procurements of ILS marker beacons will provide for the electronic equipment to be housed in a portable shelter approximately 6 feet (2 m.) by 6 feet (2 m.) with the antennas mounted on an adjacent folding mast located on the extended runway centerline. The antenna will have an overall height of approximately 26 feet (8 m.). A 20-foot (6 m.) by 20-foot (6 m.) site is suggested. The FAA regional office should be contacted for detailed siting information.

26. COMPASS LOCATOR (COMLO). A COMLO, an auxiliary aid to the ILS, is a nondirectional radio beacon collocated with the ILS outer marker (OM) beacon. Future COMLO installations will consist of a self-supporting antenna not over 65 feet (19.5 m.) in height. The electronic components will be installed in the OM shelter. The COMLO facility will require a buried counterpoise with a field diameter of approximately 100 feet (30 m.).

27. DISTANCE MEASURING EQUIPMENT (DME). Although the DME is not considered an integral component of the ILS, it may be used in conjunction with the ILS to provide equipped aircraft with position information. When used, the DME is located at the localizer site. The DME may be used in lieu of the outer marker beacon when site conditions prevent the installation of an outer marker beacon; i.e., an approach over water.

28.-29. RESERVED.

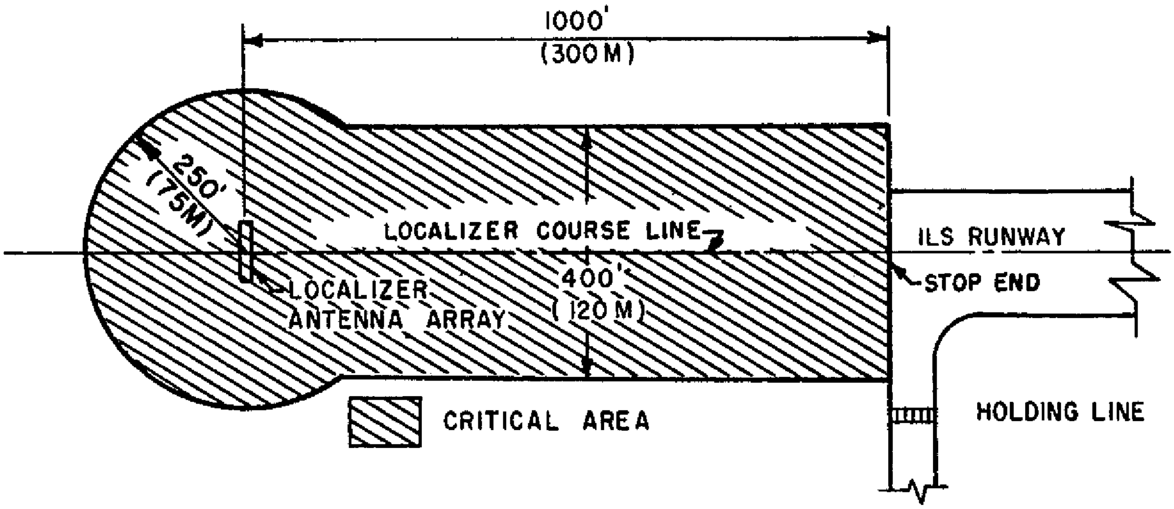


FIGURE 2-1. LOCALIZER CRITICAL AREA

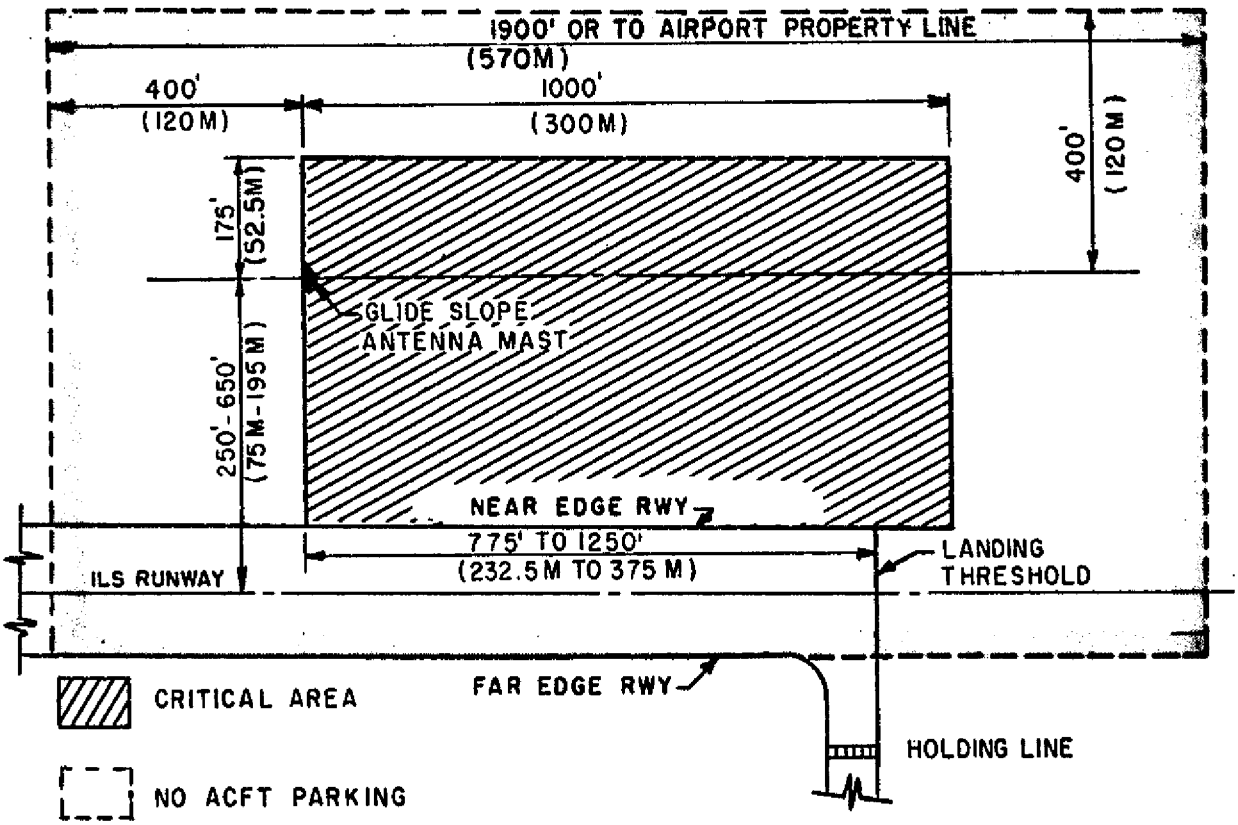


FIGURE 2-2. GLIDE SLOPE CRITICAL AREA

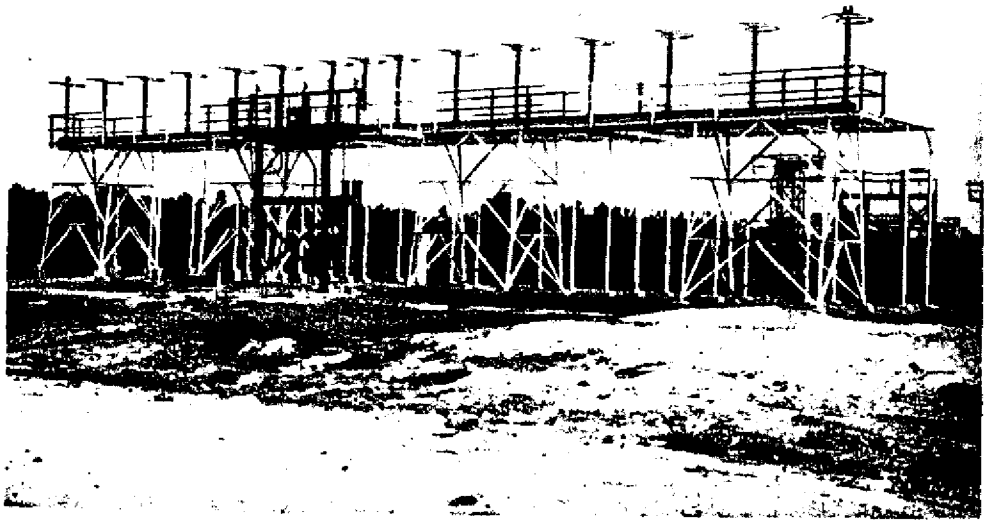


FIGURE 2-3. V-RING LOCALIZER ANTENNA

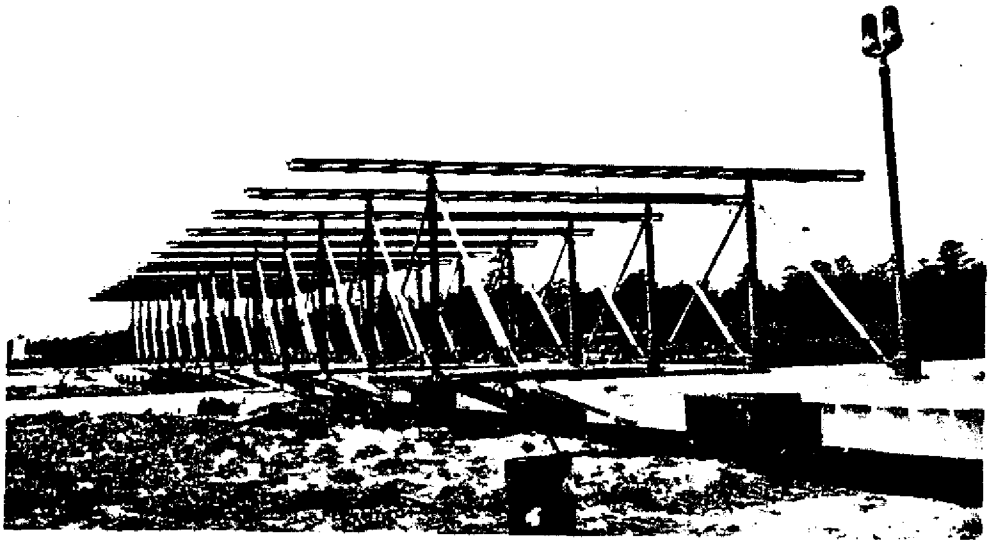
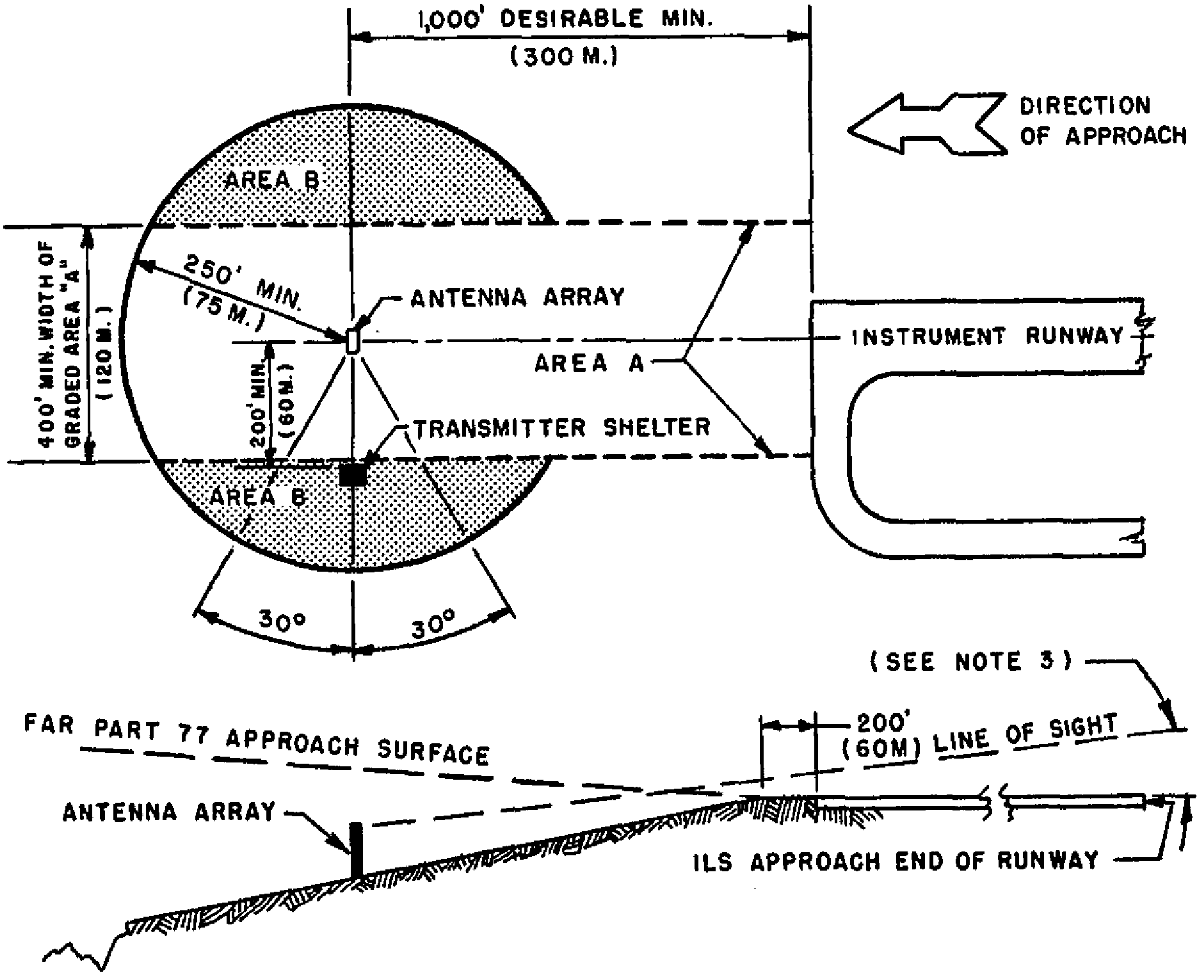


FIGURE 2-4. TRAVELING WAVE LOCALIZER ANTENNA



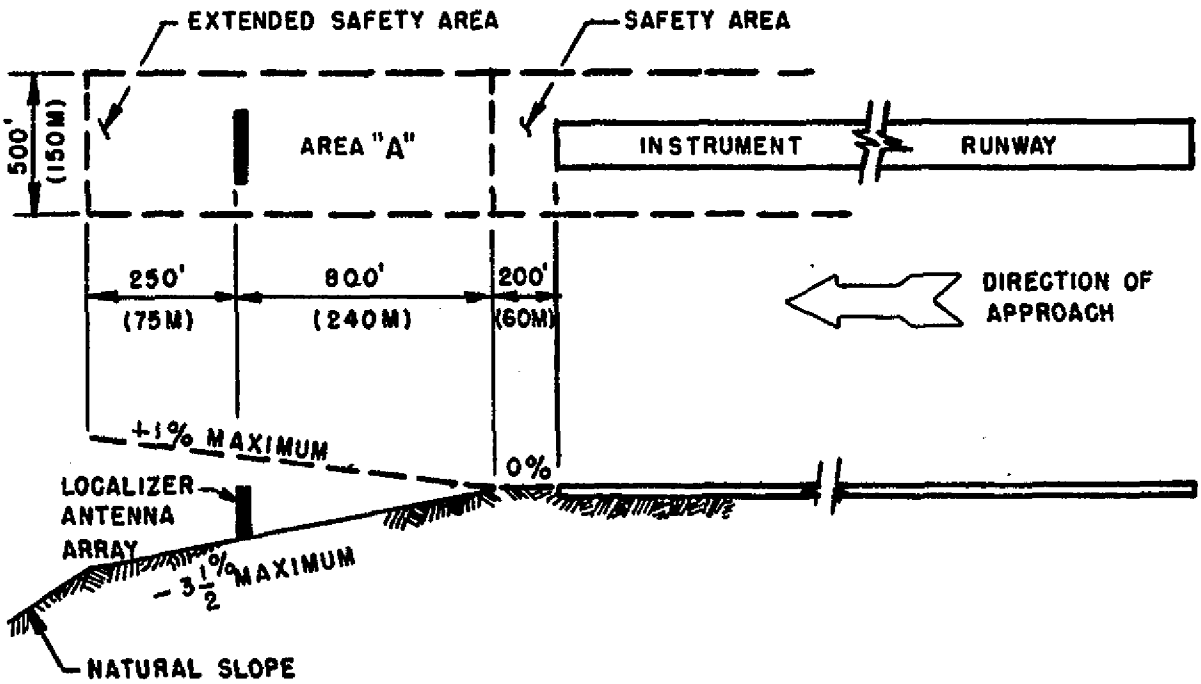
NOTES:

1. Areas A and B (plan view) are to be clear of buildings, roads, metal fences, overhead powerlines, etc.

2. Grade areas A and B (profile view) to remove terrain irregularities causing signal aberrations. Refer to Figure 2-6 for grading requirements on an extended runway safety area.

3. Locate antenna to clear FAR Part 77 approach surface and to provide an unobstructed line-of-sight to an aircraft at the appropriate threshold crossing height. (See paragraph 24b(1).)

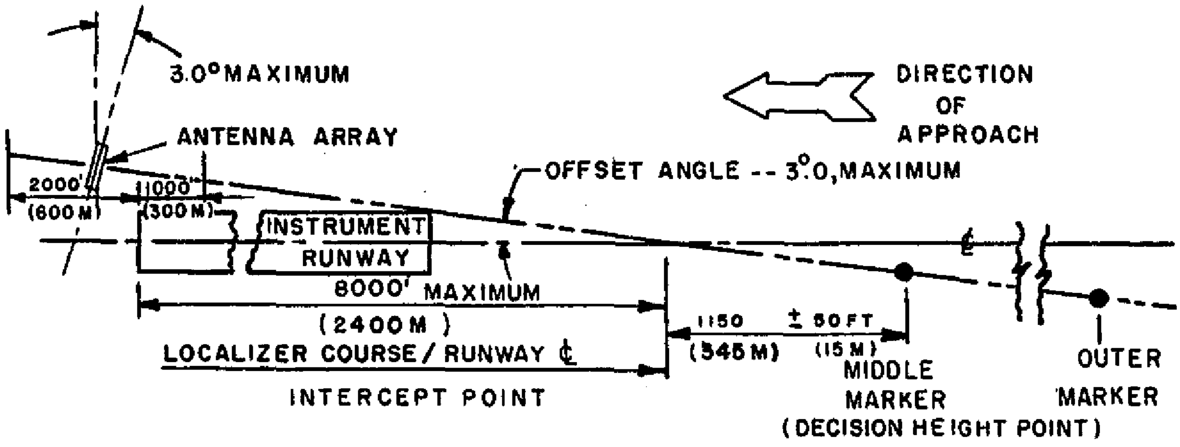
FIGURE 2-5. SITING REQUIREMENTS FOR ILS LOCALIZER



NOTES:

1. Keep area A free of objects which cause localizer interference such as trees, buildings, roads, metal fences, and overhead utility lines.
2. Grade area A uniformly and provide smooth transitions to adjacent areas.
3. Grade area A transversely within plus 3 percent to minus 5 percent maximum.

FIGURE 2-6. LOCALIZER GRADING IN EXTENDED RUNWAY SAFETY AREA



NOTES:

1. Middle and outer markers to be installed along offset localizer course.

2. Localizer antenna array may be located from 1,000 feet (300 m.) short to 2,000 feet (600 m.) beyond runway end.

3. No element of the localizer antenna array may be within 250 feet (75 m.) of the runway centerline.

4. No element of the localizer antenna array shall penetrate a 10:1 surface originating at the elevation of the runway centerline nearest the facility.

5. No element of the localizer antenna array shall be located within the applicable taxiway safety area.

6. The localizer antenna array shall be sited to provide both vertical and horizontal clearance to aircraft taxiing on the adjacent taxiway.

FIGURE 2-7. OFFSET LOCALIZER CONFIGURATION

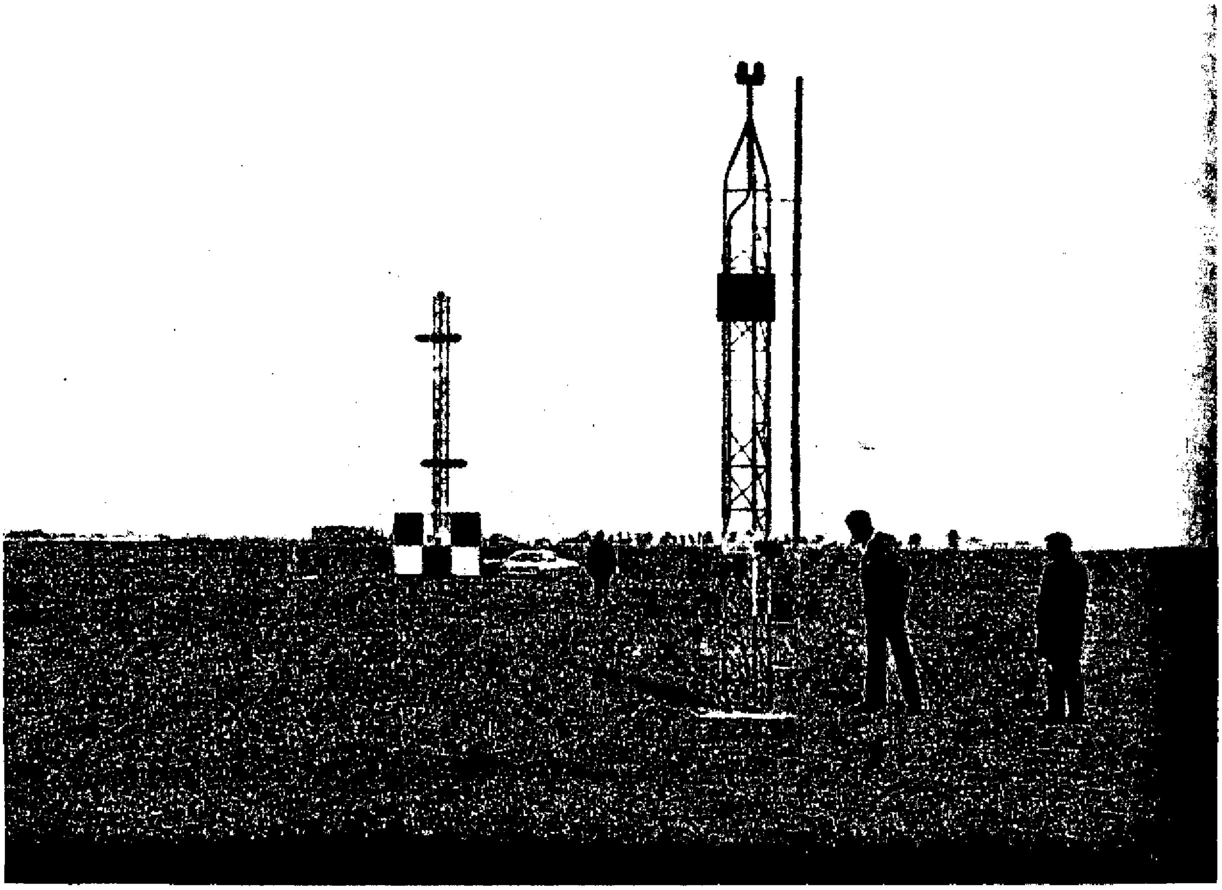
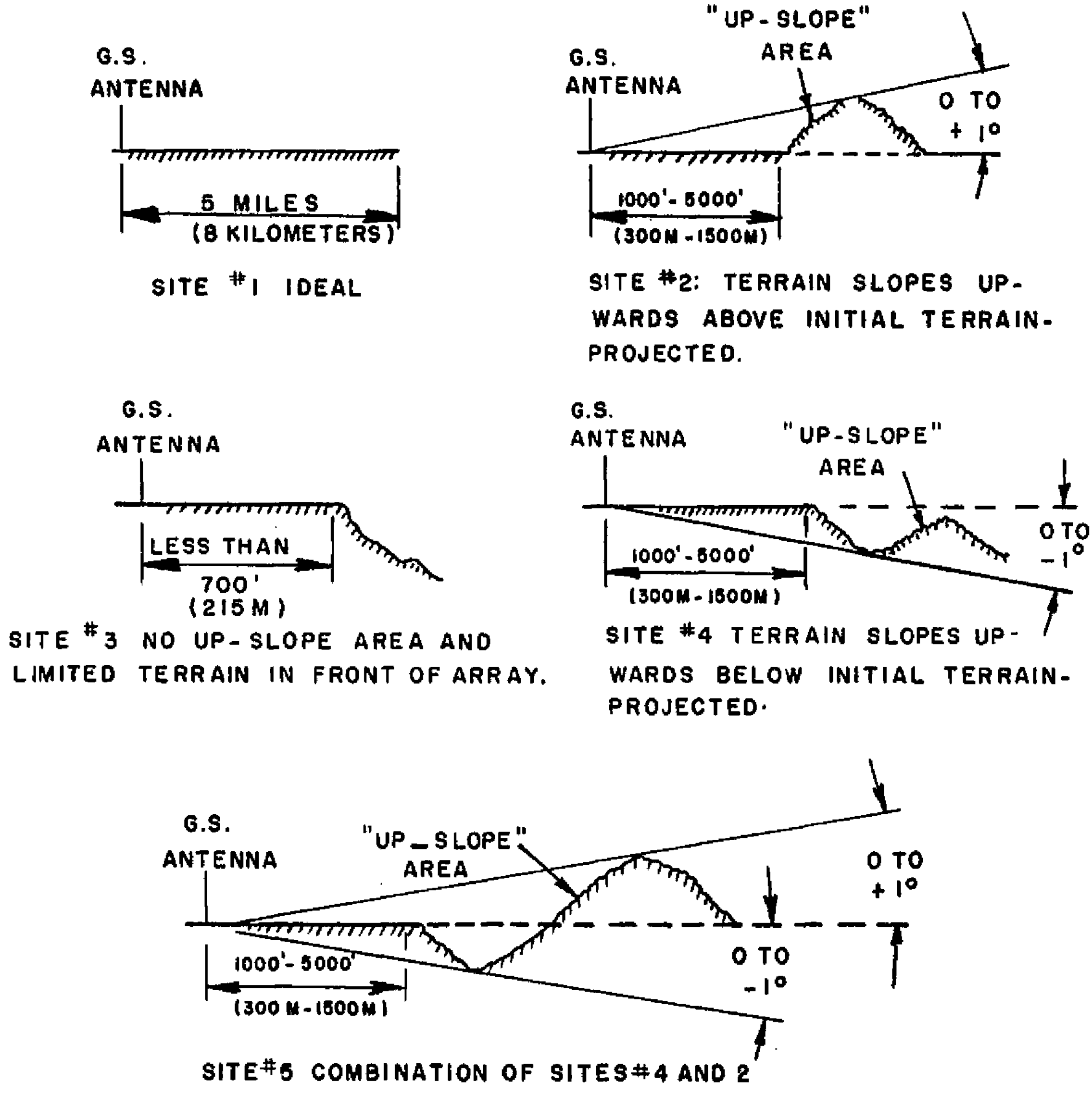
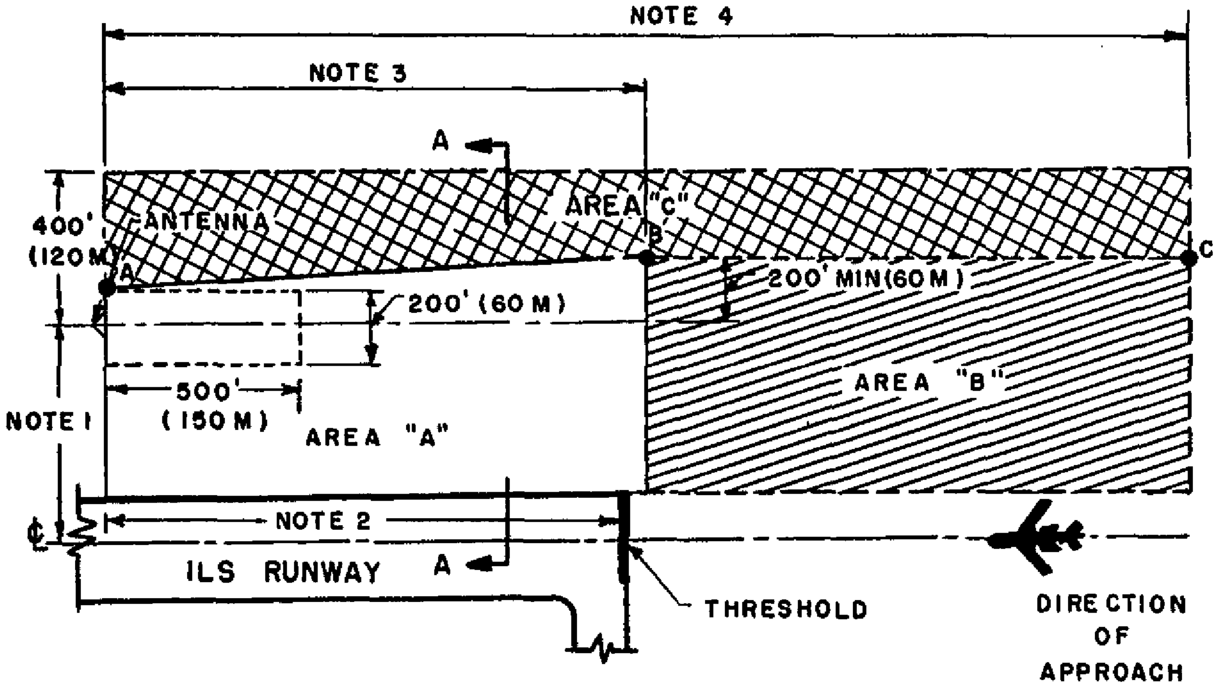


FIGURE 2-8. TYPICAL ILS GLIDE SLOPE FACILITY INCLUDING PATH MONITOR TOWER



APPROXIMATE PERCENT OF TOTAL SITES	SITE #1 5%	SITE #2 20%	SITE #3 15%	SITE #4 15%	SITE #5 45%
NULL REFERENCE	ALL	VERY FEW	NONE	FEW	VERY FEW
SIDE BAND REFERENCE	ALL	FEW	VERY FEW	MANY	FEW
CAPTURE EFFECT	ALL	MOST	NONE	MOST	MOST

FIGURE 2-9. MATCHING GLIDE SLOPE SYSTEMS TO SITE CONDITIONS



NOTES:

1. Locate glide slope facility on that side of the runway which is most free of surface traffic or interference sources at a distance of 250 feet (75 m.) to 650 feet (195 m.) for ILS CAT I or from 400 feet (120 m.) to 650 feet (195 m.) for ILS CAT II or III.

2. Longitudinal location is determined by glide slope operational requirements.

3. Length of area A is the greater of:

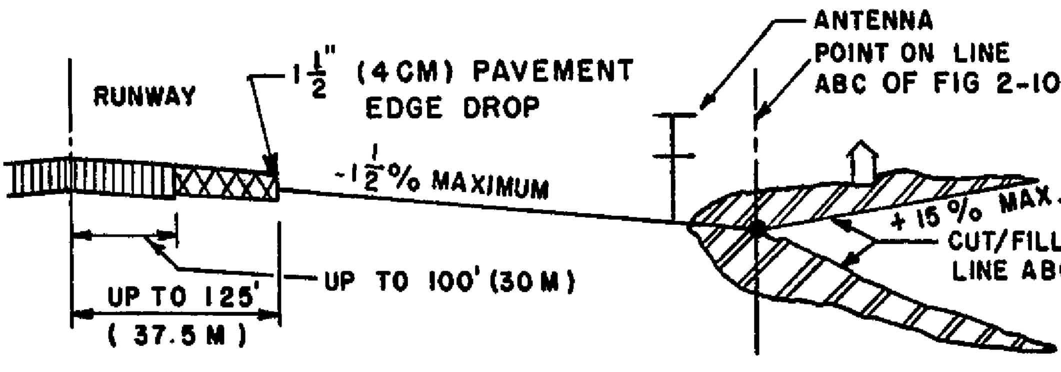
   a. 1,000 feet (300 m.); or
   b. To the end of the runway safety area.

4. Length of area A plus B or C shall be the least of:

   a. 3,000 feet (900 m.);
   b. Distance to end of airport property; or
   c. Distance to feasible limits of electronically smooth terrain.

5. All interference sources (metal buildings, fences, etc.) shall be removed from areas A, B, and C.

FIGURE 2-10. ILS GLIDE SLOPE SITING CRITERIA



TRANSVERSE SECTION A-A

NOTES:

1. Area A of Figure 2-10 shall be uniformly graded. The longitudinal grade is that of the runway centerline. The transverse grade is that depicted above.

   a. The 500-foot (150 m.) by 200-foot (60 m.) monitor field shall be protected from extensive vegetation growth and shall be graded to assure drainage.
   b. Finished grades of area A shall not exceed design grades by more than ± 1/10-foot (4 cm.).

2. Area B of Figure 2-10 shall be graded to remove severe irregularities in the terrain as specified by the FAA.

3. Area C of Figure 2-10 shall be graded to eliminate signal interference sources. Slope of cut sections may not exceed the 15 percent limitation but may be further restricted by application of the transitional surface criteria of FAR Part 77.

4. When required, drainage ditches adequate to handle the expected runoff shall be located beyond line ABC.

FIGURE 2-11. ILS GLIDE SLOPE GRADING DETAILS

Type	Function	Nominal Location	Location Tolerances
Outer Marker (OM)	Marks intercept point of glide slope and minimum holding altitude	The intercept point, located 4 to 7 miles (6-11 km.) from the threshold	± 800 feet (240 m.) laterally and longitudinally
Middle Marker (MM)	Marks decision height point for CAT I ILS operations	The decision height point, approximately 3,500 feet (1,050 m.) from threshold	± 300 feet (90 m.) laterally; ± 500 feet (150 m.) longitudinally
Inner Marker	Marks decision height point for CAT II ILS operations	The decision height point, where glide slope elevation is 100 feet (30 m.) above touchdown zone elevation (Note 1)	± 25 feet (7.5 m.) laterally and longitudinally; can penetrate the approach light plane but not the FAR Part 77 approach surface

NOTES:

1. Touchdown zone is first 3,000 feet (900 m.) of runway.
2. Radar (ASR) and DME may be used as a substitute for the outer marker (OM) under certain circumstances.

FIGURE 2-12. ILS MARKER BEACON CRITERIA

CHAPTER 3. NAVIGATIONAL AIDS FOR NONPRECISION INSTRUMENT APPROACHES

30. GENERAL. A nonprecision instrument approach procedure utilizes electronic alignment and position location information. Pilots flying a nonprecision approach are guided to a point in space where they must establish visual contact with the runway or airport to accomplish the landing. This chapter describes the significant siting aspects of nonprecision NAVAIDS located on or in close proximity to the airport.

31. VERY HIGH FREQUENCY OMNIRANGE (VOR). The VOR, the standard navigational aid used throughout the airway system to provide azimuth information, may be used for the development of a nonprecision instrument approach procedure. When the VOR is located on or in close proximity to the airport for the purpose of establishing a nonprecision procedure or to otherwise enhance the existing IFR capabilities of the airport, it is referred to as a terminal VOR (TVOR). An FAA Flight Procedures Specialist should be consulted to obtain the best TVOR location.

a. On Airport TVOR Sites. The preferred on airport TVOR facility is sited so that one of the transmitted course radials provides alignment guidance to the approach end of the runway(s). Airports with intersecting runways are encouraged to locate the TVOR at a site that is adjacent to the intersection. However, TVOR facilities should be located at least 500 feet (150 m.) from a runway centerline and 250 (75 m.) from a taxiway centerline.

b. Off Airport TVOR Sites. The preferred off airport TVOR facility is sited on the extended runway centerline anywhere from 1,200 feet (360 m.) to 7 miles (11 km.) off the runway end. When a centerline site is not available, every effort should be made to select a site that will meet TERPS' operational criteria for a straight-in approach to a runway. Ideally, the off airport TVOR facility would be located on the highest ground in the vicinity and would have no signal interference objects within 3,000 feet (900 m.) of the antenna. The minimum desired tract for the off airport facility is a rectangular plot, 70 feet (21 m.) by 80 feet (24 m.).

32. TERRAIN CONSIDERATIONS. Terrain adjacent to the TVOR facility should be generally uniform without such major irregularities as ravines, ditches, embankments, rock outcroppings, etc. When present, these irregularities should not exceed a height or depth variation measured from the average ground line that is more than one percent of the distance to the antenna. It is desirable that a level area be provided with a minimum radius around the antenna of 150 feet (45 m.). Beyond this area, a downward slope not to exceed four percent is desired. Figure 3-1 illustrates these criteria. The graded TVOR area may be treated with a soil sterilant and covered with a minimum of 3 inches (8 cm.) of crushed stone or gravel to minimize future grounds maintenance problems.

33. OBSTACLE CLEARANCES. Broad reflective surfaces of airport terminal buildings, hangars, and other structures may cause interference problems with the TVOR signal, particularly if the structure is located within 750 feet (225 m.) of the antenna. Metal fencing (chain link, wire mesh, wire strand) should be at least 500 feet (150 m.) from the antenna and overhead lines (power, telephone, etc.) should be at least 1,200 feet (360 m.) from the antenna to minimize signal interference. Natural objects (trees) should be removed if they are within 1,000 feet (300 m.) of the antenna; however, an isolated tree less than 30 feet (9 m.) in height may be tolerated provided it is at least 500 feet (150 m.) from the antenna. Trees or structures located beyond the specified distances should not violate the pertinent angular clearance planes which are measured from the antenna elevation or the elevation of the ground at the antenna site. Figure 3-1 depicts terrain and obstacle clearance requirements.

34. DISTANCE MEASURING EQUIPMENT. When distance to the facility information is needed together with azimuth guidance to develop an approach procedure, distance measuring equipment (DME) is added to the VOR facility. In some instances, the DME may be that of the military's Tactical Air Navigational (TACAN) system. The installation is then referred to as a VORTAC. The siting requirements for either the VOR/DME or VORTAC, when located on the airport, are generally similar to those for the TVOR. Figure 3-2 is a photograph of a typical VORTAC installation.

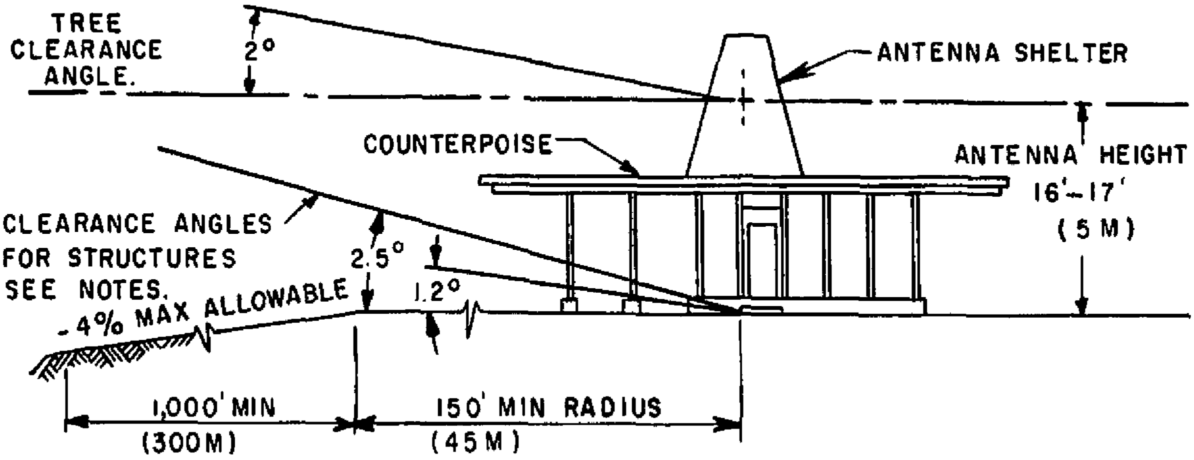
35. DOPPLER VOR. The Doppler VOR utilizes an antenna system which is designed to obtain improved electronic performance at locations where a conventional VOR/TVOR has site problems. Generally, the siting criteria for the conventional VOR apply to the Doppler VOR; however, a larger land area is required since the Doppler VOR counterpoise has a 150-foot (45 m.) diameter whereas the conventional VOR counterpoise is but 52 feet (16 m.) in diameter. Figure 3-3 is a photograph of a typical Doppler VOR installation.

36. LOCALIZER TYPE DIRECTIONAL AID (LTDA). An LTDA facility is a localizer installation whose course alignment exceeds the 3-degree limitation of the offset localizer described in Chapter 2. An LTDA may be established when an existing VOR facility can be used to affect the transition from an enroute to the localizer course. Site requirements for the localizer and marker beacon of the LTDA facility are identical to those for the ILS localizer and outer marker beacon described in Chapter 2.

37. NONDIRECTIONAL RADIO BEACON (NDB). The NDB is no longer an FAA funded NAVAID except when installed as a compass locator in an ILS. (See Chapter 2.) A commercially obtained NDB is occasionally installed by an airport owner or fixed-base operator to transmit a nondirectional

signal on which a pilot may "home" using automatic direction finder (ADF) equipment installed in the aircraft. The commercial NDB facility antenna may consist of a wire strung between two poles spaced approximately 250 feet (75 m.) apart or a whip antenna mounted on the building or a convenient pole. Antenna installation instructions for a commercially obtained NDB is provided by the equipment manufacturer or supplier.

38.-39. RESERVED.



NOTES:

1. A graded, level, and circular pad with a minimum radius of 150 feet (45 m.) is recommended.

2. Beyond the 150-foot (45 m.) pad, a downward slope not exceeding four percent may be tolerated in the next 1,000 feet (300 m.). Contours in this downslope area should be circular around the antenna.

3. Trees are not desired within 1,000 feet (300 m.) of the antenna. Beyond 1,000 feet (300 m.), trees should not exceed a vertical angle of more than two degrees as measured from the top of the antenna.

4. Above ground structures are not permitted within 750 feet (230 m.) of the antenna. Beyond 750 feet (230 m.), metal structures should not exceed a vertical angle of 1.2 degrees as measured from the base of the antenna. The angle for wooden structures is 2.5 degrees.

FIGURE 3-1. TVOR TERRAIN AND OBSTACLE REQUIREMENTS

FIGURE 3-2. TYPICAL VORTAC FACILITY

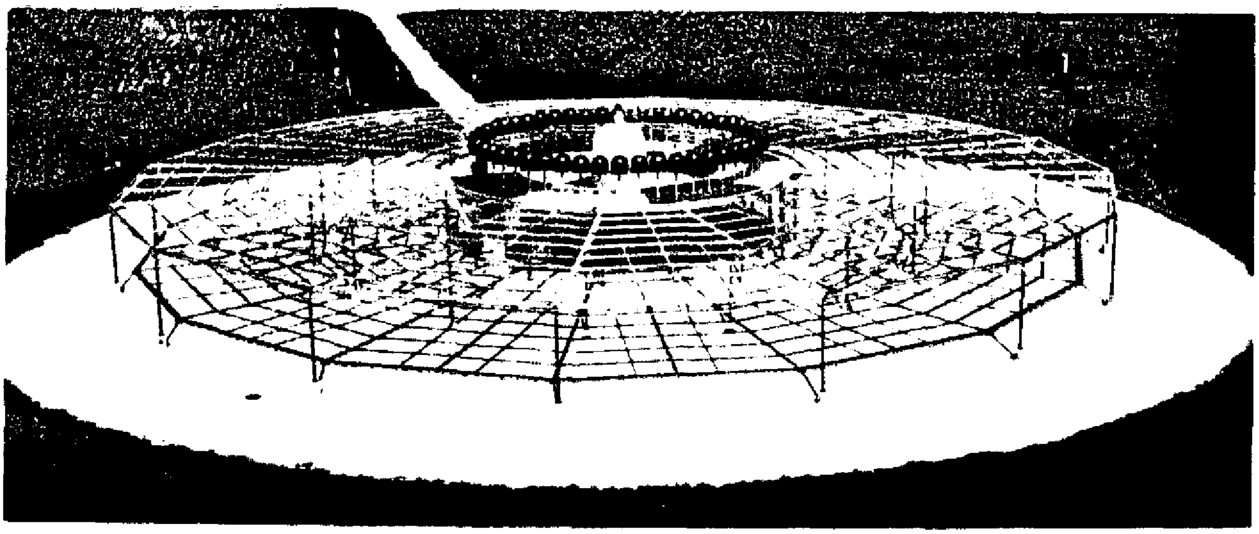


FIGURE 3-3. TYPICAL DOPPLER VOR FACILITY

CHAPTER 4. APPROACH LIGHT SYSTEMS

40. GENERAL. An approach light system (ALS) is a configuration of signal lights symmetrically placed about the extended runway centerline starting at the landing threshold and extending outward into the approach zone. The ALS installations are adjuncts of the electronic NAVAIDS in IFR precision and nonprecision approaches. They also serve as visual guides for night landing operations during VFR visibility conditions. The ALS is intended to provide the pilot with visual clues on runway alignment, roll guidance, and horizon reference during the critical moments prior to touchdown. This chapter covers the significant aspects of the ALS installations that have an impact upon airport design.

41. ALS CONFIGURATIONS. Design information for the ALS configurations depicted in Figure 4-1 is found in FAA Order 6850.2. The following paragraphs emphasize those details of ALS siting criteria of significance to the airport designer.

42. HIGH INTENSITY APPROACH LIGHT SYSTEMS. The FAA utilizes the following high intensity ALS's:

a. ALSF-2 Installations. The ALSF-2 is a 3,000-foot (900 m.) long high intensity ALS with sequenced flashers. It is the international and United States standard ALS configuration for CAT II ILS operations.

b. ALSF-1 Installations. A 2,400-foot (720 m.) long high intensity ALS with sequenced flashers is specified for CAT I ILS's with glide slope angles of 2.75 degrees or higher. A 3,000-foot (900 m.) length is required for ILS glide slope angles lower than 2.75 degrees. The 3,000-foot (900 m.) system is required on certain runways at United States airports having international operations (see Appendix 1).

43. MEDIUM INTENSITY APPROACH LIGHT SYSTEMS. The FAA utilizes the following medium intensity ALS's:

a. MALSR. The MALSR is a medium intensity ALS with runway alignment indicator lights (RAIL). It is the United States standard ALS configuration for ILS operations during CAT I visibility minima. A 2,400-foot (720 m.) length is specified for approaches with an ILS glide slope angle of 2.75 degrees or higher. A 3,000-foot (900 m.) length is specified for approaches with an ILS glide slope angle lower than 2.75 degrees.

b. MALSF. The MALSF is a 1,400-foot (420 m.) medium intensity ALS with sequenced flashers. It is used in nonprecision approaches. The sequenced flashers added to the three outer ALS light bars aid in pilot identification.

c. MALS. The MALS is a 1,400-foot (420 m.) medium intensity ALS. The MALS configuration is not depicted in Figure 4-1 since it is identical to that of the MALSF configuration sans the flashing lights.

44. LAND REQUIREMENTS. The FAA recommended minimum land requirements for the cited ALS installations are listed below. The length of the ALS tract is measured from the landing threshold with the tract located symmetrically about the extended runway centerline.

a. ALSF-2 and 3,000-Foot (900 m.) ALSF-1. These ALS installations require a tract 3,200 feet (960 m.) in length by 400 feet (120 m.) in width.

b. 2,400-Foot (720 m.) ALSF-1. These ALS installations require a tract 2,600 feet (780 m.) in length by 400 feet (120 m.) in width.

c. MALSR, MALSF, MALS. A tract 1,600 feet (480 m.) in length by 400 feet (120 m.) in width is required for the MALSF and MALS and for the MALS portion of the MALSR installation. The RAIL portion of the MALSR requires an additional tract 1,000 feet (300 m.) in length by 25 feet (7.5 m.) in width when the ILS glide slope angle is 2.75 degrees or higher; and a tract 1,600 feet (480 m.) in length by 25 feet (7.5 m.) in width when the ILS glide slope angle is lower than 2.75 degrees. The 25-foot (7.5 m.) width is considered adequate in flat open terrain. A width up to 100 feet (30 m.) may be required for the RAIL portion of the installation to meet specific visibility, accessibility, or other conditions.

45. PREFERRED INSTALLATION. The preferred ALS installation is accomplished when the ALS adheres to the following conditions (Figure 4-2 depicts these conditions):

a. Approach Light Plane. The approach light plane is an imaginary horizontal plane passing through the beam center and extending 200 feet (60 m.) beyond all steady burning lights in the system. It also extends 200 feet (60 m.) beyond the last flashing light of any existing or planned RAIL system.

b. Obstacle Clearances. No object may protrude above the approach light plane. For airport design purposes, apply the following criteria:

(1) Roads, Railroads, Etc. All roads, railroads, etc., are to be considered vertical solid objects and vertical clearance dimensions are applied in accordance with Subpart C of FAR Part 77.

(2) Airport Service Roads. Where airport vehicular traffic is controlled in some manner to preclude blocking the pilot's view of the approach lights, the roadway is not considered to be a vertical solid object.

c. Clear Line-of-Sight. A clear line-of-sight is required to all lights of the system from any point on an imaginary surface located 1/2 degree below the ILS glide path. For nonprecision ILS approaches, assume a 3-degree glide path intersecting the runway 1,000 feet (300 m.) from the landing threshold. The imaginary surface is 500 feet (150 m.) wide and 1,600 feet (480 m.) in length. It begins at the outermost light in the ALS and extends outward into the approach path.

46. PERMISSIBLE DEVIATIONS. The ideal ALS installation described in paragraph 45 may not be obtainable for a number of valid reasons. While this paragraph describes permissible deviation, it is recommended that FAA regional offices be contacted for technical advice as to the probable effect of each proposed deviation.

a. Approach Light Plane.

(1) Horizontal Plane Not Available. When a horizontal light plane is not practical due to terrain or solid objects within its area, the plane may be raised provided it is deemed more economical than removing, lowering, or displacing the interfering object(s). The light plane may also be lowered when sharply descending terrain makes it economically desirable to do so.

(a) Slope Gradient. The slope gradient of the light plane shall be kept as small as possible not exceeding a plus 2 percent or a minus 1 percent from the horizontal.

(b) Slope Starting Point. The sloping segment shall not start within 200 feet (60 m.) of the landing threshold.

(c) ALSF-2, ALSF-1 Systems. Only one sloping segment is permitted in a system with the segment containing at least three light bars. The slope may continue to the end of the system or may revert to a horizontal segment of at least four light bars. A negative slope is not permitted within 1,500 feet (450 m.) of the landing threshold for ALSF-2 installations.

(d) MALSR, MALSF, MALS Systems. A sloping segment shall contain at least three light bars. Only one positive sloping segment is permitted in a system. The sloping segment may begin at the first light bar and extend to the end of the system or may be preceded by a horizontal segment or followed by either a horizontal or negative sloping segment.

(2) RAIL Portion of MALSR. Economic considerations dictate that the flashing (RAIL) lights be installed to follow the terrain contours. However, no light of the RAIL may penetrate a 2 percent positive slope line which starts at the elevation of the last steady burning light bar of the system. In following the terrain contour, it is recommended that each sequence flasher of the RAIL system be within 8 feet (2.4 m.) of the height of the light (steady burning or flashing) next closer to the runway.

(3) Object Protuberance.

(a) Elevated Lights. The elevated threshold bar and approach lights located within 200 feet (60 m.) of the landing threshold are considered to be at the runway end elevation.

(b) Steady Burning Lights. Since the approach light plane passes through the beam centers of all steady burning lights, a portion of the light unit hardware will technically penetrate the plane. This protuberance is ignored.

(c) Flashing Lights. Because of the size and mounting problems of sequenced flashers, the light beam centers of FAA Specification 1106 units may be up to 8 feet (2.4 m.) below the light plane established by the steady burning lights.

b. Location and Orientation. The longitudinal position of light bars along the centerline may be adjusted, as necessary, to avoid roads, buildings, railroads, etc. Where a light bar must be displaced longitudinally from its normal position, the adjacent light bars should be displaced proportionally to maintain essentially equal longitudinal spacing. A ± 10-foot (3 m.) spacing is tolerated on high intensity systems with a ± 20-foot (6 m.) spacing tolerated on medium intensity systems. Lateral displacement is not permitted.

47. GRADING REQUIREMENTS.

a. General. Normally, only that grading necessary to permit the erection of the light fixture(s) or its supporting structure, together with an access way for the power supply and maintenance vehicles is necessary.

b. Extended Runway Safety Area. Where any of the ALS's discussed in this chapter are planned for installation at an airport with an extended runway safety area, special grading requirements apply. Figure 4-3 illustrates these requirements. It requires the use of frangible fixtures within 1,000 feet (300 m.) of the landing threshold, fulfilling the intent of the extended runway safety area; i.e., enhanced safety for aircraft that undershoot or overrun the runway.

48.-49. RESERVED.

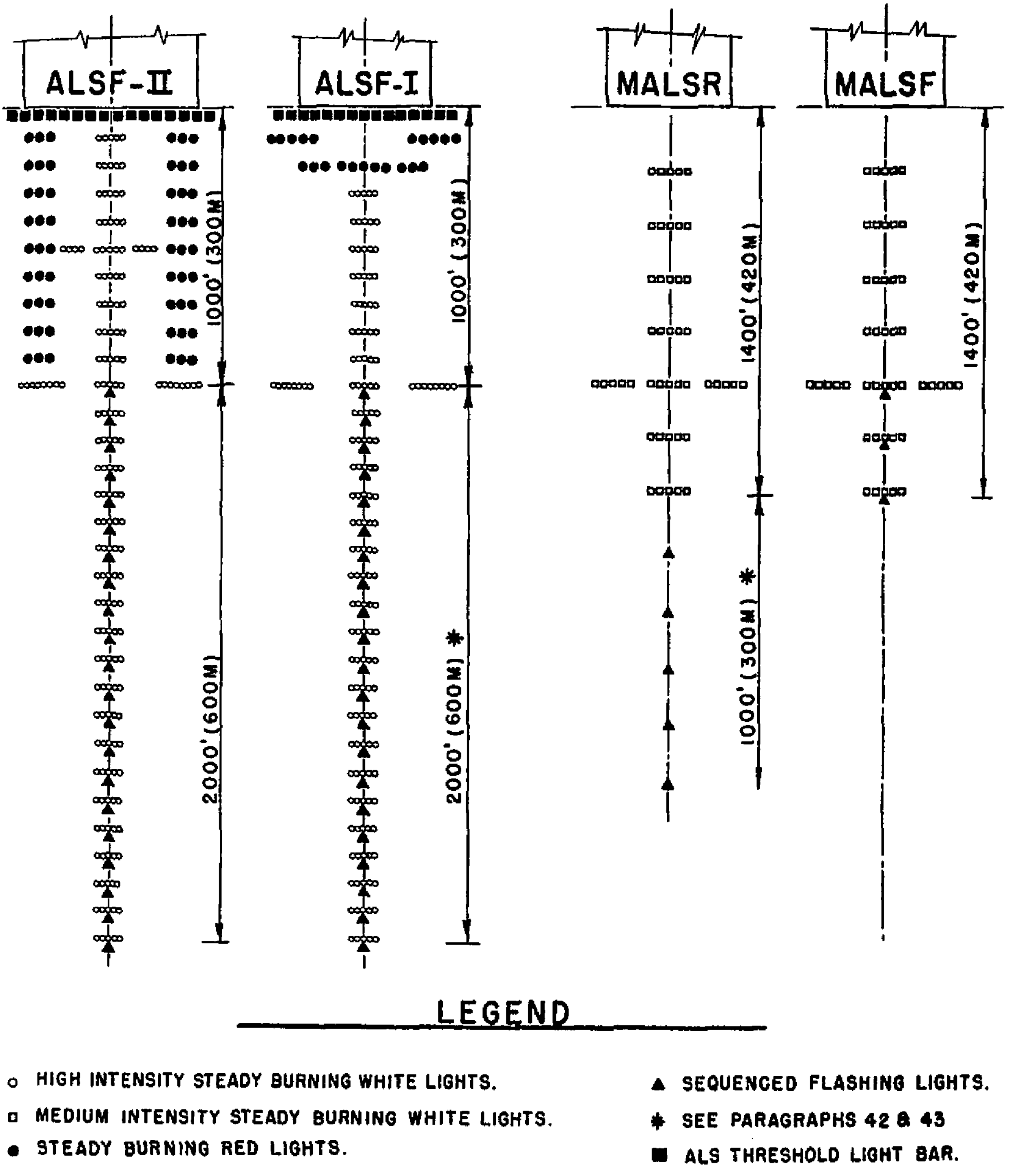
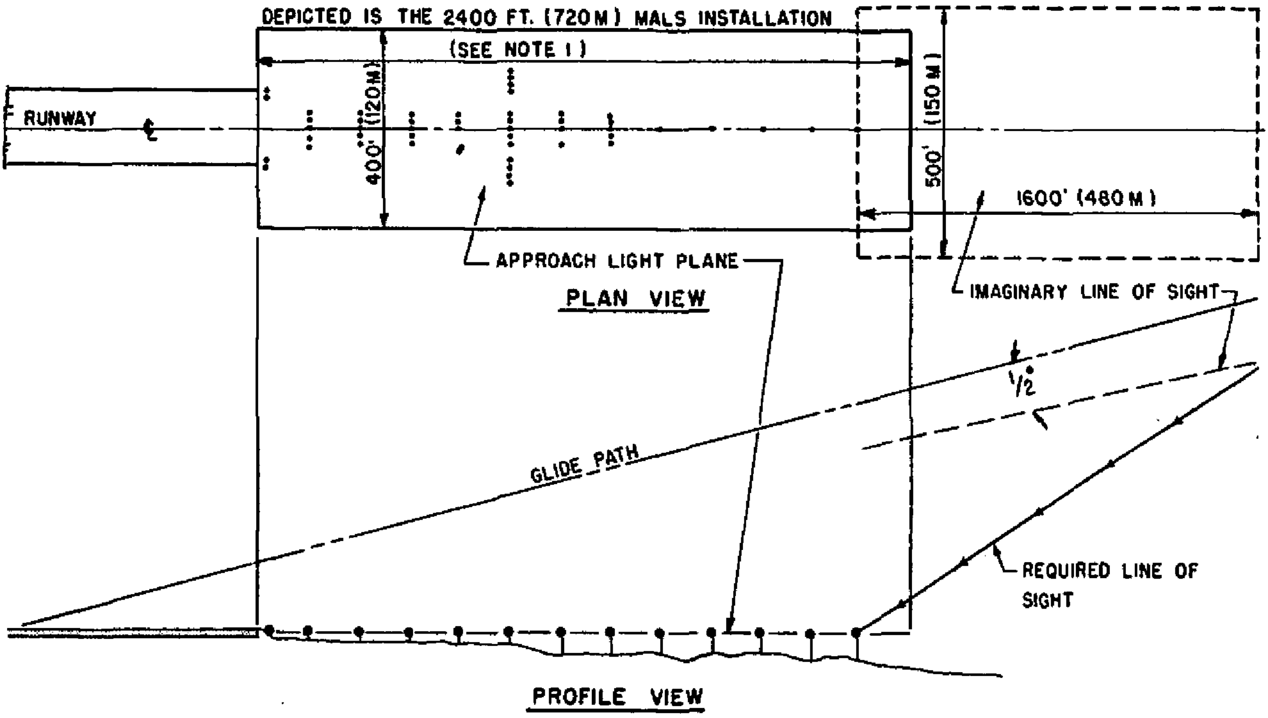


FIGURE 4-1. APPROACH LIGHT SYSTEMS



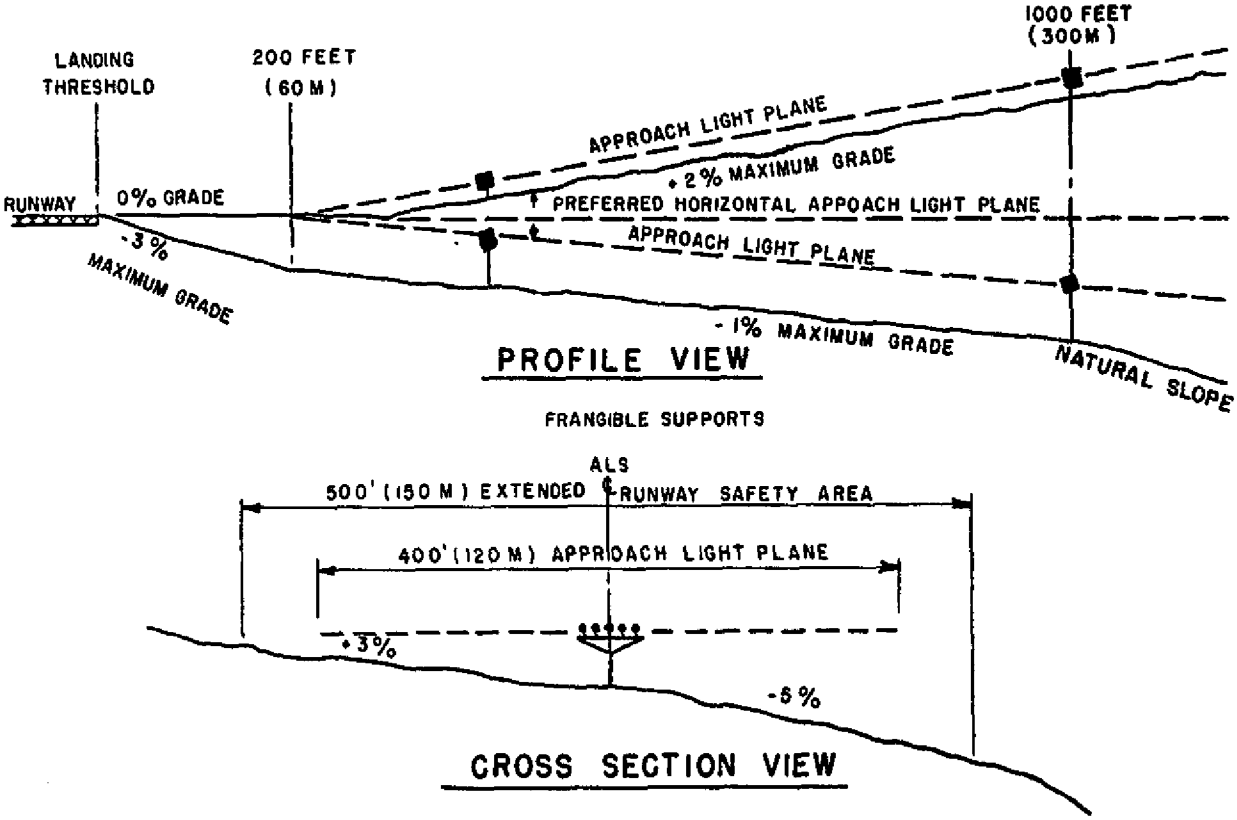
NOTES:

1. The approach light plane is 400 feet (120 m.) wide and extends 200 feet (60 m.) beyond the last light unit in the system.

2. No object is to protrude above the approach light plane which passes through the beam centers of all steady burning lights.

3. There must be a clear line-of-sight to all lights of the system from any point on an imaginary surface located outboard from the last light in the system and 1/2 degree below the ILS glide path. The dashed lines on the above drawing depict the location of the imaginary surface.

FIGURE 4-2. APPROACH LIGHT SYSTEM SITING REQUIREMENTS



NOTES:

1. The optimum location of approach lights is in a horizontal plane at the elevation of the runway end.

2. A maximum plus 2 percent (upward) longitudinal slope is tolerated to raise the light pattern above objects within its area.

3. A maximum minus 1 percent (downward) longitudinal slope is tolerated to reduce the height of suppo ing structures.

4. No objects, except components of the ILS, shall protrude above the approach light plane.

5. Transverse grades may not exceed the plus 3 percent or minus 5 percent indicated above.

FIGURE 4-3. ALS GRADING REQUIREMENTS

CHAPTER 5. VISUAL APPROACH AIDS AND AIRPORT BEACON

50. GENERAL. A number of visual aids are available for use at airports to provide pilots with visual clues for day and/or night operations under visual flight rule (VFR) weather conditions. This chapter covers siting criteria for these aids.

51. VISUAL APPROACH SLOPE INDICATOR (VASI) SYSTEMS. The VASI system is designed to provide visual approach slope (descent) guidance information for both day and night operations during VFR weather conditions. The light units, usually placed on the left side of the runway on approach, are designed to project a split beam of light having a white upper segment and a red lower segment. Pilots making an "on course" approach will see a red bar over a white bar. On a "high" approach, both light bars appear white; while on a "low" approach, both light bars appear red. To accommodate aircraft with high wheel-to-pilot-eye heights (747, C5-A, DC-10, L-1011), the FAA may install the Walker three-bar VASI to provide two visual approach paths. Figure 5-1 depicts a typical VASI-4 installation. Figure 5-2 illustrates VASI configurations.

52. VASI SITING CRITERIA. General siting criteria applicable to the VASI-4 (2-bar) and Walker three-bar VASI installation are illustrated in Figure 5-3. Specific guidance on VASI installations is to be found in FAA Order 6850.2. Advisory Circular 150/5340-14 contains siting information applicable to a VASI-2 installation to be used at small general aviation airports. To avoid pilot confusion, it is important not to locate other lights in the vicinity of the VASI installations.

53. OBSTACLE CLEARANCE. The first light bar is the critical bar of a VASI installation insofar as physical location, aiming, and obstacle clearance are concerned. The first light bar is positioned to obtain one (1) degree of clearance over the highest or most critical object which exists within the runway visual approach surface. The runway visual approach surface, illustrated in Figure 5-4, begins at a point on the runway centerline opposite the first light bar of the VASI installation. It subtends an angle of 10 degrees to either side of the extended runway centerline and extends for a horizontal distance of 6 miles (11 km.).

a. VASI-2, VASI-4, and VASI-12. Each light bar is aimed so that the resulting effective visual glide path angle is three degrees above the horizontal. An effective visual glide path angle of as high as four degrees may be authorized for runways used exclusively by propeller-driven aircraft.

b. Walker Three-Bar VASI. For Walker-three bar VASI installations, the aiming angles of the light bars have been fixed at 2.75 degrees for the first bar, 3.00 degrees for the second bar, and 3.25 degrees for the third bar. Figure 5-5 illustrates the effective visual glide path relationships for a typical three-bar VASI installation.

54. CATEGORY "D" TURBOJET OPERATIONS. To accommodate Category "D" turbojet aircraft operations on a runway without an ILS, the light bars of a VASI-4 installation are positioned to provide an effective visual glide path that intercepts the runway at a distance of 1,000 feet (300 m.) from the landing threshold. For VASI-6 installation, the effective visual glide path for the downwind zone is identical to the VASI-4 with the effective visual glide path intercept point for the upwind zone located so that it will not be more than 1,800 feet (540 m.) from the landing threshold.

55. RUNWAY END IDENTIFIER LIGHTS (REIL). The REIL's function is to provide the pilot with a rapid and positive visual identification of the approach end of the runway. The system consists of a pair of synchronized white flashing lights, situated on each side and abeam of the runway landing threshold facing the approaching aircraft. The REIL's are intended for day and night VFR use and may be placed on the same runway end as the VASI system; however, REIL's are not installed on the same runway end as an approach light system. Figure 5-6 illustrates a typical REIL layout.

56. LEAD-IN LIGHT SYSTEM (LDIN). The LDIN consists of a series of flashing lights installed at or near ground level to define the desired course to a runway or final approach. Each group of lights is positioned and aimed so as to be conveniently sighted and followed by the approaching aircraft under conditions at or above authorized approach minimums. The system may be curved or straight or a combination thereof. The LDIN system may be terminated at any approach approach lighting system or at a distance from the landing threshold which is compatible with the authorized visibility minimums permitting visual reference to the runway environment. Each LDIN system configuration must be specially designed to suit local conditions.

57. AIRPORT ROTATING BEACONS. A rotating beacon is installed to aid the pilot in visually locating the airport after dark.

a. Color of Lights. Alternating white and green flashes are used to indicate a lighted civil use airport. White flashes indicate an unlighted civil airport.

b. Location. The beacon must be located so it will not dazzle pilots of approaching aircraft or cause distraction to air traffic control personnel in the control tower.

(1) Minimum Distance:

(a) Runways 3,200 Feet (960 m.) or Less. For airports with runways 3,200 feet (960 m.) or less in length, the beacon should be located at least 350 feet (105 m.) from the runway centerline.

(b) Runways Over 3,200 Feet (960 m.). For airports with runways over 3,200 feet (960 m.) in length, the beacon should be located at least 750 feet (225 m.) from the runway centerline.

(2) Maximum Distance: For all airports, the beacon should not be located more than 5,000 feet (1,500 m.) from the nearest point of the usable landing area, except in cases where surrounding terrain will unduly restrict the visibility of the beacon. In these cases, the distance may be increased to a maximum of 2 miles (3.22 km.) from the usable landing area provided an identification beacon is installed on the airport as near as practical to the appropriate inner limit.

c. Beacon Size. Airports with medium intensity runway lighting may install a 10-inch (25 cm.) beacon conforming to FAA specification L-801. Airports with high intensity runway lighting, or airports where background lights could cause identification problems, should install the 36-inch (91 cm.) beacon conforming to Specification CAA-291.

58.-59. RESERVED.

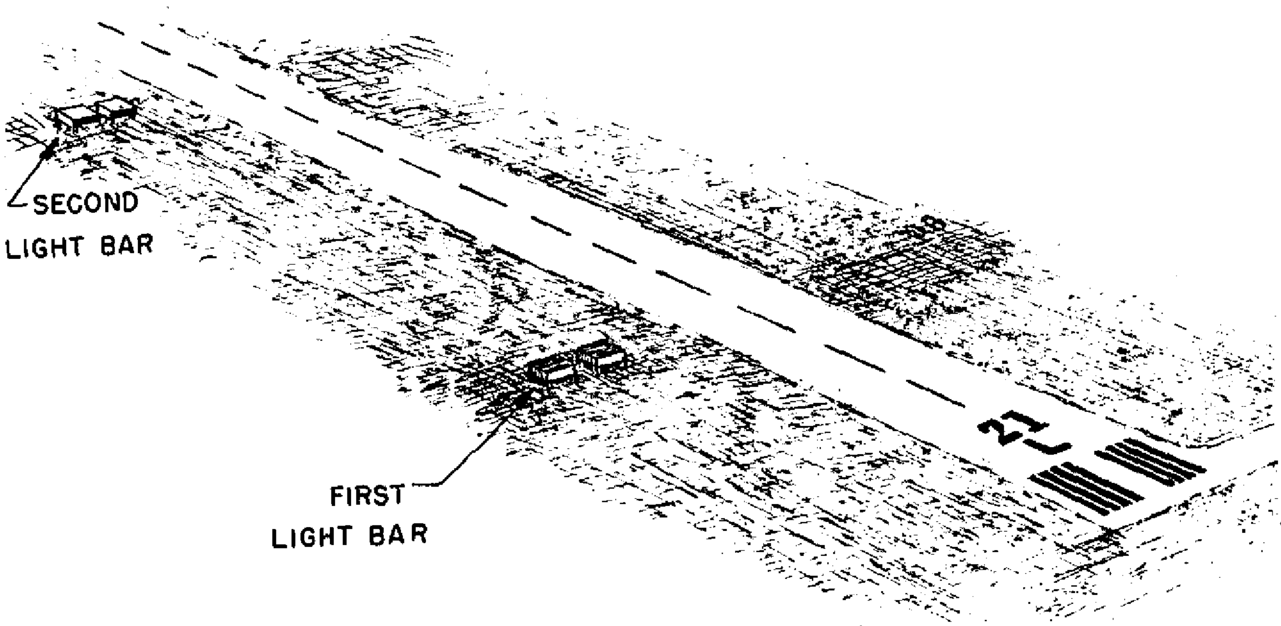
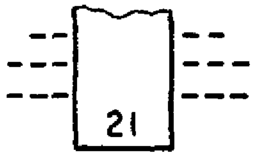
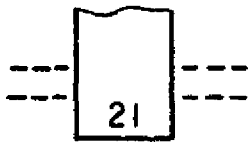
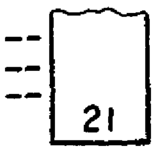
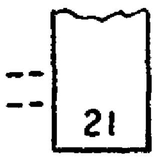
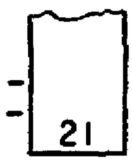
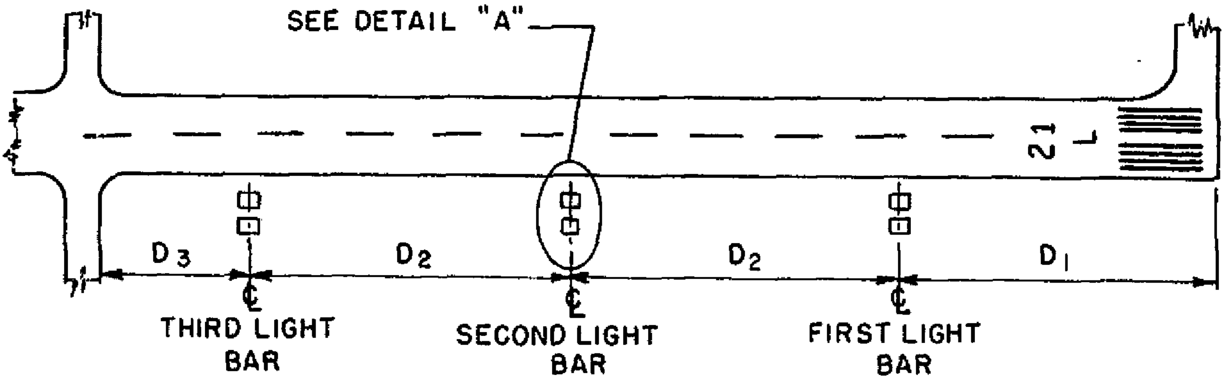


FIGURE 5-1. TYPICAL VASI-4 INSTALLATION

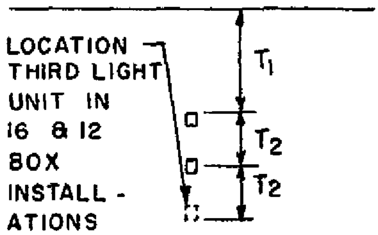
TYPE	SCHEMATIC	DAY VFR RANGE	COMMENTS
Walker 3 Bar		5 Nautical Miles (9.3 kilometers)	Use at major airports requiring maximum boldness of signal. Serves all aircraft types.
VASI-12		5 Nautical Miles (9.3 kilometers)	Use at major airports requiring maximum boldness of signal. Cannot be used by (1)
Walker 3 Bar		4 Nautical Miles (7.4 kilometers)	FAA standard 3-bar VASI. Serves all aircraft types.
VASI-4		4 Nautical Miles (7.4 kilometers)	FAA standard 2-bar VASI. Cannot be used by (1)
VASI-2		3 Nautical Miles (5.6 kilometers)	Cannot be used by jet aircraft.

(1) Aircraft with high wheel-to-pilot-eye heights.

FIGURE 5-2. VASI CONFIGURATIONS



ITEM	DIMENSIONS		
	PREFERRED	MINIMUM	MAXIMUM
D_1	500' (150 M)	125' (37.5 M)	800' (240 M)
D_2	700' (210 M)	500' (150 M)	1000' (300 M)
D_3	–	75' (22.5 M)	–
T_1	50' (15 M)	50' (15 M)	60' (18 M)
T_2	16' (4.9 M)	15.5' (4.7 M)	16.5' (5.0 M)



DETAIL "A"

NOTES:

1. All light bars are located at the same distance from the runway edge.

2. The center of the optical aperture of all light units must be within ± 1 foot (.3 m.) of the runway centerline elevation.

3. Longitudinal (D) minimum/maximum dimensions are to be used only to avoid taxiways, cross runways, etc., or to achieve the desired unit height required by terrain conditions.

4. Transverse (T) minimum/maximum dimensions are to be used only to avoid ditches, catch basins, manholes, etc.

FIGURE 5-3. VASI SITING CRITERIA

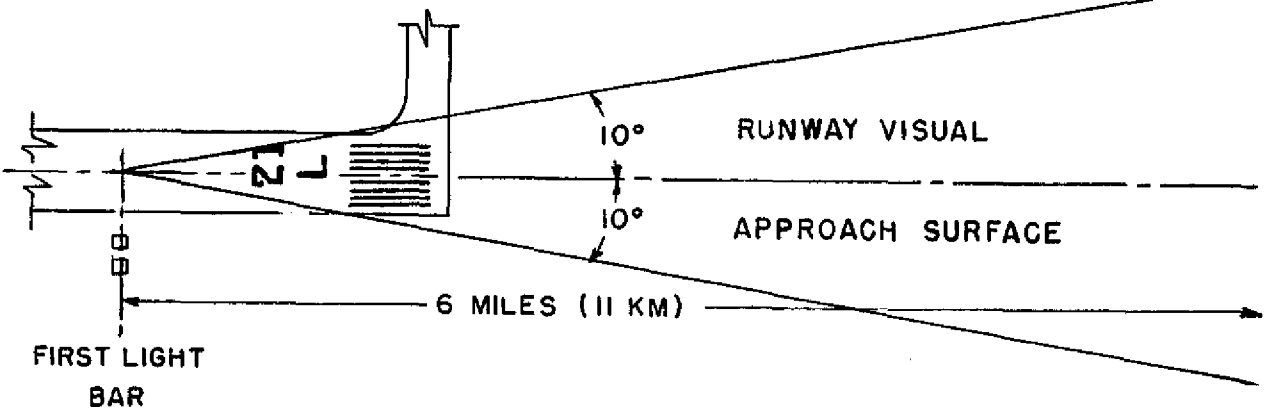


FIGURE 5-4. RUNWAY VISUAL APPROACH SURFACE

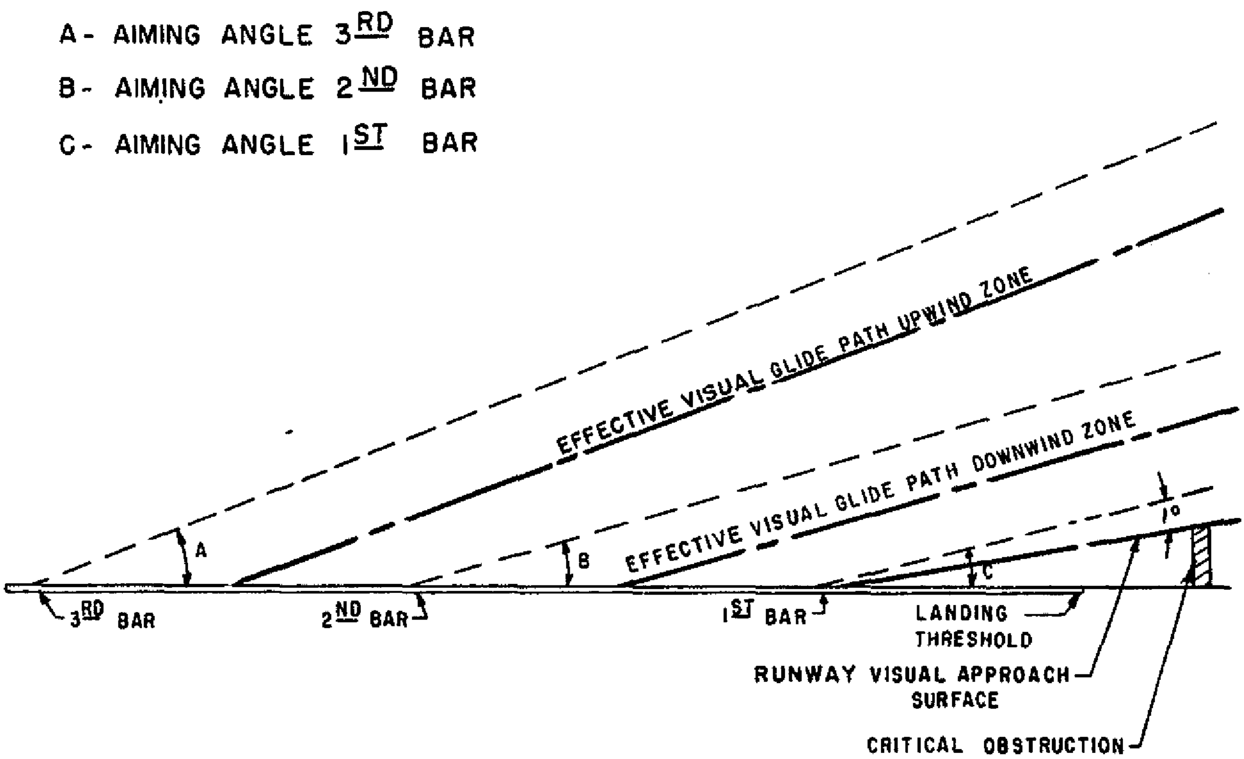
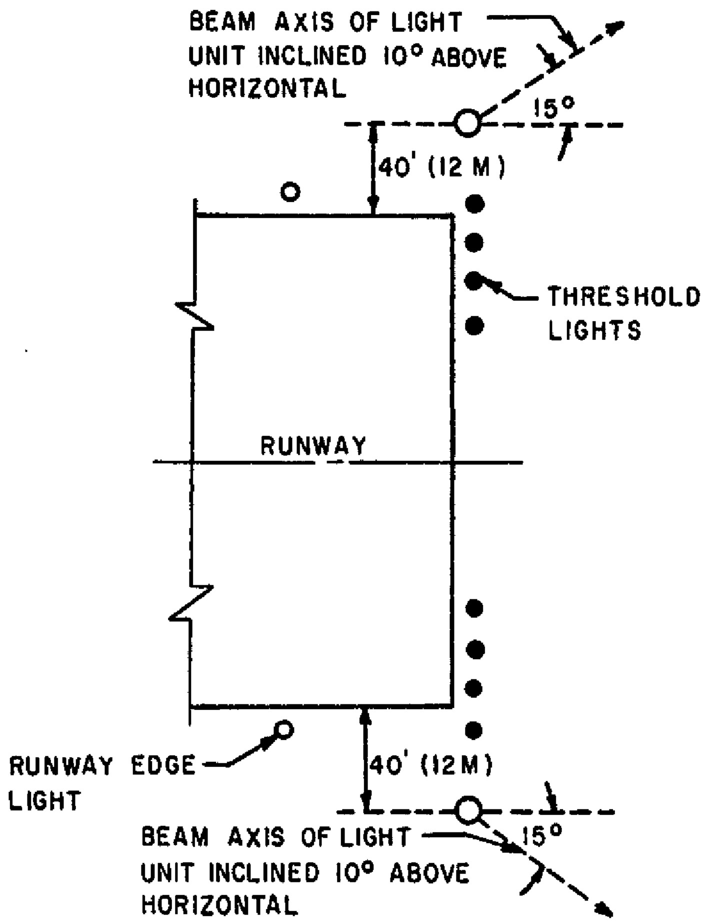


FIGURE 5-5. EFFECTIVE VISUAL GLIDE PATH - WALKER THREE-BAR VASI



NOTES:

1. Optimum location of the REIL is as shown above.

2. To meet operational/site problems, the REIL units may be installed with a longitudinal tolerance of 200 feet (60 m.) in either direction from the threshold light line, up to 75 feet (22.5 m.) out from the runway pavement edge, and with a horizontal angle of 10 degrees and a vertical angle of 3 degrees.

3. REIL equipment should be at least 10 feet (3 m.) from taxiway edge.

4. If the REIL is used with a VASI system, install them at the 75-foot (22.5 m.) outboard location.

FIGURE 5-6. TYPICAL REIL LAYOUT

CHAPTER 6. AIR TRAFFIC CONTROL AND RELATED FACILITIES

60. GENERAL. Airport located facilities discussed in this chapter are utilized in the control of air traffic or in obtaining measurements to determine the type of flight rules/operating limits to be in effect.

61. AIR TRAFFIC CONTROL (ATC) TOWER. The ATC tower is the focal point for the safe control of aircraft operating in the airport's designated airspace and on the airport's surface maneuvering area. Airport configuration and development can cause problems in the selection of a suitable ATC tower site. Accordingly, it is recommended that airport owners consult with the FAA regional office before reserving any land for one. ATC tower siting criteria is found in FAA Order 6480.4.

62. SITE CONSIDERATIONS. Site considerations of an engineering nature include but are not limited to the following:

   a. Utilities. Are the necessary utilities (water, sewer, power, telephone) available or reasonably accessible?

   b. Design. Are there potential problems in the design of the foundation or structure due to surface or subsurface conditions?

   c. FAA Standards. Will the site meet current FAA standards regarding orientation, positioning, and layout of the tower cab portion of the facility?

   d. Site Size. Is the site plot of sufficient size to accommodate the initial and future building area considering the requirement for adequate vehicle parking for ATC personnel?

   e. Conflicts. Is there minimum interference with the operation of installed/future NAVAIDS or ATC facilities?

   f. Clearances. Will the tower height conform to the clearance limitations of FAR Part 77? Are deviations necessary and operationally acceptable?

63. OPERATIONAL CONSIDERATIONS. In addition to the "engineering" considerations described above, the tower site will also be evaluated on the following operational considerations:

   a. Flight Patterns. Will the controller have maximum visibility of flight operations in the airport area?

   b. Approach Visibility. Will the controller have an unobstructed and direct view of the approach to the ends of the primary instrument runway and to all other runways or landing areas?

c. Ground Visibility. Will the controller be able to see and have adequate depth perception of all airport surface areas utilized by aircraft?

64. AIRPORT SURVEILLANCE RADAR. Airport surveillance radar (ASR) is used for the control of air traffic within predetermined airspace areas, normally 40 miles (68 km.) of the airport at which the ASR is located. The ASR scans through 360 degrees of azimuth and presents target information on radar display equipment located in the ATC facility. The information presented is used by ATC personnel independently or in conjunction with other NAVAIDS to control terminal area traffic. Figure 6-1 is a photograph of a typical ASR antenna installation. To assure acceptable radar coverage of the airport's airspace area, the FAA must consult with the airport owner to select the antenna site.

a. Antenna Location. The radar antenna is normally located between 1,000 feet (300 m.) and 12,000 feet (3,650 m.) from the radar display equipment. It is desirable that the antenna be at least 1,000 feet (300 m.) from any above ground object that might cause reflections. It is usual practice to keep the ASR antenna at least one-half mile (.8 km.) from a runway end.

b. Obstruction Criteria. The ASR antenna siting is governed by FAR Part 77 standards for determining obstructions.

65. AIRPORT SURFACE DETECTION EQUIPMENT. Airport surface detection equipment (ASDE) is installed at selected airports to permit ATC tower personnel to observe aircraft and vehicular ground traffic during restricted visibility conditions. Figure 6-2 is a photograph of a typical ASDE antenna installation.

a. Antenna Location. The ASDE antenna is usually located in the airport terminal area on an existing building although it may be on a free standing structure. The choice of locations is dependent upon obtaining satisfactory surveillance of the airport's operational areas.

b. Obstruction Criteria. The ASDE antenna siting is governed by FAR Part 77 standards for determining obstructions. Free standing ASDE towers range from 20 feet (6 m.) to 120 feet (36 m.) in height to meet specific airport configuration and terrain conditions.

66. TRANSMISSOMETER FACILITIES. Transmissometer facilities are installed on an ILS runway to measure horizontal visibility. Measurements are in terms of runway visual range (RVR); i.e., an RVR readout of 2,400 infers that the pilot should be able to see a high intensity runway edge light some 2,400 feet (720 m.) ahead of him. Transmissometer

installations are required near the landing threshold and at the roll-out end of all runways less than 8,000 feet (2,400 m.) in length with CAT II or III ILS operations. A third transmissometer is required near the midpoint if the runway is over 8,000 feet (2,400 m.) in length. Transmissometer installations are not required for CAT I ILS operations unless justified by a special operational study.

a. Transmissometer Components. The transmissometer installation consists of a transmitter, a receiver, and a recording/readout instrument. The transmitter directs a beam of light to a receiver located near the ILS glide slope equipment building. The receiver sends an electronic signal by cable to a recording readout unit located in the ATC tower. Controllers relay the RVR reading to approaching pilots to alert them to the visibility conditions on the runway.

b. Siting Criteria. Transmitter and receiver units are mounted on individual platforms, approximately 14 feet (4.25 m.) in height, spaced 250 feet (76.2 m.) apart. The base line is positioned at an angle between 0.05 degrees and 14.5 degrees from the runway centerline. There must be a clear line-of-sight at least 10 feet (3 m.) above the ground at all points between the transmitter and receiver units. The line-of-sight should be within 0.1 degree of the horizontal plane. Maximum platform height may not exceed 15 feet (4.5 m.) above the elevation of the nearest runway centerline. Both units must be placed outside of the glide slope facility's restricted area so there will be no interference with the glide slope operation. The optimum location of the transmitter unit is 400 feet (122 m.) off of the runway centerline. Neither unit should be closer than 400 feet (122 m.) from the runway centerline or within 150 feet (45 m.) of a taxiway centerline. Figure 6-3 illustrates the layout and siting tolerances of the transmissometer installation.

67. ROTATING BEAM CEILOMETER. The rotating beam ceilometer is installed to obtain a vertical measurement of the cloud base over the airport. The system consists of a light beam projector and one or two detector units installed in a straight line at 400-foot (122 m.) intervals. While it is preferable to have both the projector and detector units at the same elevation, an elevation differential of up to 50 feet (15 m.) is tolerated. The preferred location for the rotating beam ceilometer is near other airport located weather instruments. The installation shall conform to the height limitations of FAR Part 77 and shall not cause visual interference with pilots making an approach to land.

68.-69. RESERVED.

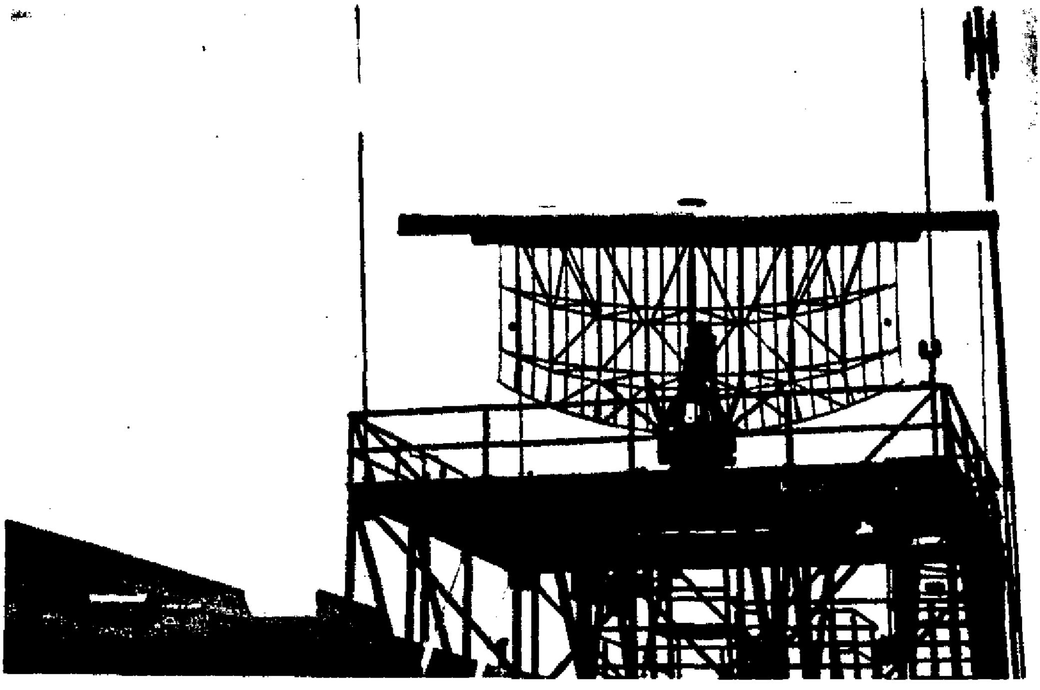


FIGURE 6-1. TYPICAL ASR ANTENNA INSTALLATION

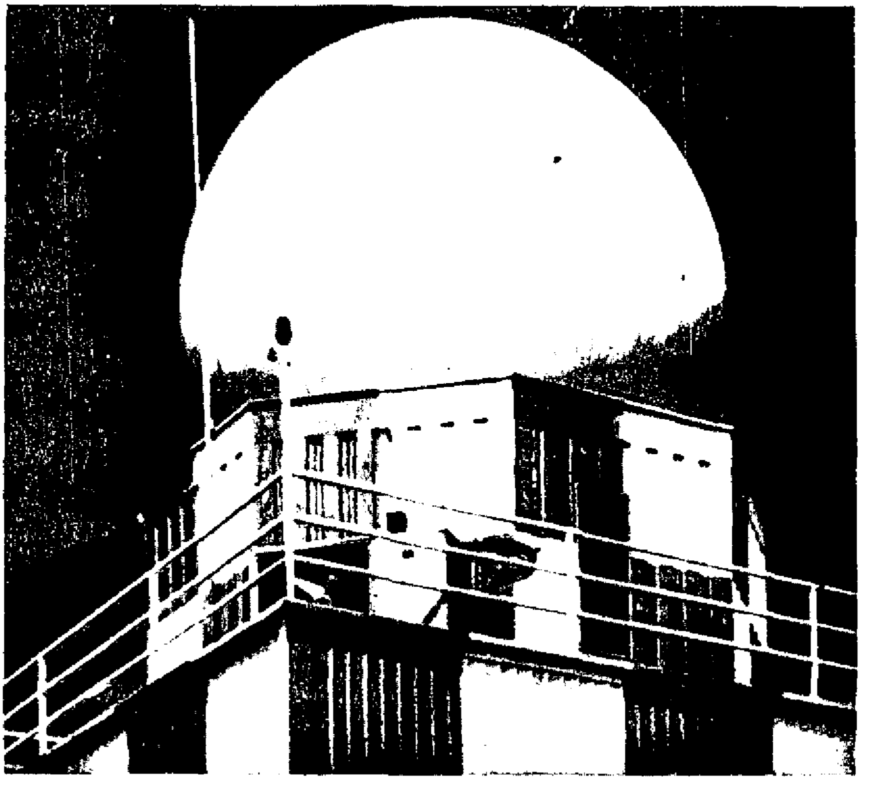
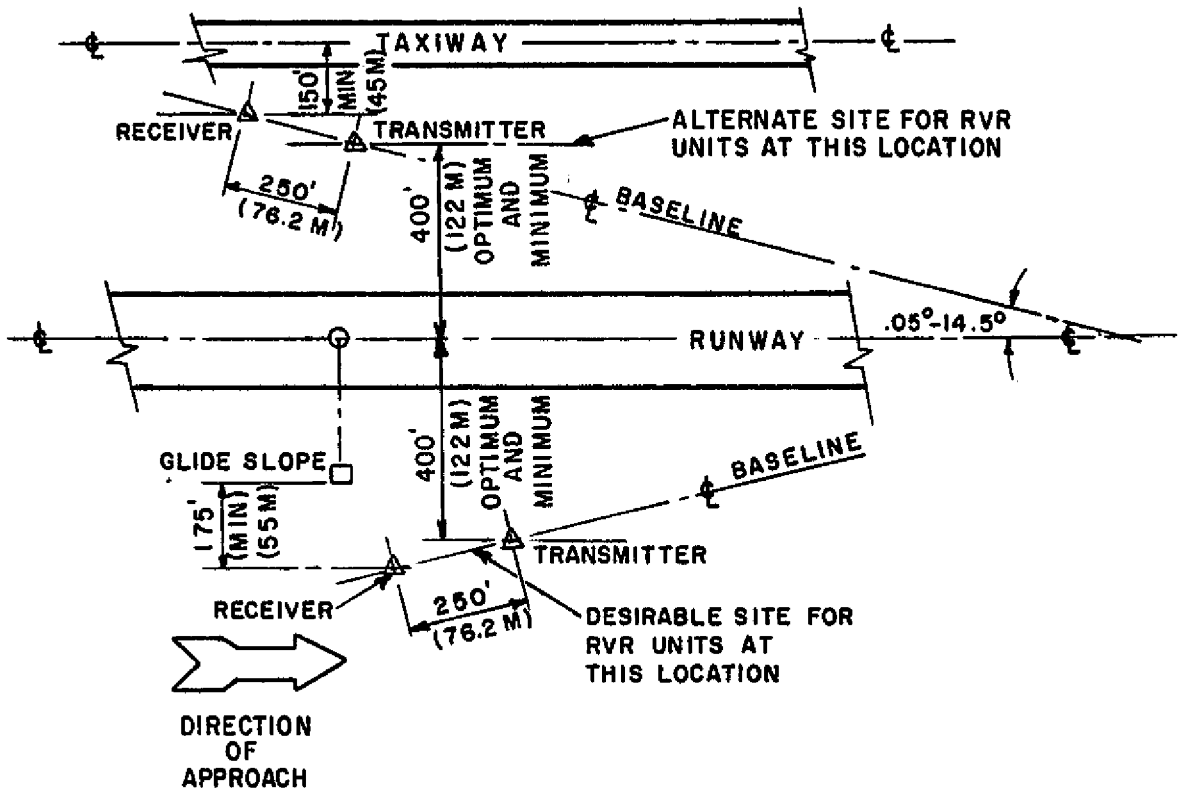


FIGURE 6-2. TYPICAL ASDE ANTENNA INSTALLATION



NOTES:

1. The transmitter shall be within 500 feet (150 m.) of the runway centerline.

2. The transmissometer units shall be within 1,500 feet (450 m.) of the intersection point of the runway centerline with the perpendicular intercept through the glide slope equipment building.

FIGURE 6-3. SITING CRITERIA FOR TRANSMISSOMETER SYSTEM

CHAPTER 7. PROTECTING NAVIGATIONAL AIDS

70. GENERAL. The reliability of the signal/operation of the navigational aids discussed in this advisory circular are important to a pilot conducting an approach to land. To assure this reliability, unauthorized persons must be denied access to these aids. Preventing access is also for the good of the innocent intruder since high voltage and/or electronic radiation may be present.

71. PROTECTING OFF AIRPORT NAVAIDS. Normally, NAVAIDS located off of the airport will be provided the protection deemed necessary at the time they are established. The extent of protection provided, which can range from a warning sign to a locked security fence, depends upon whether the protection could interfere with the NAVAID signal, whether the NAVAID is in a rural or urban environment, whether there is vandalism in the area, and whether the NAVAID could be dangerous to or adversely affected by human or animal intrusion.

72. PROTECTING ON AIRPORT NAVAIDS. The NAVAIDS located on the airport proper present different security problems. To the extent possible/necessary, security measures will be provided when the aid is established. Fencing, which is the usual form of intrusion barrier, cannot be used in all cases as it may adversely affect the NAVAID operation or may constitute a physical hazard to aircraft during ground operations. In these instances, it is necessary to rely on the general security provided by airport owners to restrict the access of unauthorized persons unto operational areas of the airport.

73. ADDITIONAL GUIDANCE. Additional information on security protection for an airport is to be found in Advisory Circular 107-1 and FAR Part 107. Contact the appropriate FAA regional office for guidance on specific problems in providing NAVAID protection.

APPENDIX 1. INTERNATIONAL AIRPORTS

The following airports are identified by the FAA as International Airports in accordance with the Air Navigation Plan, ICAO document 8755/4 dated September 1971, 4th Edition. These airports require a 3,000-foot (900 m.) approach light system.

State	City	Airport
Alaska	Anchorage	Anchorage International
	Cold Bay	Cold Bay
	Fairbanks	Fairbanks International
	Kodiak	Kodiak Naval Station
	Shemya	Shemya Air Force Base
Arizona	Tuscon	Tuscon International
California	Los Angeles	Los Angeles International
	San Diego	San Diego Internanational (Lindbergh Field)
	San Francisco	San Francisco International
Distric of Columbia	Washington	Dulles International
Florida	Fort Lauderdale	Fort Lauderdale-Hollywood International
	Miami	Miami International
	Tampa	Tampa International
	West Palm Beach	Palm Beach International
Hawaii	Honolulu	Honolulu International
Illinois	Chicago	Chicago O'Hare International
Louisiana	New Orleans	New Orleans International - Moisant Field
Maryland	Baltimore	Friendship International
Massachusetts	Boston	Gen. Edward Lawrence Logan International
Michigan	Detroit	Detroit Metropolitan - Wayne County
New Jersey	Newark	Newark International
New York	New York	John F. Kennedy International

State	City	Airport
Pennsylvania	Philadelphia	Philadelphia International
	Pittsburgh	Greater Pittsburgh International
Texas	Corpus Christi	Corpus Christi International
	Dallas/Fort Worth	Dallas/Fort Worth Regional
	Harlingen	Harlingen Municipal (Harvey-Richards Field)
	Houston	Houston Intercontinental
	McAllen	Miller International
	San Antonio	San Antonio International
Washington	Seattle	Seattle-Tacoma International

APPENDIX 2. BIBLIOGRAPHY

1. The following Federal Aviation Regulations (FAR) and advisory circulars (AC) may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Make check or money order payable to the Superintendent of Documents; no c.o.d. orders are accepted.

   a. FAR, Volume VI ($9.00) - contains Parts 91 and 107

   b. FAR, Volume X ($7.00) - contains Part 152

   c. FAR, Volume XI ($5.00) - contains Parts 77, 97, 157, and 171

   d. AC 150/5070-6, Airport Master Plans ($2.00)

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

2. The latest issuance of the following free publications may be obtained from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590. Advisory Circular 00-2, updated triannually, contains the listing of all current issuances of these circulars and changes thereto.

   a. AC 00-2, Federal Register Advisory Circular Checklist and Status of Regulations

   b. AC 70/7460-2, Proposed Construction or Alteration of Objects that May Affect the Navigable Airspace

   c. AC 90-1, Civil Use of U.S. Government Produced Instrument Approach Charts

   d. AC 107-1, Aviation Security - Airports

   e. AC 120-28, Criteria for Approval of Category IIIa Landing Weather Minima

   f. AC 120-29, Criteria for Approving Category I and Category II Landing Minima for FAR Part 121 Operators

   g. AC 150/5000-3, Address List for Regional Airports Divisions and Airports District Offices

   h. AC 150/5340-1, Marking of Paved Areas on Airports

   i. AC 150/5340-14, Economy Approach Lighting Aids

j. AC 150/5340-16, Medium Intensity Runway Lighting System and Visual Approach Slope Indicators for Utility Airports

k. AC 150/5345-12, Specification for L-801 Beacon

l. AC 150/5345-45, Lightweight Approach Light Structure

m. AC 150/5900-1, The Planning Grant Program for Airports

3. The following FAA orders and specifications are available for examination upon request at FAA regional offices (see AC 150/5000-3 listed above):

a. Order 6480.4, Airport Traffic Control Tower Siting Criteria

b. Order 6560.10, Runway Visual Range (RVR)

c. Order 6750.16, Siting Criteria for Instrument Landing Systems

d. Order 6850.2, Visual Guidance Lighting Systems

e. Order 7031.2A, Airway Planning Standard Number One - Terminal Air Navigational Facilities and Air Traffic Control Services

f. Order 8260.3A, United States Standard for Terminal Instrument Procedures (TERPS)

g. Specification CAA-291, Specification for Beacons, 36-inch Rotating, Double Ended Type

h. FAA Specification 1106, Condenser Discharge Sequenced Flashing Light System

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