Kasia Badger

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Private Pilot Research - Aircraft Instruments (Altimeter)

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The altimeter on aircrafts indicates the height of the aircraft above a reference point. In order to mitigate potential mistakes or miscommunications, all pilots use the same reference point: sea level. Using sea level as a reference point, pilots are able to measure their height above any area, such as an airport runway. The three needles of an altimeter indicate 100s of feet, 1,000s of feet, and 10,000s of feet. The longest and thickest needle represents 100s of feet, while the shortest needle represents 1,000s of feet and the skinniest needle represents 10,000s of feet.

When pilots measure their altitude compared to their reference point, they can use one of two terms: Mean Sea Level (MSL) or Above Ground Level (AGL). For example, an aircraft above sea level would have the same MSL and AGL. In contrast, however, an aircraft above a mountain range would have a consistent MSL and a changing AGL. This is because the heights of the mountains, or the distance between the mountain tops and the aircraft, would continuously change.

The principle of operation of the altimeter is aneroid wafer. The aneroid wafer expands and contracts depending on the altitude of the aircraft. Because the altitude of the aircraft determines the atmospheric pressure around the aircraft, the aneroid wafer, which has exactly 29.92 inHg of pressure inside it at all times, either expands or shrinks depending on the altitude of the aircraft. For example, as the aircraft altitude increases, the outside pressure decreases, causing the static port to fill the altimeter with lower pressure, allowing the aneroid wafer to expand. On the other hand, as the aircraft altitude decreases, the outside pressure increases, causing the static port to fill the altimeter with higher pressure, allowing the aneroid wafer to shrink. The movement of the aneroid wafer is what moves the needles on the face of the altimeter.

Altimeter also measures the height of the aircraft above a specific reference. For example, on a standard day, the atmospheric pressure at sea level is 29.92 inHg. If a pilot sets the pressure reference point on the altimeter to 29.92 inHg, then the altimeter can also show the height above sea level of the aircraft. In order to set the specific reference pressure on the altimeter, the pilot uses the Kollsman window. In order to find the correct reference pressure for a specific day, pilots use local weather reports that show the local pressure of the area. Another resource to find local pressure is the control tower. Another thing to remember is that the altimeter pressure reference setting must be changed throughout the course of the flight in order to have the most accurate reference point.

Using the Kollsman window to adjust sea level atmospheric pressure throughout a flight is important because pressure changes during the day from meteorological conditions. In fact, the pressure will change from airport to airport. Because of this, everyone flying in the same area should be on the same pressure setting.

Atmospheric pressure is always reported as if it were recorded at sea level. Which is why at sea level, on a standard day, pressure is reported as 29.92 inHg. This means that no matter the true elevation above sea level of the ground at a certain point, the ground pressure will always be identified in reference to the true sea level. In cases where, for example, an airport is 5000 feet above sea level, the ground pressure will be reported as 29.92, even though the true pressure is 24.92. This is done to accurately measure the distance between the aircraft and the ground.

Not only does local weather affect local pressure, but local temperature also affects local pressure. In fact, changes in local pressure and temperature have an effect on the altitude reported on the altimeter and the actual altitude of the aircraft above the ground. For example, if an aircraft flies from a high pressure area to a low pressure area without adjusting the Kollsman window, then the aircraft will end up at a lower actual altitude, even though the altimeter is reading the same altitude. When it comes to temperature changes, warm air is less dense than cold air, therefore flying through warm air is equivalent to flying through low altitude. What this means is that flying from warm air to cold air will have the same effect as flying from high pressure to low pressure: the aircraft will end up at a lower actual altitude, even though the altimeter is reading the same altitude. Because of these two scenarios, it is good to remember the following: "From high to low, look out below". This means that whether it be pressure or temperature, flying from an area with a higher variable into an area with a lower variable should prompt the pilot to look out below, in order to ensure they are not dropping in altitude.

When it comes to setting the Kollsman window on an altimeter, make sure to always record the most updated weather report. Additionally, when flying cross-country, check local weather reports or use the altimeter setting reported by the air-traffic controller (ATC). Furthermore, before takeoff, verify the altimeter setting on the ground by setting the altimeter to the reported altitude and read the altimeter setting in the Kollsman window. If the altimeter is not within 75 feet of the correct airport elevation when the altimeter setting is correct, there is something wrong with the altimeter. In other words, a working altimeter should have a 75-foot margin of error.

The three types of altitude expressed by the altimeter are the following:

- Indicated Altitude: read from the altimeter
- True Altitude: vertical distance of the aircraft above sea level (Mean Sea Level or MSL)
- Absolute Altitude: vertical distance of the aircraft above the ground (Above Ground Level or AGL)

- Pressure Altitude: indicated on the altimeter when Kollsman window set to 29.92 inHg and corrected for non-standard pressure
- Density Altitude: pressure altitude corrected for non-standard temperatures and indicates aircraft performance