FLY
AVIATION

**Training aid only, not flight instruction.** Review it with your CFI and get their approval before you use it in training or in the airplane. Check every number against the POH and current FAA sources. Last reviewed Nov 7, 2026 against the FAA Chart Supplement effective Oct 29, 2026.

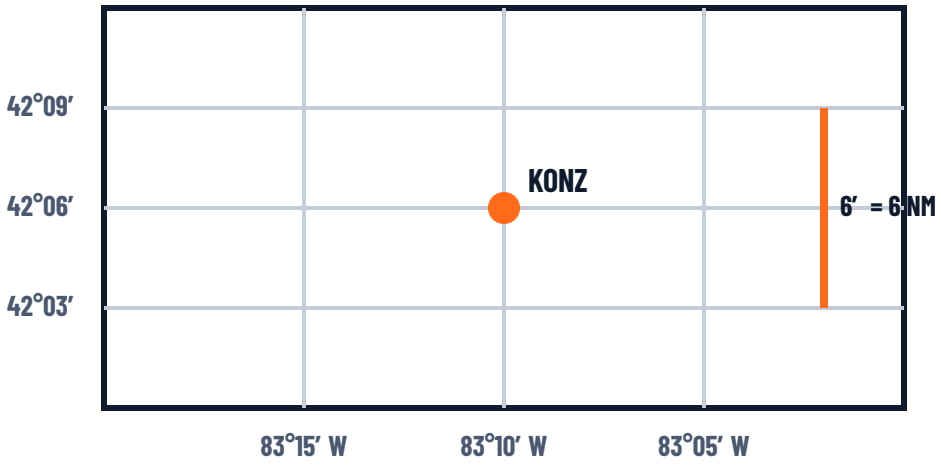
# NAVIGATION

Private pilot · Knowledge test, oral and checkride · Flying from KONZ

## THE EARTH AND THE CHART

Every navigation problem starts with where you are on the earth and how the chart shows it.

- **Latitude** lines run east-west and measure north or south of the equator. **Longitude** lines run north-south and measure east or west of Greenwich.
- Each degree has 60 minutes. **One minute of latitude is one nautical mile.** That makes the latitude scale on the side of any chart a ready-made distance ruler.
- A minute of longitude gets shorter as you go north, so never measure distance along a line of latitude using the longitude ticks.
- KONZ sits at about **42° 06′ N, 83° 10′ W**.




### True north and magnetic north

- Charts are drawn to **true north**. Your compass points to **magnetic north**. The angle between them is **variation**.
- **Isogonic lines** (dashed magenta on the sectional) join places with the same variation. Near KONZ the variation is about **7° west** (the FAA lists it as 07W).

- The **agonic line** is where variation is zero. It runs through the middle of the country, west of Michigan.

### Which chart

| Chart | Scale | Use it for |
|---|---|---|
| Sectional | 1:500,000, about 6.86 nm per inch | Cross-country planning and en route |
| Terminal Area Chart (TAC) | 1:250,000, twice the detail | Flying near Class B airspace. Use the **Detroit TAC** around KONZ |
| Chart Supplement | Not a map | Airport details, frequencies, procedures |

- Sectionals and TACs are on a **56-day cycle**. Fly with current charts, paper or electronic.

## COURSES AND HEADINGS

The course is the line on the chart. The heading is where you point the nose to make the airplane follow it.

1. **True course (TC):** measured on the chart with a plotter, from true north.
2. **± wind correction angle (WCA):** turn into the wind. Gives **true heading (TH)**.
3. **± variation: East is least, west is best.** Subtract easterly, add westerly. Gives **magnetic heading (MH)**. Near KONZ, add about 7°.
4. **± deviation:** from the compass correction card in the airplane. Gives **compass heading (CH)**, the number you fly.

- The memory hook for the order: **T**rue **V**irgins **M**ake **D**ull **C**ompanions (true, variation, magnetic, deviation, compass).
- **Magnetic course** (TC ± variation, no wind) is what sets your VFR cruising altitude: odd thousands plus 500 for 0–179°, even plus 500 for 180–359°.
- The full wind triangle and a calculator are in the Cross-Country Study Guide. A worked trip from KONZ is in the Cross-Country Planning Aid.

## PILOTAGE AND DEAD RECKONING

Pilotage is flying by what you see. Dead reckoning is flying by math. A good cross-country uses both, and checks one against the other.

### Pilotage

- Pick **checkpoints every 10 to 20 nm** that you can't miss: a lake, a river bend, a town with a water tower, an airport, a highway crossing a railroad.
- Big linear features make good "catch lines". Around KONZ the **Detroit River shoreline** and the **western shore of Lake Erie** are hard to miss, and interstate highways run through the area. Check every feature on the current chart before you rely on it.
- Read from the ground to the chart, not the other way round: find something distinctive outside, then find it on the chart.

### Dead reckoning

- Fly the computed heading for the computed time. At each checkpoint, note the time and work out the real groundspeed.
- **Groundspeed = distance ÷ time.** If it differs from the plan by more than about 10%, redo the ETA and fuel for the rest of the trip.

### The 1-in-60 rule

- At 60 nm, 1° of error puts you 1 nm off course. So **degrees off = 60 × miles off ÷ miles flown**.
- **To get back on course** at the next point, turn the angle you're off plus the angle needed to close the gap: **60 × miles off ÷ miles remaining**.
- Example: 2 nm left of course after 30 nm, with 30 nm to go. Track error: 60 × 2 ÷ 30 = 4°. Closing angle: 60 × 2 ÷ 30 = 4°. **Turn 8° right** to arrive at the destination.
- If you only want to fly parallel to the original course, correct by the track error alone: 4°.

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## VOR NAVIGATION

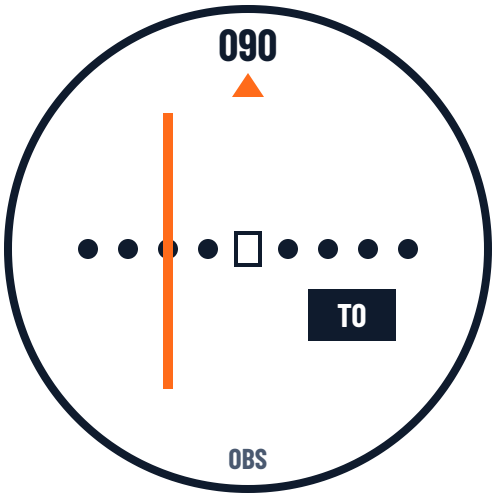
A VOR is a ground station that sends out 360 radials. Your receiver tells you which radial you're on and whether the course you've set will take you to or from the station.

### How it works

- A **radial** is a magnetic bearing **from** the station. The 090 radial runs east from the station.
- **Identify** every VOR by its Morse code before you use it. No ident, or a test signal, means don't use it.
- VORs are line of sight. Higher altitude means longer reception range.

### The OBS, CDI and TO/FROM flag

- Turn the **OBS** (omni bearing selector) to a course. The **CDI** needle shows whether that course line is left or right of you. Fly toward the needle.
- **Full-scale deflection is 10°.** On a five-dot display, **each dot is 2°**.
- The **TO/FROM flag** says whether the course you've set takes you toward the station or away from it. It doesn't depend on your heading.
- **Reverse sensing:** if you fly a heading roughly opposite to the course set in the OBS, the needle works backward. Keep the course you've set close to the way you're pointing.
- **Station passage:** the flag flips from TO to FROM. Near the station the needle swings fast. Don't chase it.




**COURSE 090, TO FLAG**

You are west of the station, roughly on the 270 radial.

**NEEDLE 2 DOTS LEFT**

The course is 4° to your left. Turn left to intercept.

## Tracking, intercepting and fixing position

- **To find which radial you're on:** turn the OBS until the needle centers with a **FROM** flag. That number is your radial.
- **To fly to a station:** center the needle with a **TO** flag and fly that heading, correcting for wind.
- **To intercept a radial:** set the course, turn to a heading about 30° to 45° toward the course line, and turn onto it as the needle starts to center.
- **Position fix:** find your radial from two different VORs. Where the two lines cross on the chart is where you are.
- **DME** gives distance to the station in nautical miles. It's **slant range**, so it reads more than the ground distance when you're high and close.

## VORs near KONZ

| VOR | Frequency | Where KONZ is from it |
|---|---|---|
| Carleton (CRL) | 115.70 | About the 080 radial, 13.5 nm |
| Detroit (DXO) | 113.40 | About the 133 radial, 11.4 nm |
| Salem (SVM) | 114.30 | About the 137 radial, 26.7 nm |

- From FAA data effective October 29, 2026. Check the current chart and Chart Supplement before you fly.

## VOR checks

- Required only for **IFR** flight: within the previous **30 days** (14 CFR 91.171).
- Tolerances: **±4°** with a VOT or a ground checkpoint, **±6°** with an airborne checkpoint, **4°** between two VORs checked against each other.
- Record the date, place, bearing error and sign the log.

## GPS

GPS is the main navigation tool in most cockpits now. Use it, but don't let it do your thinking.

- **WAAS** GPS adds correction signals for better accuracy and vertical guidance. **Non-WAAS** units rely on **RAIM** (receiver autonomous integrity monitoring) to warn you when the position isn't reliable.
- Keep the **database current**. An out-of-date database can have wrong frequencies, airspace and airports.
- **Direct-to** is quick, but it may route you through airspace or terrain. Look at the line on the map before you follow it.
- **CDI scaling** changes with the phase of flight: about 5 nm full scale en route on many units, tighter near an airport. Know what yours shows.
- **iPad and EFB apps** are great for situational awareness. Keep a backup: a second device, a paper chart, or both.
- **ADS-B In** brings free weather (FIS-B) and traffic (TIS-B) to many devices. The weather can be several minutes old, and not every airplane shows up as traffic. Keep looking outside.

# FLIGHT FOLLOWING AND RADAR SERVICES

VFR flight following gives you traffic advisories and someone who knows where you are. It's a big help in the busy airspace around Detroit.

- Ask Detroit Approach after departure from KONZ. The calls are in Radio Calls for Our Flying.
- Flight following doesn't clear you into Class B, and ATC can drop it if they get busy.

# DIVERSIONS

Weather, a sick passenger, or a rough engine: a diversion means deciding fast and flying a new course you didn't plan.

1. **Turn first.** Turn toward the new destination right away, roughly by eye on the chart.
2. **Estimate.** Lay a straightedge, pencil or finger on the chart. Estimate the course and distance. Use the latitude scale for distance.
3. **Note the time.** Work out ETE and fuel from the groundspeed you've been getting.
4. **Refine.** Once established, tighten the heading with pilotage and the GPS.
5. **Tell someone:** ATC if you're talking to them, and close or amend your flight plan.

- Know your alternates before you need them. The Nearby Airport Cards cover ten fields around KONZ.

# LOST PROCEDURES

Being lost is a problem you solve with a calm routine: the **five Cs**.

- **Climb:** better radio range, radar coverage and a wider view, if the clouds allow.
- **Communicate:** call ATC or Flight Service. Use **121.5** if you can't reach anyone else.

- **Confess:** say you're unsure of your position. Controllers can help.
- **Comply:** follow their headings and altitudes.
- **Conserve:** reduce power and lean for best range. Fuel buys time.
- Squawk **7700** if you're in distress. Don't wander. If you must keep flying, head toward a large feature you can't miss, such as a shoreline.

## NAVIGATING NEAR KONZ

Three things shape every flight out of KONZ. They are covered in more detail in the KONZ Airport Guide and the Airspace Study Guide.

- **The Detroit Class B** sits over and around the field. Use the Detroit TAC, know the shelf floors on your route, and stay out unless you have an explicit clearance.
- **The Canadian border** runs down the Detroit River, just east of the island. Don't drift across it while sightseeing; crossing needs a flight plan, a transponder code and customs arrangements.
- **Lake Erie** is to the south and east. Over water there is nothing to land on and no landmarks. Stay within gliding distance of shore unless you've planned for overwater flight.

## SELF-CHECK

Tap a question to see the answer.

**How many nautical miles is one minute of latitude?**

One nautical mile. One degree of latitude is 60 nm.

**True course is 090°. Variation is 7° W. What is the magnetic course?**

097°. West is best: add westerly variation.

**True course 270°, wind correction 5° left, variation 7° W. What is the magnetic heading?**

TH = 270 – 5 = 265°. MH = 265 + 7 = 272°.

**Variation is 4° E and true heading is 180°. What is the magnetic heading?**

176°. East is least: subtract easterly variation.

**Where do you find deviation?**

On the compass correction card in the airplane.

**What is the scale of a sectional? A TAC?**

Sectional 1:500,000. Terminal Area Chart 1:250,000.

**You're 3 nm right of course after flying 45 nm. How many degrees off are you?**

60 × 3 ÷ 45 = 4°.

**– You're 2 nm left of course after 30 nm, with 30 nm to go. How much do you turn to reach the destination?**

4° for the track error plus 4° to close the gap: 8° right.

**– A VOR radial is measured which way?**

Magnetic, outbound from the station.

**– OBS set to 360, FROM flag, needle centered. Where are you?**

On the 360 radial, north of the station.

**– OBS set to 360, TO flag, needle centered. Where are you?**

On the 180 radial, south of the station. Flying 360 takes you to it.

**– The needle is two dots right on a five-dot VOR display. How far off course are you?**

About 4°. Each dot is 2°, and full scale is 10°.

**– What tells you that you've passed over a VOR?**

The TO/FROM flag flips from TO to FROM.

**– What are the VOR check tolerances for IFR?**

±4° with a VOT or ground checkpoint, ±6° airborne, and no more than 4° between two VORs. Within the last 30 days (14 CFR 91.171).

**– What are the five Cs if you're lost?**

Climb, communicate, confess, comply, conserve.

## SOURCES


- FAA Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), chapter 16, Navigation.
- Aeronautical Information Manual, chapter 1, Air Navigation.
- FAA Aeronautical Chart User's Guide.
- 14 CFR 91.171, VOR equipment check for IFR operations.
- VOR radials and distances from FAA airport data effective October 29, 2026.
- Charts, frequencies and procedures change. Use current charts and the Chart Supplement.


Training aid only, not flight instruction. The POH in the airplane and its placards win: check every number against them, and fly with your CFI.