# SWR FLIGHT SAFETY

# AIRCRAFT ICING
# DEC 2016

# Aircraft Icing

- Ice in flight is bad news.
- It destroys the smooth flow of air, increasing drag while decreasing the ability of the airfoil to create lift.
- The actual weight of ice on an airplane is insignificant when compared to the airflow disruption it causes.
- PIC

# Aircraft Icing

- As power is added to compensate for the additional drag and the nose is lifted to maintain altitude, the angle of attack is increased, allowing the underside of the wings and fuselage to accumulate additional ice.

- Ice accumulates on every exposed frontal surface of the airplane—*not just* on the wings, propeller, and windshield, but also on the antennas, vents, intakes, and cowlings.

- Ice can also cause engine stoppage by either icing up the carburetor or, in the case of a fuel-injected engine, blocking the engine’s air source.

# Aircraft Icing

- It can cause antennas to vibrate so severely that they break.

- In moderate to severe conditions, a light aircraft can become so iced up that continued flight is impossible.

- The airplane may stall at much higher speeds and lower angles of attack than normal. It can roll or pitch uncontrollably, and recovery might be impossible.

# Aircraft Icing

**Structural ice is the stuff that sticks to the outside of the airplane. It is described as rime, clear (sometimes called glaze), or mixed.**

- ***Rime ice*** **has a rough, milky white appearance, and generally follows the contours of the surface. Much of it can be removed by deice systems or prevented by anti-ice.**

- ***Clear (or glaze) ice*** **is sometimes clear and smooth, but usually contains some air pockets that result in a lumpy, translucent appearance. The larger the accretion, the less glaze ice conforms to the shape of the wing; the shape is often characterized by the presence of upper and lower "horns." Clear ice is denser, harder, and more transparent than rime ice, and is generally hard to break.**

- ***Mixed ice*** **is a combination of rime and clear ice.**

# Aircraft Icing

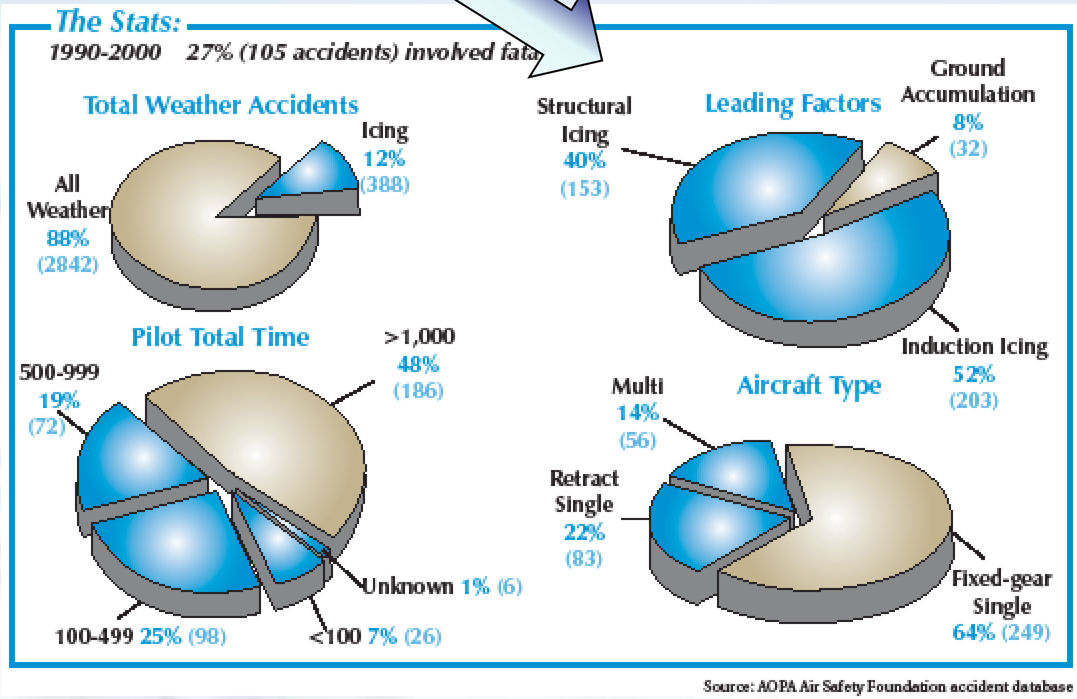
- Ice can distort the flow of air over the wing, diminishing the wing's maximum lift, reducing the angle of attack for maximum lift, adversely affecting airplane handling qualities, and significantly increasing drag.

- Wind tunnel and flight tests have shown that frost, snow, and ice accumulations (on the leading edge or upper surface of the wing) no thicker or rougher than a piece of coarse sandpaper can reduce lift by 30 percent and increase drag up to 40 percent.

- Larger accretions can reduce lift even more and can increase drag by 80 percent or more.

# Icing Accidents

- The leading causes of icing accidents are induction icing and in-flight structural icing.



# Icing Risk

• Ice can form on aircraft surfaces at 0 degrees Celsius (32 degrees Fahrenheit) or colder when liquid water is present

• It is fairly easy to predict where the large areas of icing potential exist, but the accurate prediction of specific icing areas and altitudes much more difficult.

• Mountains, bodies of water, wind, temperature, moisture, and atmospheric pressure all play roles

**Icing Risk**

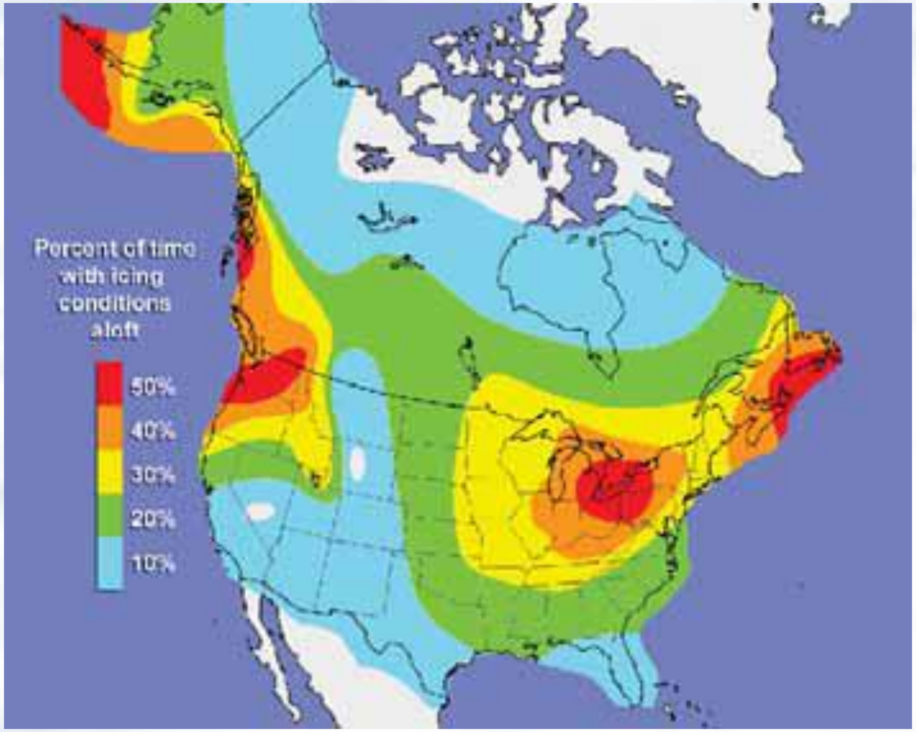
| Cumulus Clouds | | Stratiform Clouds | | Rain and Drizzle |
|---|---|---|---|---|
| 0° to -20°C<br>32° to -4°F | High | 0° to -15°C<br>32° to 5°F | High | 0°C and below<br>32°F and below |
| -20° to -40°C<br>-4° to -40°F | Med. | -15° to -30°C<br>5° to -22°F | Med. | |
| < than -40°C<br><than -40°F | Low | < than -30°C<br><than -22°F | Low | |

Icing risk

# Icing Map

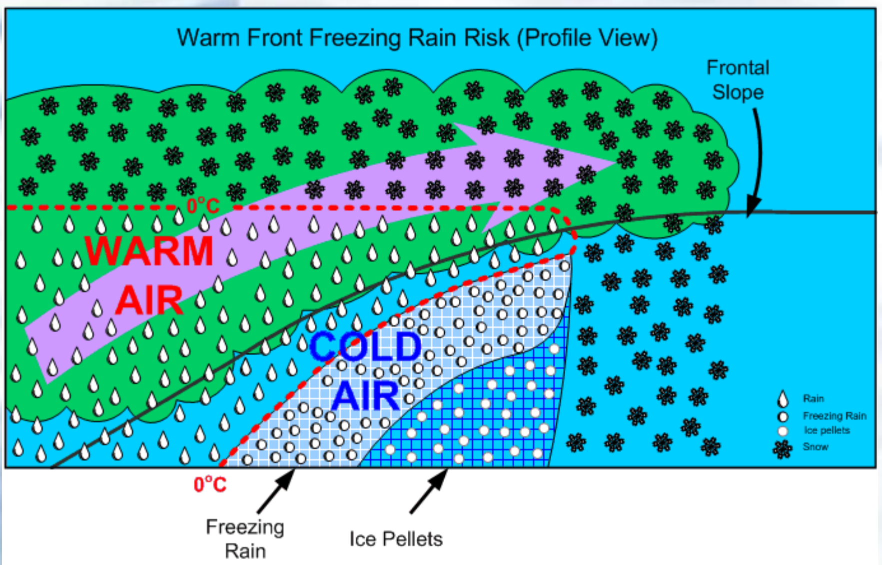
- All clouds are not alike. There are dry clouds and wet clouds. Dry clouds have relatively little moisture and, as a result, the potential for aircraft icing is low.

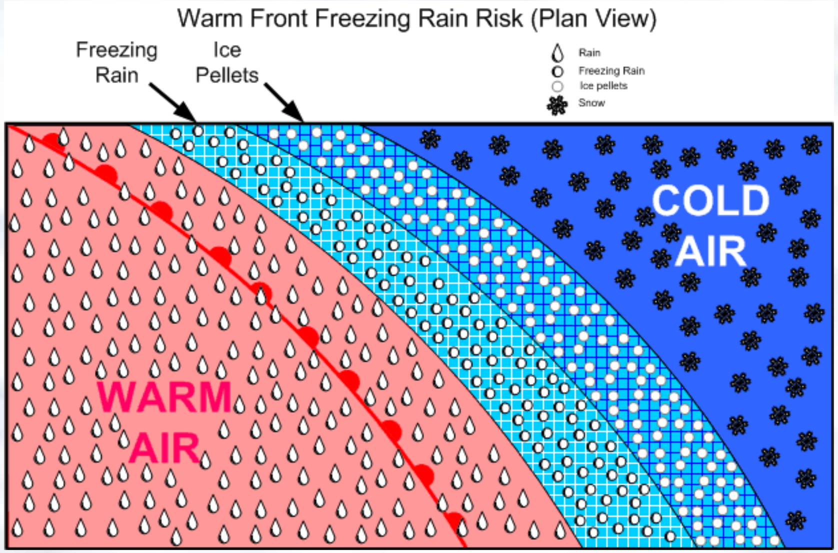
- Winter in the Great Lakes region often brings a tremendous amount of moisture with the cold air and lots of wet clouds that, when temperatures are freezing or below, are loaded with ice.



# Icing Conditions

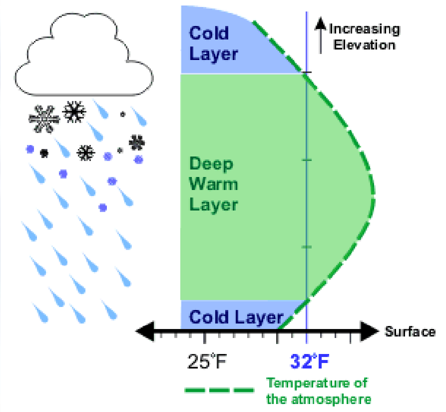
- Fronts and low-pressure areas are the biggest ice producers
- However, isolated air mass instability with plenty of moisture can generate enough ice in clouds to make light aircraft flight inadvisable.



# Icing Conditions

- Freezing rain and drizzle are the ultimate enemy that can drastically roughen large surface areas or distort airfoil shapes and make flight extremely dangerous or impossible in a matter of a few minutes.
  - Freezing rain occurs when precipitation from warmer air aloft falls through a temperature inversion into below-freezing air underneath. The larger droplets may impact and freeze behind the area protected by surface deicers.
  - Freezing drizzle is commonly formed when droplets collide and coalesce with other droplets. As the droplets grow in size, they begin to fall as drizzle.

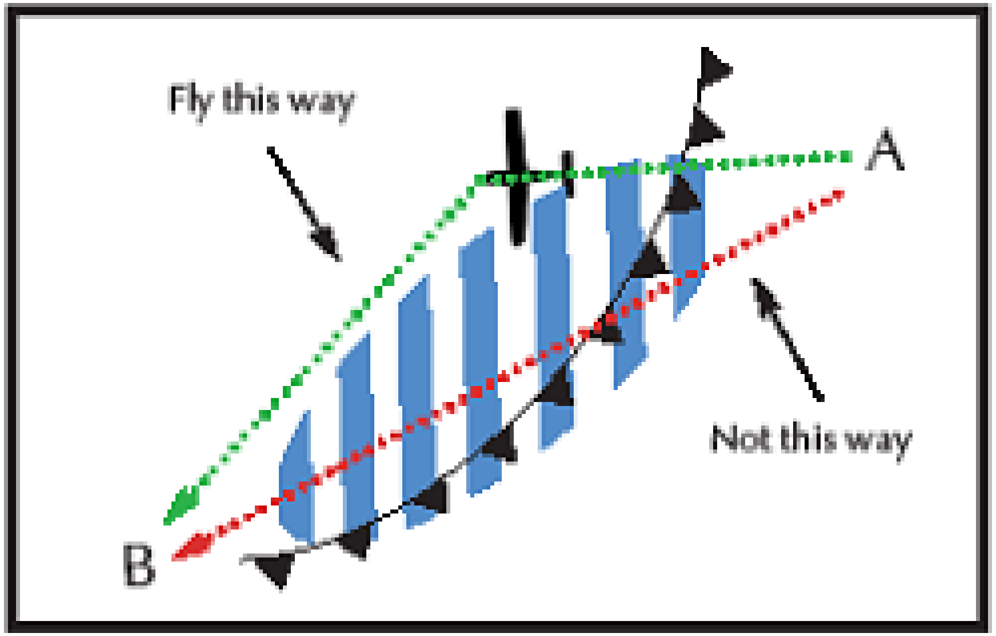


# Icing Conditions

- Both freezing rain and drizzle can fall below a cloud deck to the ground and cause ice to form on aircraft surfaces during ground operations, takeoff, and landing if the surface temperature is below freezing

# Fly the shortest route…

If at all possible, fly the shortest route through a front.




Fly the shortest route through a front

# Even better icing news…

- The horizontal stabilizer balances the tendency of the nose to pitch down by generating downward lift on the tail of the aircraft.

- When the tail stalls, this downward force is lessened or removed, and the nose of the airplane can severely pitch down.

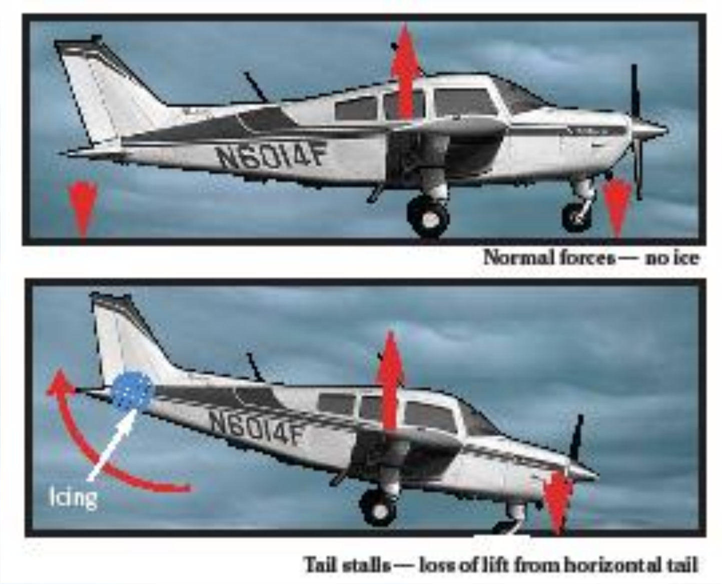
- Because the tail has a smaller leading edge radius and chord length than the wings, it can collect proportionately ***two to three*** times more ice than the wings

- And, often, the ice accumulation is not seen by the pilot.

# Tail Stall

## Recognizing and Recovering from a Tail Stall

- You are likely experiencing a tail stall if:
  - The pitch control forces become abnormal or erratic when flaps are extended to any setting.
  - There is buffet in the control column (not the airframe).



# Tail Stall

- Recovery from a tail stall is exactly opposite the traditionally taught wing stall recovery.
  - Immediately raise flaps to the previous setting.
  - Pull aft on the yoke. Copilot assistance may be required
  - Reduce power if altitude permits; otherwise maintain power.
  - Do not increase airspeed unless it is necessary to avoid a wing stall.

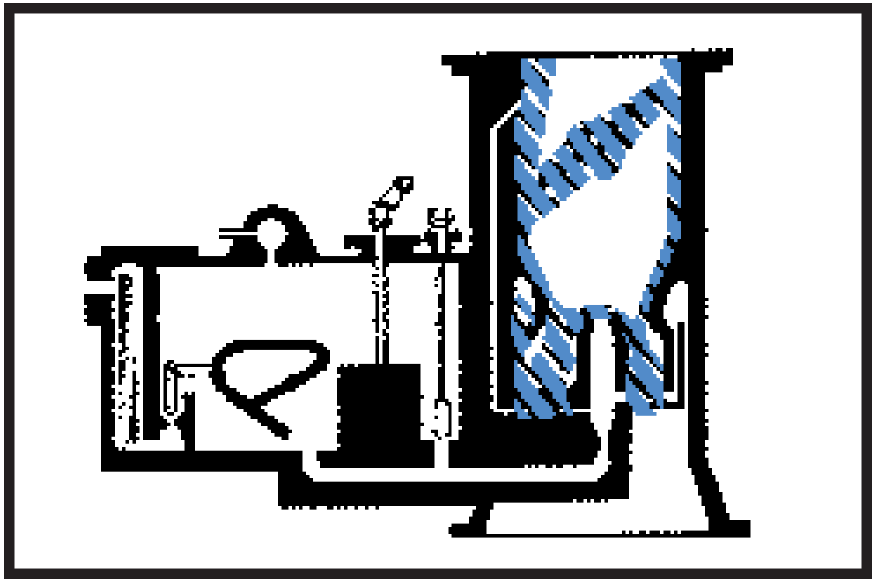
# Icing

- Not all aircraft ice is structural
- Induction icing is the cause of many accidents.
- Two kinds of induction icing
    - carburetor icing
    - air intake blockage
- Induction icing comprise 52% of icing accidents.

# Carburetor Icing

- In a normally aspirated engine, the carburetion process can lower the temperature of the incoming air as much as 60 degrees Fahrenheit.

- If the moisture content is high enough, ice will form on the throttle plate and venturi, gradually shutting off the supply of air to the engine.



Carburetor icing

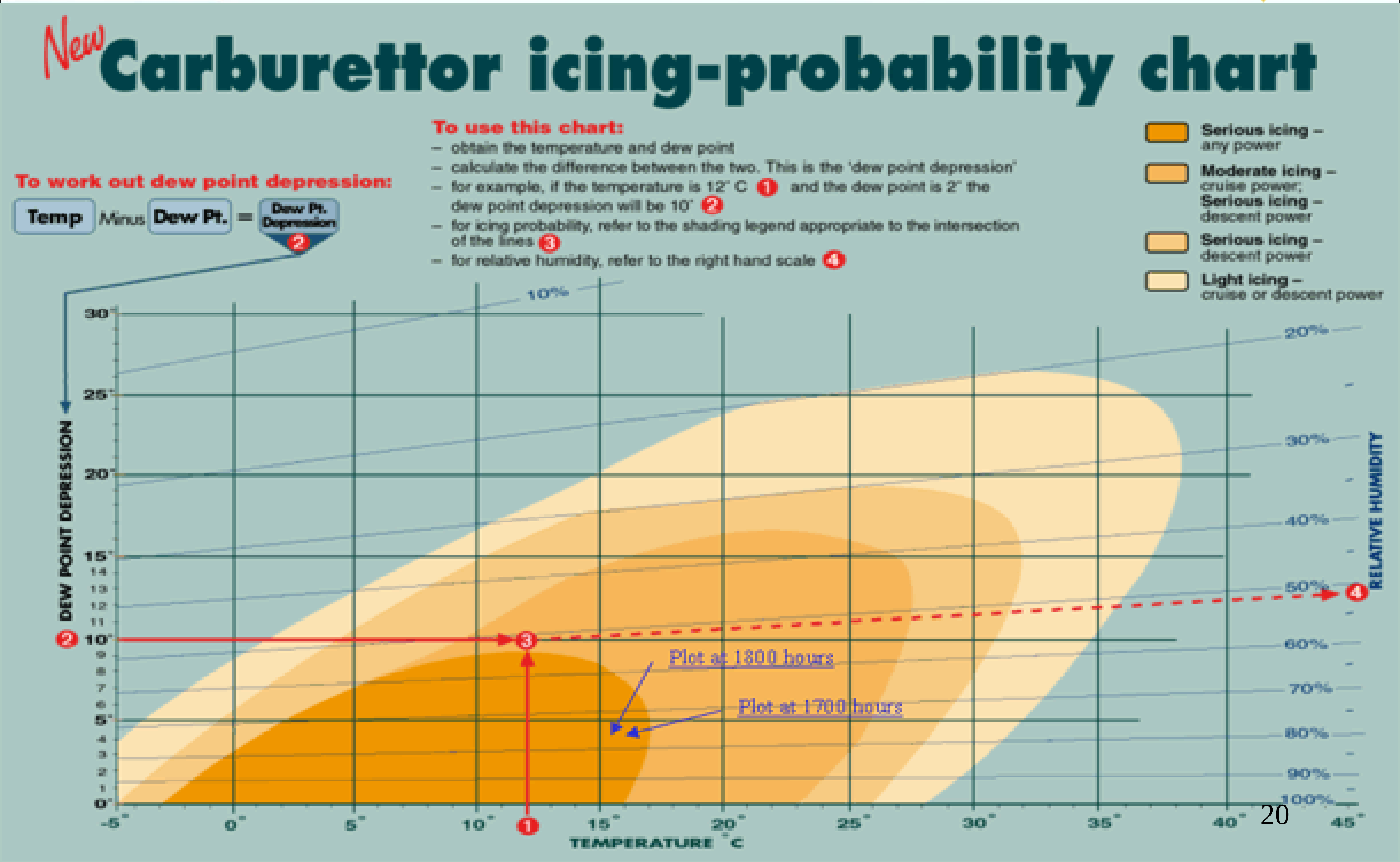
# Carburetor Icing

- Even a small amount of carburetor ice will result in a power loss, indicated by reduced rpm with a fixed-pitch propeller and a loss of manifold pressure with a constant-speed propeller, and may make the engine run rough.

- It is possible for carburetor ice to form even when the skies are clear and the outside air temperature is as high as 90 degrees Fahrenheit, if the relative humidity is 50 percent or more particularly when engine rpm is low.

- Carburetors can, however, ice up at cruise power when flying in clear air and in clouds. The envelope for the most severe buildups of carburetor ice is between 60 and 100 percent relative humidity and 20 to 70 degrees Fahrenheit.

# Icing Probability



# Carburetor Icing

- At the first indication of carburetor ice, apply full carburetor heat and **LEAVE IT ON**.

- The engine may run rougher as the ice melts and goes through it, but it will smooth out again. When the engine runs smoothly, turn off the heat.

# What can you do?

- Preflight
  - AFI11-2CAP-USAFV3, 3.7.1. Flight into areas of forecast or reported freezing rain or icing is prohibited.
  - Remove all frost, snow, or ice from the wings. There is no point in starting the day with two strikes against you.
  - A perfectly clean wing is the only safe wing. Don't count on blowing snow off when taking off. There could be some nasty sticky stuff underneath the snow. If you think it's light enough to blow off, it should be very easy to brush off before starting. Do it!

# What can you do?

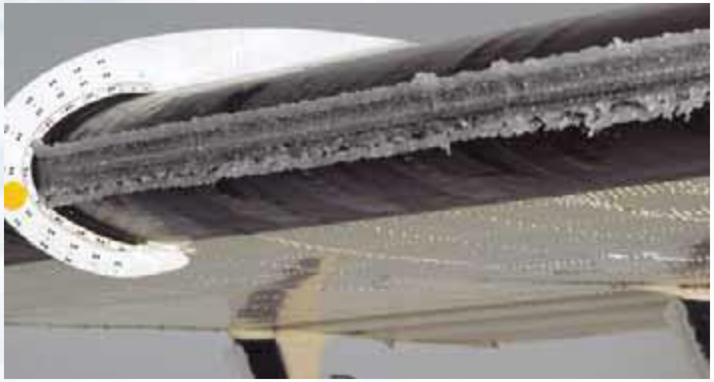
- Taxiing
  - Taxi slowly on icy taxiways.
  - AFI11-2CAP-USAFV3, 3.3.5.1. Do not taxi through snowdrifts and significant accumulations of ice.
  - AFI11-2CAP-USAFV3, 3.4.2. Wind Limitations. Do not takeoff, land, or taxi if the wind velocity exceeds 30 knots. This speed restriction is reduced to 25 knots when operating on a wet runway and 15 knots when operating on <u>ice</u> or <u>snow packed</u> surfaces.
  - The wind may become a limiting factor because the ability to steer and counteract weathervaning tendencies is poor. Tap the brakes lightly and briefly. Hard braking pressure will lock the wheels, resulting in a skid. If the run-up area is slick, it may be impossible to run the engine up without sliding.

# What can you do?

- Departure
  - Know where the cloud bases and the tops are, and check for recent PIREPS.
  - If you encounter icing conditions, have a plan either to return to the departure airport or climb above the ice.
  - If you decide to return, be sure you can safely fly the approach in the existing weather conditions.

# What can you do?

- Enroute
  - Airspeed is a key to measuring ice accumulation.
  - If normal cruise speed is 140 KIAS and you notice the airspeed has dropped to 130 KIAS, it’s time to exit immediately.
  - If you can’t climb or descend, then a 180-degree turn is the only option, and that will result in a loss of at least another 10 KIAS until you’re out of the ice.
  - A 20-knot drop in airspeed is plenty. Add power to increase airspeed, since stall speed margins shrink with speed loss.
  - Speed discipline is essential in icing conditions.



# What can you do?

- Approach and Landing
  - Most icing accidents occur in the approach and landing phases of flight.
  - When carrying ice do not lower the flaps.
  - The airflow change resulting from lowering the flaps may cause a
  - tail with ice accretion to stall.
  - Remember the stall speed is increased when carrying a load of ice, and the stall margin is reduced when you slow to land.
  - If the aircraft is iced up, carry extra power and speed on final approach—*at least 10 to 20 knots* more speed than usual.
  - Do not use full flaps when carrying this extra speed, or a tail stall may occur.

# AIRCRAFT ICING

**Presented by your SWR Safety Team**

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Maj Barbara Harper, Assistant Safety Director
C/Col Jessica Parsons, Cadet Advisor

**Have a SAFE & Happy Holiday Season!**

References: Air Force Instruction AFI11-2 CAP-USAF
www.aopa.org