STRUCTURAL ICING
Ground Training

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3 Hours

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OBJECTIVES: You will acquire the necessary knowledge for understanding the basic functions and use of aircraft anti-ice and de-ice systems, controls, indicators, limitations and operational procedures.

COMPLETION STANDARDS: You show by written record, and will demonstrate through oral questioning that you have acquired sufficient aeronautical knowledge to safely operate the aircraft, understanding the basic functions of aircraft anti-ice and de-ice systems, the use of the systems and controls, and the operational procedures. Quizzes are to be reviewed, and corrected to 100% prior to proceeding. The passing test score is 100%.

Lessons 3 Hours

Standard Operating Procedures, Aircraft General, Engines, Propellers, Flight and Engine Instruments, Normal Procedures, Limitations

Name____________________________ Date____________

1 - Induction Ice

Induction icing consists of any ice accumulation that blocks the venturi, air filter, ducting, and/or fuel metering device. Impact ice, a type of induction ice, can occur anywhere that temperatures are near or colder than the freezing point of 0° C. Impact ice can block the air filter and rob the engine of air needed for combustion, even on a fuel injected engine. If you suspect impact ice, activate alternate air or carburetor heat as directed by your POH/AFM.

Carburetor icing occurs when ice forms within an engine's carburetor. Rapid cooling of air caused by the drop in air pressure inside the venturi and also due to the vaporization of fuel can induce freezing and ice accumulation within the carburetor intake tube. If you suspect carburetor ice, immediately apply alternate air or carb heat and leave it on until all ice has been removed. Be prepared for an initial further decrease in engine performance after carb heat is applied. Always follow specific manufacturer recommendations.

2 - Structural Ice

Moisture can exist as a supercooled liquid until about -40° Celsius, the theoretical limit. Contaminates in the atmosphere, however, set the practical limit to approximately -20°C. For ice to form naturally in the atmosphere, either very cold temperatures must exist or ice nuclei must be available to trigger the freezing process. Structural icing is most likely when the static air temperature is between +2°C and -20°C and liquid precipitation or clouds are present.

3 – Types of Structural Icing

There are three types of structural icing:

Clear ice typically forms when temperatures are around 2 °C. to -10° C. and water droplets are large, or freezing drizzle or freezing rain is present. Clear ice is the most dangerous type of ice since it is hard to see, can change the shape of the airfoil, and often forms well beyond the ice-protected areas of the aircraft.

Rime ice forms if the droplets are small and freeze immediately when contacting the aircraft surface, typically when temperatures are between -15° C. to -20 ° C. Rime ice has a milky, opaque appearance.

Mixed ice is a combination of clear ice and rime ice. with the worst characteristics of both. It can form rapidly when ice particles become embedded in clear ice, building a very rough accumulation. It is most likely to form at temperatures between -10° C to -15° C.

4 – Structural Icing Intensity

There are three levels of intensity for structural icing, based primarily on the rate of accumulation. The greater the liquid water content of the cloud, the more rapidly ice accumulates on aircraft surfaces. Theoretically, the amount of water in the air is measured in mass of water per volume of air, g/m³ and can also affect the ice shape. However, droplet size is a major factor in determining the level of icing intensity. Large droplets can quickly lead to severe icing.

5 - Certification

With regard to ice protection, an aircraft manufacturer must demonstrate that the aircraft is "able to operate safely" while accumulating ice within two operational envelopes. *Continuous maximum* is intended to represent icing typical to stratus clouds with amounts of liquid water between 0.2-0.8 g/m³ and droplet sizes 15-40 microns in diameter over a 17.4 nm encounter. *Intermittent maximum* is intended to represent icing typical to isolated cumulus clouds with amounts of liquid water ranging between 1.1-2.9 g/m³ and droplet sizes 15-50 microns in diameter over a 2.6 nm encounter.

An airplane equipped with some types of deice and/ or anti-ice systems may not be approved for flight into known icing conditions. Also, it is possible to encounter clouds that have significantly greater amounts of liquid water, larger droplet sizes, and cover larger areas than used for certification purposes. Several accidents in recent years are presumed to have occurred after encounters with conditions that exceed these envelopes.

6 - Supercooled Large Droplets

Most icing encounters involve droplets of a median volumetric diameter (MVD) between 15 and 50 microns (about the size of a thin human hair). An icing-certificated aircraft is certificated for flight in Stratus-Type clouds with MVDs up to 40 micrometers and for cumulus-type clouds with MVDs up to 50 micrometers. Supercooled Large Droplets (SLD) can be up to 100 times larger. The mass of these large droplets is so great that they can strike well aft of the protected regions of an ice protected aircraft. These droplets are, by definition, larger than those for which any aircraft is certificated, and accidents and incidents have occurred following sustained flight in freezing drizzle or freezing rain.

7 - Weather Forces that Produce Icing

To determine if conditions along any portion of the planned route of flight are likely to produce serious icing encounters, know where the temperature range and the moisture content of the air is conducive to icing. If the air is unstable or there are fronts or mountains that can lift it, the risk of inflight icing can be high.

If you encounter icing in stratiform clouds, immediately activate the ice protection system. Monitor the situation. Change your altitude by at least 3,000 feet as flight at a constant altitude may result in prolonged icing exposure.

If the temperature is prime for icing conditions and you can maintain visual separation, navigate laterally around cumulus clouds.

The geography near the intended route of flight provides important cues to icing threat.

8 - Fronts

The areas near fronts can be conducive to icing due to the enhanced lifting and moisture that may be present. In the vicinity of a warm front, stratus cloud formations hundreds of miles ahead of the front are often apparent. During colder months, warm fronts can be very dangerous. Warmer air rising over a layer of subfreezing air may result in the formation of freezing rain or freezing drizzle.

Shallow cold fronts are typically associated with the cold season. Widespread stratus behind the front can cover several states, but they are capped by a temperature inversion and typically not very deep - usually less than 5,000 feet. The classic cold front is characterized by extensive cumulus cloud development which often straddles the front and is typically associated with the warm season. Intense lifting by the front usually limits the cloud development to narrow bands of clouds tens of miles wide near the surface location of the front. These convective clouds can develop into full blown thunderstorms with heavy precipitation, turbulence, hail, and high levels of supercooled liquid water.

9 - Preflight Brief

Be familiar with current and forecast weather along your route and along your alternate routes. Always obtain a standard weather briefing from flight service, https://www.1800wxbrief.com/Website/#!/?, but utilize other resources such as https://www.aviationweather.gov/, to supplement and prepare for the brief. Checks should also include Area Forecasts, AIRMETS, SIGMETS, and CIP/FIP products.

10 - Briefing Continued

Check PIREPS, winds aloft, as well as METARs and TAFs for your routes. Build or revise a flight plan that will minimize the risk you will have a serious icing encounter. Have alternate routes and altitudes, as well as alternate airports. Consider MEAs, MOCAs, etc in your planning and have an escape route. Know how you would exit icing.

Flight into icing is neither safe nor legal unless the aircraft's ice protection system is functioning properly. Properly check all components prior to flight in accordance with Airplane Flight Manual or Pilot's Operating Handbook specifications.

11 - Roll Upset & Tail Stall

Wing stalls typically occur following a speed reduction or premature flap retraction. To recover from a roll upset or wing stall, immediately reduce the angle of attack and add power.

Tail stalls usually occur during an approach when flaps ar at full extension and/or the aircraft is being flown near the upper speed limit for flap extension. There may be few or no symptoms prior to flap extension, but they can include abnormal elevator authority, vibrations, and or/effectiveness, sudden uncommanded nose down pitch and/or autopilot performing excessive pitch trimming.

To recover from a tail stall, you must take actions that are almost completely opposite from those required to recover from a wing stall. If flaps are extended and you experience lightening of the controls, difficulty trimming, or buffet in the control column, immediately retract the flaps and maintain or reduce thrust. Undo what you just did. Pull yoke back, retract flaps, and maintain or reduce thrust.

12 – Quiz and Review