NAVIGATION AIDS: VOR

LESSON OUTLINE

LESSON OBJECTIVE

To determine that the student exhibits proficient knowledge of the elements related to navigation aids: VOR by describing the elements on the following slide.

LESSON SOURCE(S)

Pilot's Handbook of Aeronautical Knowledge
FAA-H-8083-25

Aeronautical Information Manual

LESSON OUTLINE

LESSON ELEMENTS

VOR, VOR/DME, VORTAC
Symbology
Service Volumes
Inner Workings
Cockpit Instruments
Reverse Sensing
VOR Checks

TIMEFRAME

45 Minutes

approximately

Discuss Objectives
Present and Review Material
Student Questions
Conclusion and Quiz

EQUIPMENT/TOOLS

Lesson Presentation
Whiteboard and Markers
FAA Sources and References

LESSON OUTLINE

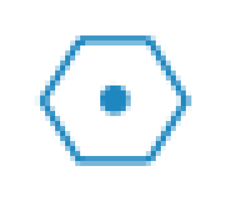
INSTRUCTOR ACTIONS	STUDENT ACTIONS	COMPLETION STANDARDS
Present Objectives and Standards Teach Lesson from Presentation Ask and Answer Student Questions Assign Homework Check Student's Post Lesson Quiz	Participate in Lesson Take Notes Ask and Respond to Questions Pass the Post Lesson Quiz	Student is able to understand and differentiate between the different lesson elements. Student is further able to apply this acquired knowledge in flight training/flight operation scenarios effectively and appropriately.

VOR

VOR stands for “Very High Frequency Omnidirectional Range.” It is a transmitting ground station that projects straight line courses (radials) from the station in all directions.

VOR

This is a stand-alone VOR that provides magnetic bearing information to and from the station. It does not have any associated distance information.



VOR/DME

This is a VOR co-located with a DME (Distance Measuring Equipment) station to provide distance information to the pilot.

VORTAC

This is a VOR co-located with TACAN. TACAN is reserved for military use only but these also give distance information to civilian pilots as well.

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VOR Information Box

The VOR Information Box on aeronautical charts gives pilots all of the information they need about each VOR that can be used in flight.
Such as the:

- Type of VOR
- Name of the VOR
- Frequency of the VOR
- DME Channel (if applicable)
- VOR Identifier
- Morse Code Identifier

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VOR Service Volumes

A Service Volume is the range at which a VOR can be safely and reliably used by pilots in flight. There are a few different principles to discuss. First, is that VORs operate on a “Line of Sight” principle. This means that it must be able to “see” the ground based VOR to be reliable and accurate. If terrain or obstructions are between the aircraft and the VOR, then the signal will be disrupted or even unusable.

Line of Sight

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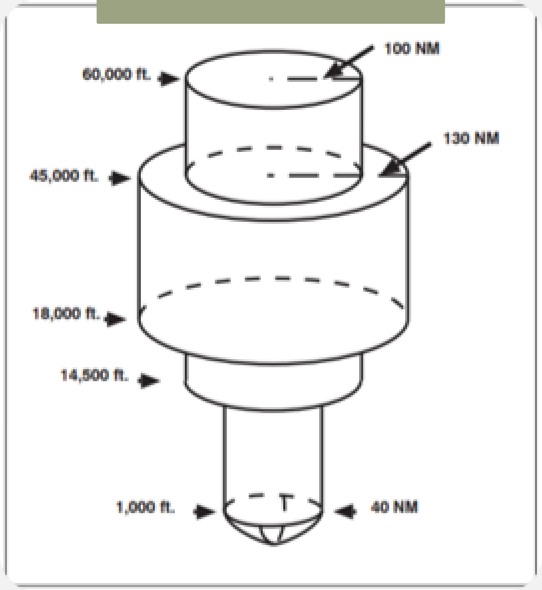
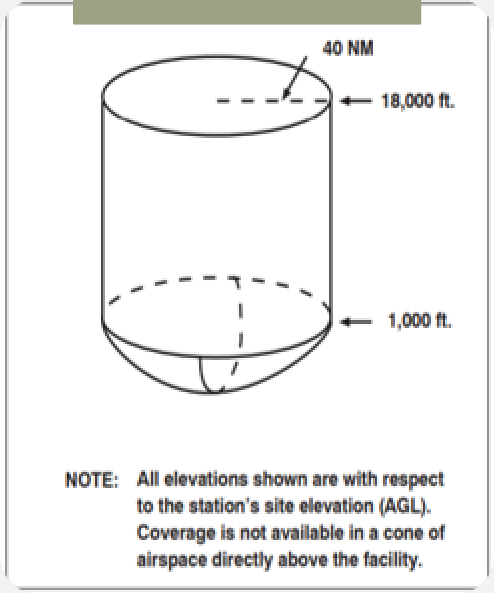
VOR Service Volumes

Secondly, VORs have different ranges based on their type (High Altitude, Low Altitude, and Terminal). If a pilot is attempting to navigate using a VOR outside of the service volumes shown, the indications may be inaccurate or unusable. On aeronautical charts, Low Altitude VORs are indicated with an "L", and Terminal are indicated with a "T." High Altitude do not have a symbol.

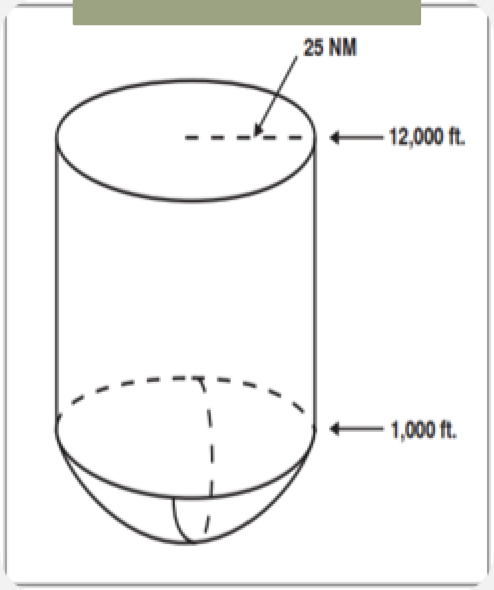
High



Low



Terminal



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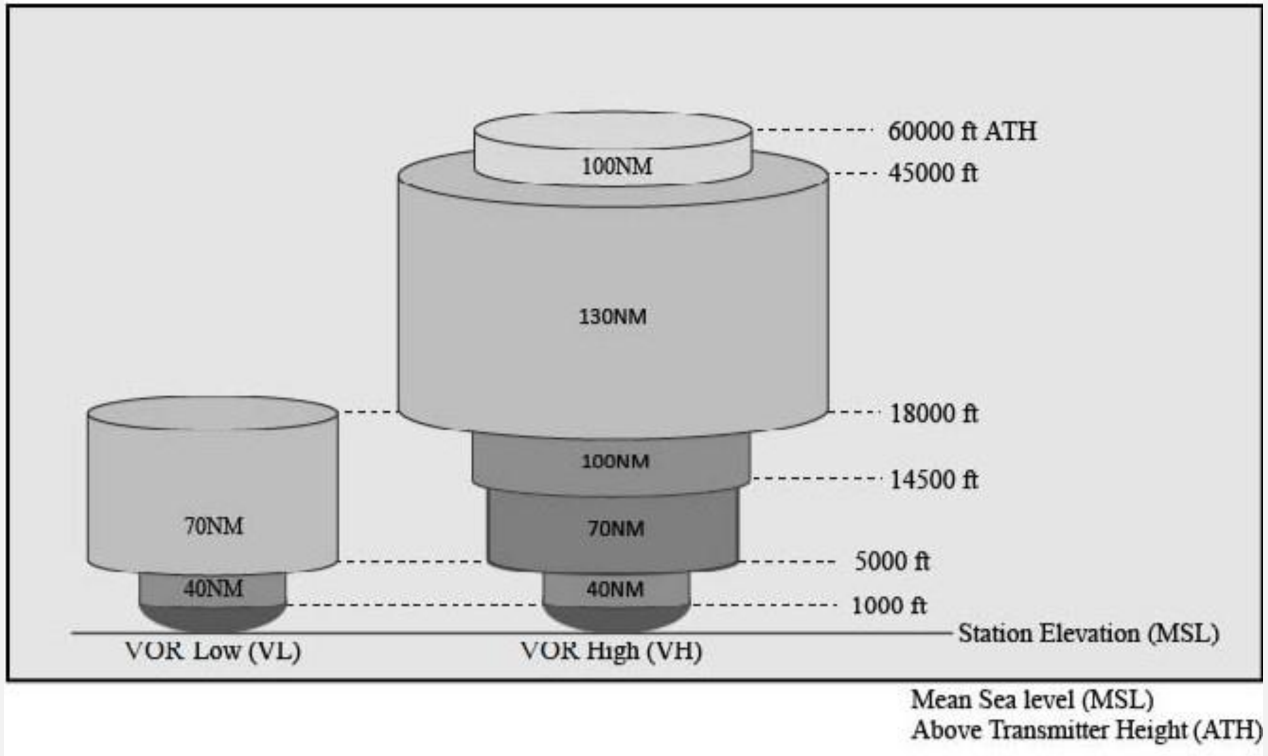
New Service Volumes

Recently the FAA has created 2 new Standard Service Volumes (SSV’s) for VOR’s. The service volumes seen on this page are the new service volumes while the ones on the previous slide are the Original VOR Service Volumes.



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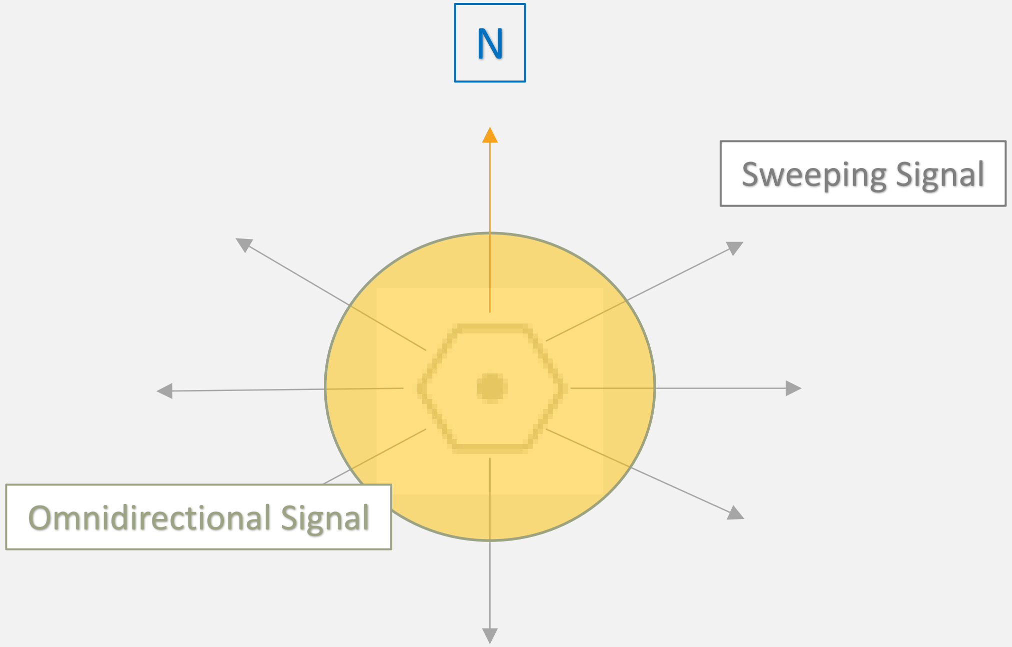
VOR Inner Workings

A VOR works based on timing between 2 different radio signals. One is a unidirectional, sweeping signal while the other is an omnidirectional signal. Each time the sweeping signal passes North, the omnidirectional signal flashes. Let's create a visual for better understanding.



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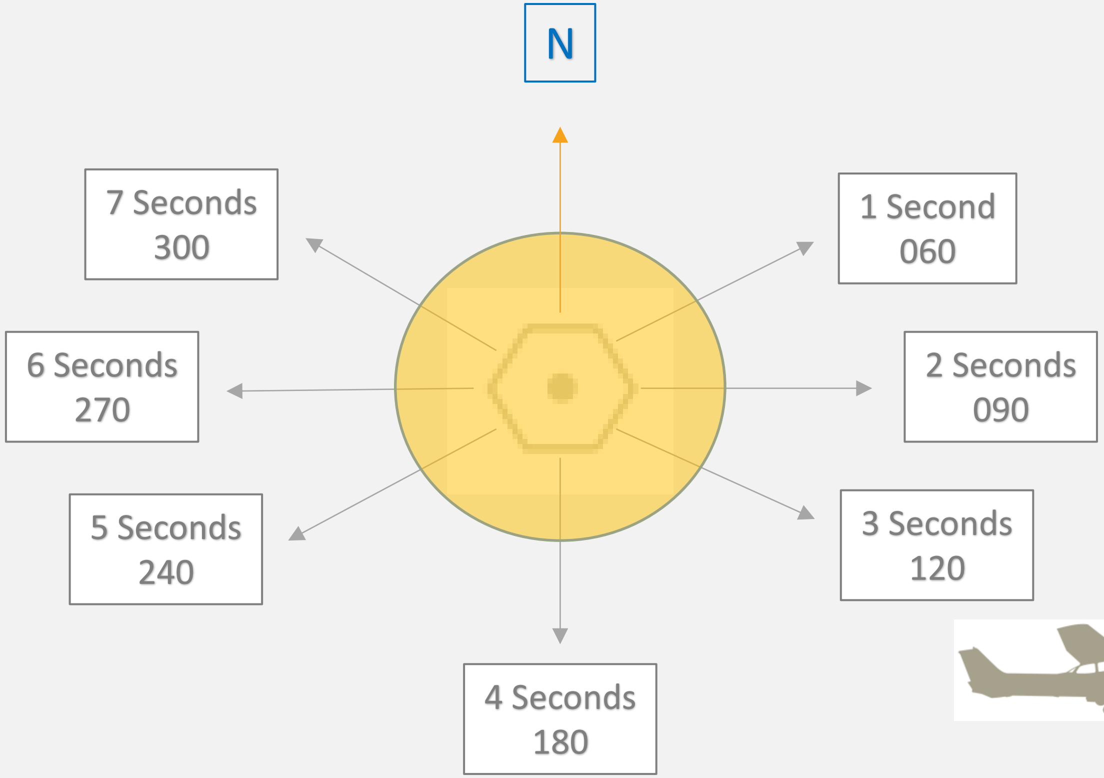
VOR Inner Workings

Now that we understand our two signals, we simply assign timing to each of the different signals to create "radials."

Example

If the VOR receiver in our aircraft acquired the sweeping signal 3 seconds after receiving the omnidirectional signal, then we would be on Radial 120.



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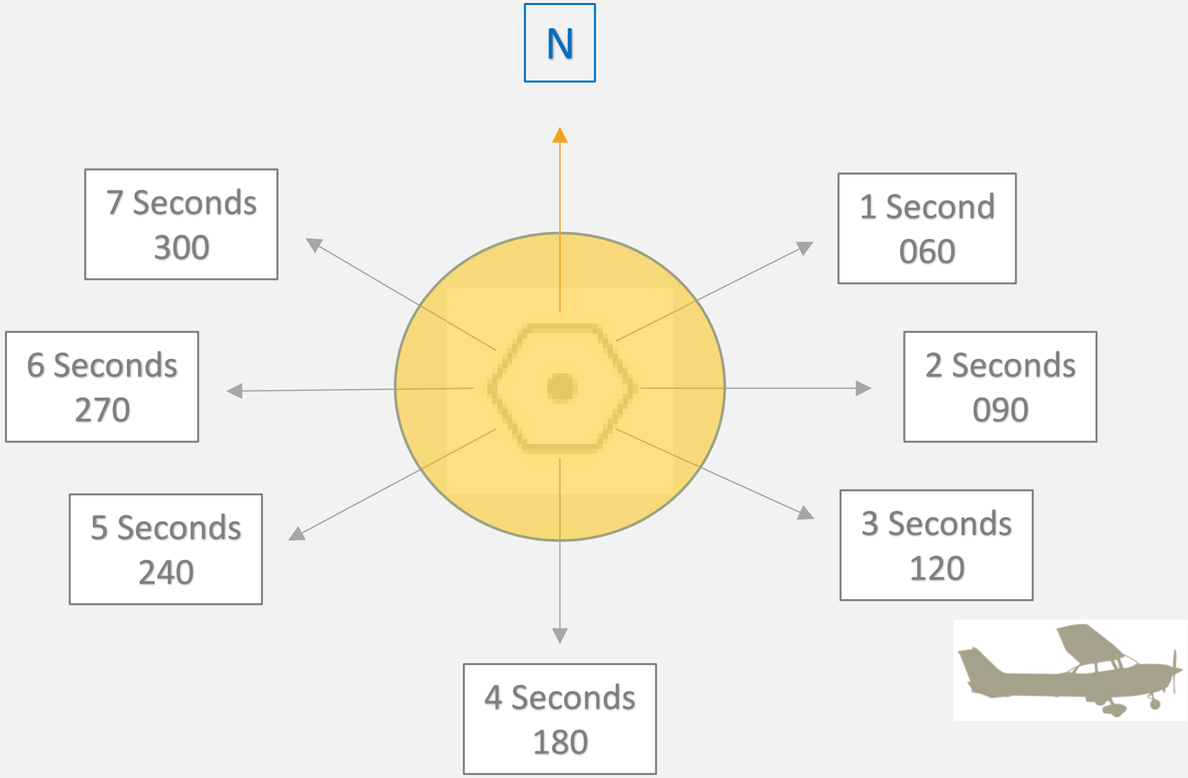
VOR Inner Workings

This is exactly how VORs work. Except, in our example, we just used arbitrary numbers for easier understanding. In reality, the sweeping signal of a VOR rotates at approximately 1800 revolutions per minute. So, instead of full second differences between sweeping and omnidirectional signals they would be in fractions of seconds.



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Cockpit Instruments

Now that we understand the inner workings of the VOR, let's look at examples of how to use them in flight. We will begin by looking at the cockpit instruments that are used to receive VOR signals and translate their data to information that can be used by pilots.

VOR OBS vs HSI

Both instruments provide essentially the same information to pilots. However, the HSI rotates with the aircraft heading while the OBS does not.

VOR OBS

Omnibearing Selector

HSI

Horizontal Situation Indicator

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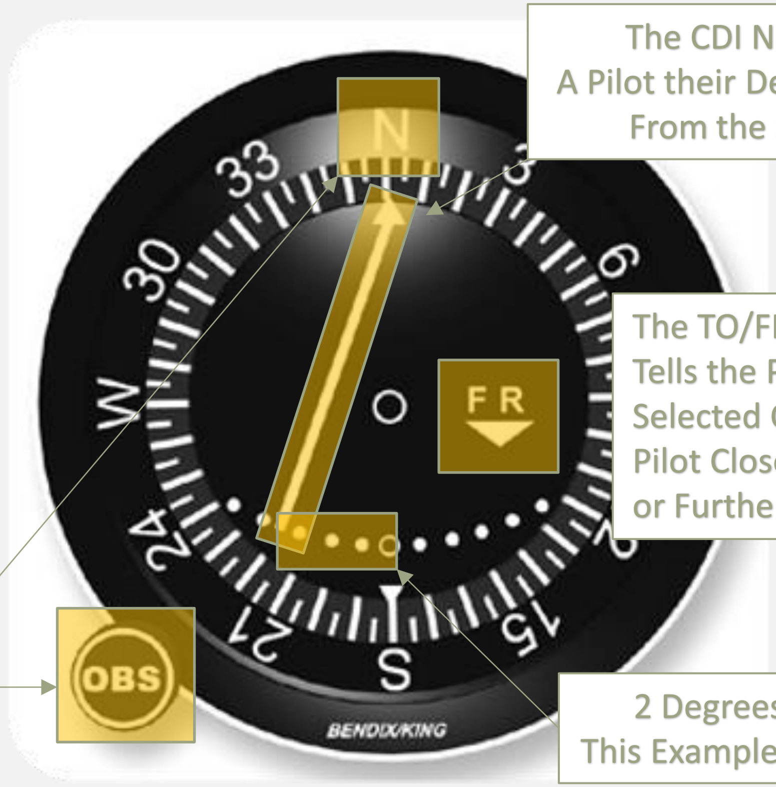
Cockpit Instruments

These cockpit instruments relate the following information to pilots:

1. Which radial the airplane is on or,
2. Amount of deviation from the radial selected, and
3. If the selected radial will take the pilot closer TO or further FROM the VOR.



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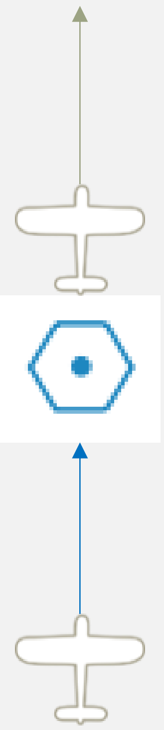
The TO/FROM Indicator

When will the TO/FROM Indicator switch indications?

- If Crossing over the VOR:
    - At Station Passage
- If not Crossing over the VOR:
    - At 90 Degrees from the Selected Radial



FROM Indication
We are Getting Further FROM the VOR

TO Indication
We are Getting Closer TO the VOR

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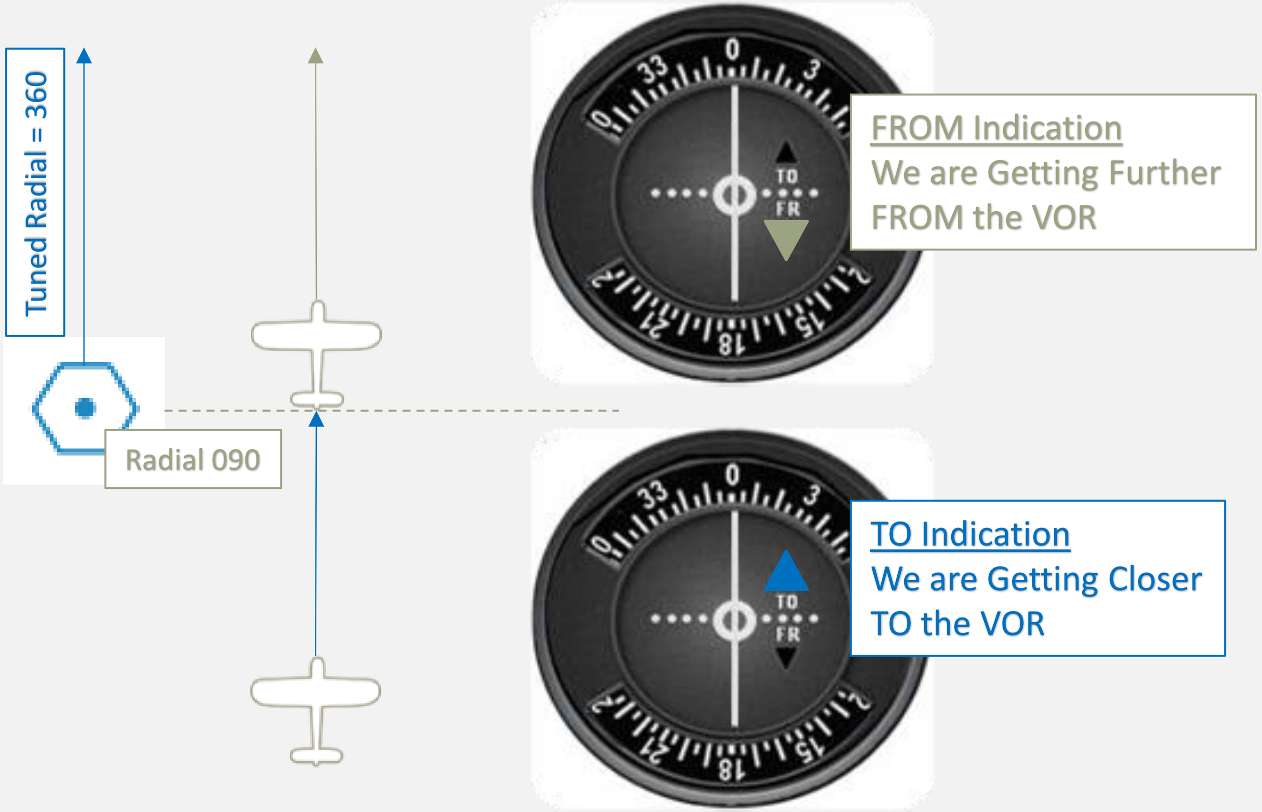

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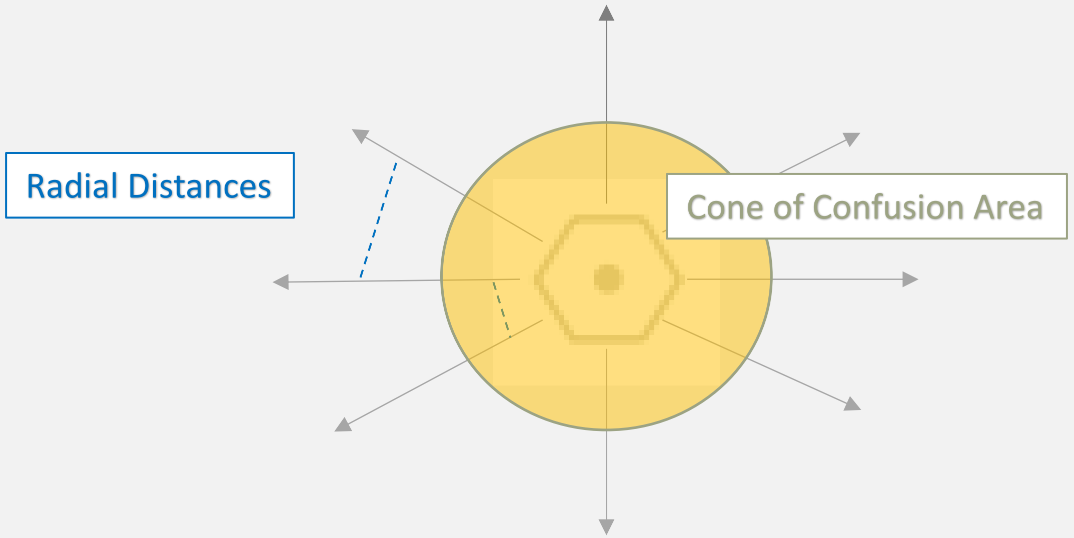
The Cone of Confusion

The closer the airplane gets to the VOR the smaller the distance between the different radials. In this area the CDI Needle Indications become extremely sensitive. This zone is known as the “Cone of Confusion.” When approaching this area the pilot should maintain his/her course and make very small adjustments (if any) in “Chasing the CDI Needle.”



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Flying with the OBS

As can be seen, we have selected a course of 360 with the OBS Knob. We can then see that our CDI Needle is deflected to the West. This means we need to make a course correction toward the West to get on our desired course. Remember to “Chase the Needle.”

Also, we can see (on the TO/FROM Indicator) that if we continue flying North, we will get further FROM the VOR.

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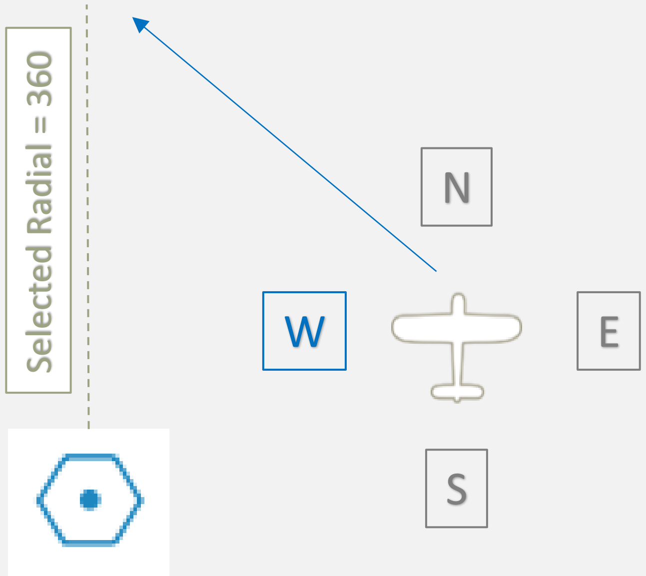

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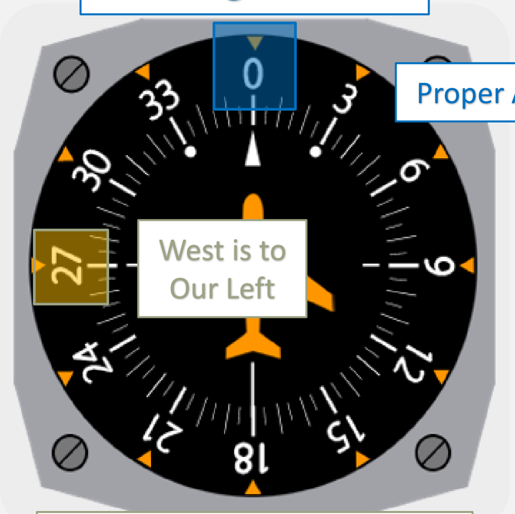
Reverse Sensing

Reverse Sensing is a pilot induced error that can confuse the pilot into making incorrect course corrections. This occurs when the pilot's Heading Indicator is not aligned properly with their VOR OBS. This error is not as common when using an HSI because the HSI rotates with the aircraft's heading.

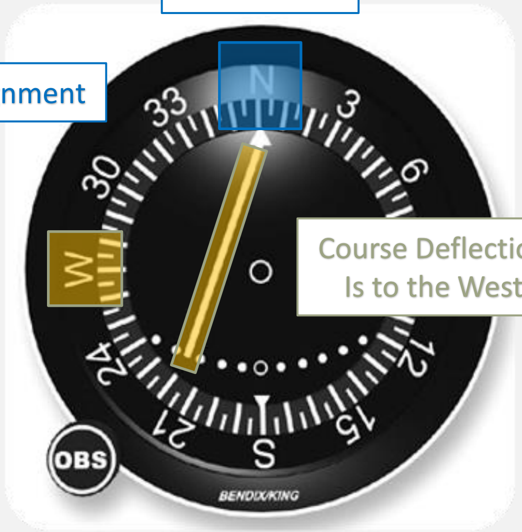
Heading Indicator



Hence, the Pilot Needs to Make a Left Course Correction

Proper Alignment

VOR OBS



Course Deflection Is to the West

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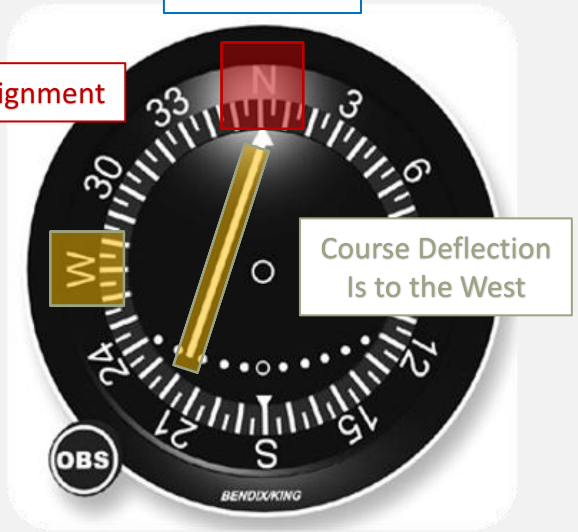
Reverse Sensing Example

In this example, we can see that our Heading Indicator and VOR OBS are not aligned properly. This could lead to reverse sensing. The pilot in this example may be tempted to make a course correction to the Left (because the CDI Needle is deflected Left) but that would be incorrect since West is to our Right. If the pilot were to make a Left Course Correction, he/she would get further from the Desired Course rather than getting closer to it.

Heading Indicator

Improper Alignment

VOR OBS



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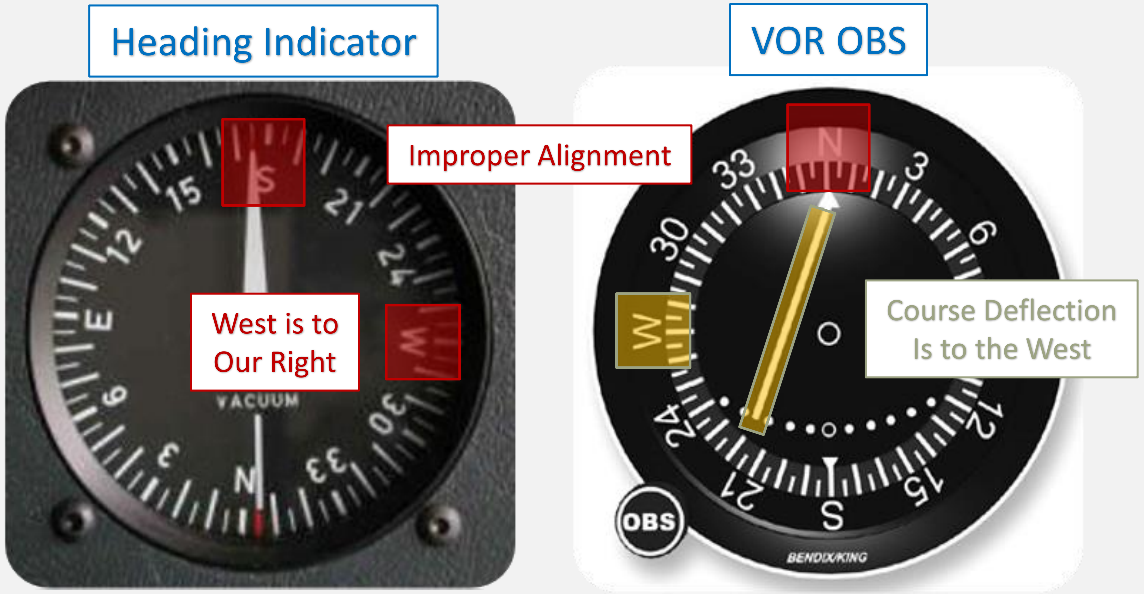
Reverse Sensing Avoidance

How can pilots avoid Reverse Sensing? Simple, when making course corrections never use the words “Left” or “Right.” Instead, always say the Cardinal Direction of the course correction needed (ie, North, East, South, West, etc.) That way, the pilot will catch their error, if they’ve made one, and realign the VOR OBS appropriately so it is giving correct information.



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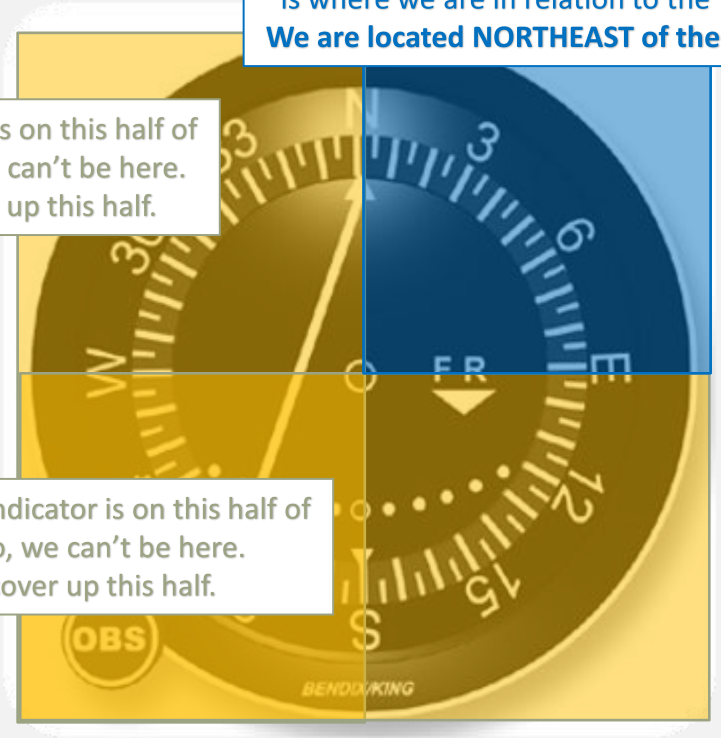
The VOR Trick

A VOR OBS that is working properly (and tuned in to the correct VOR) will never be confused on the pilot's position in relation to the VOR, you shouldn't be either. This trick is simple to master and is extremely helpful in answering those tricky questions on the FAA Written Exams and for actual in-flight application.

Think of it like this, the CDI Needle and the TO/FROM Indicator always tell a pilot where he/she is NOT in relation to the VOR.



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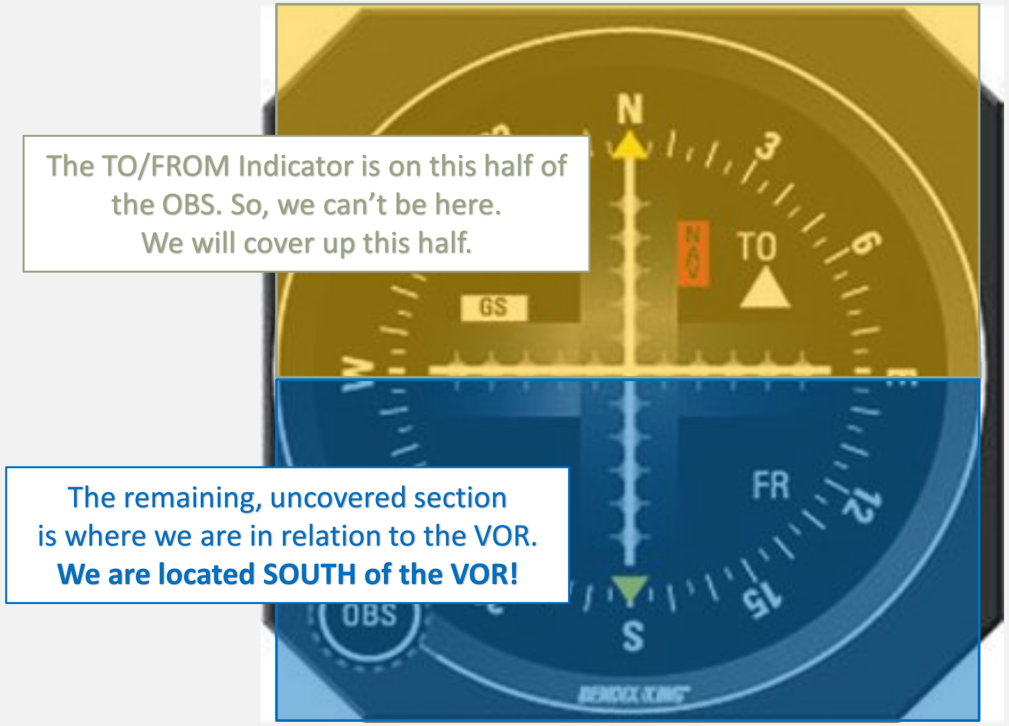
The VOR Trick

What if the CDI Needle is Centered, does the trick still work? First off, this trick works in every scenario, 100% of the time! So, yes, it still works.

In this situation, we would not cover up the Left or Right halves of the OBS (since the CDI Needle is Centered) we would only cover up to Top or Bottom half based on where the TO/FROM Indicator is.



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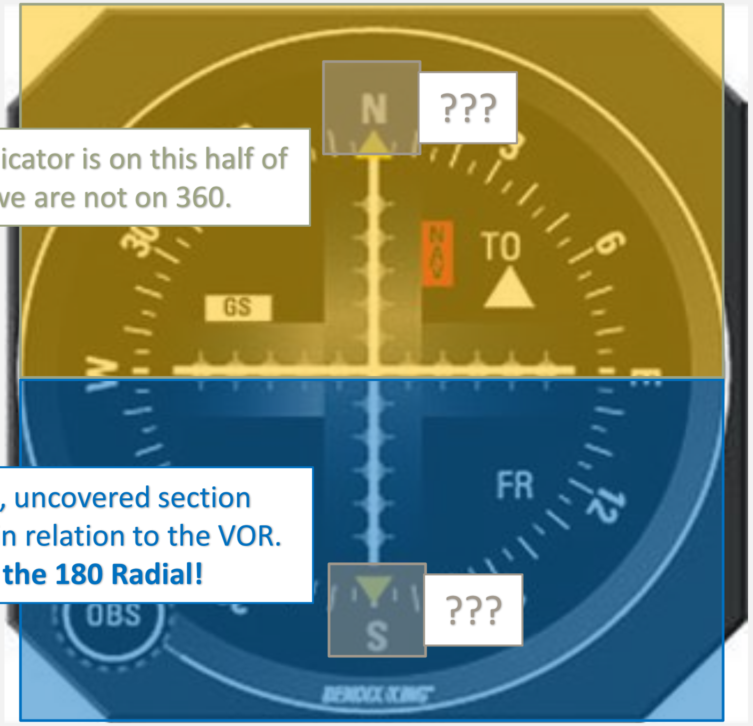
The VOR Trick

Additionally, if the CDI Needle is Centered, we can know (without hesitation) which radial we are on in relation to the VOR. In this example, students know they can either be on the 360 or 180 Radial and they usually guess incorrectly. Let's take out the guess work using the same trick.

Again, we will simply cover up the half of the OBS where the TO/FROM Indicator is. The remaining uncovered section is the Radial that we are on in relation to the VOR.



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Time to the Station

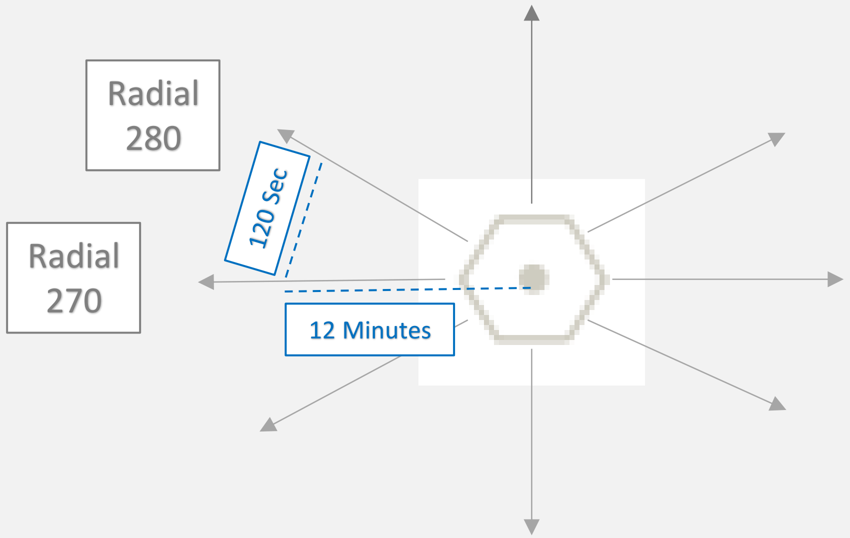
A pilot can calculate their time to reach the VOR using the simple mathematical calculation seen here.

Time-Distance Check Example

$$\frac{\text{Time in seconds between bearings}}{\text{Degrees of bearing change}} = \text{Minutes to station}$$

For example, if 2 minutes (120 seconds) is required to fly a bearing change of 10 degrees, the aircraft is—

$$\frac{120}{10} = \text{12 minutes to the station}$$



VOR CHECKS

VOR Receivers are required to be checked every 30 days when performing IFR Flight Operations. However, it is also important that VFR pilots check their receivers for accuracy as well.

A Pilot Must Annotate

Remember the acronym “SLED.”

- Signature (of the pilot performing the check).
- Location (of where the check to place).
- Error (amount of error detected during the check).
- Date (that the check took place).

“VOR has to be checked every 30 days”

VOR test procedures			
VOT test signal (see A/FD)	± 4º	Ground check (see A/FD)	± 4º
Dual VOR check	± 4º	Airborne check	± 6º

DATE	PLACE	ERROR	SIGNATURE

VOR_check_log.doc — Williams Pontel CFII – Jun 2006

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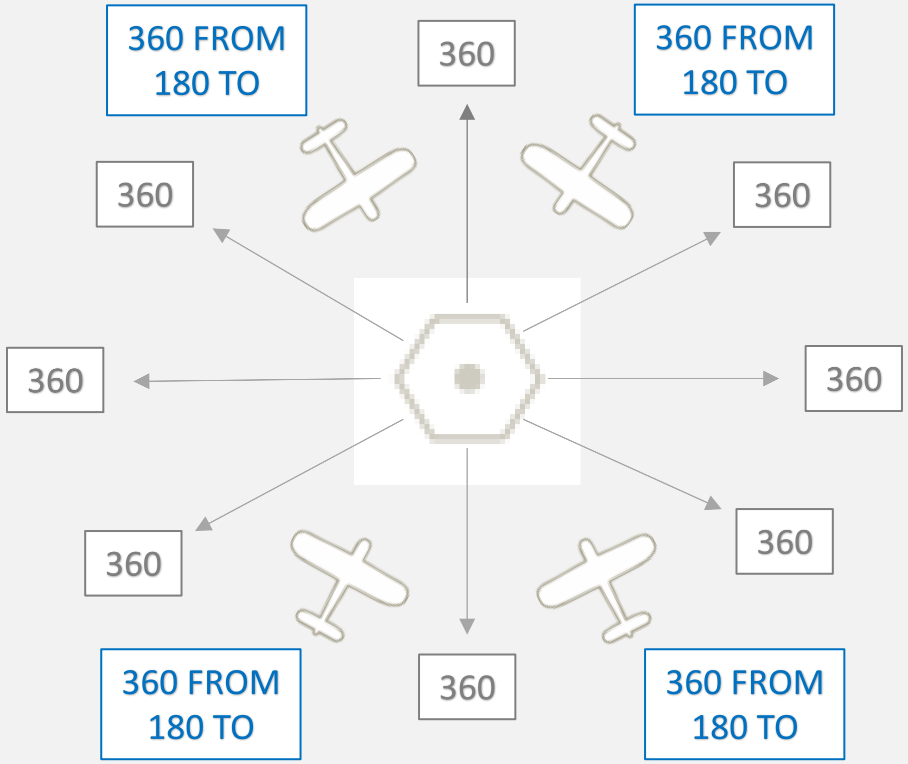
The VOT Check

VOT stands for 'VOR Test Facility." It is essentially a VOR that is coded to emit the 360 radial in all directions from the station. These can be used to check the accuracy of a VOR Receiver but are not helpful for navigation (since they only emit one radial).

When performing a VOT Check, the pilot can position the aircraft in any location to the VOT. When doing so, the pilot should then center the CDI Needle. This should show the pilot on either the 360 Radial with a FROM Indication or the 180 Radial with a TO Indication.



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Tolerances
+/- 4 Degrees

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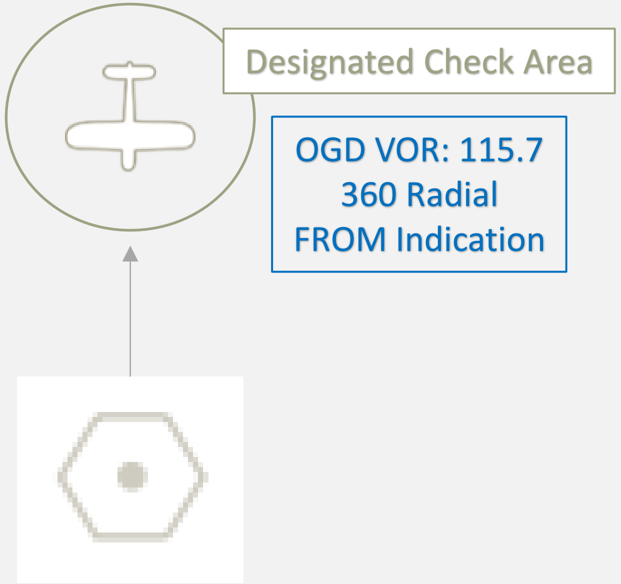
The Ground Check

With a VOR Ground Check, the pilot must park the airplane within the designated check area. The pilot then follows the instructions (usually on a nearby sign) to tune into the appropriate VOR and perform the check. With this check, the pilot must know which radial he/she should be on and if they should have a TO or a FROM Indication when parked in the designated area.



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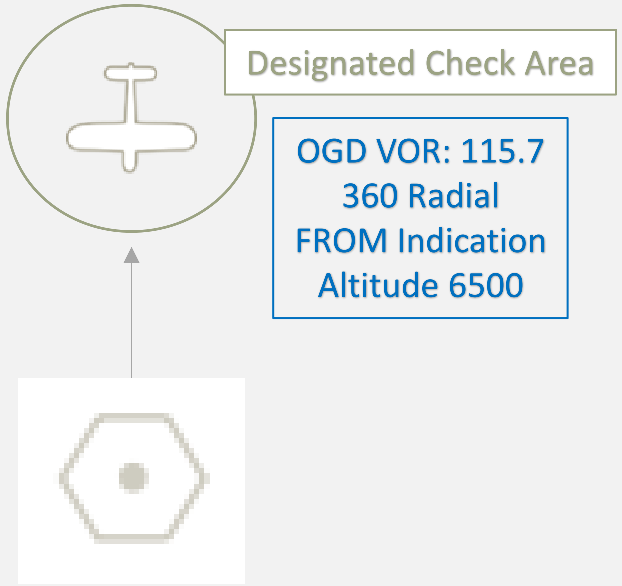
Airborne Check

The Airborne Check is done in essentially the same way as the Ground Check. The airplane must be positioned over a particular point in space and at a particular altitude. Again, the pilot will center their needle (within the designate check zone) for appropriate indications. Since Airborne Checks are not as accurate as Ground Checks, the VOR Receiver is allowed some additional leeway. Airborne Check Points can be found in the Chart Supplement, US.



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Tolerances
+/- 6 Degrees

VOR CHECKS

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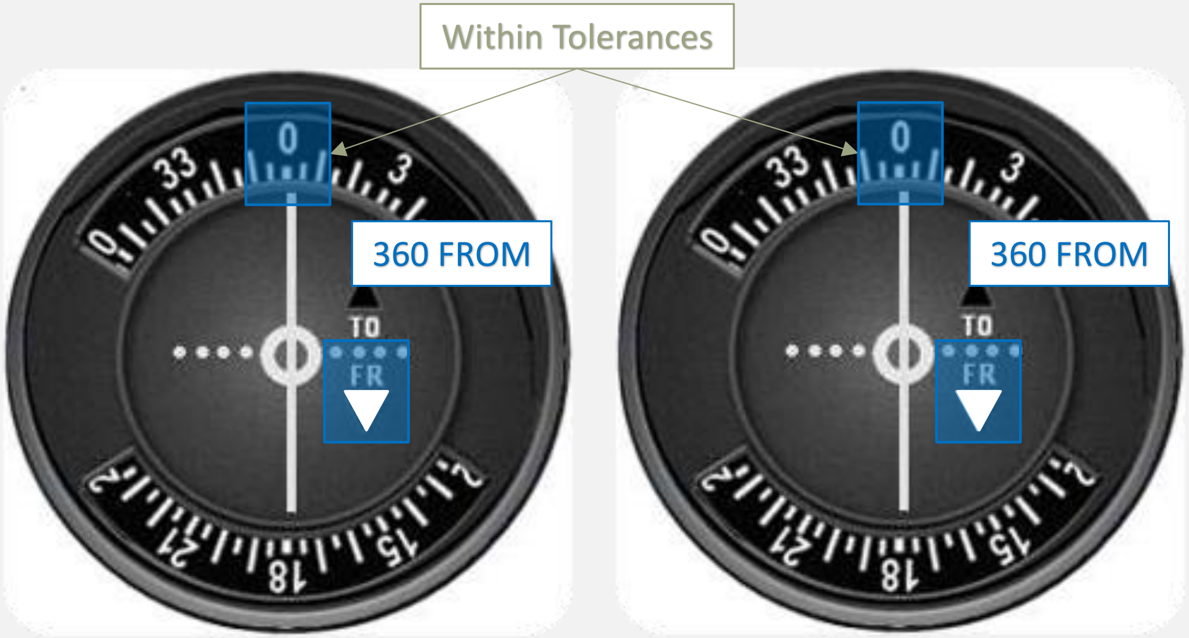
Dual VOR Check

This check can only be done in aircraft that have Dual VOR Receivers. The pilot tunes both VOR Receivers to the same VOR and checks them against each other for accuracy.

Tolerances

Receivers must be within 4 degrees of each other.



LESSON SUMMARY

In this lesson we discussed VOR symbology, the inner workings of the VOR, flying with VORs and reverse sensing, and the various types of VOR Checks.