ALTITUDE

As altitude increases, the air becomes thinner or less dense. This is because the atmospheric pressure acting on a given volume of air is less, allowing the air molecules to move further apart. Dense air contains more air molecules spaced closely together, while thin air contains less air molecules because they are spaced further apart. As altitude increases, density altitude increases.

TEMPERATURE

Temperature changes have a large affect on density altitude. As warm air expands, the air molecules move further apart, creating less dense air. Since cool air contracts, the air molecules move closer together, creating denser air. High temperatures cause even low elevations to have high density altitudes.

MOISTURE (HUMIDITY)

The water content of the air also changes air density because water vapor weighs less than dry air. Therefore, as the water content of the air increases, the air becomes less dense, increasing density altitude and decreasing performance.

Humidity, also called "relative humidity," refers to the amount of water vapor contained in the atmosphere, and is expressed as a percentage of the maximum amount of water vapor the air can hold. This amount varies with temperature; warm air can hold more water vapor, while colder air can hold less. Perfectly dry air that contains no water vapor has a relative humidity of 0 percent, while saturated air that cannot hold any more water vapor, has a relative humidity of 100 percent.

Humidity alone is usually not considered an important factor in calculating density altitude and helicopter performance; however, it does contribute. There are no rules-of-thumb or charts used to compute the effects of humidity on density altitude, so you need to take this into consideration by expecting a decrease in hovering and takeoff performance in high humidity conditions.

HIGH AND LOW DENSITY ALTITUDE CONDITIONS

You need to thoroughly understand the terms "high density altitude" and "low density altitude." In general, high density altitude refers to thin air, while low density altitude refers to dense air. Those conditions that result in a high density altitude (thin air) are high elevations, low atmospheric pressure, high temperatures, high humidity, or some combination thereof. Lower elevations, high atmospheric pressure, low temperatures, and low humidity are more indicative of low density altitude (dense air). However, high density altitudes may be present at lower elevations on hot days, so it is important to calculate the density altitude and determine performance before a flight.

One of the ways you can determine density altitude is through the use of charts designed for that purpose. [Figure 8-1]. For example, assume you are planning to depart an airport where the field elevation is 1,165 feet MSL, the altimeter setting is 30.10, and the temperature is 70°F. What is the density altitude? First, correct for nonstandard pressure (30.10) by referring to the right side of the chart, and subtracting 165 feet from the field elevation. The result is a pressure altitude of 1,000 feet. Then, enter the chart at the bottom, just above the temperature of 70°F (21°C). Proceed up the chart vertically until you intercept the diagonal 1,000-foot pressure altitude line, then move horizontally to the left and read the density altitude of approximately 2,000 feet. This means your helicopter will perform as if it were at 2,000 feet MSL on a standard day.

Most performance charts do not require you to compute density altitude. Instead, the computation is built into the performance chart itself. All you have to do is enter the chart with the correct pressure altitude and the temperature.

WEIGHT

Lift is the force that opposes weight. As weight increases, the power required to produce the lift needed to compensate for the added weight must also increase. Most performance charts include weight as one of the variables. By reducing the weight of the helicopter, you may find that you are able to safely take off or land at a location that otherwise would be impossible. However, if you are ever in doubt about whether you can safely perform a takeoff or landing, you should delay your takeoff until more favorable density altitude conditions exist. If airborne, try to land at a location that has more favorable conditions, or one where you can make a landing that does not require a hover.

In addition, at higher gross weights, the increased power required to hover produces more torque, which means more antitorque thrust is required. In some helicopters, during high altitude operations, the maximum antitorque produced by the tail rotor during a hover may not be sufficient to overcome torque even if the gross weight is within limits.

WINDS

Wind direction and velocity also affect hovering, takeoff, and climb performance. Translational lift occurs anytime there is relative airflow over the rotor disc. This occurs whether the relative airflow is caused by helicopter movement or by the wind. As wind speed increases, translational lift increases, resulting in less power required to hover.

The wind direction is also an important consideration. Headwinds are the most desirable as they contribute to the most increase in performance. Strong crosswinds