Taxiing, Airport Signs, and Lighting

Objective	
To ensure the applicant learns and can exhibit a clear understanding of taxi procedures and how to taxi safely and properly.	
Purpose	
Every flight begins with taxiing. This lesson introduces aspiring pilots to taxi procedures, airport signs and lighting, and emphasizes the special safety considerations that all pilots must be aware of during taxi operations.	

Schedule	Equipment
Ground Lesson: 10 minutes - *In the airplane* - Initial **Before Flight**: 5 minutes - *Introduction and Demonstration* - Every Flight **Before Flight**: 5 minutes - *Student Performs*	- Airplane Checklist - Airport Diagram

Student Actions	Instructor Actions
- Ask any questions, receive study material for the next lesson. - Watch linked video. - Review listed references.	- Deliver the ground lesson (below). - Demonstrate the maneuver before flight. - Debrief after each flight.

Completion Standards
Ground: Student can explain the basics of taxiing and how to steer the airplane on the ground.   **Flight**: Student can taxi the airplane by doing the following: - Performing a Before Taxi checklist, checking the brakes, and visually clearing the area.   - Positioning the flight controls appropriately for the wind.   - Using an airport diagram to plan the taxi route.   - Receives and correctly reads back ATC taxi clearances, as applicable. (Or makes CTAF calls)   - Maintains vigilance in non-movement areas and around other airplanes.   - Maintaining taxiway centerline, taxiing at an appropriate speed, and using the throttle and brakes properly.   - Maintaining a sterile cockpit and avoiding runway incursions.

References

- ERAUSpecialVFR - "Taxiing Lesson 1"
  - YouTube - https://www.youtube.com/watch?v=pK7KqQXPb7I
- AIM-2024-03-21 (Aeronautical Information Manual) - Chapter 2, Section 1-11 [Taxiway Lights], Chapter 2, Section 3 [Airport Marking Aids and Signs]
- FAA-H-8083-25C (Pilot's Handbook of Aeronautical Knowledge) - Chapter 14, Page 5-16 [Airport Markings and Signs], Chapter 14, Page 16-20 [Airport Lighting]
- FAA-H-8083-3C (Airplane Flying Handbook) - Chapter 2, Page 18-21 [Taxiing]
- FAA AC 150/5340-30J (Design and Installation Details for Airport Visual Aids)
- FAA AC 150/5340-18G (Standards for Airport Sign Systems)
- FAA-S-ACS-6C (Private Pilot ACS) - Area II Task D
- FAA-S-ACS-7B (Commercial Pilot ACS) - Area II Task D
- FAA-S-ACS-25 (CFI ACS) - Area V Task D

Ground Lesson Outline

- Before Taxi Checklist
  - Brake Check, Instrument Check
- Taxi Technique
  - Use of Rudder Pedals - Differences from driving a car
  - Use of Throttle and Brakes
  - Proper Appearance of Taxiway Centerline - Parallax
  - Flight Control Positioning for Winds - "Turn Towards the Wind/Dive Away from the Wind"
    - See *Supplement* below
- Taxi Safety
  - Wingtip Clearance
  - Avoiding Other Airplanes - Parked and Not Parked
  - Avoiding Hazards in Non-Movement Areas
- Taxiing in the Airport Environment
  - Runway Incursion Avoidance (see lesson on *Runway Incursion Avoidance* [Area II, Task B])
  - Taxi Clearances and Taxi Route Planning, Hot Spots
  - Use of Airport Diagrams, Minimize Distractions / Sterile Cockpit / Situational Awareness
  - Non-Towered Airport Taxi Operations
    - CTAF Taxi Self-Reporting
    - Visual scanning for conflicting airplanes, cars, etc.
    - Hazardous / Poor Condition Taxiway Surfaces
  - Airport Markings for Taxi Operations
  - Airport Signs and Lighting
- Airport Wind Indicators
- Challenges of Taxiing in Low-Visibility or Night Conditions

Common Errors

- **Improper use of brakes.**
- Improper positioning of the flight controls for various wind conditions.
- Hazards of taxiing too fast.
- **Hazards associated with the failure to comply with airport/taxiway surface marking, signals, and ATC clearances or instructions.**
- **Hazards of becoming distracted while taxiing.**
- Hazards associated with failing to adhere to sterile cockpit procedures.
- **Failure to use proper runway incursion avoidance procedures.**

Ground Lesson Supplements

- **Taxi Operations** - *Taxiing* is simply movement of aircraft on the airport environment, both on *taxiways* and on *runways*.
    - **Unique challenges** - Airplanes are designed to fly, with very little consideration given to ground handling. This presents unique challenges.
        - **Steering/Maneuvering** - Airplanes may be difficult to steer or maneuver. There is no ability to move in reverse, as a car might, and wide wingspans or long fuselage and tail sections can cause parts of the airplane to encroach on runway areas even if the rest of the airplane is not.
        - **Flight Control Positioning for Winds** - Even while taxiing on the ground, the position of the flight controls is crucial for the stability of the airplane. Failure to do so can allow rogue wind gusts to provide upsets or losses of directional control during taxi.
        - **Situational Awareness/Maintaining Taxiway/Runway Position** - Taxiways often have many intersecting taxiways, runways, aprons, etc. Pilots must maintain situational awareness of their position on the airport at all times. Airplanes may have poor outside ground visibility, making it difficult to see taxiway and runway signs and markings.
            - **Other airplanes, vehicles** - In addition to their own position, pilots should maintain a mental picture of where other airplanes and vehicles are moving on the airport environment.
- **What are Runway Incursions?** - Simply put, a *runway incursion* occurs any time an airplane (or ground vehicle) enters a runway, or continues on a runway in a manner for which they were not cleared. Accidentally taxiing past a hold line into a runway area, or taxiing beyond a hold line on a runway into an intersecting runway, or making a wrong turn into a runway area are all runway incursions.
    - **Dangers of Runway Incursions** - Although it was not directly caused by a runway incursion in the traditional sense, the *Tenerife Airport Disaster* in 1977 demonstrates the sort of disaster that can occur when two airplanes are on the same runway during flight operations. Being the worst aviation accident in history, the Tenerife Disaster claimed the lives of 583 passengers and crew, and came about because of a **fundamental confusion about the position of other airplanes on the airport and runway environment**. Similar disasters are possible any time a runway incursion occurs.
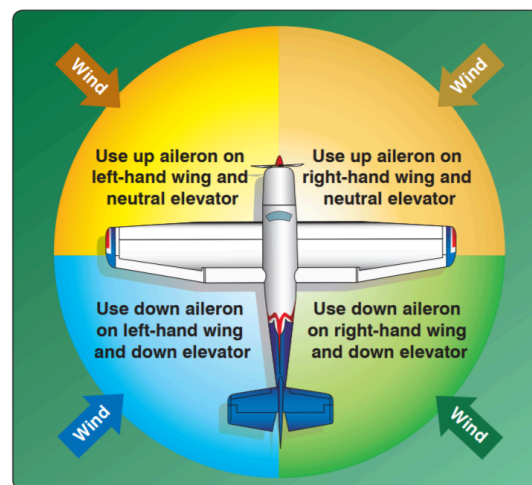
- **Taxi Clearances and Taxi Route Planning** - When operating at towered airports, pilots must first obtain a taxi clearance from ATC. A taxi clearance will include a destination, and a route that the pilot should take to get there.
    - **Example:** *"Cessna 1234, Taxi to Runway 25 at Alpha 2 via Alpha, cross Runway 13 on Alpha"*
    - **ATC Communication During Phases**
        - **Before Takeoff/Taxi** - Before taxi for takeoff, contact the Ground controller and ask for clearance to taxi for departure before entering any *movement areas*. **Pilots are required to read back taxi or hold short clearances in full, including their callsign and any runways given by ATC.**
            - **Non-Movement Areas** - Aircraft may taxi freely on *non-movement areas*, which are airport areas that are not controlled by ATC. *Movement areas* are areas (taxiways, runways, generally) where aircraft movements are controlled by ATC. **While taxiing in non-movement areas requires no clearance, vigilance must be maintain by pilots since other vehicles or people may be present anywhere at any time!**
        - **Before Landing** - Before landing, pilots should brief the runway exit they intend to use, and note any nearby intersecting runways where they will need to hold short.
        - **After Landing** - After landing, pilots may taxi clear of the landing runway, **ensuring they fully cross the hold short line to exit the runway**, but may not continue taxiing without an ATC clearance! Pilots should be vigilant to not cross any other nearby hold lines without clearance.
    - **Techniques** - There are several techniques pilots can use to minimize confusion about taxi instructions
        - **Writing down Taxi Clearances** - Before reading back a taxi or hold short clearance, write it down on a kneeboard or scribble it on the airport diagram, to aid in memory.
        - **Airport Diagrams/Route Planning/Briefing Hot Spots** - It is best to actively look at the airport diagram as the taxi clearance is received, so that pilots can form a mental model of the taxi route. Pilots should ideally highlight the received taxi route on their airport diagram, and especially brief any hot spots that will be encountered on the route.
            - **Hot Spots** - Airport *hot spots* are areas where other pilots (or vehicles) have commonly made mistakes leading to runway incursions. They are often confusing or irregularly shaped hold lines or intersections, and **pilots should be extra vigilant for the presence of hold lines or runway identifier signs in these locations.**
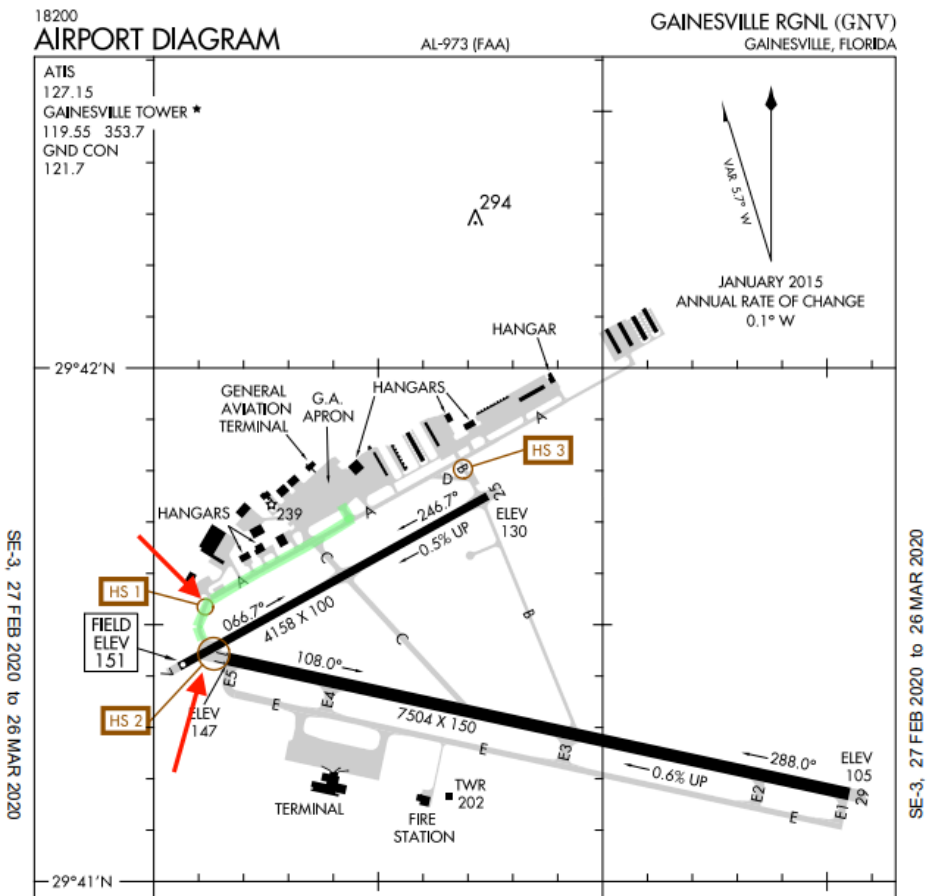
- **Minimizing Pilot Workload** - During taxi operations, in addition to maintaining a sterile cockpit, pilots should avoid unnecessary tasks (e.g. programming the GPS, working on EFB, etc.) so that their full attention can be devoted to taxiing and maintaining situational awareness.
- **Confirm/Always Be Sure** - Most importantly, **if any uncertainty exists about the taxi clearance or the airplane's position on the runway or airport, the pilot *must* clarify the instructions with ATC.** Uncertainty about taxi instructions or the position of airplanes in relation to runways and taxiways is extremely dangerous and can lead to disastrous results. **If in doubt, ask again!** Pilots can also ask for *progressive* taxi instructions, where ATC will provide turn-by-turn guidance.
  - **Verbalize** - When approaching a runway hold line, pilots should refer to their taxi clearance and confirm to themselves that they are in fact cleared to cross.
    - Example: (approaching Runway 31 hold) "I am cleared to cross Runway 31".
  - **Case Study** - *December 6, 1999 Providence, RI Incident*
    - This incident had many contributing factors, including:
      - Pilot uncertainty about position
      - Vague descriptions of signage "we are by the runways", not "we are by Runway 23L"
   - Not cross-referencing outside sight picture with airport diagram
    - https://www.youtube.com/watch?v=equVF3ULVw8
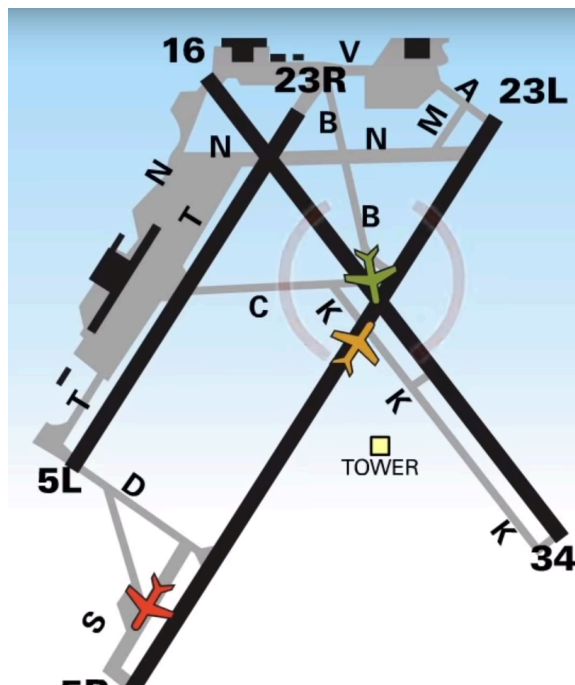
Transcript:
United: And, uh, United 1448, we're approaching Kilo
here, uh, um, somebody just took off!

- **Dangers of Confirmation and Expectation Bias** - It is critical that pilots actively *listen* to their taxi instructions and not fall prey to confirmation or expectation bias. These biases can lead pilots to hear what they are expecting to hear, rather than what was actually said.
  - **Example** - A pilot is *always* cleared to taxi to Runway 25 "via Alpha, Bravo", but this time they are cleared "via Alpha, hold short of taxiway Bravo". This difference can easily be missed.
- **Non-Towered Airport Taxi Operations** - Although there is no ATC at non-towered airports to manage taxi operations, pilots should nonetheless remain vigilant for runway incursions. Pilots should maintain situational awareness about the position of other airplanes and vehicles on runways and taxiways, and **always self-announce taxi intentions and the intention to enter a runway**.
  - **Planning and radio calls for Before Takeoff, Before Landing, After Landing** - Just as with a towered airport, pilots should consult the airport diagram before taxi, takeoff, and landing to be sure that they know the route they will use to enter and exit the runway.
    - Because no explicit takeoff or landing clearances are available at non-towered airports, pilots must also **visually confirm** that the runway *and final approach* are clear before entering any runways.
- **Taxi Safety Techniques** - Pilots can enhance safety by always **visually confirming** that a runway (and final approaches) are clear before crossing or entering any runway surface, *whether cleared or not*. Other techniques include:
  - Turning on airplane strobes, taxi, and landing lights to enhance visibility.
  - Maintaining eyes outside the cockpit when in any runway area.
  - Taxiing clear of runways quickly and without delay.
- **After-Landing Taxi Operations** - Many runway incursions actually occur after landing, when pilots let their guard down and may taxi into other nearby runway areas.
  - **Briefing landing rollout to a taxiway exit** - Pilots should always brief the expected runway exit before landing, especially if there are nearby runways.
  - **Proximity to other runways/hold lines** - When two runways are nearby, or exiting the runway will put the airplane near another runway, pilots should be especially vigilant that they cross only the *correct* hold line when exiting the runway.
    - **Parallel runways** - In the case of exiting between parallel runways, the available taxi area for runway exit may be quite small, and the danger of a runway incursion is higher.

Always brief this potential hazard before landing!

- ○ **LAHSO** - ATC at some airports may offer so-called "LAHSO" (Land And Hold Short Operations) operations. **Pilots must explicitly accept (and may reject) a LAHSO clearance**, however if a LAHSO clearance is accepted, pilots should explicitly brief the landing and be vigilant that they do not rollout past the LAHSO line during landing.
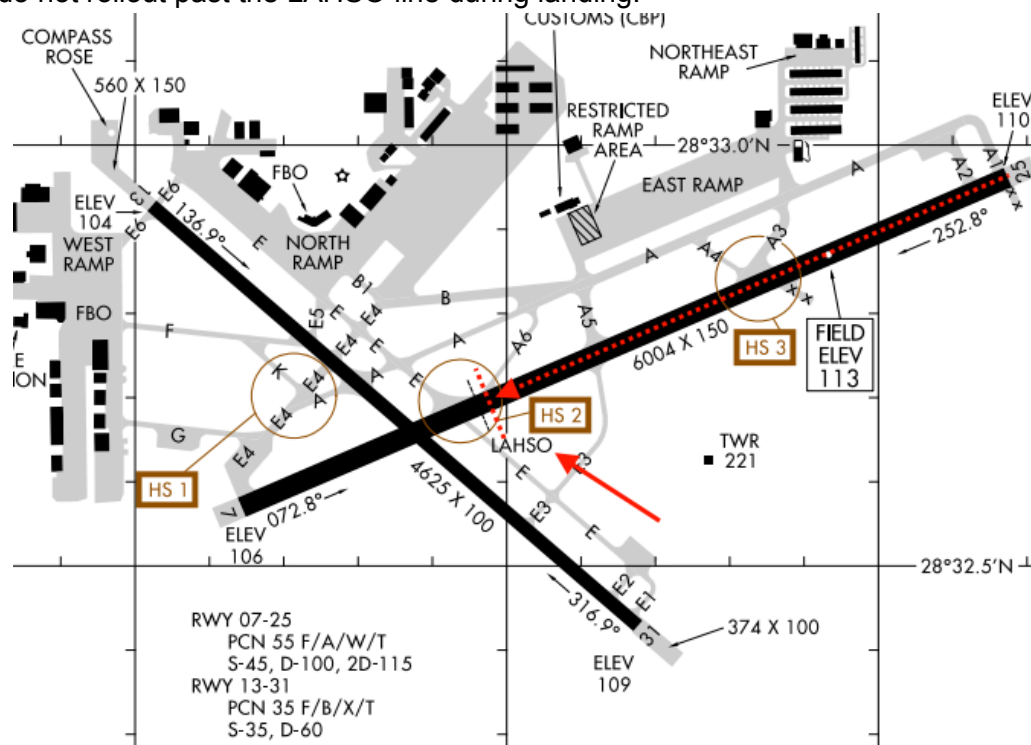
- ● **Airport Markings important to Taxi Operations**
  - ○ **Hold Lines** - *Hold lines* are the primary marking that indicates the boundaries of runways or other protected areas. Often called *hold short lines*, they are depicted on the pavement as two solid and two dashed lines. Crossing from the dashed lines to the solid lines requires no clearance (as in, exiting a runway area), however, **crossing from the solid lines to the dashed lines always requires explicit ATC clearance!** (At towered airports)

- ○ **ILS Critical Areas** - Identify areas where pilots must hold short (when instructed by ATC) when

ILS approaches are in use. Only used in low visibility conditions, below VFR weather minimums.
- ○ **Taxiway Centerlines** - Solid yellow lines identify the centerline of a taxiway.
  - ■ **Enhanced Taxiway Centerline Markings** - Near hold lines

- ● **Airport Signs**
  - ○ **Mandatory Instruction Signs** - **Red** and White. Hold Lines, Runway Safety Areas, Runway Entrances, Restricted Areas, etc.
    - ■ **Runway Hold Position** - One of the most important airport signs that pilots should keep watch for is the *runway hold position* sign. The **red** color of the sign is used only for important hold signs on airports, and should always be a clue that there is a hold line nearby.

  - ■ **Be aware for runway incursions when these are nearby!**
  - ○ **Direction/Information Signs** - Black on Yellow, indicate info or the direction of taxiways or runways.
  - ○ **Taxiway Location Signs** - Yellow on Black, indicate the name of the current taxiway.
  - ○ **Runway Distance Remaining** - White on Black, In Thousands of Feet
  - ○ **Runway Safety Area Exit** - Black on Yellow. Indicate the location of the runway safety area hold lines when exiting a runway.

AIRPORT SIGN SYSTEMS

TYPE OF SIGN AND ACTION OR PURPOSE		TYPE OF SIGN AND 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

- **Airport Lighting**
  - **Runway Lighting**
    - **REIL** - Runway End Identifier Lights, flashing lights on either side of the threshold.
    - **Centerline Lighting** - Found only at larger airports, embedded in the pavement.
    - **Edge Lighting** - The most common type of runway lighting, just mark the runway edges.

- **Threshold Lighting** - Green lights indicate the start of the runway, and red lights indicate the end of the runway.


- **Runway Status Lights** - Found only at large airports, used to indicate when the runway is safe to enter or start takeoff.
    - **REL** - Runway Entrance Lights
    - **THL** - Takeoff Hold Lights
- **Closed Runway Markings/Lighting** - Used when runways are temporarily or permanently closed.

○ **Taxiway Lighting**
- **Taxiway Edge Lighting** - Omnidirectional, blue lights.
- **Taxiway Centerline Lighting** - Omnidirectional, green lights. In-pavement.
- **Clearance Bars** - 3 in-pavement yellow lights, at hold positions
- **Runway Guard Lights** - Taxiway/Runway intersections, pair of elevated flashing yellow

lights or in-pavement yellow lights across the length of the hold bars

- ■ **Stop Bar Lights** - Confirm ATC clearance to enter a runway, red in-pavement lights
- **Airport Wind Indicators** - Especially when operating at non-towered airports, pilots should always note the orientation of airport wind indicators. Many windsocks are also lighted for visibility at night.
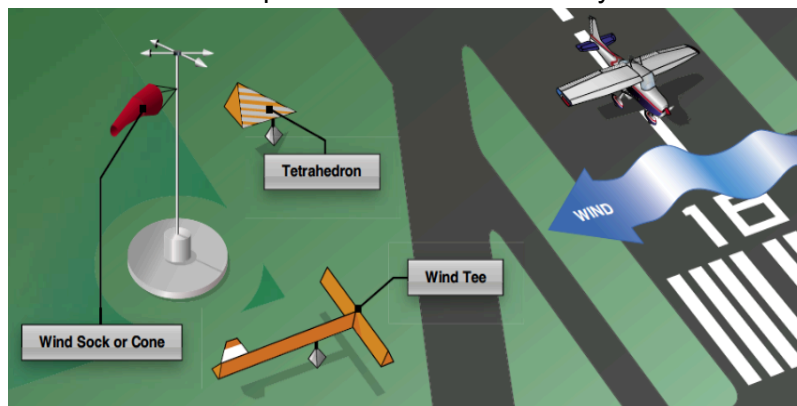
- **Challenges of Night and Low-Visibility Operations** - When operating at night, or in low visibility conditions, it is more difficult to distinguish taxiway markings, signs, and identify other aircraft. Therefore, the potential for ATC to mis-identify aircraft (issue the right instructions to the wrong aircraft) is higher, and pilots must be extra vigilant about maintaining situational awareness of their own position, as well as that of other airplanes and vehicles. **If an instruction does not make sense, and goes against what was planned or briefed, ask for clarification from ATC!** (See Providence, RI Case Study)