Icing and FIKI

Objective

To understand how in-flight icing forms, why it is hazardous, how to avoid it, and to understand aircraft which are certified for Flight Into Known Icing (FIKI)

Motivation

- Even a small amount of ice can seriously degrade performance and controllability
- IFR flight places aircraft in places where icing is common
- Understanding forecasts, icing products, and aircraft limitations is essential
- Flight-into-known-icing adds capability to aircraft, but is not a free pass

Overview

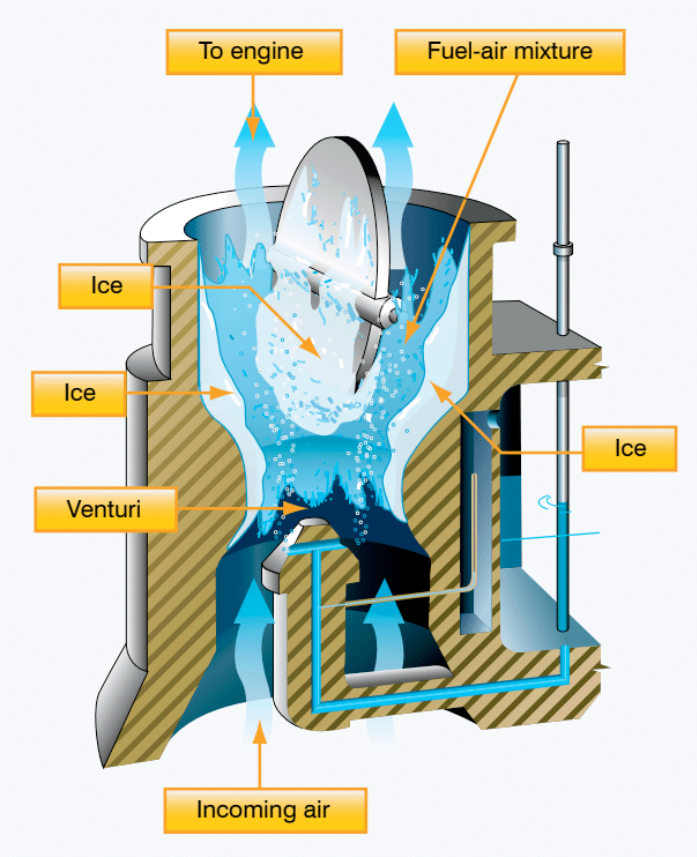
- What is icing?
- Induction system icing
- Structural icing and hazards
- Factors affecting accumulation
- Accumulation rates and PIREPs
- Frost/ground icing
- Icing weather products
- Conditions that create icing
- What to do if you encounter ice
- FIKI certification and its limitations

What Is Aircraft Icing?

Ice that accumulates on the airframe or in the induction system during flight

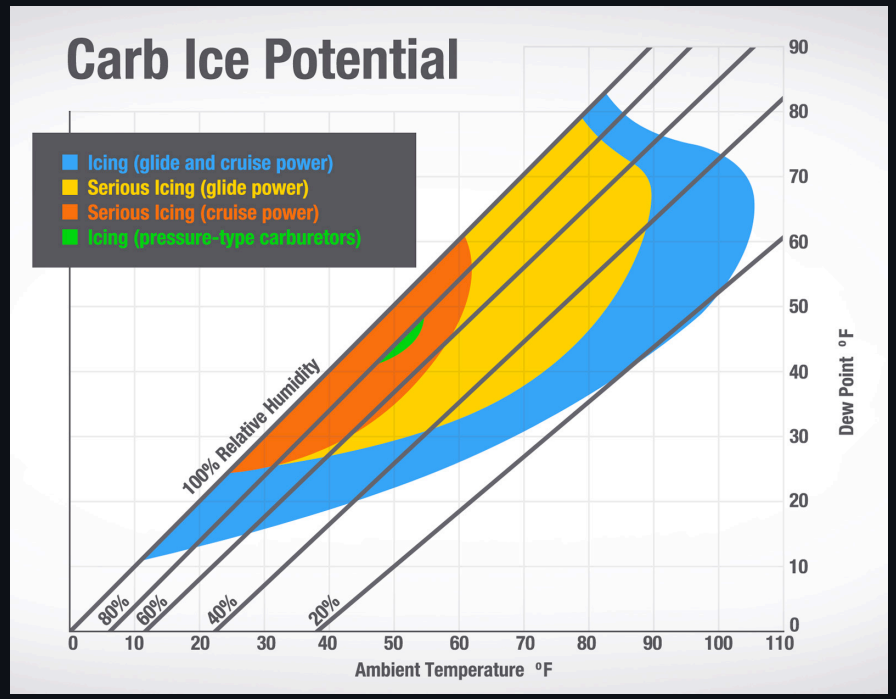
- **Structural icing**
  - Ice forming on external surfaces such as wings, tail, propeller, and antennas
- **Induction system icing**
  - Ice forming inside the engine’s air induction system (e.g., carburetor, alternate air)

Induction System Icing



- **Carburetor icing mechanism**
  - Fuel vaporization and pressure drop in the venturi cause a sharp temperature decrease
  - Water vapor can condense and freeze on internal carburetor surfaces and throttle plate
- **Typical conditions**
  - Most likely when outside air temperature is below about 70°F and humidity above 80%
  - Can still occur with temperatures as high as 100°F and humidity as low as 50%

Induction System Icing (cont.)



- **Symptoms**: Slow reduction in RPM, low IAT (if equipped)
- **Remedy**: Apply carburetor heat, may experience some engine roughness as the ice is ingested

Structural Icing

- Ice that forms on the aircraft’s exterior surfaces in visible moisture and near-freezing temps
- Tends to form on leading edges, thin or narrow parts (tail surfaces, antennas, control surface gaps)

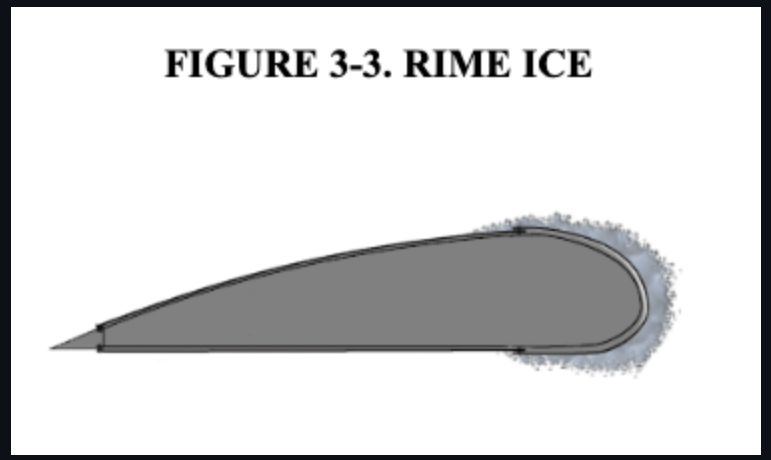
Types of Structural Icing: Clear Icing

- Forms in warmer subfreezing temperatures with larger droplets and higher water content
- Water “runs back” before freezing, sometimes beyond protected areas
- Often more dangerous due to the smooth, heavy accretion and possible runback ice

FIGURE 3-1. CLEAR ICE

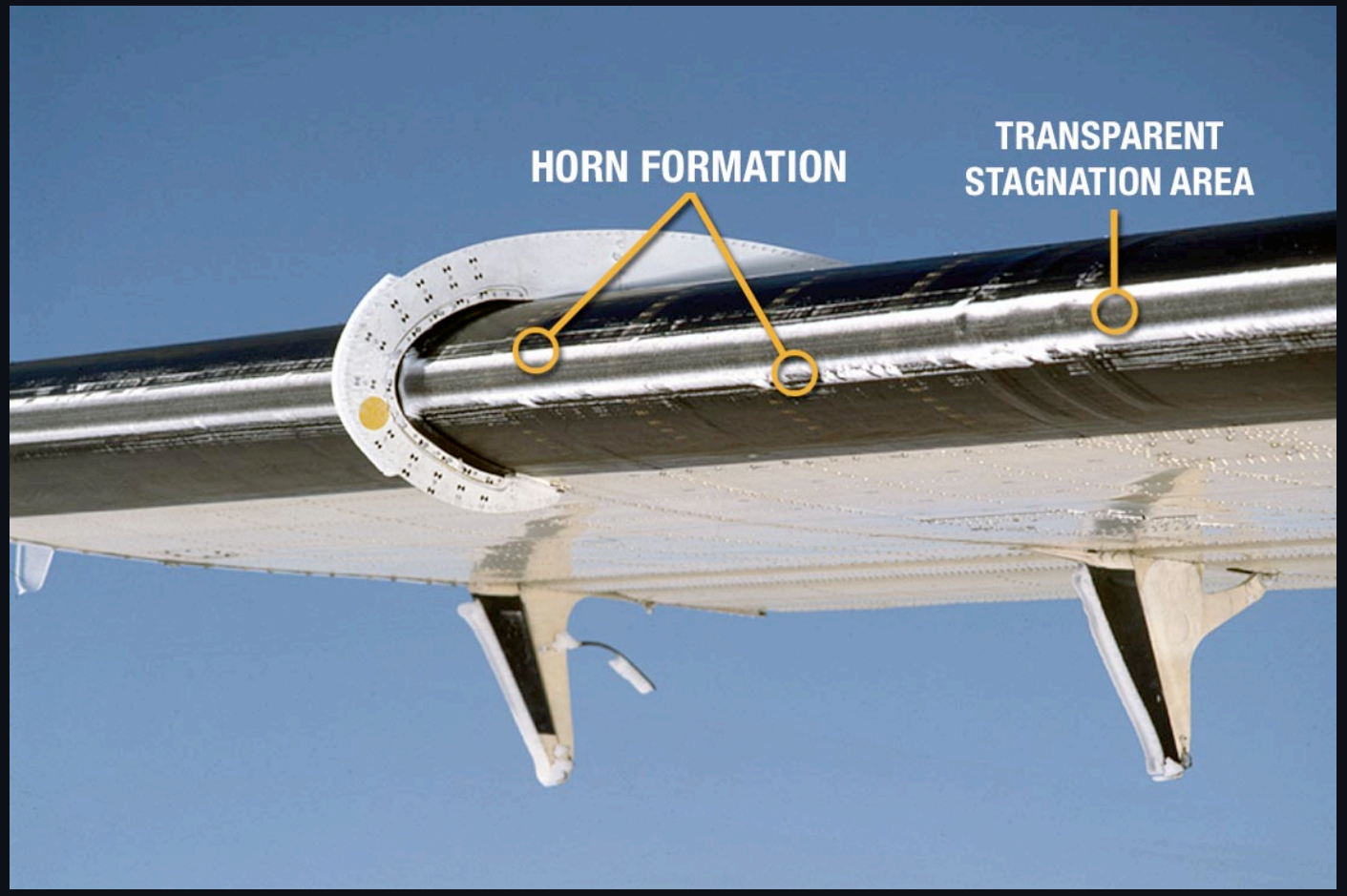
FIGURE 3-2. CLEAR ICE BUILDUP WITH HORNS

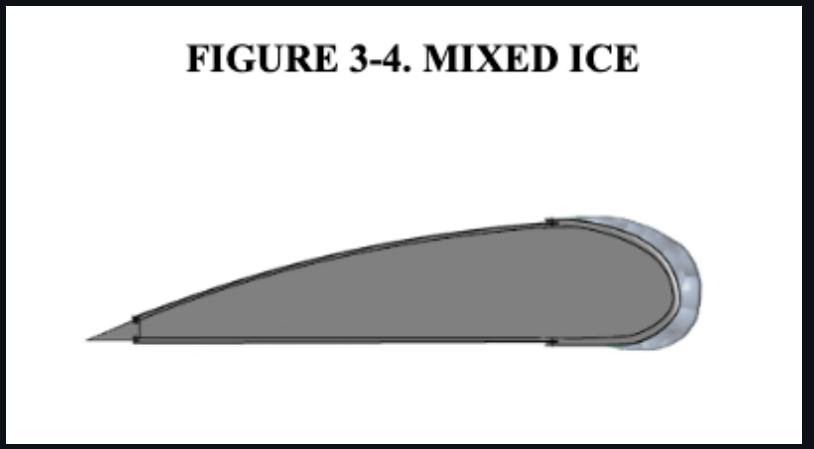
Types of Structural Icing: Rime Icing



- Usually forms in colder temperatures with smaller droplets and less water content
- Builds a rough surface that disturbs airflow but tends to stay near leading edges

Types of Structural Icing: Mixed Ice

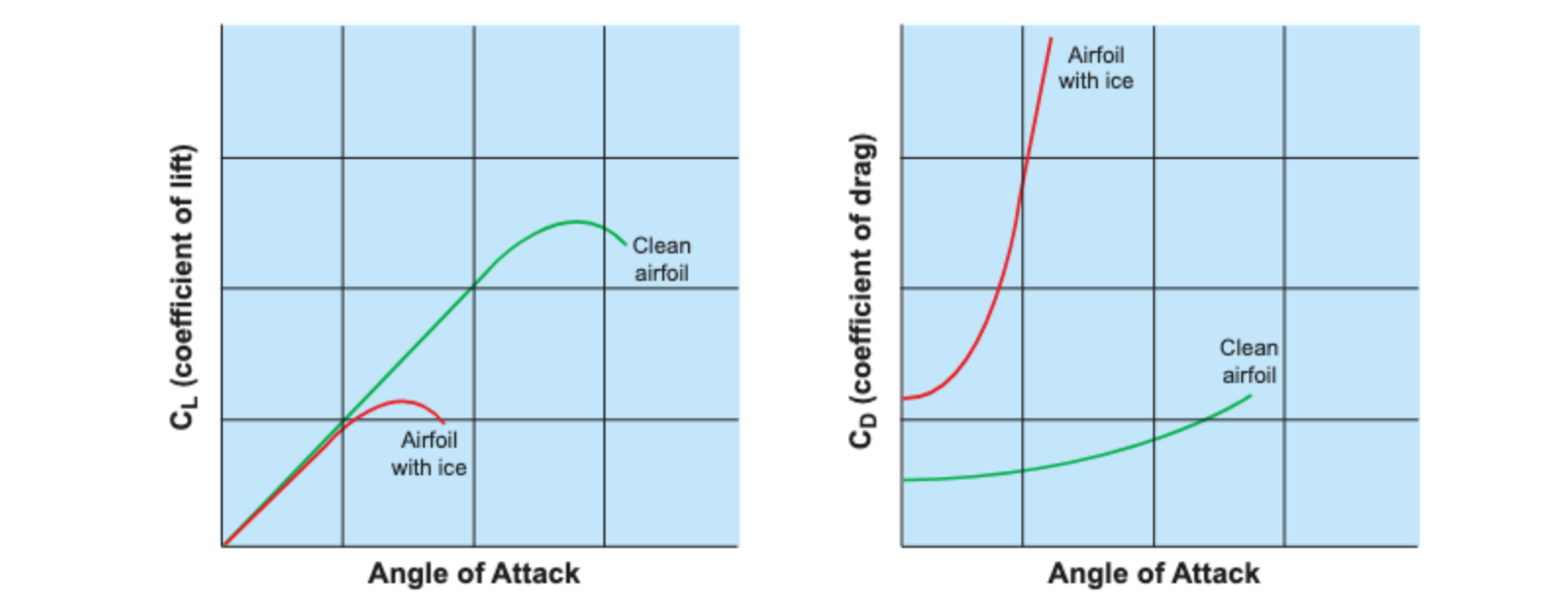




Hazards of Structural Icing

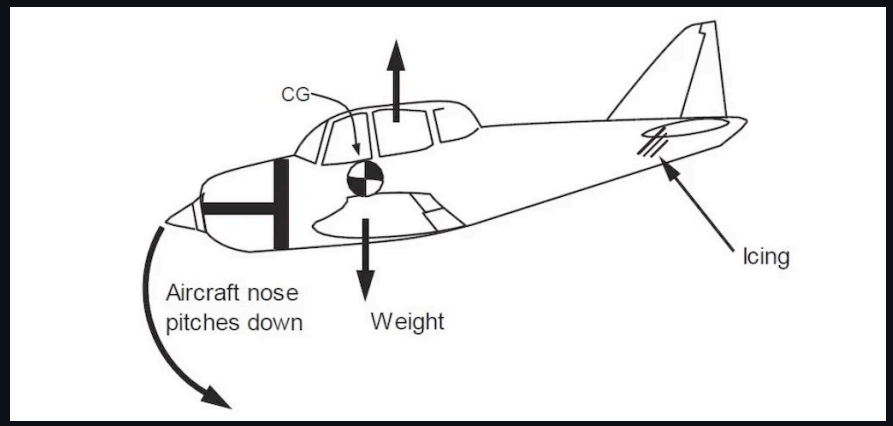
- **Airfoil performance changes**
  - Ice reshapes the airfoil and can reduce the critical angle of attack
  - Stability and controllability may be adequate in cruise, but significantly degrade during approach and landing
- **Control effectiveness**
  - Ice can restrict or jam control surfaces and hinges
  - Roll upset can occur if ailerons self-deflect due to uneven ice buildup
- **Weight and drag**
  - Ice adds weight and increases drag, reducing climb performance and cruise speed

Effect of Icing of Lift



Ice-Contaminated Tailplane Stall (ICTS)

- The horizontal stabilizer is thinner than the main wing and can ice up faster
- Symptoms: Abrupt nose-down pitch, changes in elevator feel, trim changes, pulsing or vibrations (especially after flap extension)
- **If a tailplane stall is suspected**
  - Retract flaps if they are extended
  - Add power and return to a known straight-and-level attitude and airspeed



Propeller and Windshield Icing

- **Propeller icing**
  - Ice accumulates on the spinner and inner portions of the blades
  - Reduces thrust because the propeller becomes less aerodynamically efficient
- **Windshield icing**
  - Can severely limit forward visibility and make landing and taxiing hazardous

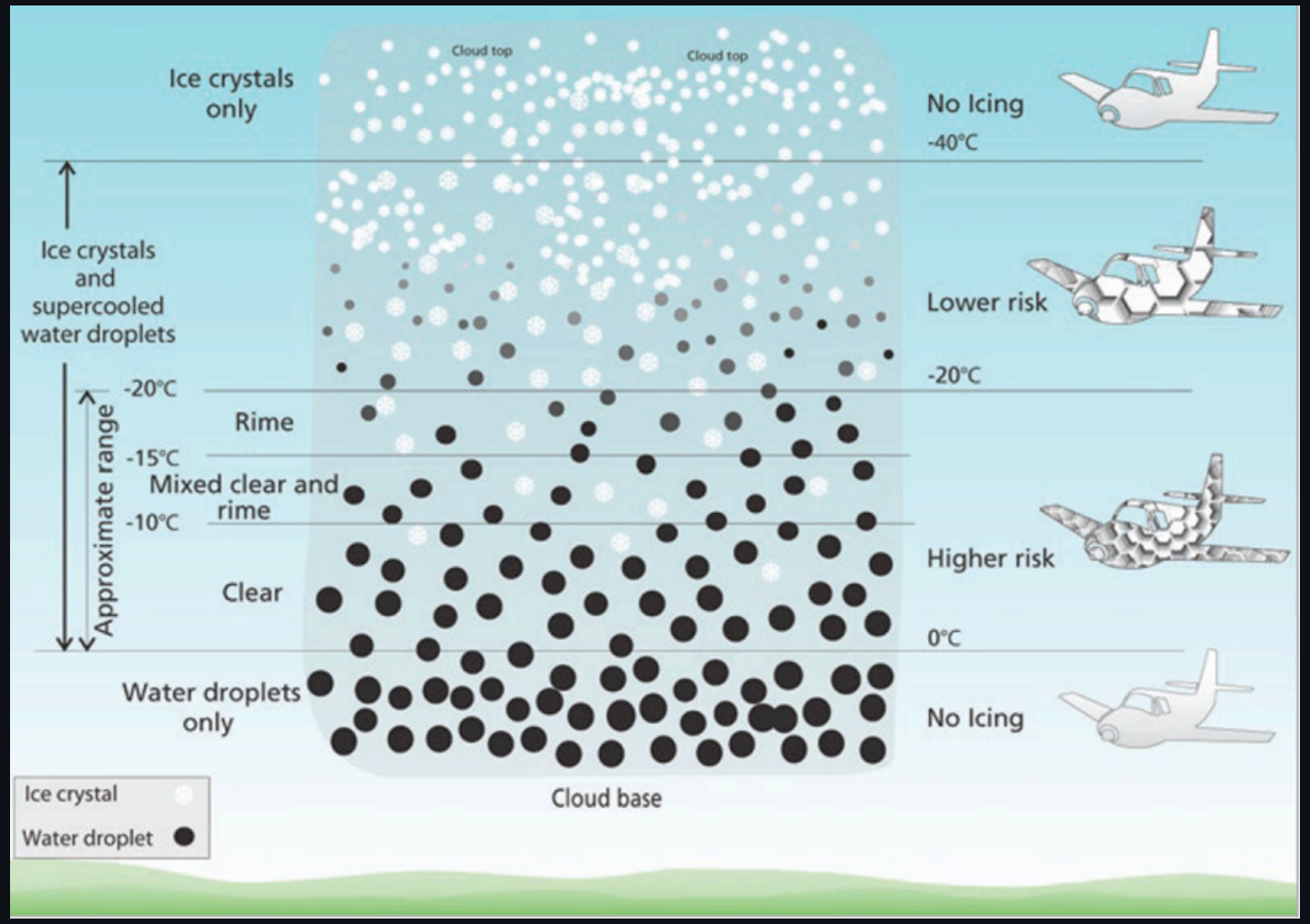
Other Hazards

- **Sensor and system icing**
  - Stall warning vanes, AoA sensors, and pitot-static components can become blocked
- **Antenna icing**
  - Protruding antennas accumulate ice rapidly, degrading radio reception
  - In severe cases, antennas can break off from ice weight or shedding

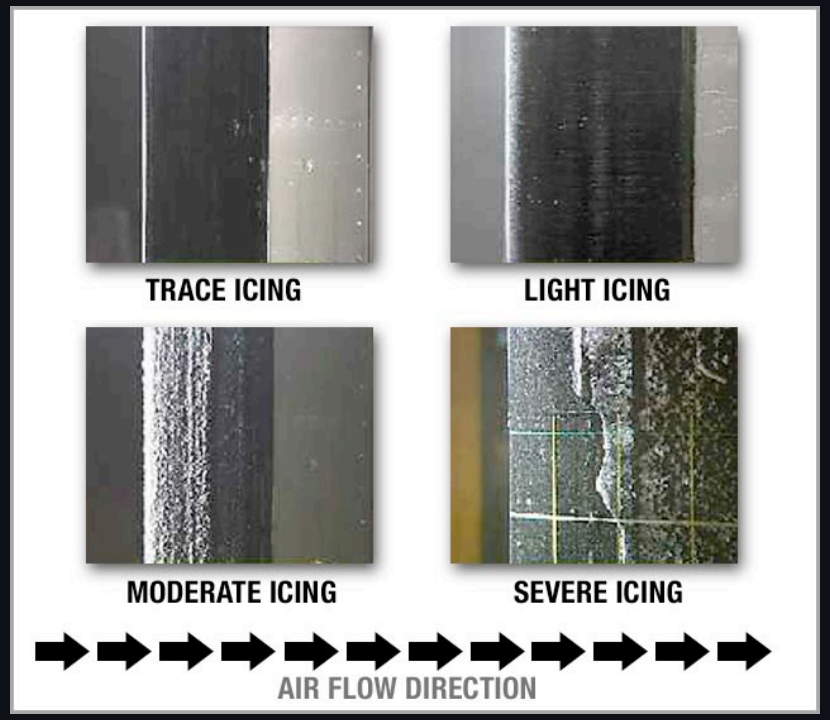
Factors Affecting Ice Accumulation

- **Water content**
  - More liquid water in the cloud generally means faster ice buildup
- **Temperature**
  - Greatest icing threat typically between about -20°C and 0°C
- **Droplet size**
  - Larger supercooled droplets (SLD) can cause severe clear or runback icing
- **Aircraft design**
  - Wing shape, surface finish, and location of inlets and probes affect ice patterns
- **Airspeed**
  - Higher speeds increase the rate at which droplets strike the airframe

Accumulation Risk



Icing Accumulation Rates (AIM 7-1-19)

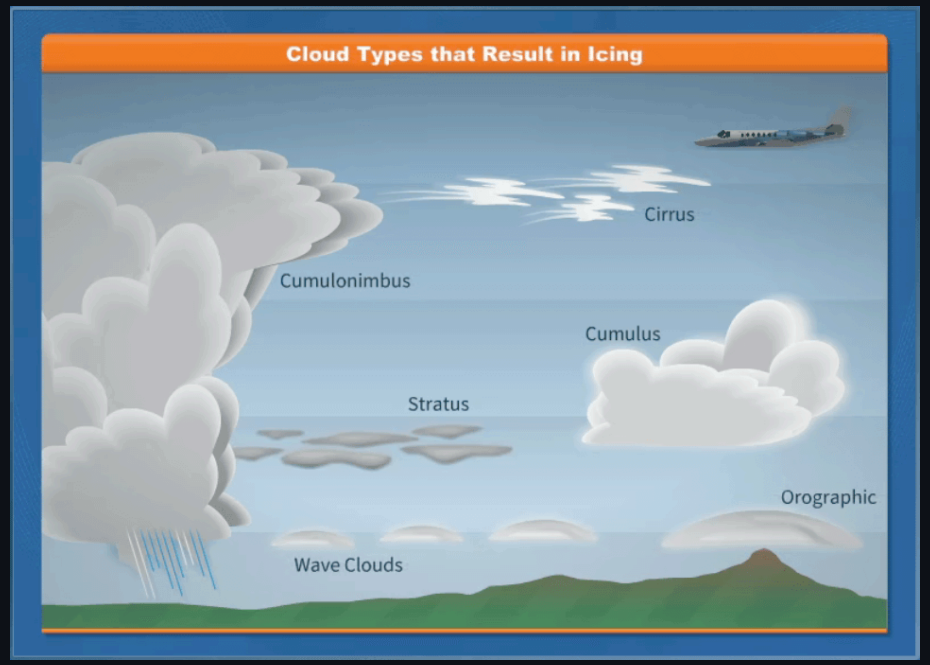


- **Trace**: Ice is just becoming noticeable; accumulation slightly exceeds sublimation. Can be managed for longer periods but still requires monitoring
- **Light**: Occasional use of deicing systems is needed. Can be hazardous for an hour or more
- **Moderate**: Continuous use of ice protection systems is needed. Diversion or exit from icing conditions
- **Severe**: Ice protection systems cannot remove faster than accumulation. Immediate exit from icing conditions is required

Ground Icing – Frost

- Formation: Occurs when moisture in the air freezes on cold surfaces, often overnight
- Effect: Roughens the wing surface, disrupting airflow and reducing lift. Adds weight
- Regulations prohibit takeoff with frost, ice, or snow adhering to aircraft surfaces
- Deicing fluid and rags, approved deicing sprays, or gentle brushing as appropriate

Conditions That Create In-Flight Icing

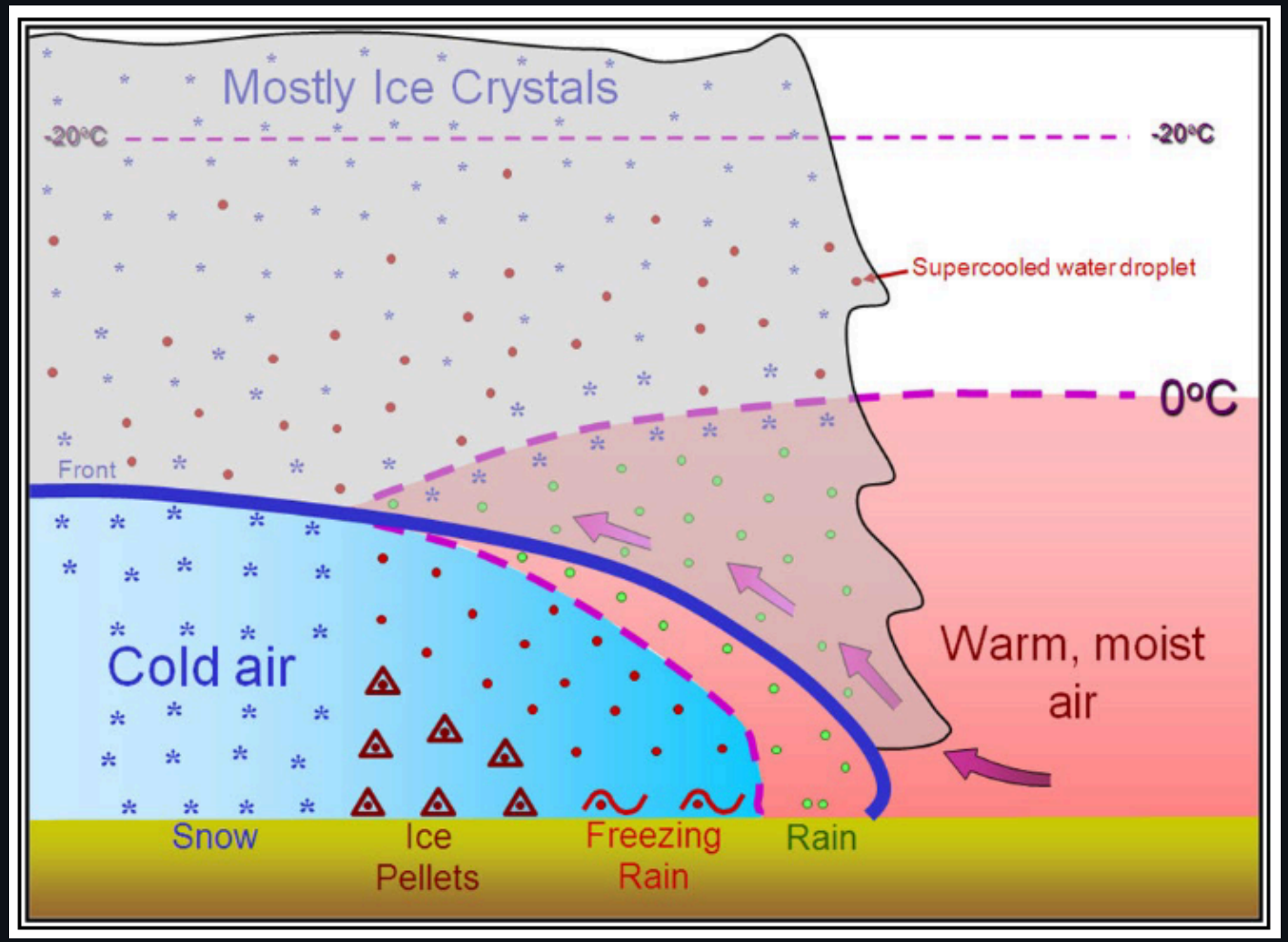


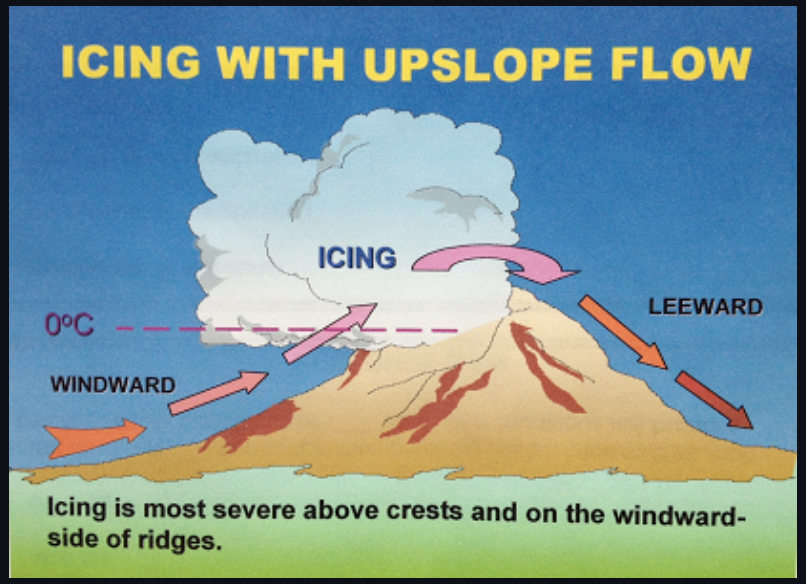
1. Visible moisture (cloud, precipitation, fog)
    - Cumulus clouds: icing possible at many levels, often with SLD aloft
    - Stratiform clouds: typically trace to light icing; vertical extent may allow climb or descent out
2. Freezing air temperatures
    - Most icing reports occur between about -20°C and 0°C
    - Many reports cluster between -8°C and -12°C and altitudes of roughly 5,000–13,000 ft

Freezing Rain and SLD

- **Freezing rain**
  - Often associated with warm fronts and temperature inversions
  - Can lead to extremely rapid, severe clear or runback icing
- **Supercooled large droplets (SLD)**
  - Droplets remain liquid well below freezing and freeze upon impact
  - Can cause ice to form beyond protected leading edges

SLD and Freezing Rain Near a Front



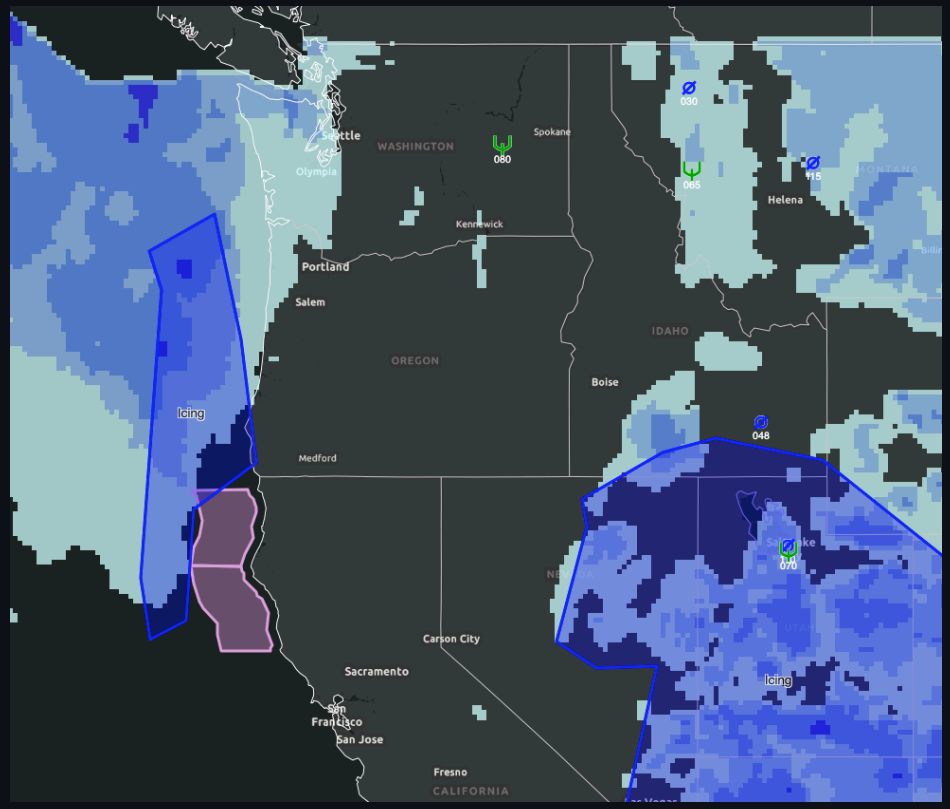


Freezing Fog

Fine droplets in subfreezing temperatures cause rapid surface icing, especially during approach and landing

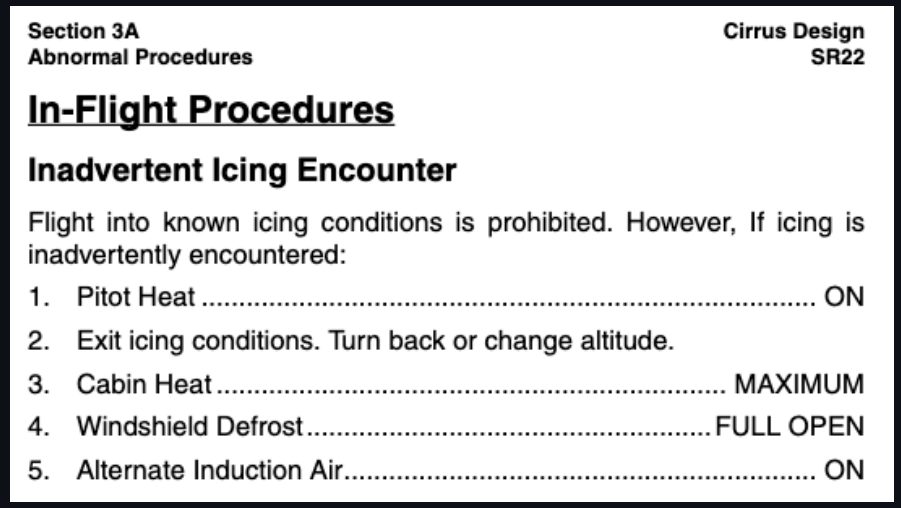
- Freezing Rain: `FZRA`
- Freezing Drizzle: `FZDZ`
- Freezing Fog: `FZFG`

Icing Weather Products



- **Freezing level analysis**
  - Identifies the altitude of the 0°C isotherm and helps plan safe cruise and escape altitudes
- **AIRMET Zulu and G-AIRMET**
  - Identify areas of widespread moderate or greater icing and low freezing levels
- **SIGMETs**
  - Highlight severe icing or conditions like widespread freezing rain

Ice Accumulation Playbook



Section 3A
Abnormal Procedures

Cirrus Design
SR22

In-Flight Procedures

Inadvertent Icing Encounter

Flight into known icing conditions is prohibited. However, If icing is inadvertently encountered:

1. Pitot Heat ..... ON
2. Exit icing conditions. Turn back or change altitude.
3. Cabin Heat ..... MAXIMUM
4. Windshield Defrost ..... FULL OPEN
5. Alternate Induction Air ..... ON

- **Initial actions when ice is encountered**
  - Turn pitot heat ON
  - Activate ice protection systems (boots, TKS, etc.) as recommended in the POH/AFM
  - Turn windshield defrost or anti-ice ON as available
- **Next steps**
  - Plan and execute an exit: climb, descend, or turn to get out of icing conditions
  - Use the aircraft’s inadvertent icing or FIKI checklist as appropriate

Removing Ice in Flight

- **Leaving icing conditions**
  - Moving into clear, dry air allows ice to sublimate, but this can be slow
  - Descending into warmer air will often melt accumulated ice more quickly
- **System limitations**
  - Boots and TKS remove or slow accumulation, but do not guarantee a clean airframe
  - Do not assume that systems will remove all ice behind or between protected areas

Landing With Accumulated Ice

- Be very caution of configuration changes, particularly flaps. Deploy flaps in stages
- Perform a reduced-flap landing on a long runway, if possible
- Carry a higher-than-normal power setting into the approach
- Refer to the POH/AFM for approach airspeed with ice
    - Increase approach airspeed by at least 25 percent above non-icing airspeed for the applicable flap setting

Icing Regulations (91.527)

- **Takeoff restrictions**
  - No takeoff with frost, ice, or snow adhering to propellers, windshields, control surfaces, powerplant installations, or critical instruments and wings
- **Flight into known or forecast icing**
  - Prohibited flight into known or forecast light or moderate icing unless the aircraft is properly equipped and certified (FIKI)
  - "Known icing" is based on all available information: forecasts, PIREPs, and real-time observations

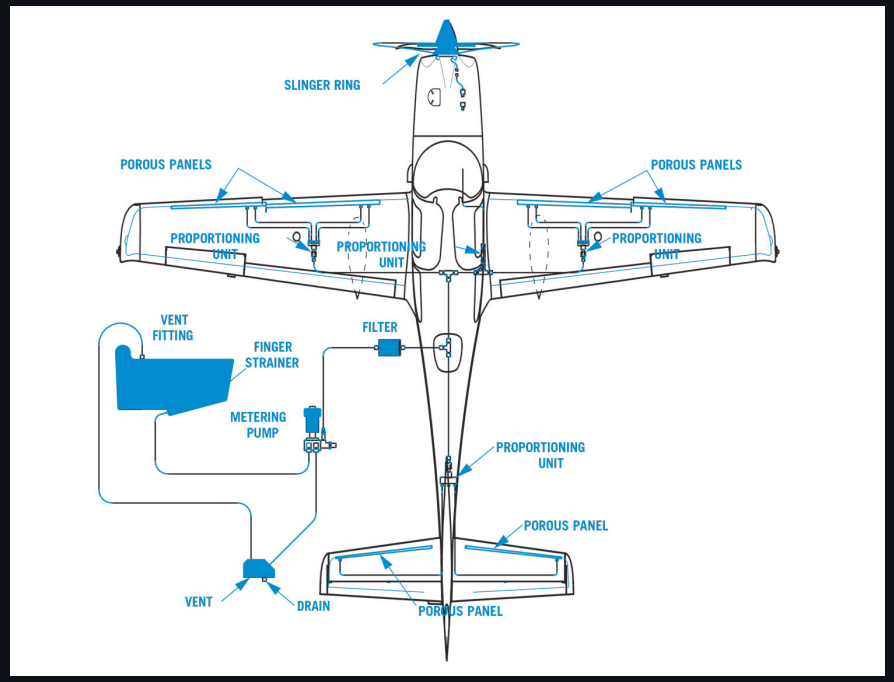
Flight Into Known Icing (FIKI)

- **"Flight into known icing"**
  - Any flight conditions where you'd expect the possibility of ice forming or adhering to the aircraft based on all available preflight information
- **FIKI Certification** The aircraft has been tested and approved to operate in specified icing envelopes
  - Certification is done during design and certification
- **FIKI limitations**
  - Does not authorize flight into severe icing, freezing rain, or freezing drizzle
  - Does not guarantee safety if you remain in icing conditions indefinitely

Is This Aircraft FIKI-Certified?

- **How to determine FIKI status**
  - Check the AFM or POH for references to icing certification standards (e.g., Part 25 Appendix C or similar language)
  - Review the Minimum Equipment List (if applicable) for items required in icing conditions
- **Don't assume FIKI based on equipment**
  - Some aircraft may have ice protection (boots, TKS, heated props, heated pitot, etc.) but are not FIKI-certified (like our SR22)

Typical Features of a FIKI-Certified Aircraft



- **Enhanced anti-ice and deice systems**
  - Higher-capacity pitot heat and windshield defrost or anti-ice panels
  - Leading-edge boots or TKS “weeping wing” systems with fluid quantity indicators
  - Propeller anti-ice or deice systems
- **Protected sensors and systems**
  - Heated stall warning vanes or AoA sensors
  - Carburetor heat or alternate air for engines that require it

Summary

- **Icing formation and types**
  - Structural and induction icing
  - Rime, clear, and mixed icing
- **Hazards**
  - Icing degrades lift, increases drag and weight
  - Ice can compromise control surfaces, tailplane, propeller, and sensors
- **Weather and avoidance**
  - Use icing forecasts, frezzing levels, and PIREPs
- **FIKI operations**
  - FIKI aircraft provide more options but still require conservative planning, timely exits, and strict adherence to procedures

Knowledge Check

Youu are cruising in IMC at -5°C and begin to see light ice forming on the wings. What immediate actions should you take, and how will you plan your exit?

Knowledge Check

Your aircraft has boots, heated pitot, and a heated propeller, but the POH does not list any FIKI approval. What does this mean for your ability to launch into forecast light icing?

Knowledge Check

On approach with known ice on the airframe, how will you adjust your flap usage, power settings, and approach speed?