Three Types of Aircraft Icing

Clear Icing

- Between 2 ° C to -10° C
- Appears lumpy and translucent or clear and smooth
- Results from supercooled liquid water droplets striking the surface but not freezing immediately upon contact
- Tends to form horns or other complex shapes which can significantly disrupt the airflow

Photos Courtesy NASA GRC

Rime Icing

- Between -10° C to -15° C
- Appears rough, milky, and opaque
- Formed by the instantaneous freezing of supercooled droplets as they strike the aircraft
- Tends to form conformal or wedge-shaped accretions

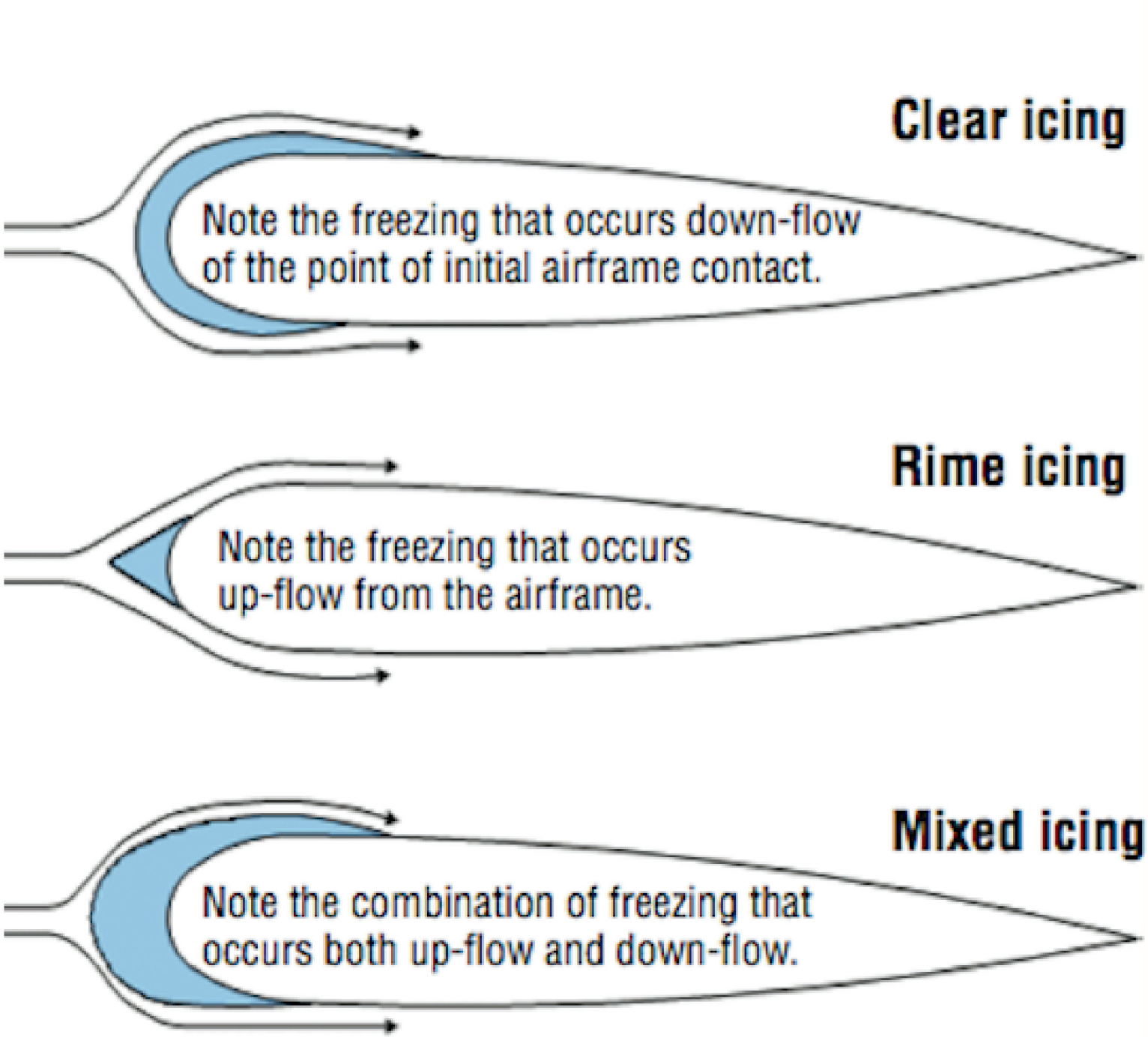
Aircraft Icing Awareness Week

Mixed Icing

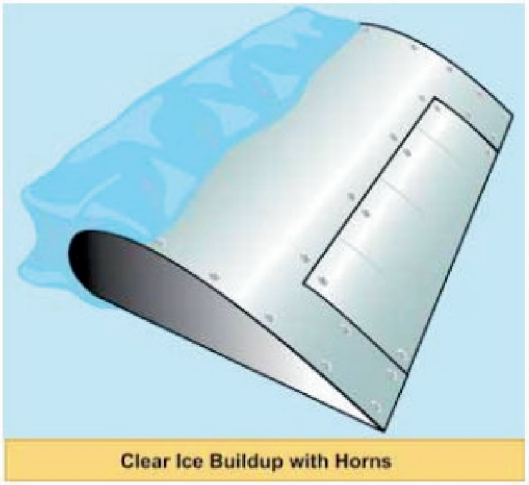
- Between -15° C and -20 ° C
- Combination of clear ice and rime ice
- Forms rapidly when ice particles become embedded in clear ice
- Builds a very rough accumulation

www.aviationweather.gov/icing

Ice types

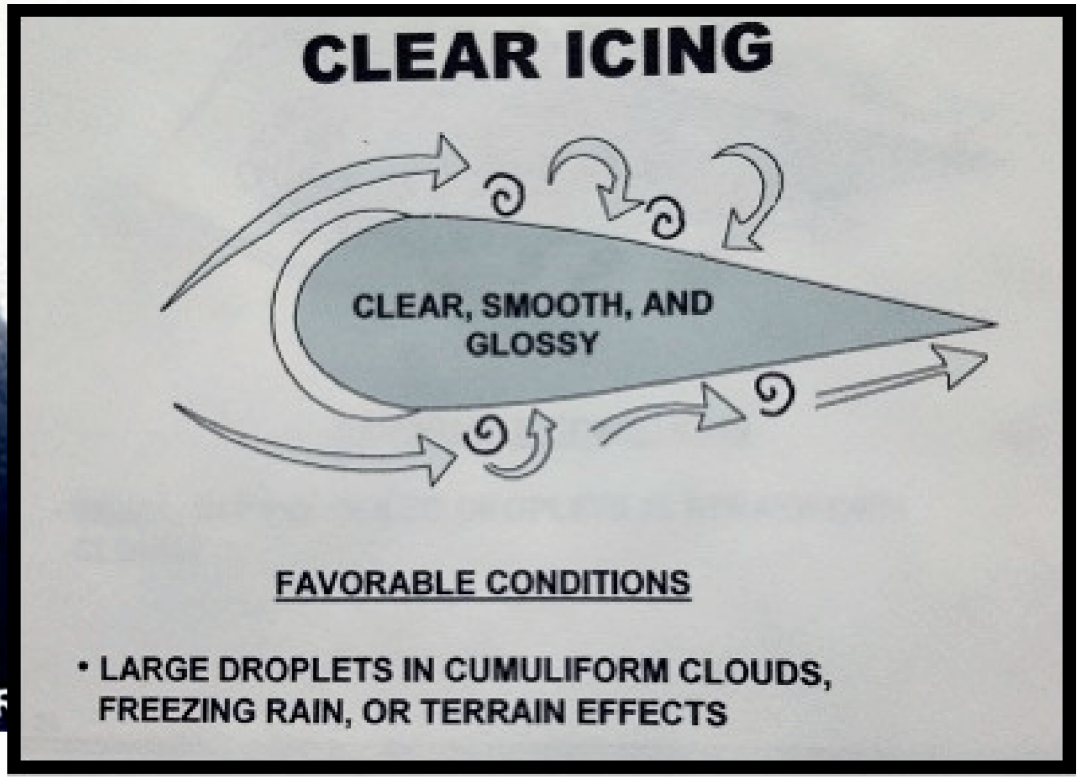

Clear icing
Note the freezing that occurs down-flow of the point of initial airframe contact.
Rime icing
Note the freezing that occurs up-flow from the airframe.
Mixed icing
Note the combination of freezing that occurs both up-flow and down-flow.

Clear / Glaze Ice

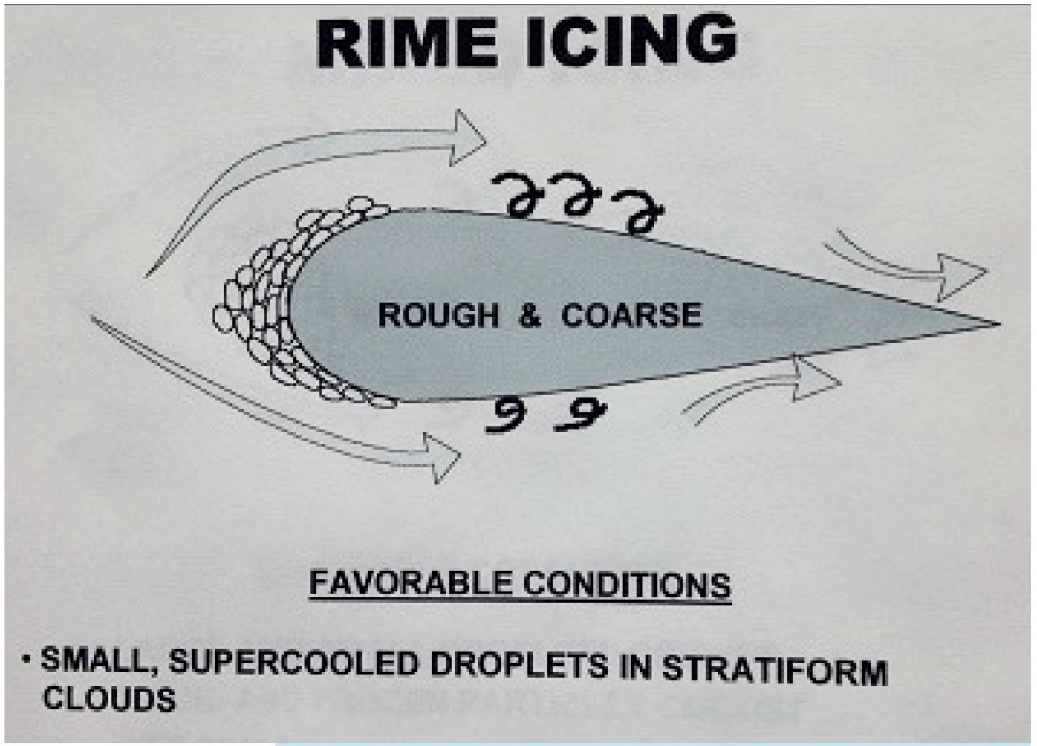


Clear ice forms when, after initial impact, the remaining liquid portion of the drop flows out over the aircraft surface gradually freezing as a smooth sheet of solid ice. This type forms when drops are large as in rain or in cumuliform clouds. Forms mostly when conditions are between 0 and -10˚C.

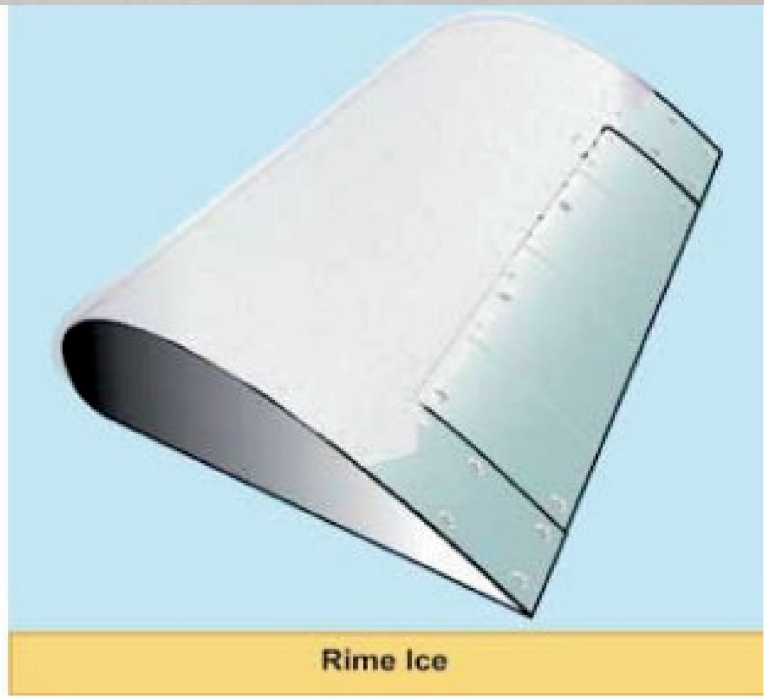
Think large amounts of liquid water, high aircraft velocities, and large droplets



Rime Ice



Rime ice is an opaque, or milky white, deposit of ice that forms when the airplane is flying through filmy/stratiform clouds. It is dependent on a low rate of catch of small supercooled water droplets. It accumulates on the leading edges of wings and on antennas, pilot heads, etc. For rime to form, the aircraft skin must be at a temperature below 0°C. Forms generally between -10°C and -20°C. The drop will then freeze completely and quickly without spreading from the point of impact. Thus, the droplets retain their spherical shape as they freeze, creating air packets between the frozen particles. This process creates an irregular shape of the ice.

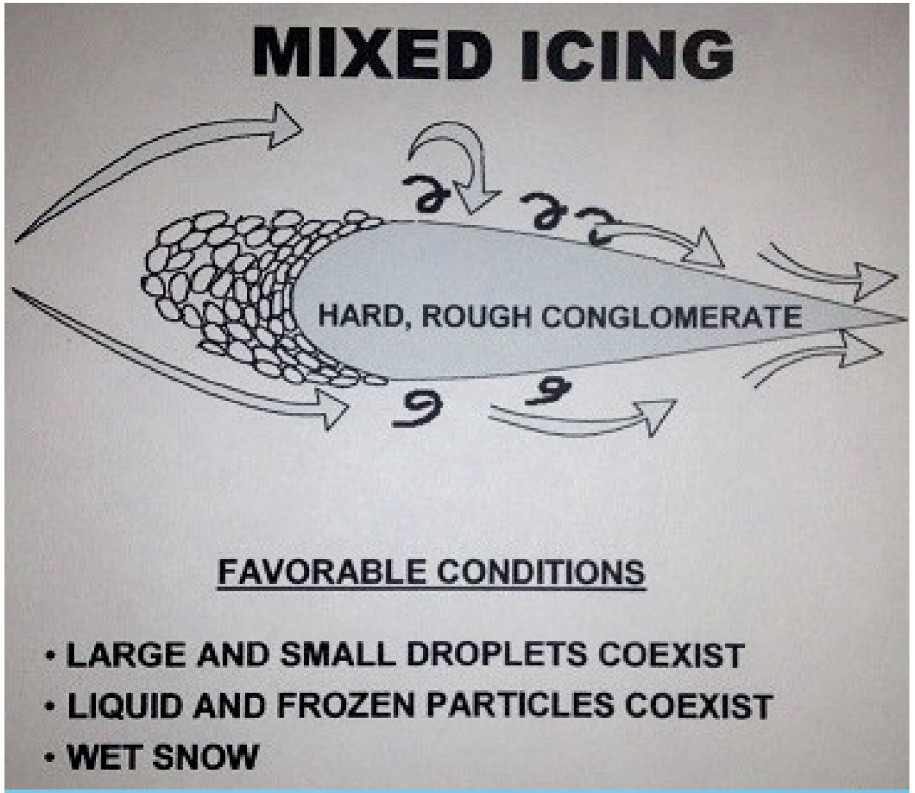


The deposit has no great weight, but its danger lies in the aerodynamic alteration of the wing camber and in the choking of the orifices of the carburetor and instruments. Rime is usually brittle and can easily be dislodged by de-icing equipment. Occasionally, both rime and clear ice will form concurrently. This is called mixed icing and has the bad features of both types.

Mixed Ice

Simultaneous appearance or a combination of rime and clear/glaze ice characteristics. Since the clarity, color, and shape of the ice will be a mixture of rime and glaze characteristics, accurate identification of mixed ice from the cockpit may be difficult.

Mixed icing, as the name implies, has the properties of both clear and rime icing. Large and small supercooled droplets coexist. Appearance is whitish, irregular and rough. Favorable conditions include liquid and frozen particles found in the colder portion of the cumuliform cloud and wet snow flakes. The formation process for mixing icing includes that of clear and rime icing. Mixed ice can accumulate rapidly and is difficult to remove. Occurs generally -8°C to -15°C



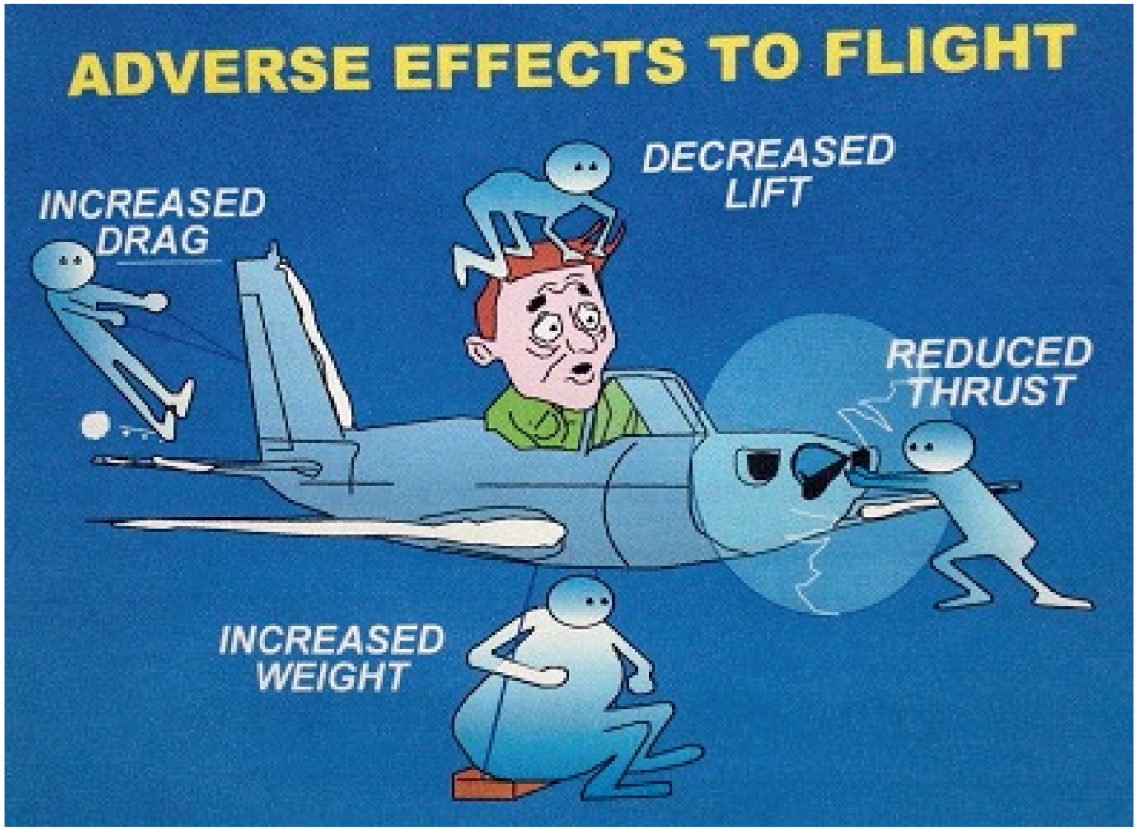
Frost & Dew

- Thin layer of crystalline ice
- Normally occurs on clear, calm wind nights when air temperature and dew point are below freezing
- May occur when descending from a zone of freezing temperatures into high humidity

A white semi-crystalline frost which covers the surface of the airplane forms in clear air by the process of deposition. It may also interfere with radio by coating the antenna with ice. It generally forms in clear air when a cold aircraft enters warmer and damper air during a steep descent. Aircraft parked outside on clear cold nights are likely to be coated with frost by morning. The upper surfaces of the aircraft cool by radiation to a temperature below that of the surrounding air.

Frost which forms on wings, tail and control surfaces must be removed before take-off. Frost alters the aerodynamic characteristics of the wing sufficiently to interfere with take-off by increasing stall speed and reducing lift. Frozen dew may also form on aircraft parked outside on a night when temperatures are just below freezing. Dew first condenses on the aircraft skin and then freezes as the surface of the aircraft cools. Frozen dew is usually clear and somewhat crystalline, whereas frost is white and feathery. Frozen dew, like frost, must be removed before take-off. In fact, any snow or moisture of any kind should be removed since these may freeze to the surface while the airplane is taxiing out for take-off. The heat loss due to the forward speed of the airplane may be sufficient to cause congelation.

Effects of Icing



Primary Force	Icing Effect on Force	Resulting Effect on Aircraft
Lift	Decreased	Excessive loss of lift will cause aircraft to lose altitude
Weight	Increased	Excessive weight will cause aircraft to lose altitude
Thrust	Decreased	Excessive loss of thrust will cause aircraft to lose airspeed and lift
Drag	Decreased	Excessive drag will cause aircraft to lose airspeed and lift

ICING INTENSITY

Icing Intensity Classification	
Intensity	**Rate of Accumulation**
Trace	Perceptible, no significant accumulation
Light	Significant accumulations for prolonged flight (over 1 hour)
Moderate	Significant accumulations for shorter periods of flight
Severe	Rapid, dangerous accumulations

Icing Intensity Effects	
Icing Itensity	**Airframe Ice Accumulation**
Trace	Usually not hazardous event if de-icing/anti-icing equipment is NOT used
Light	Occasional use of de-icing/anti-icing equipment removes/prevents accumulation
Moderate	Rate of accumulation is such that event short encounters become potentially hazardous and use of de-icing/anti-icing equipment or flight diversion is necessary
Severe	De-icing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary

Trace
- Stratus clouds

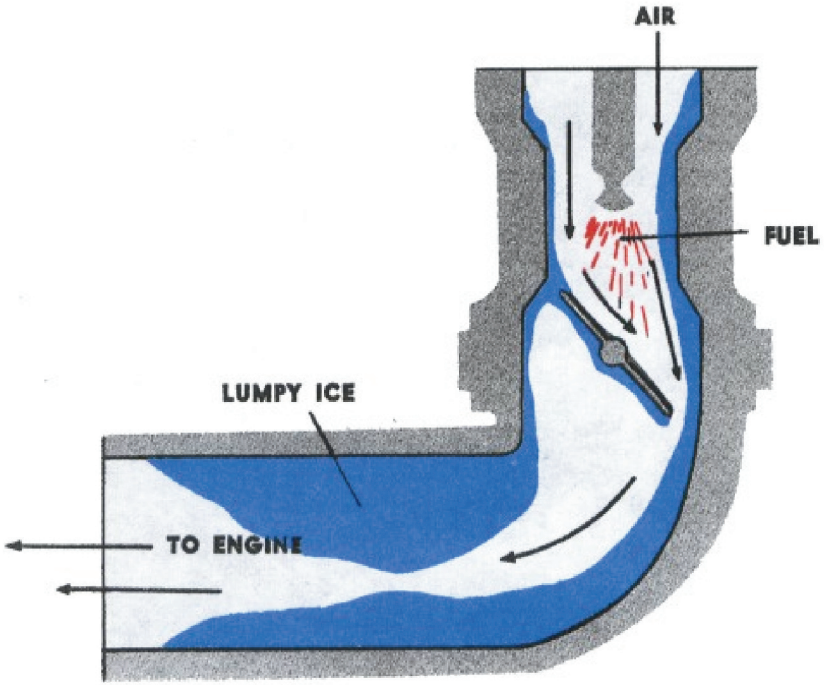
Light
- Stratus clouds and weak weather-producing system
- Widespread weak cumulus or stratocumulus clouds

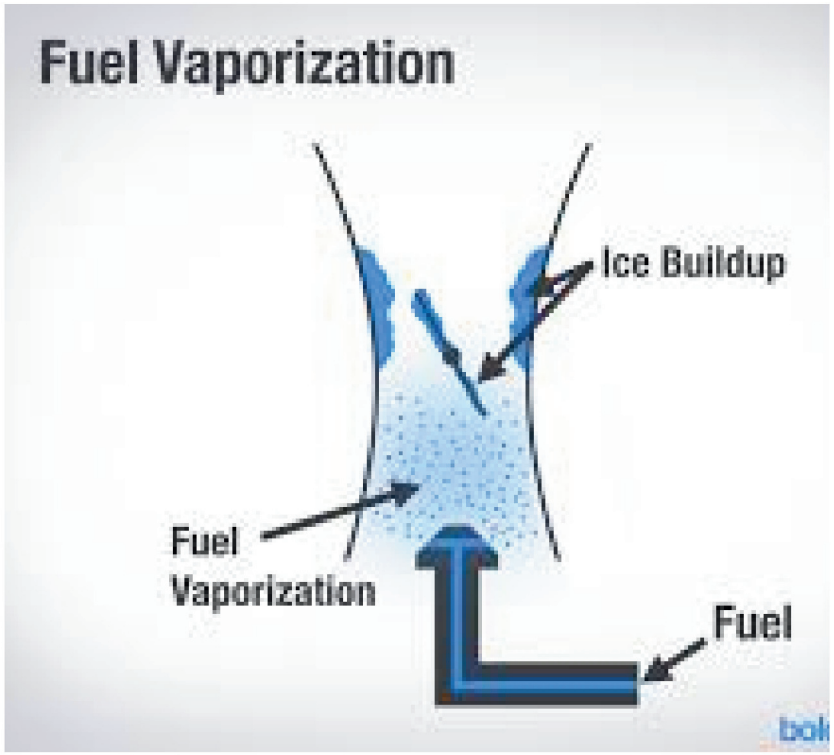
Moderate
- Nimbostratus clouds and weather-producing system
- Stratocumulus and turbulent mixing
- Light freezing rain, freezing drizzle
- Extensive vertically-developed cumuliform clouds

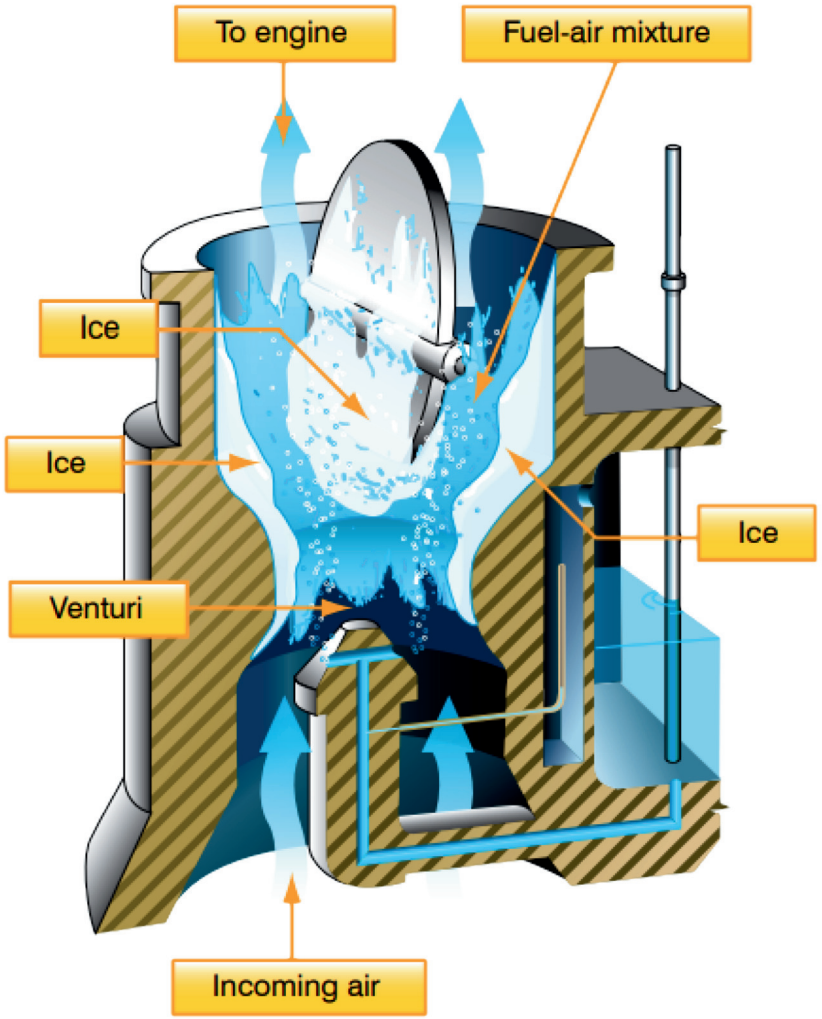
Severe
- Nimbostratus clouds and strong weather-producing system
- Freezing rain
- Cumulonimbus

Factors which affect the icing threat include:

Particle size
Particle concentration
Shape of aircraft surfaces
Aircraft speed
Environmental temperature
Aircraft surface temperature (must be 5°C or colder)


AIR
FUEL
LUMPY ICE
TO ENGINE


Fuel Vaporization
Ice Buildup
Fuel
Vaporization
Fuel


To engine
Fuel-air mixture
Ice
Ice
Ice
Venturi
Incoming air

In some Cessna 172S Models:

The induction system has a spring-loaded alternate air door inside the cowling (behind the filter on the left-hand side) that will automatically open if the air filter becomes plugged