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HOW A RUNWAY EARNS ITS STRIPES

Taking the mystery out of airport sign language

As a student pilot trainee at Long Island's Mac Arthur Airport (KISP) in Islip, NY, my introduction to navigating around an airport was eye-opening, to say the least. Besides reviewing my newly purchased Cessna 152 manual in the early days of my training, I was also instructed to become thoroughly familiar with the KISP airport diagram. The task seemed manageable, but on my first few flights I was more intent on listening for my call sign and straddling the yellow taxi line than trying to decipher the array of multi-colored lines, letters, and numbers all clamoring for my attention.

Thankfully, my instructor threw me a lifeline and spent time helping me make sense of the airport's sprawling expanse of taxiways, runways, and ramp areas. With four runways and air carrier jets taxiing to and fro, I quickly learned that KISP was no place to wind up somewhere you weren't supposed to be.

Despite that initial intimidation, I soon felt comfortable taxiing my way safely around the airport and was glad I invested extra time to learn the ins and outs of airport sign language. However, as I have learned after several periods of inactivity, keeping yourself up to snuff on airport signage shouldn't be limited to just your primary flight training days. With an average of three runway incursions (RI) each day in the United States, along with the occasional change to taxi clearances and airport markings, it's always a good idea to regularly review airport surface operations and regard them with the same importance as any other phase of flight.

Expect the Unexpected

With the excitement of the destination in your head, the chatter of anxious passengers, and the ubiquitous changes that crop up, it's understandable that pilots can become distracted and sometimes complacent during taxi. Throw in an unexpected taxi clearance, some marginal weather, and/or a heavy amount of aircraft activity, and you've got a recipe for a potentially deadly runway incursion on your hands.

Take, for example, the following narrative from the FAA's Daily Event Report on pilot deviations (PD) that shows just how close a disoriented Cessna came from being an accident statistic:

At Collin County Regional Airport (KTKI) in McKinney, TX, a Cessna 172 pilot was issued taxi instructions to Runway 35 via Taxiway Alpha which was read back correctly. The C172 taxied off the ramp, failed to make the turn southbound on Alpha, and taxied instead across Alpha. The Cessna then crossed the hold short line on Taxiway Delta for Runway 35 and came in conflict with another Cessna coming in for a touch and go on the same runway. In this case, the closest horizontal separation reported was less than 100 feet.

The good news is that preparation and a solid knowledge of airport signage can significantly mitigate the risk in these types of situations—even at airports with more taxiways than letters in the alphabet. Although it may seem like there are an infinite number of differences between airports, you'll find that markings, signage, and lights are similar and standardized, and used even more consistently than the road signs you might see on your drive to the airport. And for those who may think you know all there is to know about signage and markings, I encourage you to read on. You'd be surprised to learn how a clear majority of RIs are caused by a simple mistake with the basics of airport navigation.

Crossing the Line

There are a series of different painted airport markings that can help pilots safely navigate and identify different elements of an airfield. Let's start with taxiways, which use a continuous yellow centerline stripe and may include edge markings. Double dashed edge markings mean a pilot can use that shoulder portion of the adjoining pavement (e.g. an apron), while a continuous double line defines a boundary that should not be crossed.

While taxiing, you may also encounter several types of hold short position markings, all of which deserve careful attention. The first is a taxiway holding position marking, which is a single dashed yellow line usually found before the intersection of another taxiway. ATC may direct you to hold short here depending on the amount of traffic at your airport. Another is the holding position markings for Instrument Landing System (ILS) critical areas, which resemble a horizontal ladder and span the width of the taxiway.

Then there is the runway holding position marking, which is by far one of the most critical markings on the airport. Sadly, however, it is also one of the most misunderstood and/or overlooked markings as indicated by their mention in hundreds of runway incursion reports each year. In fact, an FAA analysis of runway safety quiz scores administered during Flight Instructor Refresher Courses (FIRC) in 2010 showed only 66 percent of the quiz takers were able to correctly identify the hold short line marking. While the FAA's education campaign on hold short lines has successfully increased awareness of this critical marking in recent months, it remains an important focus item.

To review, a runway holding position marker is a combination of four yellow lines, two solid and two dashed. The dashed lines face the runway while the solid lines are on the taxiway side. When approaching the runway, do not cross the runway holding position marking without ATC clearance at a controlled airport, or without making sure of adequate separation from other aircraft at uncontrolled airports. A memory aid I've found helpful is to "stop for solid, dash through the dashes."

To further alert a pilot that he or she is approaching a runway safety area, all part 139 airports now use enhanced taxiway centerlines. These enhanced taxiway lines are dashed lines on either side of the centerline 150 feet from the holding position marking. (see Fig. 1) You may also see surface painted holding position markings with a red background and white inscription. These markings are designed to supplement the signs at a holding position and are usually found where the holding position on the taxiway is greater than 200 feet.

One final note on hold short lines: with intersecting runways at an airport, you may also see holding position markings on the runway when it is used for Land and Hold Short Operations or taxiing operations. If ATC clears you to a land on a runway without specific instructions to hold short of an intersecting runway, you are cleared to use the entire runway length and disregard any holding position markings on the runway.

Photo by Susan Parson

Figure 1. As you can see here, the enhanced taxiway centerlines provide an important warning that you are approaching a holding position marking.

The More Paint, the More Precise

Once you cross onto the runway, several more markings can provide pilots with helpful information on runway size as well as what type of approaches are used. There are three types of markings for runways: visual, non-precision instrument, and precision instrument. Simply put, the more paint on the runway, the more precise operations you'll have. For instance, a basic VFR runway may only have centerline markings and runway numbers. Runways with a non-precision approach add on a threshold and aiming point markings, which are two white stripes 1,000 feet from the threshold that can serve as a helpful reference point for landing aircraft.

A precision instrument runway contains all the above, plus side stripes that delineate the edge of the runway, and touchdown zone markings, which are rectangular white bars that aid in instrument landings and are coded to provide distance information in 500 foot increments. See Fig. 2 for examples.

Beside helping identify the beginning of a runway that is available for landing, the long white threshold markings (depending on which of the two configurations is used) can also indicate to pilots the width of certain runways. One layout just uses eight parallel stripes, while the number of stripes used in the other corresponds directly with runway width. In this latter case, four stripes equals 60 feet, six stripes equals 75 feet, eight stripes is 100 feet, 12 stripes is 150 feet, and lastly, 16 stripes is used for a 200-foot wide runway.

It's also worth noting that because of an obstruction or construction near the end of a runway, a threshold may be relocated or displaced. When relocated, the threshold not only closes a set portion of the approach end, but also shortens the length of the opposite direction runway. A displaced threshold reduces the runway length available for landing, however, this area can be used for taxiing, takeoff, or landing rollout from the opposite direction.

Here's Your Sign…

In conjunction with surface markings, there are six types of signs you'll find at an airport: mandatory, location, direction, destination, information, and runway distance remaining. Each plays a specific role in providing pilots and vehicle operators with the information and directions they need to safely navigate around an airport. Fig. 3 shows examples of each sign and their purpose.

A few helpful memory aids when it comes to deciphering signs include: "Black square, you're there" for a location sign, "Yellow array points the way" for a direction sign, and "Red and white, runway's in sight" for a runway holding position sign.

Lights, Please

A discussion about airport navigation wouldn't be complete without mentioning lighting. Similar to runway markings and signs, airport lighting systems depend on the volume and complexity of operations at a given airport. And, like signs and markings, airport lighting systems are standardized using similar colors.

Runway edge lights are white, except on instrument runways where they turn to yellow on the last 2,000 feet or half the runway length, whichever is less. Centerline lights alternate red and white starting 3,000 feet from the end, and are solid red starting 1,000 feet from the end. Taxiway edges are marked with blue lights or reflectors and some airports will have green taxiway centerline lights.

At a towered airport, ATC controls the lighting, whereas lights at a non-towered airport are controlled by a timer, or sometimes by the pilots by using the radio microphone. Keying the mike
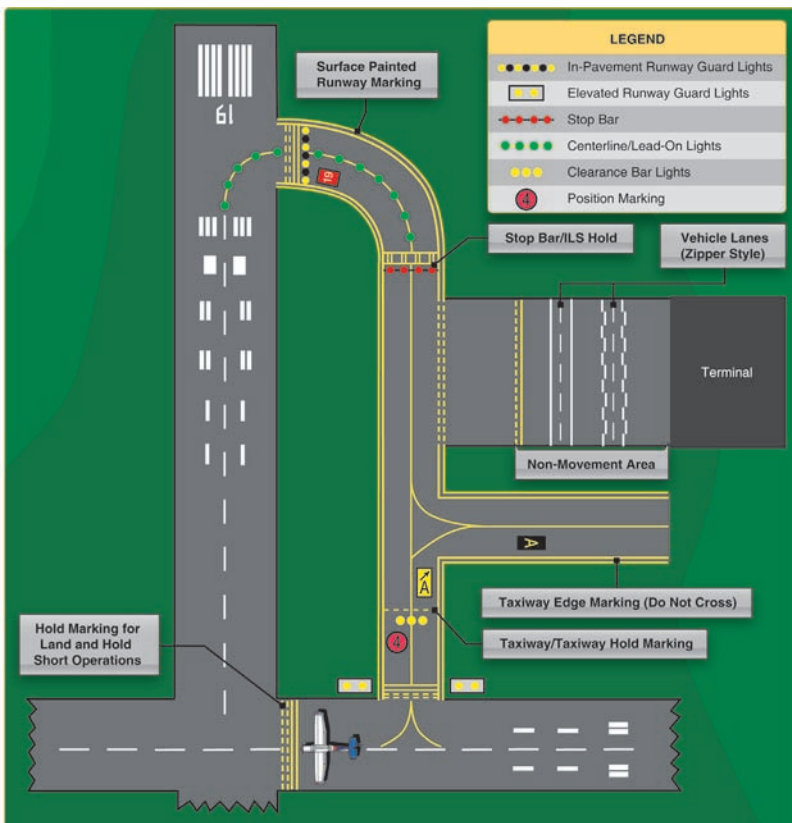

Figure 2. Airport runway and taxiway markings and surface lighting.

Airport Sign Systems

Type of Sign	Action or Purpose	Type of Sign	Action or Purpose
4-22	**Taxiway/Runway Hold Position:** Hold short of runway on taxiway	≡≡≡	**Runway Safety Area/Obstacle Free Zone Boundary:** Exit boundary of runway protected areas
26-8	**Runway/Runway Hold Position:** Hold short of intersecting runway	⊞⊞⊞	**ILS Critical Area Boundary:** Exit boundary of ILS critical area
8-APCH	**Runway Approach Hold Position:** Hold short of aircraft on approach	J→	**Taxiway Direction:** Defines direction & designation of intersecting taxiway(s)
ILS	**ILS Critical Area Hold Position:** Hold short of ILS approach critical area	↙L	**Runway Exit:** Defines direction & designation of exit taxiway from runway
⊖	**No Entry:** Identifies paved areas where aircraft entry is prohibited	22↑	**Outbound Destination:** Defines directions to takeoff runways
B	**Taxiway Location:** Identifies taxiway on which aircraft is located	↖MIL	**Inbound Destination:** Defines directions for arriving aircraft
22	**Runway Location:** Identifies runway on which aircraft is located	⁄⁄⁄⁄	**Taxiway Ending Marker:** Indicates taxiway does not continue
4	**Runway Distance Remaining:** Provides remaining runway length in 1,000 feet increments	↙A G L→	**Direction Sign Array:** Identifies location in conjunction with multiple intersecting taxiways

Figure 3. Airport signs

three, five, or seven times in five seconds will set the lights to low, medium, and high intensity respectively. Check the *Airport/Facility Directory* for more information about a particular airport's pilot-controlled lighting operations.

If available at your airport, be sure to also make use of any approach light systems, which besides providing IFR pilots a means to transition to visual flight, can also aid a VFR pilot on a day or night approach. Visual glidepath systems like the two-bar Visual Approach Slope Indicator (VASI) are among the most common. This system uses a pair of light bars (one near, one far) that change color according to the pilot's position on the glidepath. The easiest way to remember you're on glidepath is "red over white, you're alright." Another common glidepath system is the precision approach indicator, or PAPI. It's similar to VASI, except the lights are installed in a single row.

Show Me a Sign

Advances in new technology have greatly influenced the FAA's ability to develop safer and more efficient means of airport signage and lighting. While there has been considerable focus on many of the major part 139 airports, the FAA is also hard at

Photos by Tom Hoffmann

Taxiway edges are marked with blue lights or reflectors.

A raised-lighted "X" indicates a runway is temporarily closed.

work with efforts to advance safety at many smaller and predominantly GA airports. For example, a component of the Runway Status Lights system (a highly successful warning system that will be installed at 23 major airports by 2016) has been tested and used effectively at a smaller airport to help warn pilots when a runway is unsafe for landing.

Known as Final Approach Runway Occupancy Signal (FAROS), the system uses an inductive loop embedded in the runway asphalt that will flash the PAPI lights to warn pilots on approach that an aircraft has been detected on the surface. An advisory circular is underway with details on how this system may be applied in the near future at airports with medium to low traffic density.

Another area under review is the use of solar-powered and LED airport lighting. Due to their greatly reduced installation and maintenance costs, these technologies can provide opportunities for safe lighting at airports that would otherwise be inhibited by system complexity and cost.

> **Did you know… the letters "I" and "O" are not used to designate taxiways because they could be mistaken for a runway number.**

Solar-powered lights have already been tested at some airports in Alaska and a few states in the lower 48, and according to FAA Airport Safety Technology Manager Jim Patterson, have worked well in serving as a visual aid to pilots.

"Many remote airports do not have the money or the means to install lighting circuits used with traditional lights," explains Patterson. "As a result, pilots are often left without any visual aids."

A viable option for many remote airports is to install self-contained LED/solar fixtures, which provide an instant safety enhancement for users. To date, researchers have developed solar-powered LED systems to illuminate wind cones, elevated Runway Guard Lights (commonly referred to as Wig-Wags), and low intensity taxiway and runway lights. With initiatives to make our nation's airports more "green," the FAA is hopeful that this leading edge research will reduce an airport's carbon footprint and at the same time improve its safety.

Continuing Ed

Although technology is an important part of advancing runway safety, education awareness and outreach remain the cornerstone of promoting safe surface operations. In line with that education effort is a new pilot informational tool developed by the FAA's Office of Runway Safety: *Runway Safety — A Best Practices Guide to Operations and Communications*. The new guide contains dozens of helpful tips and images and is available on the FAA's Runway Safety website: www.faa.gov/go/runwaysafety. Also, a new chapter on preventing runway incursions is near completion and will be available in the next update to the *Pilot's Handbook of Aeronautical Knowledge*.

"Overall, it's a matter of raising the pilot's awareness of what he or she should be doing on the ground," says FAA Safety Engineer Chris Pokorski, who works in the Office of Runway Safety. "You're not flying per se, but you are flying the airplane on the ground and you have to be paying attention."

Tom Hoffmann is associate editor of FAA Safety Briefing. *He is a commercial pilot and holds an A&P certificate.*

Learn More

Advisory Circular (AC) 150-5340-IJ — *Standards for Airport Markings*
www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.current/documentNumber/150_5340-1

Advisory Circular (AC) 150-5340-18F — *Standards for Airport Sign Systems*
www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.current/documentNumber/150_5340-18

Aeronautical Information Manual (AIM) Chapter 2 — Aeronautical Lighting and Other Airport Visual Aids
www.faa.gov/air_traffic/publications/atpubs/aim/chap2toc.htm
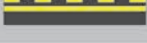
AOPA Airport Signs and Marking Quiz
www.aopa.org/asf/asfquiz/2011/110826airportsigns/index.html

FAA Runway Safety Challenge
www.faa.gov/airports/runway_safety/eQuiz/

Airport sign and marking - Quick reference guide

Example	Type of sign	Purpose	Location/convention
4-33	Mandatory: Hold position for taxiway/runway intersection	Denotes entrance to runway from a taxiway.	Located L side of taxiway within 10 feet of hold position markings.
22-4	Mandatory: Holding position for runway/runway intersection	Denotes intersecting runway.	Located L side of runway prior to intersection, & R side if runway more than 150' wide, used as taxiway, or has "land & hold short" ops.
4-APCH	Mandatory: Holding position for runway approach area	Denotes area to be protected for aircraft approaching or departing a runway.	Located on taxiways crossing thru runway approach areas where an aircraft would enter an RSA or apch/departure airspace.
ILS	Mandatory: Holding position for ILS critical area/precision obstacle free zone	Denotes entrance to area to be protected for an ILS signal or approach airspace.	Located on twys where the twys enter the NAVAID critical area or where aircraft on taxiway would violate ILS apch airspace (including POFZ).
⊖	Mandatory: No entry.	Denotes aircraft entry is prohibited.	Located on paved areas that aircraft should not enter.
B	Taxiway Location.	Identifies taxiway on which the aircraft is located.	Located along taxiway by itself, as part of an array of taxiway direction signs, or combined with a runway/taxiway hold sign.
15	Runway Location.	Identifies the runway on which the aircraft is located.	Normally located where the proximity of two rwys to one another could cause confusion.
▬▬▬▬	Runway Safety Area/OFZ and Runway Approach Area Boundary.	Identifies exit boundary for an RSA/OFZ or rwy approach.	Located on taxiways on back side of certain runway/taxiway holding position signs or runway approach area signs.
▬▬▬▬	ILS Critical Area/POFZ Boundary.	Identifies ILS critical area exit boundary.	Located on taxiways on back side of ILS critical area signs.
J→	Direction: Taxiway.	Defines designation/direction of intersecting taxiway(s).	Located on L side, priod to intersection, with an array L to R in clockwise manner.
↖L	Runway Exit.	Defines designation/direction of exit taxiways from the rwy.	Located on same side of runway as exit, prior to exit.
22↑	Outbound Destination.	Defines directions to take-off runway(s).	Located on taxi routes to runway(s). Never collocated or combined with other types of signs.
FBO↘	Inbound Destination.	Defines directions to airport destinations for arriving aircraft.	Located on taxi routes to airport destinations. Never collocated or combined with other types of signs.
NOISE ABATEMENT PROCEDURES IN EFFECT 2300 - 0500	Information.	Provides procedural or other specialized information.	Located along taxi routes or aircraft parking/staging areas. May not be lighted.
/////////	Taxiway Ending Marker.	Indicates taxiway does not continue beyond intersection.	Installed at taxiway end or far side of intersection, if visual cues are inadequate.
7	Distance Remaining.	Distance remaining info for take-off/landing.	Located along the sides of runways at 1000' increments.

Example	Type of marking	Purpose	Location/convention
▬▬▬	Holding Position.	Denotes entrance to runway from a taxiway.	Located across centerline within 10 feet of hold sign on taxiways and on certain runways.
▬▬▬	ILS Critical Area/POFZ Boundary.	Denotes entrance to area to be protected for an ILS signal or approach airspace.	Located on twys where the twys enter the NAVAID critical area or where aircraft on taxiway would violate ILS apch airspace (including POFZ)
▬ ▬ ▬	Taxiway/Taxiway Holding Position.	Denotes location on taxiway or apron where aircraft hold short of another taxiway.	Used at ATCT airports where needed to hold traffic at a twy/twy intersection. Installed provides wing clearance.
▬ ▬ ▬	Non-Movement Area Boundary.	Delineates movement area under control of ATCT, from non-movement area.	Located on boundary between movement and non-movement area. Located to ensure wing clearance for taxiing aircraft.
▬▬▬	Taxiway Edge.	Defines edge of usable, full strength taxiway.	Located along twy edge where contiguous shoulder or other paved surface NOT intended for use by aircraft.
▬ ▬ ▬	Dashed Taxiway Edge.	Defines taxiway edge where adjoining pavement is usable.	Located along twy edge where contiguous paved surface or apron is intended for use by aircraft.
4-22 4-22	Surface Painted Holding Position.	Denotes entrance to runway from a taxiway.	Supplements elevated holding position signs. Required where hold line exceeds 200'. Also useful at complex intersections.
	Enhanced Taxiway Centerline.	Provides visual cue to help identify location of hold position.	Taxiway centerlines are enhanced 150' prior to a runway holding position marking.
↖T	Surface Painted Taxiway Direction.	Defines designation/direction of intersecting taxiway(s).	Located L side for turns to left. R side for turns to right. Installed prior to intersection.
B	Surface Painted Taxiway Location.	Identifies taxiway on which the aircraft is located.	Located R side. Can be installed on L side if combined with surface painted hold sign.