B737 NG CBT - ANTI-ICE/RAIN

COURSE OUTLINES

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COURSE START

1-LEGAL CAUTION The material contained in this training program is based on the information obtained from current state, local and company regulations and it is to be used for training purposes only. At the time of designing this program contained then current information. In the event of conflict between data provided herein and that in publications issued by the authority, the authority shall take precedence.

ANTI-ICE AND RAIN REMOVAL SYSTEMS

2-ANTI-ICE AND RAIN REMOVAL SYSTEMS * Introduction * Engine Anti-ice System * Wing Anti-ice System * Window Heating System * Probe Heating system * Rain Removal System * Anti-ice Controls and Indications Review.

INTRODUCTION

3-INTRODUCTION Anti-ice and rain removal procedures are essential to every aircraft to ensure the safety of the operations. When an aircraft operates in the rain, during phases like takeoff or approach, the visibility is reduced for the pilots. When an aircraft flies in icing conditions, ice can build-up on the aircraft resulting in: a decrease in lift, an increase in drag, and an increase in aircraft weight. Engines problems can also occur while flying in icing conditions. Ice can block probes of the pitot-static system for air data system. In addition, ice on the windshield reduces visibility more than rain. The purpose of the ice and rain protection system is to protect the aircraft against those negative effects of ice and rain.

4-In flight, icing conditions exist when the total air temperature is 10 °C or below and visible moisture is present. Visible moisture is clouds, fog with visibility of one mile or less; or rain, snow, sleet or ice crystals.

5-Icing conditions also exist on the ground and for takeoff when the outside air temperature is 10°C or below and standing water, slush; ice or snow is present on the ramps, taxiways or runways.

6-There are two types of ice protection systems: Anti-icing system which prevents ice formation by operating continuously and de-icing system which removes the ice after it has formed by operating intermittently. On aircraft with jet engines anti-icing systems are used.

7-Anti-icing systems use two methods for protecting critical surfaces of the aircraft from ice accretion. Hot bleed air or electrical heating. Hot bleed air systems are referred to as thermal anti-icing systems and electrical heating systems are referred to as electric anti-icing systems. The Boeing 737 incorporates both thermal anti-icing systems and electric anti-icing systems. Thermal type anti-icing is used for engine anti-icing and wing anti-icing. Electric anti-icing systems are used to protect flight deck windows and air data probes against icing.

ENGINE ANTI-ICE SYSTEM

8-ENGINE ANTI-ICE SYSTEM The engine anti-ice system protects the engine cowl lips from icing. Ice accumulation on the engine cowl lips has two important negative effects. First, it disturbs the airflow which reduces engine performance and may lead to a compressor stall. Second, particles of ice can be sucked in by the engine which causes damage of fan blades and inlet vanes.

9-The engine thermal anti-ice system uses hot bleed air from the corresponding engine to provide ice protection. The cowl anti-ice valves which are electrically controlled and pressure actuated, connect the cowl lip ducts to the engine bleed air. Pressure sensors monitor the duct pressure. When a valve opens hot bleed air goes to the cowl lips and heats up the cowl area preventing ice build-up. The air is then vented overboard.

10-Operation of the engine anti-ice system is controlled via engine anti-ice panel which is located on the forward overhead panel.

11-On the engine anti-ice panel you will find an individual anti-ice “ON/OFF” switch for each engine, which controls the position of the cowl anti-ice valve.

12-The cowl valve open light indicates the position of the respective cowl anti-ice valve. Light is extinguished when the associated cowl valve is closed. Each light illuminates bright blue when the associated valve is in transit, or, the valve is not in the position indicated by related anti–ice switch. Each light becomes dim when the associated cowl valve is open.

13-Engine anti-icing is used both on the ground and in flight. Follow the prescribed procedures and do not rely on visual indications of airframe icing to turn the engine anti-ice on. Engine anti-ice must be immediately activated when icing conditions specified previously exist or are anticipated. Late activation of engine anti-ice may cause an ice buildup on the air intakes, which may result in engine damage due to ingested ice plates.

14-When engine anti-ice is needed, move engine anti-ice switches to the “ON” position and ensure that the cowl valve open lights illuminate bright, and then dim. When the cowl anti-ice valve is open, a thermal anti-ice indication is shown on the engine display.

15-Positioning the engine anti-ice switch to “ON” also sets the stall warning logic for icing conditions, which adjusts stick shaker and minimum maneuver speed bars on the airspeed indicator. Reference speed is not adjusted automatically. When engine anti–ice is selected to “OFF” and if wing anti–ice has not been used in flight, stall warning logic returns to normal. Thus, stick shaker and minimum maneuver speed indications also return to normal.

16-When engine anti-ice is no longer needed, turn the engine anti-ice switch “OFF”. Make sure that the cowl valve open lights come on bright, and then extinguish.

17-Do not use engine anti ice on the ground and in flight when outside air temperature and total air temperature respectively is above 10°C.

18-Now let’s do an exercise. Activate engine “1” anti-ice. You see the related cowl valve open light illuminates bright blue, then dims. This ensures you, engine “1” anti-icing is functioning properly to protect engine “1” against icing. Now activate engine “2” anti-ice. The cowl valve open light illuminates bright blue, but the light does not dim; it stays lit bright blue. What might be the reason for that?

19-When the engine anti-ice switches are selected to “ON”, if either cowl anti–ice valve does not open the related cowl valve open light remains lit bright blue and an amber thermal anti-ice indication appears on the engine display after a short delay.

20-Similarly, when the engine anti-ice switches are selected to “OFF”, if either cowl anti–ice valve fails to close, the related cowl valve open light remains illuminated bright blue and an amber thermal anti-ice indication appears on the engine display after a short delay. Follow the prescribed check list procedures, when engine cowl valve open light remains illuminated bright blue and/or an amber thermal anti-ice indication is shown on the engine display.

21-If there is excessive pressure in the duct, the pressure sensor triggers respective cowl anti-ice light on the engine anti-ice panel. In addition, the master caution and anti-ice system annunciator lights on the glare shield also illuminated. If flight conditions allow, thrust must be reduced until the cowl anti-ice light extinguishes.

WING ANTI-ICE SYSTEM

22-WING ANTI-ICE SYSTEM The wing anti-ice system protects three inboard leading edge slats from icing. Leading edge flaps and outboard leading edge slats do not need to be ice protected. The wing anti-ice system is a thermal anti-ice system which uses hot bleed air from the pneumatic system to provide ice protection. The wing anti-ice control valves connect wing distribution ducts to the pneumatic system. Temperature sensors are used to monitor the duct temperature. When a valve opens, hot bleed air enters distribution ducts and sprays through holes into three inboard leading edge slats. This heats up the leading edge area and prevents ice buildup. The bleed air is then exhausted outboard through openings in lower part of structure. The system uses telescoping ducts which makes the wing anti-icing effective with the slats in any position.

23-Operation of the wing anti-ice system is controlled via a wing anti-ice panel which is located on the forward overhead panel. It consists of a single “ON/OFF” switch which controls wing anti-ice to both sides at the same time, because both sides must always operate symmetrically.

24-Two wing anti-ice valve open lights show the position of the wing anti-ice control valves. Lights are extinguished when the control valves are closed. Each light illuminates bright blue when associated control valve is in transit, or, the valve is not in position indicated by the wing anti–ice switch. Each light becomes dim when associated control valve is open.

25-Wing anti-icing is used both on the ground and in flight when icing conditions exist or are anticipated. When wing anti-ice is needed, move wing anti-ice switch to the “ON” position and ensure that both the left and right valve open lights illuminate bright, and then dim. When wing anti-ice is no longer needed, turn the wing anti-ice switch to the “OFF position. The left and right valve open lights must illuminate bright, then extinguish. Follow the prescribed checklist procedures, if either wing anti-ice valve open light remains illuminated bright blue when you turn the wing anti-ice switch “ON” or “OFF”. Let’s now see operation of wing anti-ice system on the ground.

26-On the ground, wing anti-icing is used as a precautionary procedure which provides protection against the formation of

frost or ice on the leading edge slats. Do not use wing anti-ice as a replacement for ground de-icing or anti-icing and the inspection procedures which are necessary to comply with operating rules. Do not operate wing anti-ice on the ground when the outside air temperature is above 10°C.

27-In order to use wing anti-ice during ground operations position the wing anti-ice switch to the “ON” position. However, two additional conditions must also be met to have the control valves opened so that wing anti-ice will start to function. When the thrust on both engines is less than the take-off warning setting and if both temperature sensors find a duct temperature which is lower than preset thermal switch activation temperature, then both valves will open allowing the hot bleed air to flow to the leading edge slats.

28-With the anti-ice switch in the “ON” position; when the thrust on either engine is more than the take-off warning setting; or if either temperature sensors find a duct over temperature, both control valves will remain in the closed position preventing hot bleed air from reaching leading edge slats.

29-When the air/ground sensor is in the ground mode and wing anti-ice switch is the “ON” position, the switch stays in the “ON” position regardless of control valve position. When the air/ground sensor shifts to the air mode at lift-off, the wing anti-ice switch automatically moves to the “OFF” position. Now, let’s review operation of wing anti-ice in flight.

30-When the thrust on both engines is reduced and both temperature sensors sense a cooler duct temperature, the control valves automatically open.

31-In flight the wing anti-ice system can be used intermittently as a de-icer to remove an ice accumulation from the leading edge slats or it can be used continuously for anti-icing to prevent any ice formation on the leading edge slats.

32-Do not operate wing anti-ice in flight when the total air temperature is above 10°C.

33-When the anti-ice switch is positioned to the “ON” position in flight, the wing anti-ice control valves open. The engine thrust setting and duct temperature has no effect on the operation of the control valves.

34-Positioning the wing anti-ice switch to the “ON” position in flight also sets the stall warning logic for icing conditions, which adjusts the stick shaker and minimum maneuver speed bars on the airspeed indications. The reference speed is not adjusted automatically. Note that the stall warning logic stays set for icing conditions for the rest of the flight, regardless of subsequent wing anti-ice switch position; thus, stick shaker and minimum maneuver speed indications do not return to normal.

WINDOW HEATING SYSTEM

35-WINDOW HEATING SYSTEM The flight deck has five windows on the left and 5 windows on the right. Numbers 1 and 2 windows are electrically heated to prevent icing and fogging. The heating element is a transparent, conductive film which is located behind the outer glass panel.

36-Number 4 and 5 eyebrow windows are electric heated to prevent fogging only. Therefore, the heating film is located near the inner glass panel. There is no electrical heating for window number 3.

37-Window heat systems are controlled with the corresponding toggle switches on the window heat panel located on the forward overhead panel.

38-The forward window heat switches control window number 1 heating. The side window heat switches control windows number 2, 4, and 5 heating. A power test switch allows a check of the overheat warning function and to verify operation of the window heat system.

39-The row of lights above the window heat switches is to indicate the status of the heating on the related windows. When a switch is selected to the “ON” position and the window heat is being applied to the selected window, a green “ON” light illuminates on the associated window heat indicator. When the window heat switch is turned “OFF”, the light extinguishes. The “ON” light also extinguishes when there is a system overheat or a system failure.

40-"Note that at high ambient temperatures, when the window heat systems are switched “ON” during pre-flight, the window heat indicators remain extinguished. This is because the windows are already at the correct temperature; thus the window heat is not being applied to prevent an overheat condition.

41-Window heating is activated manually and operates automatically. When the window heat switches are selected to “ON”, the number 1 and 2 windows heating is achieved via temperature controllers. The temperature controllers receive an input signal from the temperature sensors in the umber 1 and 2 windows. When the sensors in the number 1 and 2 windows detect a window temperature lower than the correct temperature, a signal is transmitted to the controllers. The controllers then increase heating power until the correct temperature is reached thus maintaining number 1 and 2 windows at the correct temperature. This not only provides maximum protection against icing and/or fogging, but also ensures the highest impact resistance of the windows in case of a bird strike.

42-The heating of the number 4 and 5 windows is monitored by a thermal switch located on window 5, which opens and closes as necessary to keep these windows at the correct temperature.

43-The temperature controllers also monitor number 1 and 2 windows for an overheat condition. When an overheat condition is detected, the associated window heat “ON” light extinguishes and an amber overheat light illuminates on the window heat panel. The master caution and anti-ice system annunciator lights on the glare shield also illuminate.

44-When an overheat warning is received, the affected window heat must be switched “OFF” and allowed 2-5 minutes to cool before switching “ON” again.

45-Note that the overheat lights also illuminate if electrical power to the related window is interrupted.

46-In addition to electric heating, conditioned air can also be used for defogging the number 1 windows. Flow of

conditioned air, which is controlled with windshield/foot air control knobs located below the Captain and First Officer instrument panel. When you pull the windshield air control knob, conditioned air is supplied to the number 1 windows for defogging. If you pull the foot air knob, then the conditioned air is supplied to your leg position for comfort.

Window Heat Test

47-WINDOW HEAT TEST The window heat test is used to check overheat warning and power supply functions of the window heat system. Let's first take a look at an overheat test.

48-The purpose of overheat test is to ensure the correct operation of overheat warning function of the system by simulating an overheat condition. To perform an overheat test, you must select all window heat switches to the "ON" position. Then put the test switch to the overheat position and hold it in this position. If all overheat lights illuminate, all window heat "ON" lights extinguish, the master caution and ANTI-ICE annunciators lights illuminate, you can be sure that the overheat warning function is working properly. To reset the system, release the test switch, then turn the window heat switches "OFF" and back "ON".

49-The power test is used to verify that power is available for window heat. When you see that a window heat "ON" light is extinguished, although its associated window heat switch is on, and then perform a power test. Do not perform the power test when all "ON" lights are illuminated. With all switches in the "ON" position, put the test switch to the power position and hold. The power test forces the temperature controller to full power but overheat protection is still available. Look at the window heat "ON" lights. If all window heat "ON" lights illuminate, the test is completed. If any "ON" light remains extinguished, this means that the window heat system is inoperative.

50-With inoperative window heat, the airplane maximum airspeed limit is 250 knots below 10,000 feet.

PROBE HEATING SYSTEM

51-PROBE HEATING SYSTEM A very important anti-ice system for flight safety is the air data probe heating. This includes: the pitot probes, the elevator probes, the total air temperature probe and the alpha vanes. They are electrically heated against icing. There is no heating for static ports.

52-Probe heating is controlled from the probe heat panel located on the forward overhead panel. The panel consists of two toggle switches. Switch "A" controls probe heaters on the left and switch "B" on the right.

53-In some airplanes, the probe switches have "ON and OFF" positions. When a switch is selected to "ON", power is applied to the associated probe heaters. Positioning the switch "OFF" removes the power from related probe heaters.

54-In other airplanes you find that the probe switches have "AUTO" and "ON" positions. When a switch is positioned to "AUTO", the power is applied automatically to associated probe heaters when you start one of the engines. The probe heaters can also be powered manually by selecting the switch to the "ON" position, when there is a failure in the automatic circuit or for ground test.

55-When an air data probe is not heated, the associated probe heat light illuminates on the probe heat panel. The Master caution and anti-ice annunciator lights on the glare shield also illuminate.

56-If there is a failure in heating to one or more of the probes, you should avoid icing conditions. Ice accumulation can block the probe which is likely to result in unreliable flight instrument information.

57-When an airplane is on standby power, the probe heating is only available for heating the captain’s pitot probe; but the captain pitot light does not illuminate when there is a failure of the heating. In addition, the auxiliary pitot probe for standby airspeed is not heated when the airplane is on standby power.

RAIN REMOVAL SYSTEM

58-RAIN REMOVAL SYSTEM The airplane forward windows are fitted with a rain removal system to improve the visibility for the pilots in rain. The rain removal system incorporates windshield wipers and a permanent rain repellent coating on the windows.

59-Each pilot controls his or her own windshield wiper with corresponding selector on the overhead panel.

60-The windshield wiper selectors, which can be operated independently, allow for speed selection and to stow the wiper blades. In the panel shown, three different speeds can be selected. High speed is used in heavy rain. Slow speed is selected during normal rain or during taxi on the ground. Intermittent mode operates the wiper with an interval of seven seconds. When the “Park” position is selected, the wiper motor turns off the blades and the blades move to the park position.

61-Note that operating windshield wipers on a dry windshield will cause windshield scratching which can damage the permanent rain repellent coating.

ANTI-ICE CONTROLS AND INDICATIONS REVIEW

62-ANTI-ICE CONTROLS AND INDICATIONS REVIEW This is a review of anti-ice control and indications.

63-ENG 1 and 2 ANTI-ICE SWITCHES: Two switches. One for each engine: “ON” * Opens associated cowl anti-ice valve * Shifts stick shaker logic to icing conditions “OFF” * Closes associated cowl anti-ice valve * Returns stick shaker logic to normal (if wing anti-ice has not been used in flight) COWL VALVE OPEN LIGHTS (BLUE): “ILLUMINATED (BRIGHT)”: * Associated cowl anti-ice valve is “IN TRANSIT” * Associated cowl anti-ice valve is not in the position indicated by switch “ILLUMINATED (DIM)”: * Associated cowl anti-ice valve is “OPEN” “EXTINGUISHED”: * Associated cowl anti-ice valve is “CLOSED” COWL ANTI-ICE LIGHTS (AMBER): ILLUMINATED * Excessive duct pressure.

64-WING ANTI-ICE SWITCH: Single wing anti-ice switch controls left and right wing anti-ice simultaneously “ON” (In the air) * Opens wing anti-ice valves * Shifts stick shaker logic to icing conditions “ON” (on the ground) * Opens wing anti-ice valves, if; * Thrust on both engines is lower than takeoff warning setting, and * Both ducts temperature is lower than thermal switch activation temperature “OFF” * Closes wing anti-ice valves WING ANTI-ICE VALVE OPEN LIGHTS (BLUE):

“ILLUMINATED BRIGHT”: * Associated wing anti-ice valve is “IN TRANSIT” * Associated wing anti-ice valve is not in position indicated by switch “ILLUMINATED DIM”: * Associated wing anti-ice valve is OPEN “EXTINGUISHED”: * Associated wing anti-ice valve is CLOSED.

65-SIDE WINDOW HEAT SWITCHES: “ON” * Power is applied for heating number 2, 4 and 5 windows “OFF” * Window heat is not in use for number 2, 4 and 5 windows FORWARD WINDOW HEAT SWITCHES: “ON” * Power is applied for heating Window number 1 windows OFF * Window heat is not in use for number 1 windows POWER TEST SWITCH: Allows a system confidence test WINDOW HEAT ON LIGHTS (GREEN): “ILLUMINATED”: * Associated windows are being heated “EXTINGUISHED”: * Associated window switch is OFF, or * System is overheated, or * System failure is detected, or * System is at correct operating temperature WINDOW OVERHEAT LIGHTS (AMBER): “ILLUMINATED”: * An overheat condition is detected * Electric power is interrupted.

66-PROBE HEAT SWITCHES: “ON” * Related probe heating is energized “OFF” * Related probe heating is de-energized PROBE HEAT SWITCHES: “AUTO” * Power is applied automatically to associated probe heaters when you start one of the engines “ON” * Power is applied to associated probe heaters (manual operation) PROBE HEAT LIGHTS (AMBER)” “ILLUMINATED” * Associated probe heater is not functioning.

COURSE END

67-End of the course.