FLIGHT SAFETY FOUNDATION
Accident Prevention
Vol. 47 No. 8 *For Everyone Concerned with the Safety of Flight* August 1990

The Lowest Form of Cloud

Fog can obliterate visibility at critical times during low-altitude flight and landings.

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One of the most basic taboos for pilots is to avoid fog. After more than 80 years of flight, this specter continues to haunt us.

Before takeoff for a 3.5-hour flight, destination weather was below VFR but "forecast to improve before ETA." En route, a new forecast called for low ceilings and fog throughout area. After the half-way point, fog and zero visibility conditions were reported 20 miles from the destination but the pilot continued until he ran into near-zero visibility and diverted to alternate. Thirty miles short of the alternate airport the aircraft ran out of fuel and was force-landed on a dirt road, ending up in a ditch.

The aircraft had departed with a special VFR clearance because of a 600-foot overcast. The pilot reported encountering lowering ceilings and decreasing visibility in fog as he flew along a lake shoreline. After he reported a 150-foot ceiling and two-mile visibility, the aircraft entered a fog bank. Full power and a climb were initiated but the aircraft struck the side of a mountain.

The weather was marginal as the pilot took off on a VFR flight at night. The weather deteriorated en route and the pilot decided to land on a highway. Because of the reduced visibility and darkness, he did not see the powerlines stretched across the road and collided with them just prior to touchdown.

The air carrier jet encountered deteriorating weather on approach, with a ceiling of 200 feet and visibility ranging from four miles to a half mile in fog. When the runway was sighted, the aircraft was off the centerline and the pilot attempted to correct rather than make a missed approach. An outboard engine pod scraped the runway surface during a turn at low altitude and was damaged. The pilot went around but had to shut down the damaged engine en route to an alternate airport.

Surface obscuration caused by fog has bedeviled navigators on land, sea and in the air ever since travel began — and it is still a serious cause of aircraft accidents. Fog is a seemingly benign form of cloud, devoid of turbulence or precipitation (usually), but because it is in contact with the ground surface it seals off landing facilities and mountain passes with little or no warning. All fog tends to look alike to a pilot, but it is formed and is dissipated under a variety of conditions with which airmen should be familiar.

Fog is a cloud which lies on the surface of the earth, and

it is composed of water droplets or ice crystals, depending on the temperature. Because fog normally forms in very stable air, there is little or no collision between the extremely small droplets or ice crystals. Therefore, a large number of these suspended particles must be present before visibility is greatly reduced. However, fog dense enough to restrict visibility to a mile or less can form quite rapidly — a gradual thickening does not always occur. An example is the sudden increase in fog density that often occurs shortly after sunrise.

Fog may be formed by air cooling to its dew point or by the addition of moisture to the air near the surface. Ideal atmospheric conditions for fog formation are: high relative humidity (small temperature-dew point spread), an abundance of condensation nuclei, light surface wind and some cooling process to start condensation. Fog is, therefore, more prevalent in costal areas where moisture is abundant. Even when the relative humidity is less than 100 percent, fog is persistent in industrial areas, where products of combustion provide a high concentration of condensation nuclei. Fog occurs more frequently in the colder months, but the season and frequency of occurrence vary from one area to another.

Various types of fog are based upon the way they are formed. In many cases, more than one process is operating at the same time.

Radiation Fog

More commonly called "ground fog," radiation fog is the result of ground cooling on clear, calm nights. The ground cools the air to the dew point temperature. It is restricted to land areas because water areas do not have much daily variation in temperature. It forms almost exclusively at night or in the early morning and usually disappears within a few hours after sunrise. Ground fog favors flat land areas.

Light wind, up to about five knots, produces a slight mixing of the air, which tends to deepen the fog by spreading the cooling through a deeper layer. Radiation fog is usually very shallow where there is no wind flow.

Advection Fog

This type of fog forms when moist air moves over colder ground or water. Very common along costal areas, it is called "sea fog" when occurring at sea. It can also form concurrently with radiation fog.

Advection fog deepens as the wind speed increases, up to about 15 knots. Stronger winds lift the fog into a layer of low stratus.

It frequently forms offshore, largely as a result of very cold water from the ocean depths rising to the surface. The fog is then carried inland by the wind.

Advection fog results from moist tropical air moving over cold ground. It is, therefore, more common in winter than summer.

Upslope Fog

This fog forms as a result of moist, stable air being cooled by forced ascension up a sloping land surface. An upslope wind is necessary not only for its formation but also for its continued existence. If the wind becomes strong, the fog lifts and becomes low stratus clouds.

Upslope fog is common, for example, over eastern slopes of the Rocky Mountains and somewhat less frequent east of the Appalachian Mountains in the United States.

Steam Fog

The movement of cold air over much warmer water causes intense evaporation. This usually adds enough water vapor to the cold air to saturate it, forming steam fog. Steam fog rises from the water surface like smoke, and it is sometimes referred to as "sea smoke."

Since steam fog, unlike advection fog, forms over a warm surface, heating from below tends to make the air unstable. Therefore, turbulence and icing often occur in this type of fog.

In autumn, steam fog is sometimes observed over rivers and lakes in the middle latitudes. Water surfaces cool much more slowly than land surfaces in this time of year and are still relatively warm compared to an invading cold air mass. It occurs frequently in the winter over open bodies of water in polar regions.

Precipitation-induced Fog

The addition of moisture to the air through evaporation of rain or drizzle causes what is known as precipitation-induced fog. Evaporation can occur when precipitation is falling through the air and after it reaches the ground. Although it is most frequently associated with warm fronts, it may sometimes form with cold and stationary fronts. Other factors being favorable, it can occur with nonfrontal as well as frontal precipitation. Precipitation-induced fog usually forms rapidly when associated with a front and covers a large area, especially when it accompanies warm-front precipitation.

Ice Fog

Ice fog forms in moist air during extremely cold, calm conditions. The tiny ice crystals composing it are often called needles or spicules. Very bright reflections or shimmering lights result when the sun shines on these suspended particles. Effective visibility is largely dependent upon whether or not you are looking toward the sun. Ice fog occurs mostly in the Arctic.

Sudden ice fog formation over a wide area may be triggered by local sources of water vapor, condensation nuclei or turbulence, such as aircraft, automobiles, factories, laundries, animal herds, etc. When the wind is very light and the temperature is -30°F (-35°C) or lower, ice fog often forms almost instantaneously in the exhaust gases of automobiles and aircraft. It may last only a few minutes or persist for several days.

Low Stratus Clouds

Stratus clouds, like fog, are composed of extremely small water droplets or ice crystals suspended in the air. The main distinction from fog is that stratus is a layer above the ground and does not reduce the horizontal visibility at the surface below it. An observer on a mountain, enveloped in the layer, would call it fog, while one farther down the slope would call it stratus.

Stratus and fog frequently exist together. A cross-section of such a condition might appear as a layer of suspended water droplets extending from the ground to some height — perhaps several hundred feet or more — but suddenly becoming denser as the cloud base is entered. Because of the reduction in upward visibility, the observer on the ground recognizes the condition as stratus. There is no firm distinction between stratus and fog other than height above the ground. In the vertical, it is a sudden transition from a less dense fog to a fog that gives the effect of a cloud.

Establishing alternate routes and airports before departure, even for a VFR flight, is one way of preventing Mother Nature from playing tricks with your visibility. ♦

[This article is reprinted from the U.S. Federal Aviation Administration's FAA Aviation News *in the interest of sharing safety information with the worldwide aviation community. — Ed.]*

Thunderstorm Quiz

Take this refresher on a common weather phenomenon that is particularly unforgiving of familiarity or contempt.

Each time a flight crew takes to the air, it is forced to deal with two of Mother Nature's greatest forces — gravity and weather. Man can overcome the pull of gravity with mechanically produced horsepower, but there is not much he can do about weather, except prevent it from interfering with the safe end to a flight.

The following quiz is intended to reinforce pilot awareness of a hazard to flight that continues to be a formidable foe even though today's aircraft rarely need to penetrate a cumulonimbus.

1. Thunderstorms are almost always accompanied by:
   a. Strong wind gusts.
   b. Severe turbulence.
   c. Lightning.
   d. Severe icing.
   e. All the above.

2. About how many thunderstorms occur worldwide each day?
   a. 10,000
   b. 44,000
   c. 22,000
   d. 31,000

3. Thunderstorms can be found in:
   a. Tropical regions.
   b. Mid-latitudes.
   c. Arctic regions.
   d. All the above.

4. In the United States, thunderstorms are most frequent during the months of:
   a. May and June.
   b. June and July.
   c. July and August.

d. August and September.

5. The basic requirements for formation of a thunderstorm include:
   a. Unstable air.
   b. Lifting action.
   c. High moisture content.
   d. All the above.

6. In the United States, thunderstorms are most frequently found in the:
   a. Northwest and Midwest.
   b. Northeast and Southeast.
   c. Southcentral and Southeast.
   d. Midwest and Northeast.

7. The life cycle of a thunderstorm is:
   a. 2 to 4 hours.
   b. 20 minutes to 3 hours.
   c. 30 minutes to 12 hours.
   d. 2 to 8 hours.

8. Thunderstorms may occur within the cloud system of any front.
   a. True
   b. False

9. The most severe conditions are found in:
   a. Cold front thunderstorms.
   b. Squall line thunderstorms.
   c. Stationary front thunderstorms.
   d. Air-mass thunderstorms.
   e. Both a and b.

10. The least severe frontal thunderstorms are found in:
    a. Warm fronts.
    b. Cold fronts.
    c. Stationary fronts.
    d. Occluded fronts.

11. Thunderstorms that form on the windward side of a mountain when wind forces moist, unstable air up the slope are called:
    a. Orographic thunderstorms.
    b. Mountain effect thunderstorms.
    c. Convergence thunderstorms.
    d. Occluded thunderstorms.

12. Thunderstorm-related hail has been encountered as high as _____ and as far downwind as_____.
    a. 40,000 ft. … 15 miles
    b. 35,000 ft. … 15 miles
    c. 45,000 ft. … 20 miles
    d. 50,000 ft. … 25 miles

13. The storm cloud is the visible portion of a turbulent system whose updrafts and downdrafts often extend outside the storm proper.
    a. True
    b. False

14. Cold front and squall line thunderstorms with an extremely turbulent zone are often marked on the leading edge by the presence of a:
    a. Roll cloud.
    b. Cumulus cloud.
    c. Anvil cloud.
    d. Cumulonimbus cloud.

15. The majority of thunderstorm lightning discharges strike the ground.
    a. True.
    b. False.

Answers — 1. e; 2. b; 3. d; 4. c; 5. d; 6. c; 7. b; 8. a; 9. e; 10. a; 11. a; 12. c; 13. a; 14. a; 15. b.

[This is reprinted from the U.S. Air Force Military Airlift Command (MAC) publication, The MAC Flyer, *in the interest of sharing safety information with the worldwide aviation community. — Ed.]*

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