APPENDIX C
VISUAL AND NAVIGATIONAL AIDS

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An integral part of the airport system is the visual and navigational aids provided to assist pilots in navigating both on the airfield and en route.

C.1 VISUAL AIDS

To enhance visual information during the day when visibility is poor and at night, it is essential to provide visual aids that will be as meaningful to a pilot as possible. These aids can provide pilots information based on their horizontal and vertical position by providing data regarding the aircraft's alignment, height and distance, rotation, and information concerning the rate of descent and the rate of closure with the desired path. This system consists of a variety of lighting and marking aids used to guide the pilot both in the air and on the ground.

C.1.1 Airport Beacon

Airport beacons are used to guide pilots to lighted airports with a sequence of yellow, green, and/or white lights. A beacon is normally operated from dusk until dawn. If the beacon is on during other hours it typically indicates that the airport is operating under instrument flight rules.

C.1.2 Approach Lighting

Approach lighting systems are a configuration of high-intensity or medium-intensity sequenced flashing signal lights designed to guide the pilot from the approach zone to the runway threshold. Approach lights can also provide additional visual guidance for nighttime approaches under visual flight rules.

This system consists of a variety of approach lighting systems approved for use in the United States. These include a high-intensity approach lighting system with sequenced flashing lights (ALSF-2) for use on category II and category III precision-instrument approaches, a high-intensity sequenced flashing lights (ALSF-1), and three medium-intensity approach lighting systems (MALSR, MALS, and MALSF).

C.1.3 Visual-Approach Slope Aids

The visual approach slope indicator (VASI) is an optical reference device located on the ground adjacent to the sides of the runway. There are a variety of VASI designs dependent upon the desired visual range and the type of aircraft utilizing the runway. Each unit consists of a "bar" of one, two, or three light units, referred to as boxes. Each box appears a certain color depending upon the pilot's position. If the pilot is too low all of the bars will appear red, if the pilot is too high all of the bars will appear white, and if the pilot is on the desired path half of the bars will appear red and half will appear white. The most common systems found in the United States include VASI-2, VASI-4, VASI-12, and VASI-16. The number following the acronym indicates the number of boxes in the system.

The precision approach path indicator (PAPI) is a visual-approach slope aid approved for use in the United States. This system gives more precise indication to the pilot of the approach path of the aircraft and utilizes only one bar. The system consists of four lights on either side of the

approach runway. The lighting indications still consist of a series of white and/or red lights to indicate the pilot's position.

C.1.4 Threshold Lights

Threshold lights consist of a single row of green lights extending across the entire width of the runway used to indicate the beginning of the usable landing surface. At small airports, threshold lights may consists of four green lights located on either side of the threshold. These lights are two-directional and appear red from the opposite end of the runway to mark the end of the usable runway.

C.1.5 Runway and Taxiway Lighting

Runway end identifier lights (REIL) consist of high intensity white strobe lights placed on each side of the runway to enable rapid and positive identification of the runway threshold. REILs are typically installed on runways where an approach lighting system is not available.

Touchdown zone lights are white lights located 36 feet on either side of the runway centerline and extend 3,000 feet from the runway threshold or half the runway distance if the runway is less than 6,000 feet long.

Runway edge lights consist of a single row of two-directional lights bordering each side of the runway and can be classified according to three intensity levels. High intensity runway lights (HIRL) are the brightest runway lights available. Medium intensity runway lights (MIRL) and low intensity runway lights (LIRL) are, as their names indicate, lower in intensity. Instrument runway edge lights incorporate yellow runway remaining lights on the last half of the runway or last 2,000 feet, whichever is less, to inform the pilot of the amount of runway remaining. If the runway threshold is displaced but the area that is displaced is usable for takeoffs and taxiing then the runway edge lights, in the direction of operations, are red.

Runway centerline lights are white lights offset a maximum of two feet from the runway centerline. To indicate the distance remaining, the last 1,000 feet the centerline lights are red and the previous 2,000 feet alternative between red and white.

Taxiway lighting consists of blue edge lights and may also consist of green centerline lights.

C.1.6 Runway and Taxiway Markings

The FAA classifies runways based on the type of approaches they are capable of handling: visual, non-precision instrument, or precision instrument. All markings are white in color. A visual runway is intended solely for the operation of aircraft using visual approach procedures. These runways are marked only with the standard markings, which include a centerline, a number designator, and holding indications. Non-precision instrument runways are runways that have instrument approach procedures using air navigation facilities that only provide horizontal guidance. Markings include the standard markings and the addition of threshold markings and fixed distance markers. A precision instrument runway is one that has instrument approach procedures using an instrument landing system (ILS) or precision approach radar (PAR). These runways include all of the markings on a non-precision instrument runway with the addition of touchdown zone markers and side stripes.

All taxiway markings are yellow in color and consist of single-continuous centerline marking and dashed yellow holding lines. Additional yellow markings are used to indicate various movement areas and holding positions.

C.2 NAVIGATIONAL AIDS

Navigational systems vary considerably in terms of accuracy, coverage, reliability, and capabilities. The majority of navigational systems are currently designed around the geographic location and technical characteristics of ground-based navigational aids. Newer technology increasing in usage is designed around satellite-based systems that are augmented by ground-based systems.

C.2.1 VHF Omnidirectional Range (VOR)

Very high frequency omnidirectional range (VOR) is the primary ground-based en route navigational aid used throughout the United States. VOR is a system made up of a series of ground stations that broadcast directional signals used by aircraft in determining bearings to or from a station. If the VOR station is equipped with distance measuring equipment (DME), the signals can also be used for determining the distance to the station. Navigation utilizing VORs typically consists of flying airways, which are specific radials connecting VOR stations.

C.2.2 Non-Directional Beacon (NDB)

Non-directional beacons (NDB) are another ground-based navigational aid used throughout the United States. The NDB system is the oldest form of electronic navigation still in regular use. By transmitting low to medium frequencies to an automatic direction finder located in the aircraft, pilots can use the NDB system to navigate to and from the ground-based station.

C.2.3 Instrument Landing System (ILS)

The instrument landing system is a precision approach navigational aid that provides highly accurate course, glide slope, and distance guidance information to a given runway. There are three general classifications of ILS approach systems – Category I, Category II, and Category III. A Category I is the basic ILS approach system and can be used by any aircraft with the appropriate equipment. Category II and Category III ILS approach systems are more precise and require special certification for operators, pilots, aircraft, and air to ground equipment.

C.2.4 Global Positioning System (GPS)

The global positioning system (GPS) is a satellite-based radio positioning, navigation, and time-transfer station developed and maintained by the Department of Defense (DOD). GPS, at any given time, utilizes three of the strategically placed 24 satellites to calculate the aircraft's position and, from there, determine the distance, bearing, and estimated time en route to the next waypoint.

C.2.5 Wide Area Augmentation System (WAAS)

Wide area augmentation system (WAAS) is an expansion of GPS that includes integrity broadcasts, differential corrections, and additional ranging signals. Its primary objective is to provide the accuracy, integrity, availability, and continuity required to support all phases of flight. WASS consists of a network of ground reference stations that monitor GPS signals. Data from these reference stations are data-linked to master stations where the validity of the signals from

each satellite is assessed and wide area corrections provide a direct verification of the integrity of the signal from each satellite in view.

C.2.6 Local Area Augmentation System (LAAS)

Local area augmentation system (LAAS) is a differential GPS that provides localized measurement correction signals to the basic GPS. LAAS relies on precisely surveyed ground stations, called pseudolites, which are located within the airport area and are used to calculate differential correction and integrity information. This system can be used within an approximate 30 nautical mile radius to supplement the normal GPS and enable the airport to provide precision instrument capabilities.