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Airport Engineering

Part III: Signs & Markings

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Introduction

This course discusses airport signs and markings. Properly designed and standardized visual systems are vital for safe and efficient airport operations. Visual aids provide information and guidance to pilots and operators maneuvering on airports, and safety is the highest priority. As with the previous courses in this series, we will use FAA Advisory Circulars as the basis for current design guidelines:

AC 150/5340-18G *(Standards for Airport Sign Systems)*
AC 150/5340-1M *(Standards for Airport Markings)*

For the sake of clarity and brevity, some of the information in the advisory circulars has been abbreviated or abridged for this course. To achieve the most accurate and current understanding of these topics, specific details for design should be taken directly from the FAA documents.

Airport Signs

Airport sign systems gives visual information and cues to pilots and vehicle drivers on the ground. Ground

navigation information is conveyed to promote safety and efficiency within the airfield environment, while also heightening situational awareness. The system should provide the designation of any pavement on the airport and identify routes toward a destination. Sign systems also should indicate mandatory holding positions and important boundaries. It should be recognized by engineers that each airport is different and may require different number of signs even though runway and/or taxiway layout is similar. Regardless of the number of signs, the system should be logical and simple.

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There are nine types of airport signs, described here with sample images of each:

BOUNDARY SIGNS

Identifies the location of the RSA/OFZ for a pilot exiting the runway. These signs have black characters with a yellow background. Boundary signs are typically used only at controlled airports, where pilots may be asked by ATC to report when they are clear of the runway safety area.


DESTINATION SIGNS

Indicates the general direction to a remote location when taxiway location and direction signs alone are not adequate. These signs have black characters with a yellow background and always contain an arrow. Abbreviations for inbound destinations are included in Appendix A.

DIRECTION SIGNS

Used to indicate directions of taxiways leading out from a runway or intersection. These signs have black characters with a yellow background and always contain arrows, which should be generally oriented in the direction of the turn, to the nearest 22 ½°.
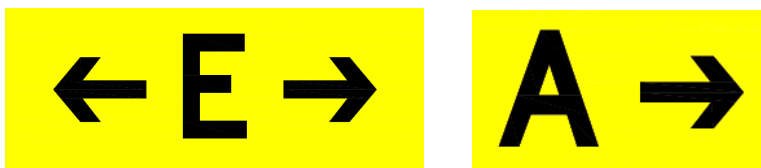
INFORMATION SIGNS

Provide general information to airside operators; black inscription on yellow background.

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LOCATION SIGNS

Identify the taxiway or runway where the aircraft is located and do not contain arrows. These signs have yellow characters with a yellow inset border on a black background.

MANDATORY INSTRUCTION SIGNS

Denote intersections, ILS critical areas, POFZ boundaries, approach and departure areas, CAT II/III operation areas, military zones, and no entry areas. White inscription with black outline on a red background.

Controlled airports require all vehicles and aircraft must obey except when cleared by ATC. Runway numbers are separated by a dash, and the order describes the orientation of the runway (i.e. 15-33 indicates Runway 15 is to the left and Runway 33 is to the right). These signs are installed to be in line with holding position markings. Typically, one sign on the left side of the taxiway or runway is sufficient. Approach or departure may be indicated with runway numbers as "APCH" or "DEP". Military landing zones are indicated with "MIL LZ". No entry signs should be located where entry is prohibited, not prior to the intersection.

RUNWAY DISTANCE REMAINING SIGNS

Provides pilots with distance remaining information during takeoff and landing; expressed in thousands of feet. White numerals on black background.

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TAXIWAY ENDING MARKER

Indicates that a taxiway does not continue beyond an intersection.

VEHICLE ROADWAY SIGNS

Signs that are intended only for ground vehicle operators. At airports with ATC towers, install "DO NOT PROCEED CONTACT ATC" signs on vehicle roadways. When a service road intersects a taxiway, install a "STOP/DO NOT PROCEED CONTACT ATC" sign. Signs indicating aircraft clearance requirements and jet blast warnings may be necessary.

SIGN LOCATIONS & CONVENTION

Determining where signs should be installed is a matter of careful analysis and knowledge of airport operations. As already mentioned, safety is priority and should govern these decisions. The following list is of general guidelines for sign placement:

1. Signs are placed on the left side of the taxiway as seen by the pilot of the approaching aircraft, unless otherwise stated. Signs may be placed on the right side of the taxiway to meet clearance requirements or if terrain or other objects conflict.
2. Holding position signs should be placed on any taxiway that access a runway and, a runway that intersects another runway.
3. Some signs may have sign panels on both sides, such as RSA/OFZ boundaries and holding position signs.
4. No signs should be installed between the taxiway runway holding position sign and the runway.
5. If necessary, place holding position signs to protect critical areas, such as the ILS boundary, POFZ, RSA, navigation signals, approach & departure areas, etc.
6. Taxi location signs should be installed where taxiways intersect runways.
7. Taxiway direction and location signs should be located before each taxiway-taxiway intersection if an aircraft is expected to turn or hold short of the intersection.
8. Runway exit signs should be installed for each runway exit.

9. Information signs should not be co-located with mandatory instruction, direction, location, or destination signs.
10. Stop and yield signs should be installed at vehicle roadways where they intersect a runway or taxiway.
11. At complex or low-visibility intersections, signs can be installed on the far side of the intersection so pilots can confirm that the correct turn has been made.
12. On a sign face, a dot means "and", such as when one arrow is common to two destinations.
13. Only mandatory instruction signs use a dash, which designates opposite runway ends.
14. If a sign panel needs to be replaced, the entire message element should be replaced to avoid panel color changes.
15. Signs may be angled toward a pilot's line of vision if necessary to improve visibility.
16. Holding position signs for runways, ILS critical areas CAT II/III, runway exit signs, approach/departure areas, and their associated taxiway location signs are illuminated when the associated runway lights are illuminated. Other taxiway guidance signs are illuminated when the associated taxiway lights are illuminated. Lighted signs are installed with a power source that will ensure consistent illumination and eliminate varying illumination when runway/taxiway lights are activated at all brightness steps.
17. If signs cannot be installed or there is a need for additional guidance, information may be painted on the pavement.

SIGN SIZE & CLEARANCES

Sign size selection is based on the following table from AC 150/5340-18G. Aircraft clearance, jet blast, and snow removal operations must be taken into account. A minimum of 12 inches of clearance is required between the top of a sign and any part of the most critical aircraft at that airport when the aircraft's wheels are at the edge of the pavement.

| Sign Size	Legend Height [inches (cm)]	Legend Panel Height [inches (cm)]	Installed (max.) * [inches (cm)]	Perpendicular distance from defined pavement edge to near side of sign [feet (m)]
1	12 (30)	18 (46)	30 (76)	10-20 (3-6)
2	15 (38)	24 (61)	36 (91)	20-35 (6-10.5)
3	18 (46)	30 (76)	42 (107)	35-60 (10.5-18)

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INSTALLATION REQUIREMENTS

Signs are to be installed on a concrete slab, concrete pedestals, or angle iron stakes. The top of the sign must be level. The concrete or iron stakes may not protrude above grade. Sign faces should be perpendicular to the centerline of the adjacent taxiway or runway, except where angling the sign is necessary. The mounting legs must be frangible, and breakaway connectors must be installed for wiring at the sign (refer to AC 150/5340-30 *Design and Installation Details for Airport Visual Aids* and AC 150/5220-23 *Frangible Connections* for further details).
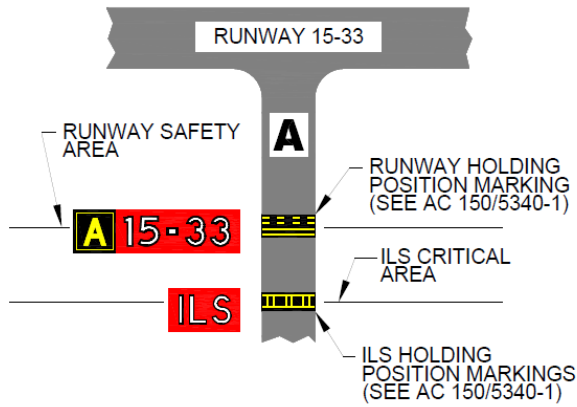
SIGN PLACEMENT EXAMPLES
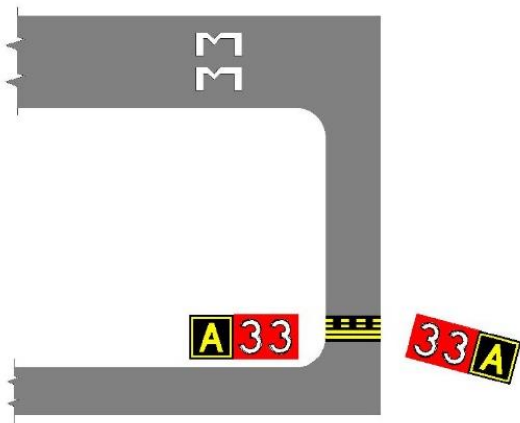
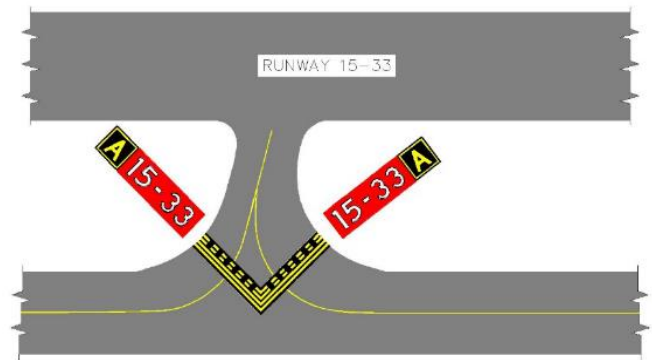*Taxiway Holding Position Signs*
(Note angled sign for visibility)
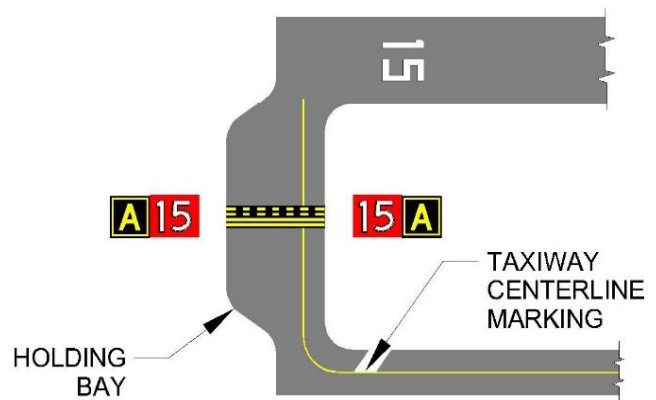
Holding Position Signs
Extending Across Holding Bay

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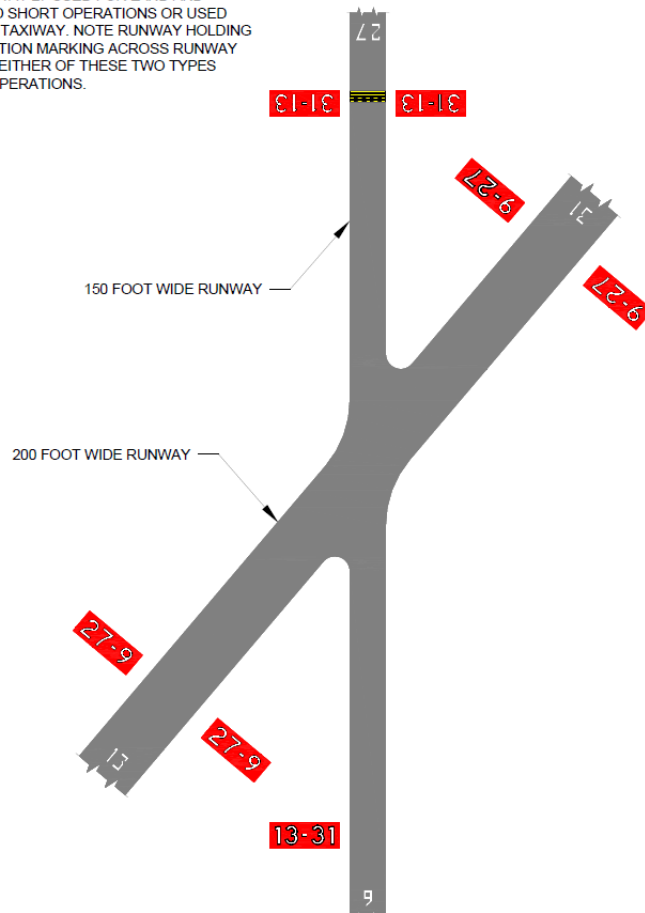*A SunCam online continuing education course*

ILS Holding Position Sign Req'd

*Holding Position Signs
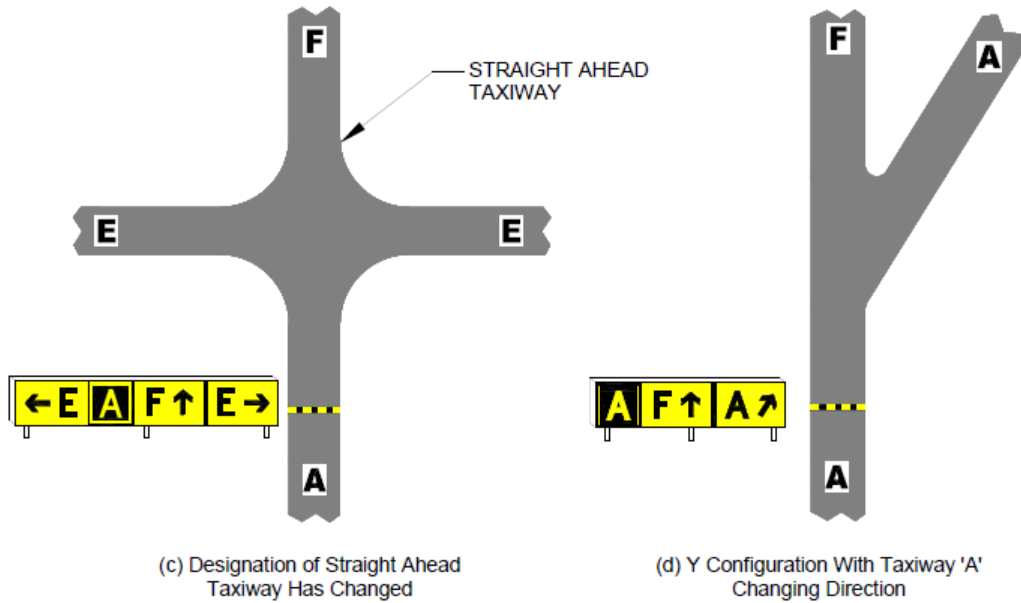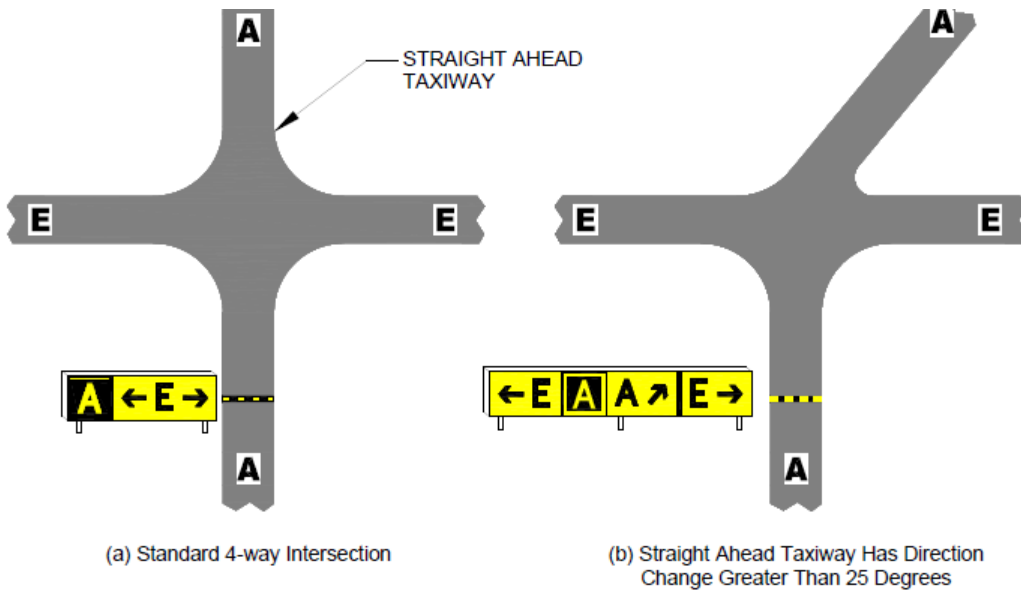Do Not Extend Across Taxiway*

Holding Position Signs at Runway/Runway Intersections

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(a) Standard 4-way Intersection

(b) Straight Ahead Taxiway Has Direction
Change Greater Than 25 Degrees

(c) Designation of Straight Ahead
Taxiway Has Changed

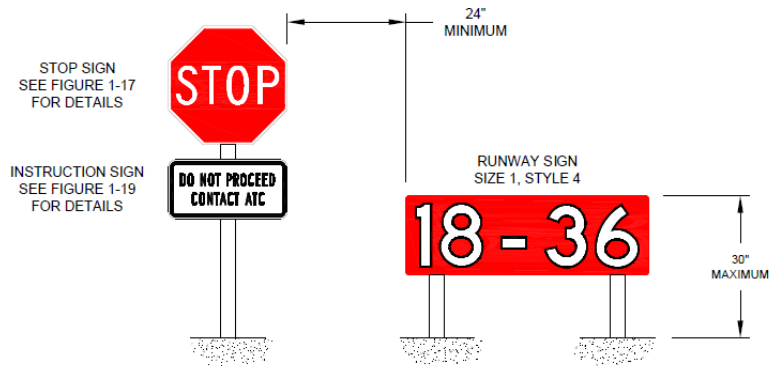(d) Y Configuration With Taxiway 'A'
Changing Direction

Taxiway/Taxiway Intersections

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INTERMEDIATE HOLDING POSITION
FOR TAXIWAY/TAXIWAY INTERSECTION
SEE AC 150/5340-1

Taxiway Ending Marker

STOP SIGN
SEE FIGURE 1-17
FOR DETAILS

INSTRUCTION SIGN
SEE FIGURE 1-19
FOR DETAILS

24"
MINIMUM

RUNWAY SIGN
SIZE 1, STYLE 4

30"
MAXIMUM

ROADWAYS INTERSECTING RUNWAYS

STOP SIGN
SEE FIGURE 1-17
FOR DETAILS

INSTRUCTION SIGN
SEE FIGURE 1-19
FOR DETAILS

24"
MINIMUM

30"
MAXIMUM
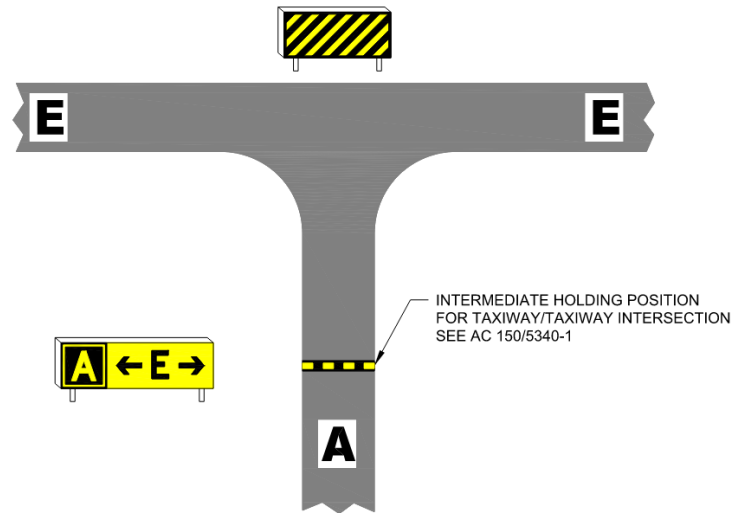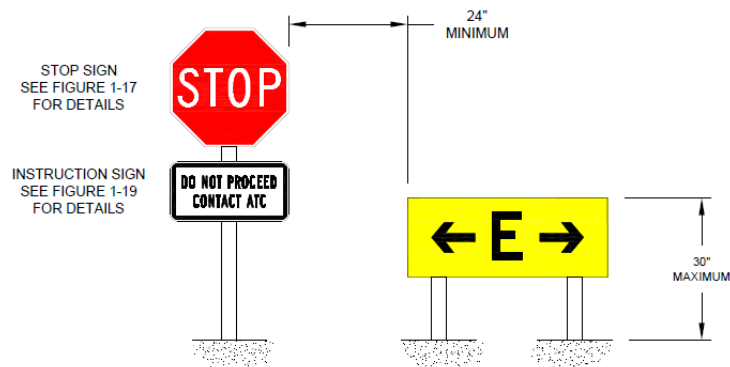
ROADWAYS INTERSECTING TAXIWAYS

Vehicle Roadway Signs

Airport Markings

SAFETY ASPECTS

When surfaces are painted, the friction coefficient generally decreases, causing a hazard for moving or braking aircraft and vehicles. To increase the friction coefficient, epoxy and methyl acrylate based paint should be coated with silica sand on the marked surface immediately after painting. Glass beads applied to the paint at a prescribed rate is also another method to increase friction. Glass beads also make the markings more conspicuous, which is an additional benefit. Preformed thermoplastic surface markings are strictly prohibited on runways due to very low friction coefficients. Reflective tapes are not to be used because of FOD potential.

However obvious it may be, airport markings must be able to be seen. To increase the contrast between the marking and the surface, markings can be outlined with black borders. Glass beads should not be used in black paint. This table guides engineers on which surface black borders are necessary:

Pavement Surface Type	Age of Pavement Surface [1]		
	New	Up to 2 years old	Over 2 years old
Portland Cement Concrete	Yes	Yes	Yes
Asphalt Concrete	No	No	Yes
Asphalt Treated	No	No	Yes

Note 1: This table serves only as a general guide since an existing asphalt pavement at one airport location may not experience the same rate of surface color deterioration as at another airport location.

Black borders should be 6 inches wide (minimum) except for taxiway centerlines, which can range from 3-6 inches. The following markings require black borders:

Runway centerlines
Runway thresholds
Runway displaced thresholds
Runway aiming points
Runway landing designators
Runway touchdown zones
Holding position markings
Intermediate holding positions for TW/TW intersections
Taxiway centerline markings
Geographic position markings
Non-movement area boundaries

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RUNWAY MARKINGS

Runway markings depend largely on the runway approach category: visual, non-precision, or precision. Additional features such as blast pads, displaced thresholds, and stopways add additional marking requirements. Appendix B presents runway marking plans for all three runway approach categories. Minimum surface marking schemes are specified in this table:

Runway Surface Marking Scheme	Threshold Approach Category		
	Visual Approach	Non-precision Approach (and approaches with vertical guidance not lower than ¾ - statute mile visibility)	Precision Approach (Approaches with lower than ¾ -statute mile visibility)
Landing Designator (par. 2.3)	X	X	X
Centerline (par. 2.4)	X	X	X
Threshold Markings (par. 2.5)	Note 1	X	X
Aiming Point (par. 2.6)	Note 2	Note 3	X
Touchdown Zone (par. 2.7)			X
Edge Markings (par. 2.8)	Note 4	Note 4	X

Note 1: Required on runways serving approach categories C and D airplanes and for runways used, or intended to be used, by international commercial air transport.
Note 2: Required on 4,200-foot (1,280 m) or longer runways serving approach categories C and D airplanes.
Note 3: Required on 4,200-foot (1,280 m) or longer instrumented runways.
Note 4: Used when the full runway pavement width may not be available for use as a runway.

A runway **landing designator** is the runway number. Parallel runways are supplemented with a letter: L (Left), C (Center), or R (Right). Numbers and letters on runways have specific dimensions, placement, and spacing. The figure on the next page details the sizes and shapes.

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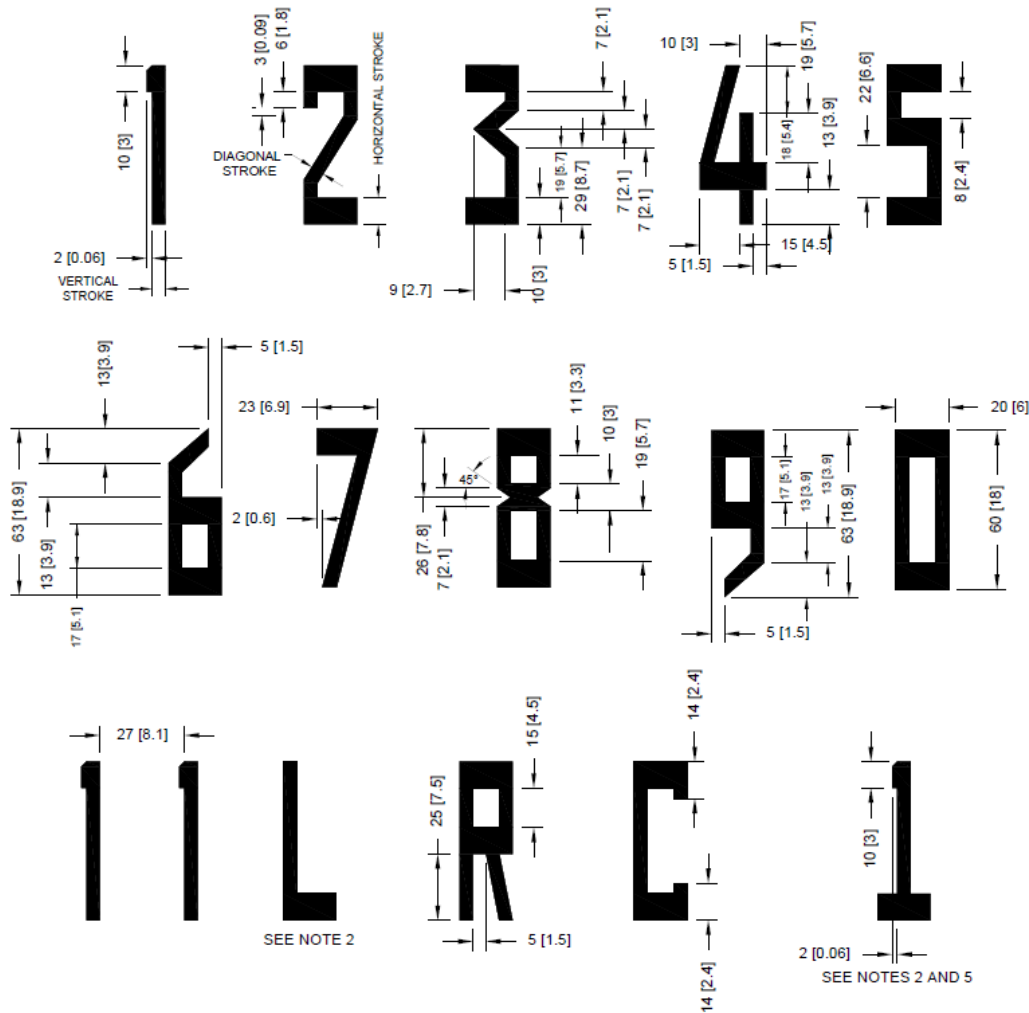
Notes:

1. Dimensions are expressed in feet (meters).
2. All characters have these characteristics (unless otherwise specified):
   - 60 [18] high
   - 20 [6] wide
   - vertical stroke of 5 [1.5]
   - horizontal stroke of 10 [30]
   - diagonal stroke of 5 [1.5]
3. All numerals except the number eleven as shown are horizontally spaced 15 [4.5] apart.
4. Single digits must not be preceded by a zero.
5. The numeral "1", when used alone, contains a horizontal stroke, as shown, to differentiate it from the runway centerline marking.
6. Single designations are centered on the runway pavement centerline. For double designations, the center of the outer edges of the two numerals is centered on the runway pavement centerline.
7. Where the runway designation consists of a number and a letter, the number and letter are located on the runway centerline in a stacked arrangement as shown in <u>Figure A-1</u>.

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Runway **centerline markings** are located in the physical center of the runway width and provide alignment guidance to pilots during takeoff and landing. RW centerlines are white dashed lines that extend between runway designators. Stripes are 120 feet long and the gaps are 80 feet in length. Minimum stripe width is 36 inches for precision runways, 18 inches for non-precision runways, and 12 inches for visual runways.

Since runways may not be exactly a multiple of the stripe and gap lengths, adjustments to the uniform pattern are made near the midpoint of the runway. Stripes may be reduced to 80 feet and gaps must be at least 40 feet in length within this section.

Threshold markings are white stripes that identify the formal beginning point of the runway when used for landing. Recall a takeoff run may start behind the threshold. Threshold markings actually start 20 feet beyond the point of the threshold, even when a transverse 10 foot threshold bar is used. The number of longitudinal strips is based on runway width:

Standard runway widths	Number of symmetrical stripes
60 feet (18.3 m)	4
75 feet (22.9 m)	6
100 feet (30.5 m)	8
150 feet (45.7 m)	12
200 feet (61 m)	16

Runway **aiming points** are large symmetrical white rectangles that give pilots a visual place to land on the runway. Dimensions vary, depending on runway length and width. Placement of aiming points is specified at 1,020 feet from the runway threshold.
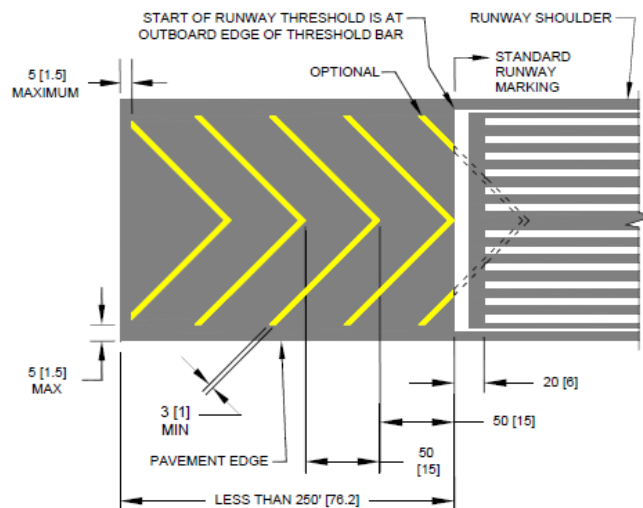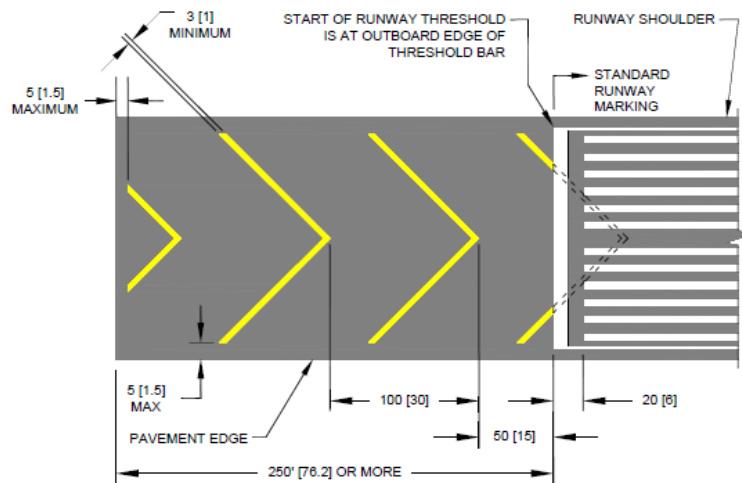
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Touchdown zone markings identify the touchdown zone on a precision runway. Spacing is 500 feet between the markings, which are white rectangles. 1,800 feet of area is left unmarked at the midpoint of the runway. Further details regarding location and dimensions are specified in AC 150/5340-1M.

Runway **edge markings** create contrast to delineate the runway edge from the adjacent terrain and runway shoulders. Edge stripes are white, with the outer side of the line located at the edge of the paved useable runway. Width varies from 18 inches (runways less than 100 feet wide) to 36 inches wide (runways wider than 100 feet). Edge markings should extend the entire length of the runway. Note that when two runways intersect, surface markings are completely intact for one runway, while the other is fully interrupted. Whichever runway has higher order of precedence dominates, based again on approach category.

Chevrons are wide yellow arrows that identify blast pads and stopways that are in line and contiguous to the runway end. Chevron angles are 45° to the runway centerline.

Displaced thresholds require several markings, namely arrows and demarcation bars. Arrows (with or without shafts) are located on the part of the runway preceding the displaced threshold. A demarcation bar delineates the start of the runway from a blast pad, stopway, or an aligned taxiway that precedes a runway. The next image shows a common displaced threshold scenario with the necessary markings; know that there are other layouts that necessitate arrows, such as an aligned taxiway, which is a rare case.
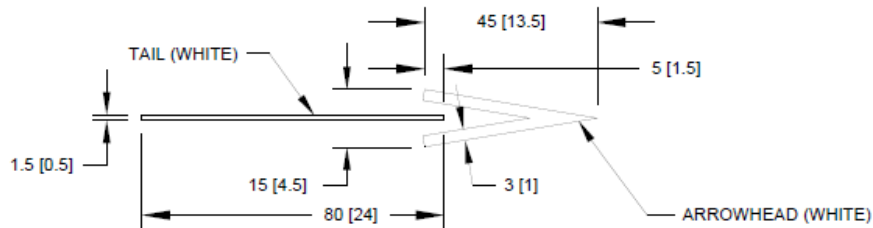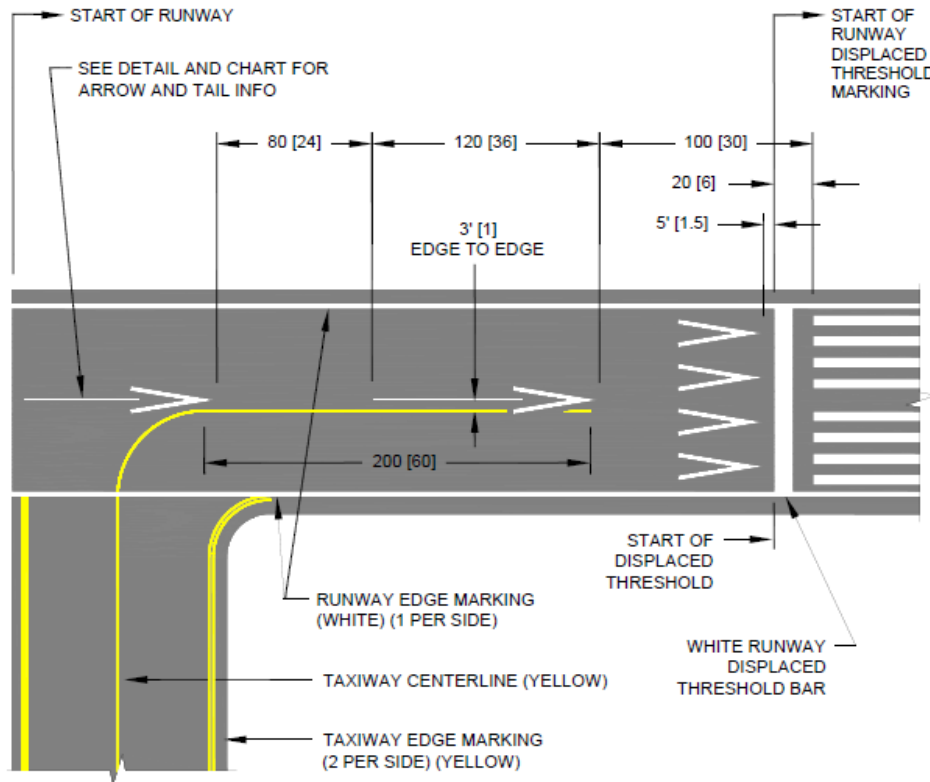

| RUNWAY WIDTH	NUMBER OF ARROWHEADS	SPACING BETWEEN ARROWHEADS (W = RUNWAY WIDTH)	SPACING TO RUNWAY EDGE
≥ 100 [30]	4	W/4	W/8
< 100 [30]	3	W/3	W/6
< 60 [18]	2	W/2	W/4

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HOLDING POSITION MARKINGS

Holding positions keep aircraft and vehicles from entering protected areas. Before an aircraft taxis onto a runway, it needs to hold short at the holding position marking. Land and hold short operations require a landing aircraft to stop before crossing an intersecting runway. Other situations requiring hold short include entering an ILS, POFZ, approach/departure areas, and taxiway intersections:
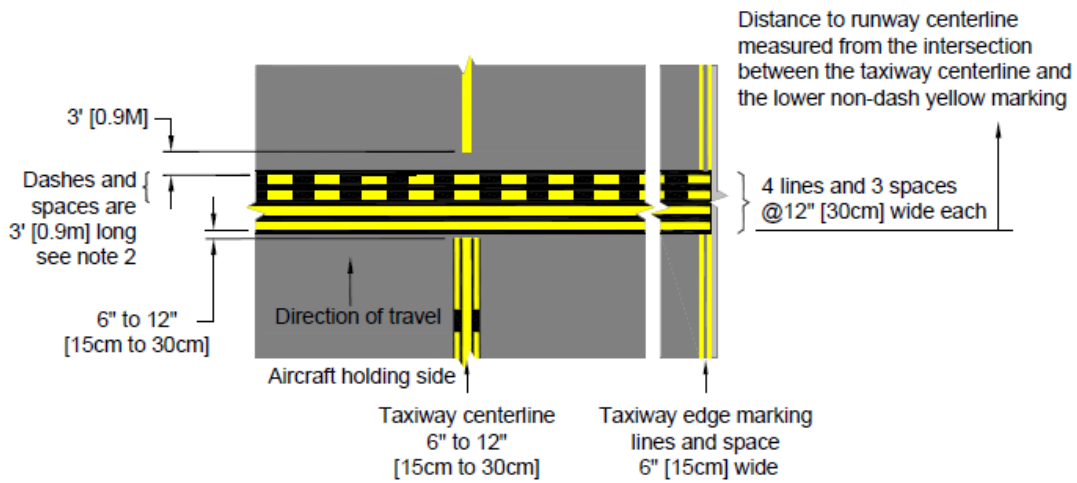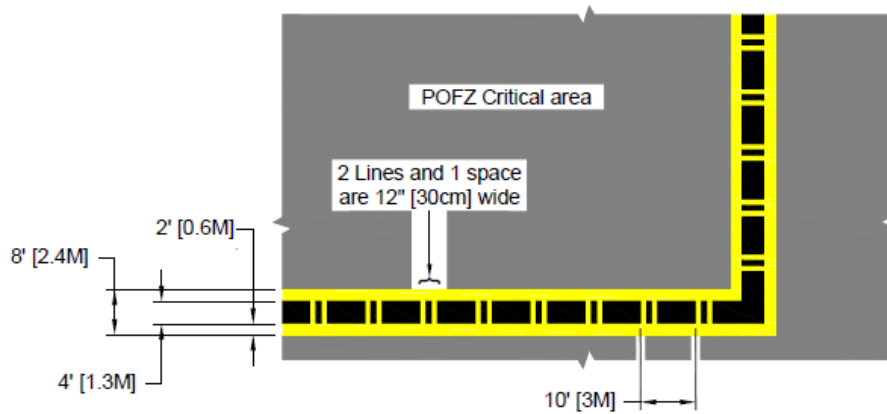

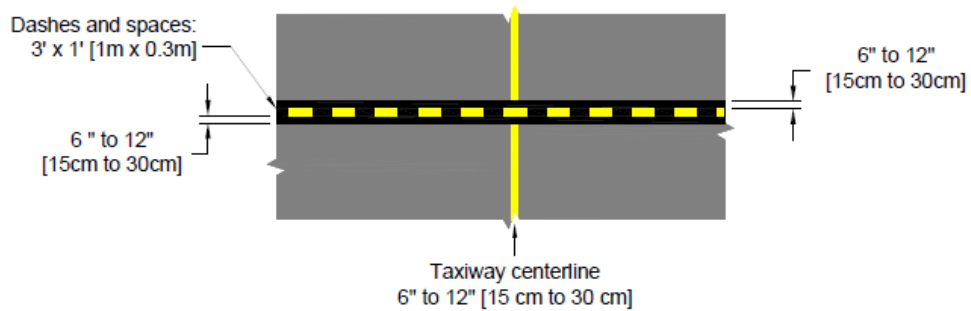

Pattern A - Runway Holding Position Marking
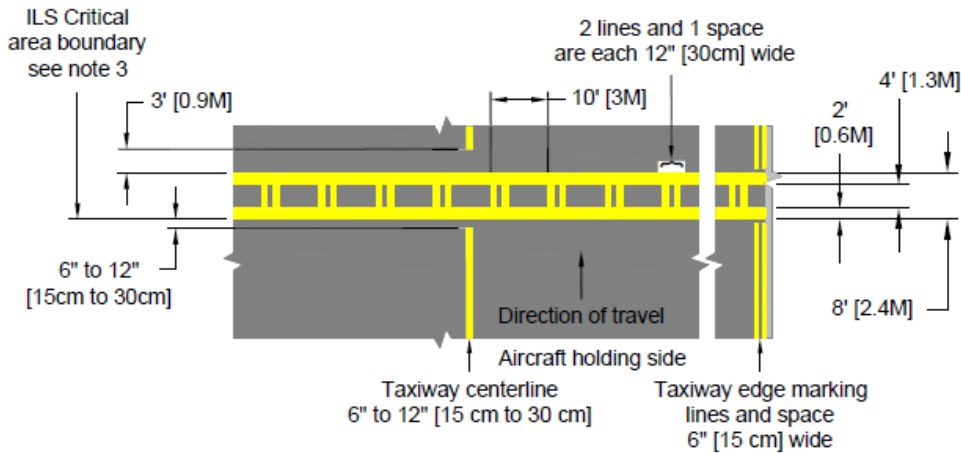
Pattern B - ILS Holding Position Marking

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POFZ Critical area

2 Lines and 1 space
are 12" [30cm] wide

2' [0.6M]

8' [2.4M]

4' [1.3M]

10' [3M]

Pattern B - POFZ Marking

Dashes and spaces:
3' x 1' [1m x 0.3m]

6" to 12"
[15cm to 30cm]

6 " to 12"
[15cm to 30cm]

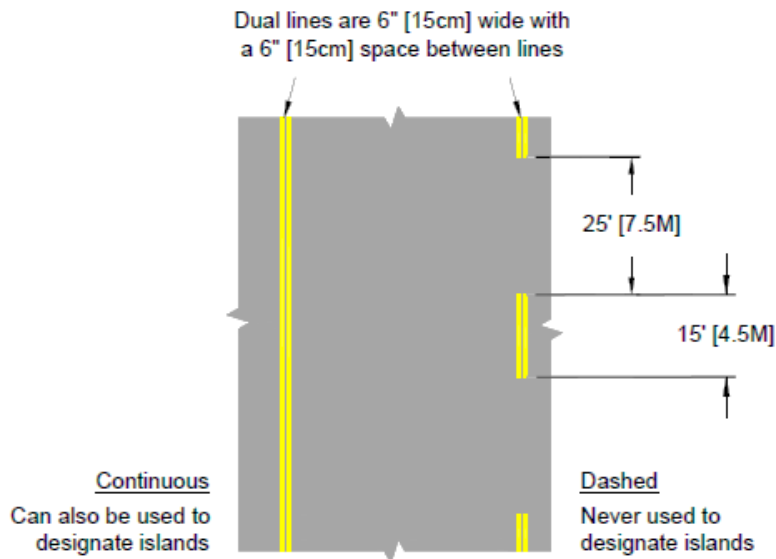Taxiway centerline
6" to 12" [15 cm to 30 cm]

Pattern C - Intermediate Holding Position Marking for Taxiway/Taxiway Intersections
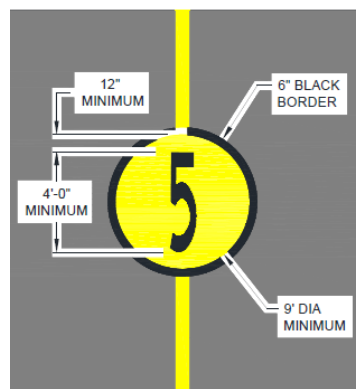
TAXIWAY MARKINGS

All taxiways have the common feature of a yellow **centerline**, regardless of width. Centerlines give pilots continuous guidance while taxiing, and should follow conventional cockpit-over-centerline steering paths. Line width is 6 inches or 12 inches, based on whether the taxiway is part of a designated taxi route. Centerline should be continuous except where intersecting a holding position marking or non-movement area marking. Glass beads must be used on taxiway centerline markings.

Taxiway **edge markings** are only necessary when there is a need to delineate the edge of the taxiway when it is not visible or obvious, such as when adjacent to a parking apron. Edge markings are yellow, 6 inches wide, and may be a dual continuous or dashed line.


Apron control markings are optional markings used to simplify communications between ATC, pilots, and ground vehicle operators. Circle or triangle shapes are recommended, which are placed near or directly over a taxiway centerline:

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OTHER SURFACE MARKINGS

Vehicle roadway markings are used to define a pathway for vehicle operations in areas used by aircraft. Vehicle roadways should conform to USDOT specifications where possible. Edge lines, dashed lanes, and stop lines are all white. Stop lines should be placed where vehicle traffic meets or crosses a taxi route. Example roadway markings are shown here:
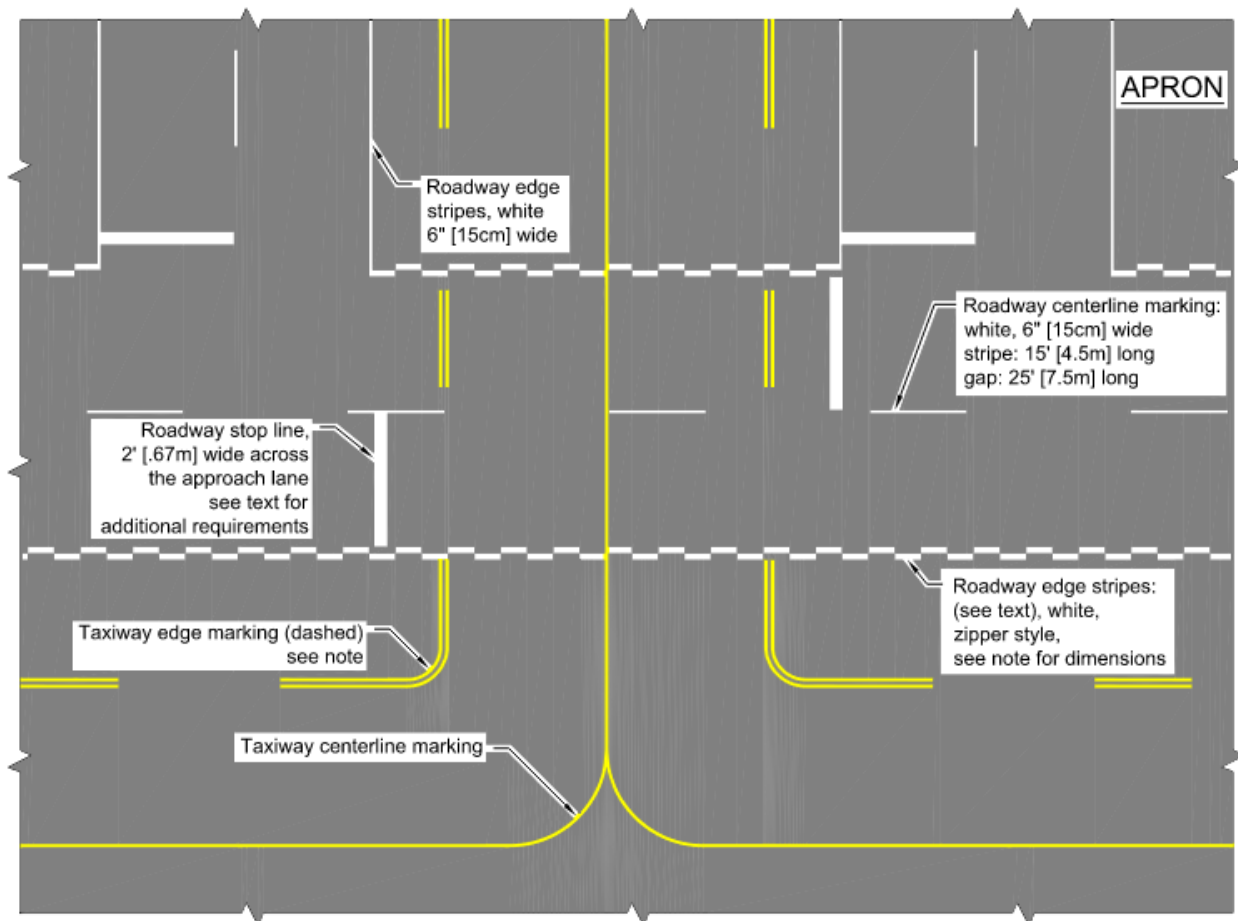
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VOR receiver checkpoints are used by pilots to confirm aircraft instruments by using NAVAID signals. The checkpoint marking is a painted circle with an arrow that aligns with the direction of the VOR station. Location is preferred to be on an apron or taxiway, and never on a runway. The checkpoint location should not cause an aircraft to obstruct other airport traffic while checking instruments.
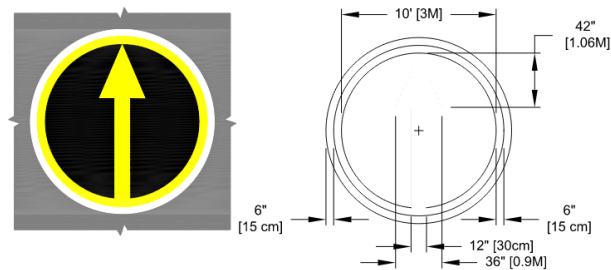
Non-movement area boundaries separate the movement areas (controlled by ATC) with the non-movement areas (not controlled by ATC). If an airport does not have a control tower, the non-movement area boundary delineates parking areas, terminals, vehicle traffic, etc. These markings are dashed/solid yellow and should never coincide with the edge of a taxiway.
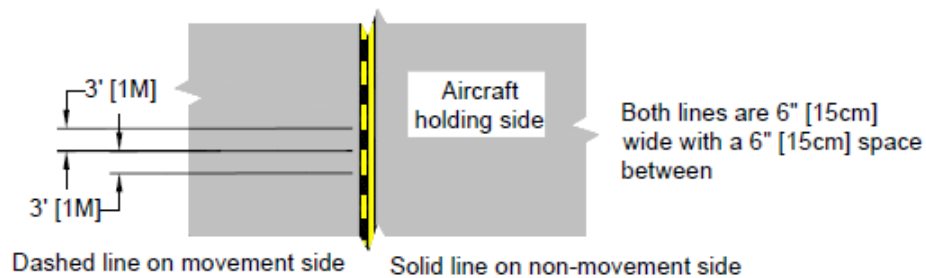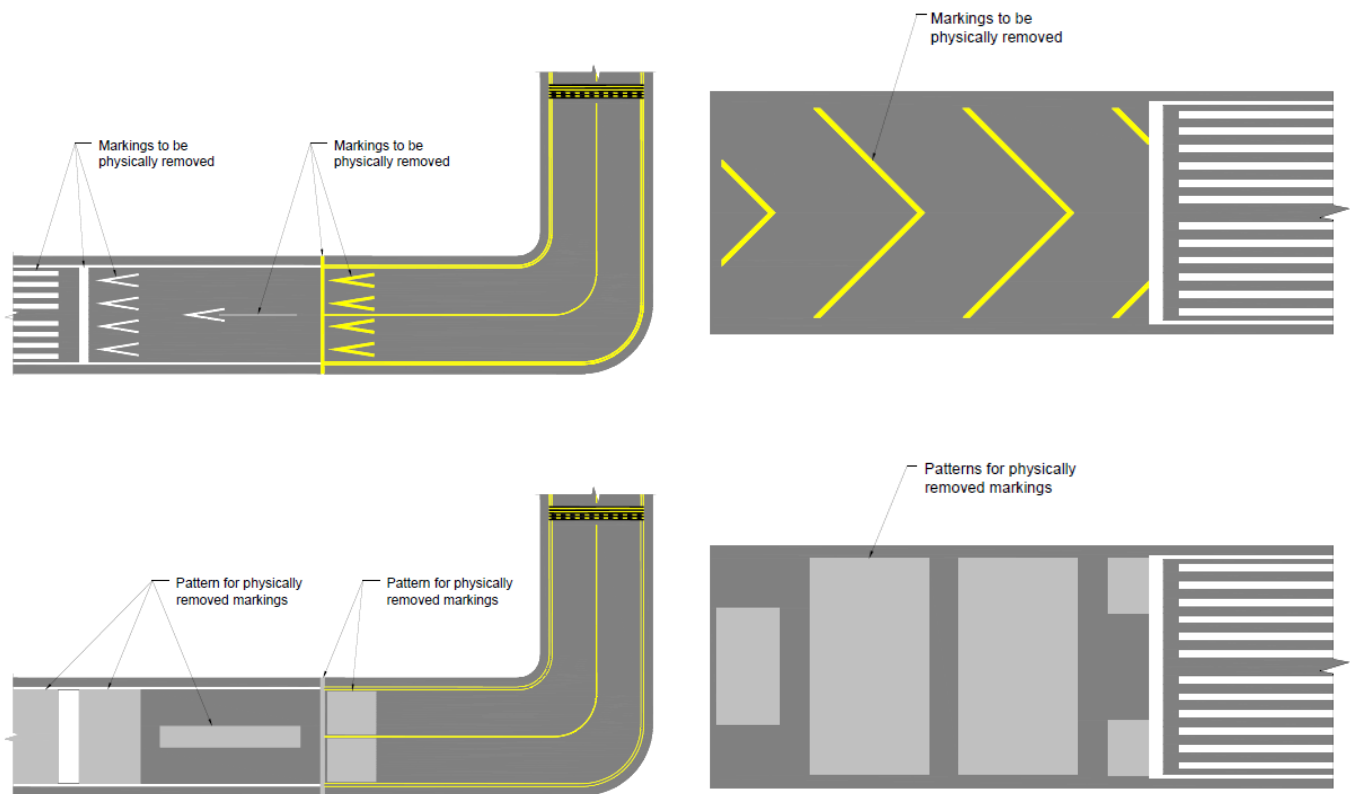
There are also specific markings for temporary closed runways and taxiways, as well as closed or abandoned airports. Deicing facilities, heliports, and construction areas also have marking requirements. Refer to AC 150/5340-1M for details.

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MARKING REMOVAL

When markings are no longer needed they should be physically removed, not painted over. Methods for removal range from media blasting (water, shot, sand) or chemical removal. The pavement should not be harmed during the removal process. The pattern of removal should be rectangular shaped and larger than the actual painted area(s). If there are multiple markings in an adjacent area, the group should be combined into one large rectangular removal region. The following images from AC 150/5340-1M visually demonstrates this:

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Markings to be physically removed

Pattern for physically removed markings

Markings to be physically removed

Pattern for physically removed markings

Markings to be physically removed

Pattern for physically removed markings

Markings to be physically removed

Pattern for physically removed markings

Markings to be physically removed

Pattern for physically removed markings

Markings to be physically removed

Pattern for physically removed markings

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Markings to
be physically
removed

16-34   16-34

Markings to be
physically
removed
(typical)

Pattern for
physically
removed
markings

Pattern for
physically
removed
markings

16-34   16-34

Relocated runway
holding position and
surface painted
holding position
markings

Appendix A: Destination Sign Abbreviations

APRON - general parking, servicing, and loading areas

RAMP - synonymous with apron

FUEL - areas where aircraft are fueled or serviced

TERM - gate positions at which aircraft are loaded or unloaded

CIVIL - areas set aside for civil aircraft

MIL - areas set aside for military aircraft

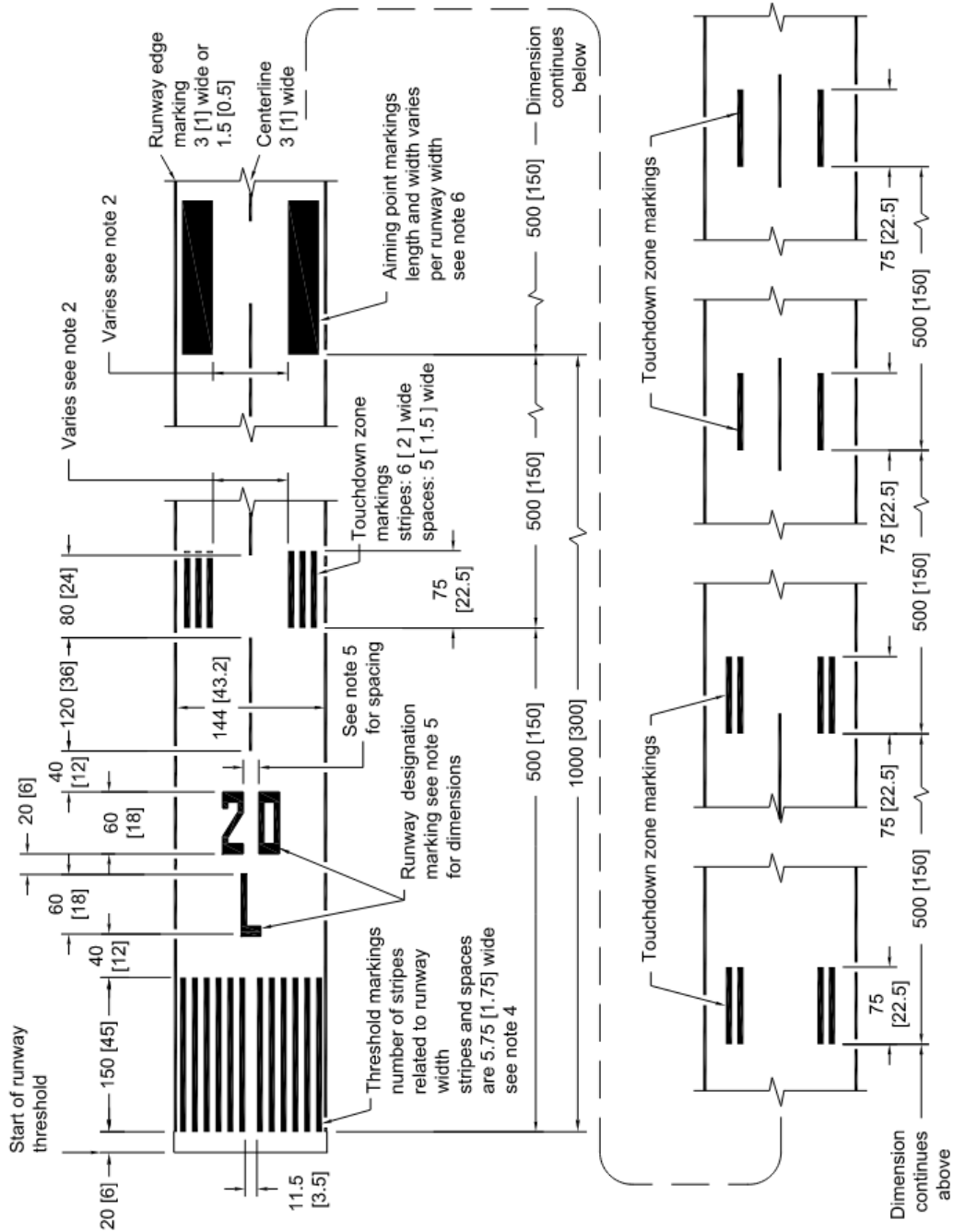**PAX -** areas set aside for passenger handling

CARGO - areas set aside for cargo handling

INTL - areas set aside for handling international flights
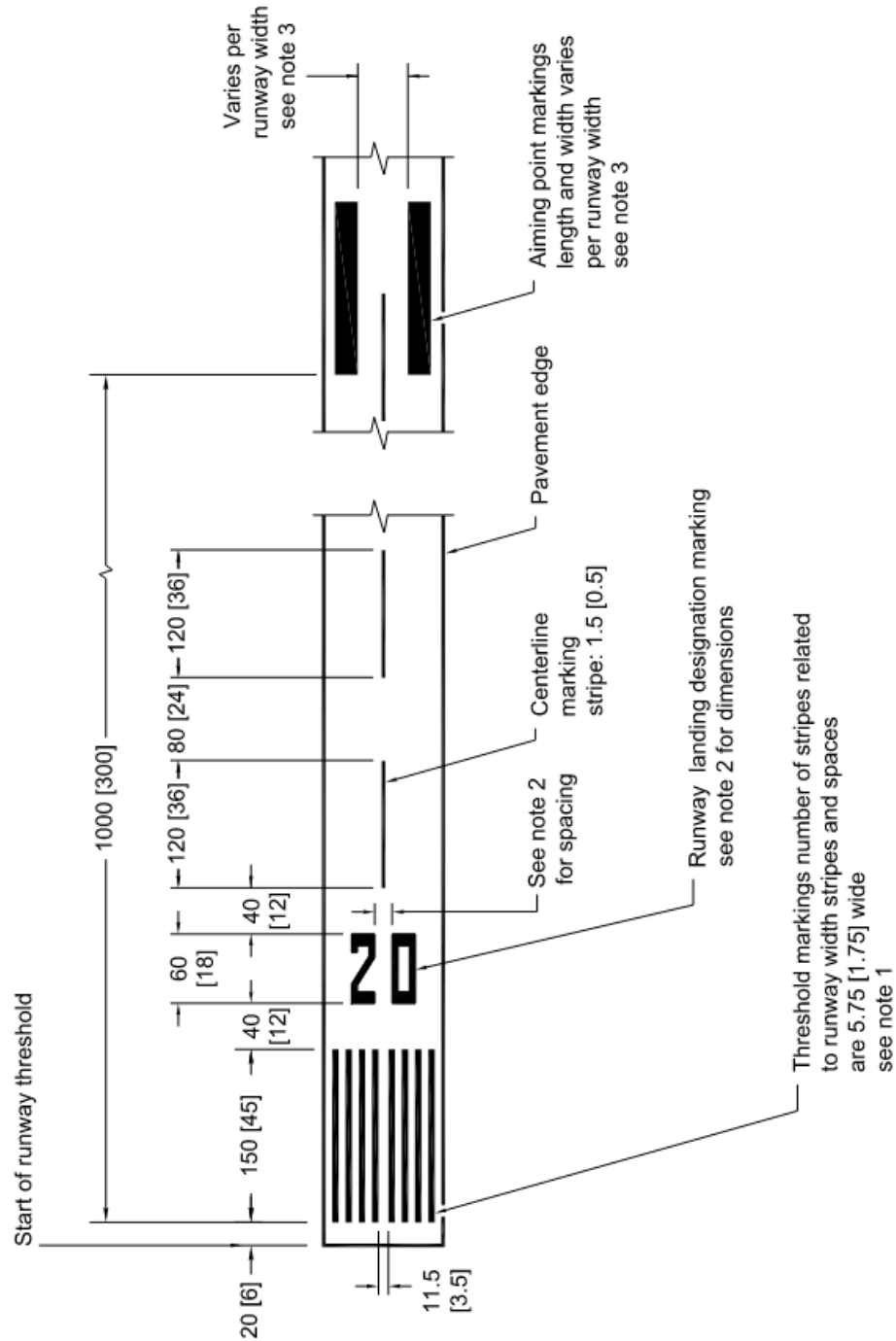
FBO - fixed-base operator
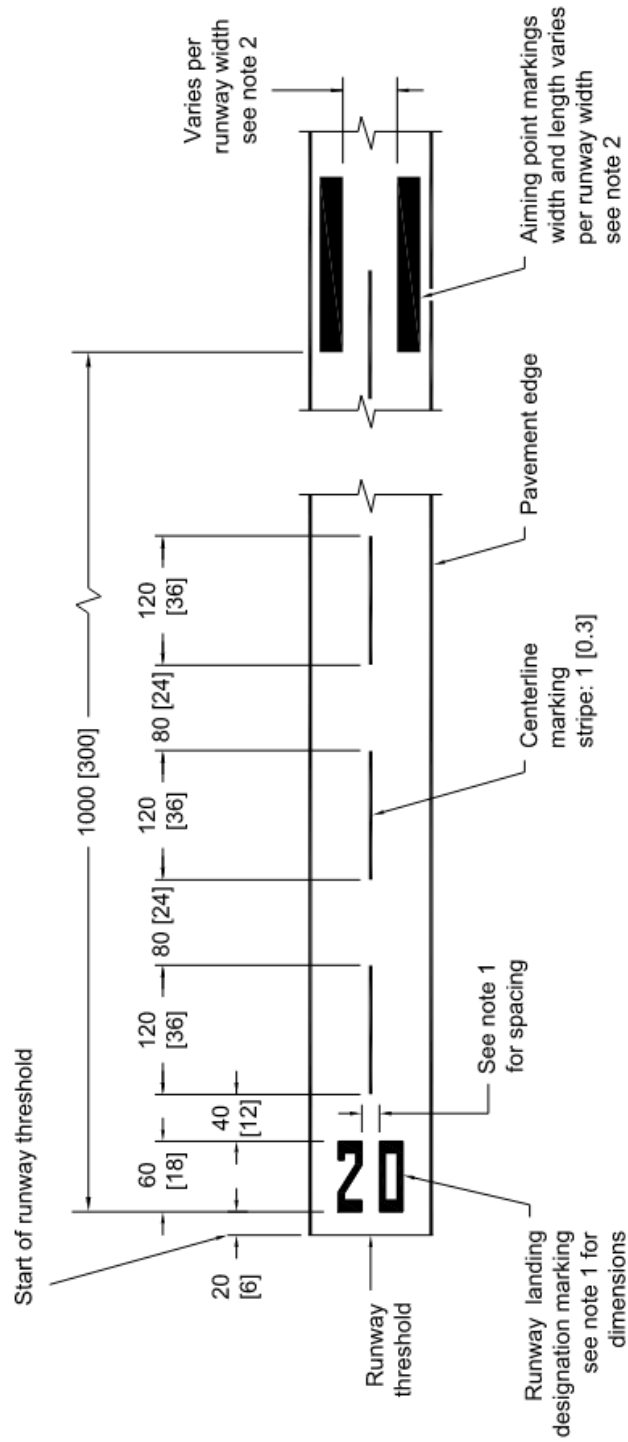
Appendix B: Runway Marking Plans

Precision Runway Markings

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Non-Precision Runway Markings

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Varies per
runway width
see note 2

Aiming point markings
width and length varies
per runway width
see note 2

Pavement edge

1000 [300]

120
[36]

80 [24]

120
[36]

80 [24]

120
[36]

Centerline
marking
stripe: 1 [0.3]

See note 1
for spacing

Start of runway threshold

40
[12]

60
[18]

20
[6]

20

Runway
threshold

Runway landing
designation marking
see note 1 for
dimensions

Visual Runway Markings

Airport Engineering - Part III
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Reference Material

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