B737 NG CBT - FLIGHT CONTROLS

COURSE OUTLINES

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COURSE START

1-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.

2-This lesson consists of two parts: part 1-primary flight controls and part 2- secondary flight controls.

PRIMARY FLIGHT CONTROLS

3-This part introduces you to primary flight controls and provides an overview of their purposes and their operation. Here is the chapter outline: * Introduction * Roll control * Pitch control * Yaw control

INTRODUCTION

4-The flight controls are used to keep the airplane at the necessary attitude during flight. There are two types of flight control systems. Primary flight control system and secondary flight control system

5-The primary flight control system is used to control the airplane around three principal axes. Lateral axis, longitudinal axis and vertical axis. The primary flight controls are the ailerons, the elevators and the rudder.

6-The secondary flight control system is used to increase the lift and handling quality of the airplane. The secondary flight controls are the leading edge flaps, the leading edge slats, the trailing edge flaps, spoilers and speed brakes and horizontal stabilizer.

7-The airplane also incorporates blended winglets which provide enhanced takeoff and climb performance, less wake turbulence and increased fuel efficiency.

8-The primary controls are normally powered by either hydraulic system A or system B

9-The ailerons and elevators may also be operated manually if necessary.

10-If system A and system B fail, the rudder may be operated by the standby hydraulic system.

11-The secondary flight controls, including trailing edge (TE) flaps and leading edge flaps and slats, are normally powered by hydraulic system B. If hydraulic system B fails, the trailing edge flaps can be operated electrically.

12-The power transfer unit (PTU) automatically powers the leading edge flaps and slats under certain conditions. They can also be extended using standby hydraulic pressure.

13-The spoilers are powered by system A and system B.

14-The multiple use flight control panel is on the overhead panel. The panel has hydraulic control switches and caution lights for several of the flight control systems.

15-Flight control switches on the flight control panel are normally guarded to ON position. Hydraulic pressure is available to the ailerons, elevators, elevator feel computer, and rudder. With the switch in OFF position, the hydraulic pressure is removed from the ailerons, rudder and elevators. The STANDBY RUDDER position activates the electric standby pump and pressurizes the standby rudder power control unit.

16-The standby hydraulic low quantity light illuminates to indicate that standby hydraulic reservoir is low on hydraulic fluid.

17-The standby hydraulic low pressure light illuminates when the standby hydraulic pump output pressure is low.

18-A standby rudder ON light, if available, which illuminates when the standby rudder power control unit is pressurized either automatically or manually.

19-Each flight Control LOW PRESSURE lights come on when the respective hydraulic system pressure to ailerons, elevators, elevator feel computer and rudder is low. When the FLIGHT CONTROL switch is placed in the “STANDBY RUDDER” position, the related light is deactivated.

20-The SPOILER switches are for maintenance crew to do system tests.

21-The yaw damper switch controls the yaw damper system operation. The yaw damper warning light illuminates when the system is disengaged.

22-The alternate flaps master switch and the alternate flaps position switch are used for alternate flaps operation.

23-The panel also incorporates several warning lights.

24-The feel differential pressure light illuminates when there is an excessive difference between the system A and system B metered pressures in the elevator feel computer.

25-The speed trim fail light illuminates when the speed trim function in the flight control computers is not operative,

26-The Mach trim fail light illuminates when the Mach trim function in the flight control computers is not operative.

27-The autoslat fail light comes on to indicate the failure of the autoslat system.

28-In some airplanes, the flight control surface positions are indicated on the lower display unit. The indicator displays the positions of ailerons, elevators, rudder and flight spoilers. You need to push the System Switch on the multi-function display (MFD) panel so that the indicator will appear on the display.

ROLL CONTROL

29-The roll control system controls the movement of the airplane around the longitudinal axis.

30-The roll control is primarily provided by ailerons and supported by spoilers.

31-As aileron on one wing moves upward, the aileron on the other wing moves downward and the airplane rolls in the direction of up-moving aileron.

32-During roll control, the flight spoilers extend on the wing with upward aileron deflection only and all other spoilers stay down. The spoilers disturb the airflow over the wing and reduce the lift. This assists the ailerons to produce the roll force.

33-These are the cockpit controls and indications in relation to the roll control: Control wheels, aileron trim indicators on the top of the control wheels and aileron trim switches on the aft electronic panel.

34-The pilots use control wheels to move the ailerons and flight spoilers. When the autopilot engages, it automatically controls the position of ailerons and spoilers.

35-The feel and centering unit controls the aileron hydraulic power control units which move the ailerons, and gives an artificial feel force to the pilot. It also moves the control wheel to a neutral position when there is no input.

36-The spoiler mixer controls the power control units on each spoiler panel to provide spoiler movement proportional to aileron movement.

37-The captain’s control wheel supplies mechanical input by cables through the feel and centering unit to the aileron power control units.

38-The first officer’s control wheel provides mechanical input by cables through the spoiler mixer to the spoiler power control units.

39-The two control wheels are connected by a cable drive system that allows actuation of both ailerons and spoilers by either control wheel.

40-The Hydraulic system A and B supply power to aileron PCUs and spoiler PCUs to move the ailerons and spoilers.

41-The FLIGHT CONTROL switches control hydraulic pressure supply to ailerons. Flight spoiler switches control hydraulic pressure supply to the spoilers.

42-In case of total hydraulic power failure, the ailerons can be mechanically moved by rotating the control wheels. However, higher control forces are required due to cable friction and aerodynamic loads.

43-The roll control also incorporates an aileron transfer mechanism which allows retaining sufficient roll control capability, when ailerons or spoilers are jammed.

44-If the aileron control system is jammed, the ailerons are inoperative and the captain's control wheel cannot move. In this case, the first officer operates the right control wheel which provides roll control through the spoilers.

45-If the spoiler control system is jammed, the spoilers are inoperative and the first officer's control wheel cannot move. In this case, the captain operates the left control wheel which provides roll control through the ailerons.

46-Dual AILERON trim switches let you trim out unwanted control wheel forces.

47-You must operate both switches at the same time for the system to work. When the aileron trim switches are pushed, say for left wing down trim, a signal is sent to the aileron trim actuator.

48-The aileron trim actuator through the feel and centering unit and aileron power control units sets the ailerons to a new neutral position

49-During aileron trim, the control wheels also move to the new neutral position and the amount of aileron trim is indicated on the top of each control column.

50-With the autopilot engaged, if you push aileron trim switches, the trim does not change the control wheel position. The autopilot continues to hold the control wheel at the position required for heading or course control regardless of trim input.

51-Note that if you apply an aileron trim when the autopilot is engaged, it may result in an out of trim condition and an abrupt rolling motion when the autopilot is disconnected.

PITCH CONTROL

52-The pitch control system controls the movement of the airplane around the lateral axis.

53-The pitch control is primarily provided by elevators and supported by an horizontal stabilizer

54-The elevators are connected by a torque tube. Up deflected elevators create nose up motion whilst down deflected elevators create nose down motion.

55-These are the cockpit controls and indications in relation to the pitch control: Control columns, stabilizer trim switches on the control wheels, stabilizer trim override switch on the aft electronic panel. There are other control and indication components on the control stand, including stabilizer trim wheels, stabilizer trim indicator and stabilizer trim cutout switches.

56-The elevators are moved by control columns, autopilot and mach trim system

57-The pilots manually control the position of the elevators with forward and aft movement of the control column.

58-Pilots' control columns are connected by cables to elevator power control units (PCUs).

59-The Hydraulic system A and B supply power to elevator PCUs to move the elevators. FLIGHT CONTROL switches control the hydraulic power supply to the elevators.

60-The elevators can be mechanically moved by forward or aft movement of the control columns, even if hydraulic power is totally lost. However, higher control forces are required due to cable friction and aerodynamic loads.

61-The elevator control system also incorporates a breakout mechanism which allows retaining sufficient elevator control capability, when a control column is jammed.

62-If a control column has a jam, apply a control column force against the jam. When the force overcomes the breakout force, the captain's and first officer's control columns separate. The control column that moves freely after the breakout can provide sufficient elevator control.

63-Note that if the jam exists during the landing phase, higher forces are required to produce adequate elevator control to flare for landing.

64-Elevator feel computer, and elevator feel and centering unit are the other components of the elevator control system.

65-The function of the elevator feel computer is to change the control column feel forces as the airspeed changes and the horizontal stabilizer moves.

66-The elevator feel computer receives hydraulic pressure from system A and system B, pitot pressure from the pitot tubes, and mechanical input from the stabilizer; and determines proper control column feel force. The computer then sends hydraulic pressure output proportional to the feel force to the elevator feel and centering unit. The computer increases the feel force as the airspeed increases

67-Failure of either hydraulic system causes a significant hydraulic pressure difference to build up in elevator feel computer and the FEEL DIFFERENTIAL PRESSURE light illuminates.

68-The FEEL DIFFERENTIAL PRESSURE light also illuminates, when an excessive air pressure differential builds up in elevator feel computer due to failure of either elevator feel pitot system. Whenever the feel differential pressure light illuminates, MASTER CAUTION lights and Flight Control annunciator also comes on. No crew action is required when FEEL DIFFERENTIAL PRESSURE light comes on.

69-Elevator feel and centering unit transmits feel force to control columns. The unit also moves the control column to a neutral position when there is no input.

Mach trim

70-As the airplane speed increases toward mach 1, the center of lift moves rearward and the airplane nose starts to drop. The mach trim prevents this nose down motion at high airspeeds.

71-When the airspeed is more than mach 0.615, Mach trim automatically activates to adjust the elevators with respect to the stabilizer as speed increases. The ADIRU sends Mach information to the flight control computers. The flight control computers calculate adequate mach trim actuator position. Then the Mach trim actuator, through the feel and centering unit, moves the elevators to a new neutral position to prevent nose down motion.

72-When mach trim function fails in both flight control computers, MACH TRIM FAIL light illuminates on the flight control panel. Master caution lights and flight control annunciator come on. You should limit airspeed to 280 knots/.82 Mach.

73-If mach trim function fails in only one flight control computer, MACH TRIM FAIL light does not come on. However, if you activate either master caution recall the light comes on.

Pitch trim

74-The electrically operated horizontal stabilizer controls the pitch trim of the airplane about the lateral axis.

75-On modern transport airplanes, like B737, pitch trim is usually provided by moving the entire horizontal stabilizer. This configuration lets the elevator be in neutral position with respect to the horizontal stabilizer permitting the autopilot full elevator control authority both sides of the trimmed position.

76-The horizontal stabilizer can travel 4.2 degrees leading edge up from the neutral position for airplane nose down trim. It can move 12.9 degrees leading edge down position for airplane nose up trim.

77-There are three methods of pitch trim depending on how the horizontal stabilizer is moved. Manual pitch trim, electric pitch trim and autopilot pitch trim

78-For manual pitch trim control, you use the stabilizer trim wheels. When you rotate the trim wheel, the cable drives a jackscrew which moves the horizontal stabilizer. Movement of the trim wheels also moves the stabilizer indicator pointer. Manual input from the trim wheels has the highest priority and can be used to override autopilot or main electric trim.

79-When flying manually, you can operate two stabilizer trim switches on each control wheel for main electric trim control. The reason for a double switch on the pitch trim is to reduce the probability of a trim runaway

80-When you move the stabilizer trim switches together, an electric input signal is sent to the stabilizer trim actuator which moves the jackscrew which, in turn, moves the horizontal stabilizer.

81-Whenever main electrical trim is activated, stabilizer trim wheels and stabilizer indicator pointer also move.

82-When the autopilot is engaged, the pitch trim is accomplished automatically. FCCs send an electric input signal to the stabilizer trim actuator to position the horizontal stabilizer through the jackscrew. The stabilizer trim wheels and stabilizer indicator pointer also move to take up the new position.

83-In addition to normal pitch trim function, autopilot pitch trim also provides a smooth hand over from automatic flight to manual flight during autopilot disengagement.

84-Stabilizer Out Of Trim light on the left forward panel illuminates when the autopilot is not trimming the horizontal stabilizer properly.

85-During large changes in trim requirements, it is normal the Stabilizer Out Of Trim light momentarily illuminates.

86-If the light remains illuminated for a longer time, grasp the control column firmly, disengage the autopilot and trim the stabilizer using stabilizer trim switches.

87-With the autopilot is engaged, activating either pair of stabilizer trim switches automatically disengages the autopilot.

88-Now let’s see some other features of main electric pitch trim and autopilot pitch trim.

89-Main electric trim and autopilot trim operations have two speed modes. When the flaps are retracted, the trim moves at a slower rate. When the flaps are extended, stabilizer trim actuator engages in high speed trim. Note that during autopilot operation, the stabilizer trim actuator operates at lower speeds than during electric operation.

90-The main electric and autopilot trim can be disconnected by either stabilizer trim cutout switches or column cutout switches

91-If there is anuncommented motion or runaway of the trim actuator, the STABILIZER TRIM MAIN ELECTRIC cutout switch and the STABILIZER TRIM AUTOPILOT cutout switch on the control stand let you disconnect the stabilizer trim actuator.

92-The main electric and autopilot pitch trim can also be disconnected via column cutout switches which are remotely located in the forward equipment compartment. When you move the control column in a direction opposite to the trim direction, the column cutout switches stop the stabilizer trim actuator

93-If the stabilizer trim is stopped out of range, you can use the stabilizer trim override switch to bypass the column cutout switches. With the switch moved to override, you can operate the electric pitch trim regardless of control column position.

94-Two stabilizer trim indicators located next to each stabilizer trim wheel display the stabilizer position in units, not in degrees. The stabilizer neutral position of 0 degrees corresponds 4 units of trim.

95-The green bands show the approved takeoff trim range. If you attempt to takeoff when the stabilizer trim is not in the takeoff range, an intermittent horn sounds

96-In manual pitch trim, the horizontal stabilizer travel is limited between -0.20 units of nose down trim and 16.9 units of nose up trim.

97-The main electric trim, with the flaps extended, is limited between 0.05 units of nose down trim and 14.5 units of nose up trim. When the flaps are up, the trim limit is between 3.95 and 14.5 units.

98-The autopilot pitch trim is limited between 0.05 units of nose down trim and 14.5 units of nose up trim.

99-As you have seen, manual trim provides a greater trim range than the electrical and autopilot trim limits.

100-If you have used manual trim wheels to position the stabilizer beyond the electrical trim limits, the stabilizer trim switches let you return the stabilizer to electrical trim limits.

Speed trim

101-The purpose of the speed trim system is to increase the airplane stability during operations with a low gross weight, aft center of gravity, low speed and high thrust.

102-The speed trim function primarily occurs during takeoff or go-around and only operates when the autopilots are not engaged.

103-The speed trim function keeps the trimmed speed set by the pilots with commands to the horizontal stabilizer. As the airplane speed decreases from the trimmed speed, the speed trim moves the horizontal stabilizer to a more nose down position to increase the speed.

104-As the speed increases from the trimmed speed, the stabilizer is moved to a more nose up position to decrease the speed.

105-When speed trim function fails in both flight control computers, SPEED TRIM FAIL light illuminates on the flight control panel. Master caution lights and flight control annunciator come on. No crew action is required in flight for speed trim system failure.

106-If speed trim function fails in only one flight control computer, SPEED TRIM FAIL light does not come on. However, if you activate either master caution recall the light comes on.

YAW CONTROL

107-The yaw control system provides control of the airplane around its vertical axis.

108-The yaw control is provided by a hydraulically powered rudder and a digital yaw damper system.

109-The rudder attaches at the trailing edge of the vertical stabilizer. Two power control units or PCUs attach to the rudder and move the main rudder PCU and standby rudder PCU.

110-Main rudder PCU has two independent input arms and two individual control valves. In airplanes without Rudder System Enhancement modification, it consists of a single input arm and control valve.

111-The standby rudder PCU incorporates a separate input arm and control valve.

112-The input arms have individual spring jam overrides that allow the system to operate normally if an input rod or downstream hardware is jammed.

113-Left deflected rudder causes nose to move left. Right deflected rudder causes nose to move right.

114-These are the cockpit controls and indications in relation to the yaw control: Rudder pedals; rudder trim indicator, and rudder trim control on the aft electronic panel; yaw damper indicator, if installed, on the center forward panel and a yaw damper switch and, if installed, a standby rudder on light on the overhead flight control panel.

115-For manual yaw control, the pilot uses the rudder pedals or the rudder trim control knob to move the rudder.

116-The pilots use the rudder pedals to command a yaw control. Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs through a feel and centering unit.

117-The rudder feel and centering unit gives artificial feel to the rudder pedals and centers the input to the PCUs.

118-The main rudder PCU is powered by hydraulic system A and B to move the rudder.

119-The main rudder PCU incorporates a load limiter system. The function of load limiter is to reduce the rudder deflection during flight when not taking off or landing as large rudder deflections are not necessary to control the airplane.

120-When the airspeed is more than 137 knots, the load limiter limits both hydraulic system A and B pressure within the main rudder PCU to reduce rudder output force by 25%, which limits the rudder movement.

121-In airplanes without rudder system enhancement modification, the load limiter system only limits the hydraulic system A pressure to reduce rudder output force by approximately 50%.

122-The main rudder PCU also incorporates a Force Fight Monitor (FFM) which detects if system A and B actuators are operating in opposition to each other. This may happen following a jam or disconnection in system A or B input. When it detects opposing pressure forces between A and B actuators, force fight monitor automatically activates the standby rudder system to allow continued operation of the rudder.

123-The standby rudder PCU is powered by the standby hydraulic system. It provides a backup if system A and/or B pressure is lost.

124-You can pressurize the standby rudder system manually by moving either flight control switch to standby rudder position.

125-The standby rudder system can also be pressurized automatically during takeoff or landing or automatically by the Force Fight Monitor.

126-Whenever the standby rudder system is activated either manually or automatically, an amber standby rudder on light, if available, illuminates on the flight control panel. Master Caution lights and Flight Control annunciator come on.

Rudder trim

127-The rudder trim system lets the flight crew trim out unwanted rudder pedal forces. The system changes the neutral position of the rudder and displaces the rudder pedals proportionately.

128-You control the rudder trim with the rudder trim control knob on the aft electronic panel. When you turn the knob to the left or right, the control sends electrical signals to the rudder trim actuator which moves the feel and centering unit. The feel and centering unit adjusts the neutral position of the rudder and the rudder pedals.

129-The rudder position indicator shows the rudder’s trimmed position. An OFF flag will appear, if there is an electric failure to the trim indication. Note that when the rudder trim indicator fails the trim function is still available.

130-If a rudder cable fails during flight, you can use the rudder trim to make rudder inputs.

Yaw damper

131-Dutch roll is an unwanted airplane motion which is identified by a combination of a continuous oscillations in yaw and roll. It starts with an unsteady yaw rate. If this initial unsteady yaw motion is counteracted, the Dutch Roll cannot develop. Yaw Damper is a system which moves rudder to prevent dutch roll.

132-Yaw damper system is also capable of providing turn coordination and gust damping.

133-The system operates for all phases of flight and is normally engaged on the ground before takeoff.

134-When yaw damper moves the rudder to reduce unwanted yaw motion, rudder pedals do not move.

135-The yaw damper system consists of a main and standby yaw damper.

136-The main yaw damper is powered by system B.

137-The standby yaw damper is powered by standby hydraulics.

138-Both yaw dampers are controlled through two Stall Management/Yaw Damper (SMYD) computers.

139-The Stall Management/Yaw Damper computers receive airspeed, yaw and roll rate, acceleration and attitude inputs from both ADIRUs.

140-During normal operation, Stall Management/Yaw Damper computer number 1 provides main yaw damping through the main rudder PCU which is powered by system B.

141-During manual reversion, that is when the system A and system B pressure is lost, Stall Management/Yaw Damper computer number 2 provides standby yaw damping through the standby rudder PCU

142-You can override either main or standby yaw damper inputs with the rudder pedals or trim inputs.

143-You use the yaw damper ON/OFF switch on the flight control panel to engage the yaw damper for either normal operation or manual reversion flight when hydraulic system A and B pressure is lost.

144-To turn on the main yaw damper for normal operation, ensure that flight control B switch is in the ON position. Move the yaw damper switch to ON position. Two seconds later the yaw damper warning light will go off to show that there is normal yaw damper operation.

145-To engage the standby yaw damper for manual reversion flight, place both FLT CONT A and B switches to OFF. Then move at least one of these switches to STBY RUD. Place the yaw damper switch to ON. Two seconds later the yaw damper warning light will extinguish to show the system is operating

146-If there is a system fault, yaw damper switch moves back to OFF and the yaw damper warning light comes ON to show the system has disengaged.

147-During Standby Yaw Damper operation, when you move the control wheel, a signal is sent to standby rudder PCU to move rudder in proportion to control wheel inputs. This helps turn the airplane when control of the ailerons is through manual reversion with standby hydraulics ON.

148-The yaw damper indicator on the center forward panel shows the rudder movement due to only main yaw damper commands.

149-The standby yaw damper inputs to the rudder are not shown on the indicator.

150-For main yaw damping, rudder movement is limited to 2 degrees with flaps up and 3 degrees with flaps down.

151-If available, the flight control surface position indicator shows both main and standby yaw damper inputs to the rudder.

152-The yaw damper warning light comes on when the yaw damper disengages. Whenever yaw damper warning light comes on, the MASTER CAUTION lights and flight controls annunciator also illuminate.

153-If it is a temporary failure, the yaw damper may reset when you move the switch from OFF to ON position.

154-If the failure is due to a yaw damper system fault detected by the stall management/yaw damper computer, the yaw damper switch cannot be reset to ON and the yaw damper warning light remains illuminated.

155-In this case, avoid areas of predicted moderate or severe turbulence. If turbulence is encountered and passenger comfort is affected, reduce airspeed and/or descend to a lower altitude. Do not exceed flaps 30 if the crosswind is more than 30 knots.

STALL IDENTIFICATION

156-The stall identification helps you identify and prevent further penetration into a stall condition. Stall identification and control is enhanced by the yaw damper, the Elevator Feel Shift (EFS) module and the speed trim system which work together.

157-During high angle of attack operations, the Stall Management/Yaw Damper computer reduces rudder movement commands to yaw damper.

158-The elevator feel shift module supplies increased system A pressure to the elevator feel and centering unit during a stall. This increases forward control column feel force up to four times normal feel. The increased feel force makes sure the pilots cannot easily override automatic stabilizer movement to nose down pitch of the airplane.

159-The elevator feel shift module is inhibited when the airplane is on the ground, or when the airplane is below 100 ft radio altitude with autopilot engaged.

160-If the elevator feel shift module is active as the airplane descends through 100 feet, it stays active until angle of attack decreases below stick shaker threshold.

161-Near stall, the speed trim system trims the stabilizer to a nose down condition to allow for trim above the stickshaker AOA and idle thrust. This means that airplane will stall at more aft column position.

SECONDARY FLIGHT CONTROLS

162-This part introduces you to secondary controls and provides an overview of their purposes and their operation. Here is the chapter outline: * Introduction * Spoilers/speed brakes * Leading edge devices and trailing edge flaps * Flap load relief * Autoslat * Alternate operation * Asymmetry and skew detection, protection and indication

INTRODUCTION

163-Secondary flight controls are used to support or to modify the effect of the primary controls.

164-Secondary flight controls include spoilers/speed brakes leading edge devices and trailing edge flaps.

SPOILERS/SPEED BRAKES

165-Spoilers are upper wing surface devices. When extended, they increase drag and decrease lift.

166-There are six spoilers on each wing. Each spoiler has a number, 1 through 12 from left to right. The most outboard and the most inboard spoiler are the ground spoilers. All the other spoilers are flight spoilers.

167-The spoilers perform two functions: Roll control function and speed brake control function

168-The roll control function is provided only by flight spoilers to help the ailerons control the airplane roll about the longitudinal axis. Spoilers roll function is described in Primary Flight controls section.

169-The flight spoilers also supply speed brake control to slow the airplane or increase the rate of descent.

170-The ground spoilers move with the flight spoilers to act as speed brakes while the airplane is on the ground. Ground spoilers do not operate in flight.

171-The flight spoilers are powered by hydraulic system A and B.

172-The Ground spoilers are powered by hydraulic system A.

173-These are the cockpit controls and indications in relation to speed brake operation: Speed brake lever on the control stand, speed brake armed/do not armed light on the left forward panel and speed brakes extended light on the right forward panel.

174-The speed brake lever lets you manually move the spoilers. The autopilot does not control the speed brake function.

175-When the SPEED BRAKE lever is actuated, only the flight spoilers move up when the airplane is in the air and all the spoilers move up when the airplane is on the ground.

176-The speed brake lever has detents at these three positions: Down, armed and flight detent. There is also UP position with no detent.

177-In the DOWN detent position all flight and ground spoiler panels are down.

178-The ARMED position is used to arm the spoilers for automatic speed brake operation which will be discussed later.

179-SPEED BRAKE ARMED light illuminates when the automatic operation of the speed brake system does arm correctly.

180-The SPEED BRAKE DO NOT ARM light comes on to indicate a fault has occurred in the automatic speed brake system. In this case, speed brakes can still be used in flight, but not on landing.

181-In airplanes with load alleviation system, the SPEED BRAKE DO NOT ARM light comes on when there is a fault in the speed brake load alleviation system with flaps up.

182-When you move the speed brake lever to the flight detent position, all flight spoilers extend to their maximum position for inflight use. Moving the SPEED BRAKE lever beyond the FLIGHT DETENT is prohibited in flight, as it may cause buffeting.

183-In some airplanes, a lever stop is incorporated in the speed brake lever mechanism to prevent an inadvertent movement of speed brake lever beyond the flight detent during flight with flaps up. When there is a loss of electrical power, the lever stop is deactivated and full speed brake lever movement is available.

184-When you operate the SPEED BRAKE lever in flight, all flight spoiler panels rise symmetrically to act as speed brakes.

185-You must be careful when operating flight spoilers during a turn, as they can significantly increase roll rate.

186-In airplanes with load alleviation feature, the speed brake lever has also a 50 percent position.

187-Under certain high gross weight/airspeed combinations, if the speed brake lever is moved beyond the 50 percent position, the lever automatically retracts to 50 percent position and all flight spoilers retract to one-half of their maximum position for inflight use.

188-When load alleviation deactivates, you can manually return speed brakes to FLIGHT DETENT position

189-You can manually override the load alleviation feature. However, greater force is needed to move the SPEED BRAKE lever beyond the 50 percent position and you must hold the SPEED BRAKE lever in place, if it is not moved to UP position.

190-If you move the SPEED BRAKE lever to UP position with load alleviation active, then it will remain fixed in this position.

191-Up position is used only when the airplane is on the ground. When the lever moved to UP position, all flight and ground spoilers extend to their maximum position.

192-The SPEED BRAKES EXTENDED light indicates spoiler operation in-flight and on the ground.

193-The SPEED BRAKES EXTENDED light illuminates in flight when the speed brake lever is beyond the ARMED position and the radio altitude is less than 800 feet or the trailing edge flaps are set more than flaps 10. These conditions occur if you operate the speed brake lever during the landing approach.

194-When you move the speed brake lever to arm or down detent, THE SPEED BRAKES EXTENDED light extinguishes

195-On the ground, the SPEED BRAKES EXTENDED light illuminates when the SPEED BRAKE lever is down and the speed brakes are not stowed. Illumination of the speed brakes extended light on the ground indicates a failure condition. Thus, you must not takeoff.

Speed brakes ground operation

196-Automatic speed brake function sets the spoilers to operate automatically on landing or during a rejected takeoff.

197-To set the automatic speed brake for landing, move the speed brake lever to ARMED position. Ensure that speed brake armed light comes on. Retard both thrust levers to idle during flare or at touchdown.

198-When the radio altitude is less than 10 feet and the main landing gear wheels spin up at a speed of more than 60 knots, the SPEED BRAKE lever automatically moves to the UP position and all the spoilers move up.

199-If a wheel spin-up signal is not detected, when any gear strut compresses, the SPEED BRAKE lever moves to the UP position and flight spoilers deploy automatically.

200-When the right main landing gear strut compresses, the ground spoilers deploy.

201-If SPEED BRAKES DO NOT ARM light has illuminated in flight, do not arm the speed brakes for landing. Manually extend the speed brakes immediately upon landing.

202-The auto speed brake system also operates during a rejected takeoff or if the SPEED BRAKE lever is in the DOWN position during landing.

203-When main landing gear wheel speed is more than 60 kts, both thrust levers are retarded to IDLE and reverse thrust levers are positioned for reverse thrust, the SPEED BRAKE lever automatically moves to the UP position and all spoilers deploy

204-After a rejected takeoff or landing, if you advance either thrust lever, the SPEED BRAKE lever automatically moves to the DOWN position and all spoilers retract. You may also retract the spoilers manually by moving the SPEED BRAKE lever to the DOWN detent.

205-On landing, if the wheel speed is less than 60kts, and the speed brake lever is in the UP position, the SPEED BRAKE DO NOT ARM light will illuminate.

206-The light will stay on until the speed brake lever is moved to DOWN detent. This is the normal operation of SPEED BRAKES DO NOT ARM light and does not indicate a system fault.

LEADING EDGE DEVICES AND TRAILING EDGE FLAPS

207-The leading edge devices and trailing edge flaps improve the takeoff and landing performance of the airplane by increasing lift and decreasing stall speed during takeoff, low speed flight and landing.

208-They achieve this by increasing the wing area and the wing camber.

209-The leading edge devices consist of two flaps and four slats on the leading edge of each wing.

210-The leading edge or Kruger flaps are located inboard of each engine. They increase the wing camber by extending from the bottom side of the wing. Leading edge flaps have two positions: Up and fully extended.

211-The leading edge slats are located outboard of each engine. When extended they create a slot at the leading edge, which permits air to flow from lower side of the wing to upper side and delays a stall condition. Leading edge slats have three positions: Up, extended and fully extended.

212-The trailing edge flaps are located inboard and outboard of each engine. The flaps are double slotted and increase the wing camber and the wing area when extended.

213-Extension of leading edge devices takes place in sequence with the movement of the trailing edge flaps.

214-During cruise, the leading edge devices and trailing edge flaps fully retract.

215-The leading edge devices and trailing edge flaps are mechanically controlled and hydraulically operated. There are two modes of operation: Normal operation and alternate operation.

216-During normal operation leading edge devices and trailing edge flaps are powered by hydraulic system B.

217-Alternate operation is used when the hydraulic system B fails. During alternate operation standby hydraulic system supplies power to extend the leading edge devices. Trailing edge flaps are electrically extended and retracted. Alternate operation will be discussed later.

218-These are the cockpit controls and indications in relation to the trailing edge flaps: Flap lever on the control stand, flap position indicator and flap limit placard on the center forward panel, and , if installed, flap load relief light on the right forward panel.

219-During normal operation, the flap lever controls the position of the trailing edge flaps and leading edge devices. When you move the flap lever, trailing edge flap control and leading edge control activate and system B pressure goes to the trailing edge drive unit and leading edge devices.

220-The flap position indicator indicates trailing edge flap positions.

221-The flap limit placard indicates the maximum speed for each flap position.

222-Indications in relation to leading edge devices include Leading Edge Devices Annunciator Panel, Leading Edge Flaps Transit and Leading Edge Flaps extended lights.

223-The leading edge devices annunciator panel indicates the position of each leading edge slat and flap. Leading edge flaps transit and extended light shows the status of the leading edge devices.

224-The leading edge slats positions are indicated by transit, extended and full extended lights on the leading edge devices annunciator panel.

225-The leading edge flaps' positions are indicated by transit and extended lights.

226-The leading edge flaps extended light comes on when all of the leading edge flaps and slats are in an extend or full extend position.

227-The leading edge flaps transit light illuminates when a leading edge flap or slat is not in the correct position or when a leading edge uncommanded motion occurs.

228-When leading edge devices are retracted, all lights extinguish.

229-When the leading edge devices are in transit or not in the correct position amber leading edge devices transit lights and leading edge flap transit light illuminate.

230-When leading edge slats are extended and LE flaps are fully extended, the leading edge devices annunciator panel green lights illuminate to reflect the position of the leading edge devices and green leading edge flaps extended light comes on.

231-When leading edge slats are also fully extended, LE slats fully extended lights illuminate on the leading edge devices annunciator panel. The green leading edge flaps extended light is on.

232-The test switch lets you test the Leading Edge Annunciator Panel lights. When you push the switch all lights on the panel come on.

233-The flap lever lets you move the trailing edge flaps to nine different positions. During normal operation, the leading devices deployment is sequenced as a function of trailing edge flaps deployment.

234-In general, trailing edge flap positions between 1–15 provide increased lift. Positions between 15–40 provide increased lift and drag. Flap positions 30 and 40 are normal landing flap positions.

235-Flap lever mechanism incorporates two flap gates. The gate at flaps 1 prevents inadvertent FLAP lever movement beyond flaps 1 during a single engine go–around. The other gate prevents inadvertent FLAP lever movement beyond flaps 15 during normal go–around.

236-When the FLAP lever is in the UP detent, all trailing edge flaps and leading edge devices are retracted.

237-When the FLAP lever is moved from the UP position to the 1, 2, 5, 10, 15, or 25 position, the trailing edge flaps extend to the commanded position and leading edge slats extend to the extend position. The leading edge flaps extend to the full extended position.

238-When the FLAP lever is moved beyond the 25 position, the trailing edge flaps extend to the commanded position and the leading edge slats extend to the full extended position. The leading edge flaps remain at the full extended position.

239-In some airplanes, when the FLAP lever is moved beyond the 5 position, the leading edge slats move to the full extended position.

240-Let’s see flap extension sequence with an example. When you set the flap lever at or below flaps 25, say flaps 10, trailing edge flaps and leading edge devices start to extend from their UP position. Leading edge devices transit lights and leading edge flaps transit light illuminate.

241-When trailing edge flaps are near the 1 position, the leading edge flaps are fully extended and the leading edge slats are extended position. Leading edge devices annunciator panel indicates the position of the leading edge devices. Leading edge flaps extended light illuminates.

242-When the flap lever is set beyond flaps 25, say flaps 40, trailing edge flaps extend to commanded position and the leading edge slats move to fully extend. The lights again show in transit and then fully extended

FLAP LOAD RELIEF

243-The flap load relief function prevents damage to the trailing edge flaps and their support structures from large aerodynamic forces.

244-The flap load relief function is provided by the flaps/slat electronics unit (FSEU). It is only operative at the flaps 10, 15, 25, 30 and flaps 40 positions during normal operation of the trailing edge flaps.

245-Note that in some airplanes, flap load relief function is available only at flaps 30 and 40.

246-Flap load relief limits the positions of the trailing edge flaps as a function of airspeed. If the airspeed is more than a limit, the FSEU sends a command to the flap load relief solenoid to retract the trailing edge flaps. The flap position indicator displays flap movement, but the FLAP lever does not move.

247-When the trailing edge flap load relief function is activated, the FLAP LOAD RELIEF light illuminates

248-When the flap lever is at 40, if airspeed exceeds 163 knots, load relief function retracts the trailing edge flaps to 30. When airspeed decreases below 158 knots, the flaps re-extend to 40.

249-When the flap lever is at 30, if airspeed exceeds 176 knots, load relief function retracts the trailing edge flaps to 25. When airspeed decreases below 171 knots, the flaps re-extend to 30.

250-When the flap lever is set at 25, if airspeed exceeds 191 knots, load relief function retracts the trailing edge flaps to 15. When airspeed decreases below 186 knots, the flaps re-extend to 25

251-When the flap lever is set at 15, if airspeed exceeds 201 knots, load relief function retracts the trailing edge flaps to 10. When airspeed decreases below 196 knots, the flaps re-extend to 15.

252-When the flap lever is set at 10, if airspeed exceeds 211 knots, load relief function retracts the trailing edge flaps to 5. When airspeed decreases below 206 knots, the flaps re-extend to 10.

LEADING EDGE AUTOSLAT SYSTEM

253-The leading edge autoslat system improves airplane stall characteristics at high angle of attack operations.

254-When the airplane approaches a stall condition during takeoff or approach to landing, the leading edge autoslat system moves the leading edge slats from the extend position to the full extend position

255-Autoslat function is available at flap positions 1, 2, 5, 10, 15, and 25. In some airplane models, it is available at flap positions 1, 2 and 5.

256-With the flap lever is at one of these detents, say 5, autoslat moves the leading edge slats to full extended before stick shaker activation.

257-When the pitch angle is reduced below the stall attitude, the slats move back to extended position.

258-Autoslat system normally uses hydraulic system B.

259-If pressure from hydraulic system B engine driven pump is not sufficient, the power transfer unit (PTU) uses hydraulic system A to pressurize hydraulic system B for autoslat operation.

260-When autoslat system is not operative, AUTO SLAT FAIL light illuminates on the overhead flight control panel. Master caution lights and flight control annunciator also illuminate. No crew action is required for an autoslat system failure.

ALTERNATE OPERATION

261-In the event that hydraulic system B fails, leading edge devices and trailing edge flaps can also be operated in alternate mode.

262-In alternate operation leading edge devices and trailing edge flaps are powered in different ways. The leading edge devices are powered by standby hydraulic system only for extension. An electrical motor powers the trailing edge flaps both for extension and retraction.

263-During alternate operation, you use the alternate flaps switches to operate the trailing edge flaps and the leading edge devices.

264-First, open the guard and move the alternate flaps arm switch to the arm position. This starts the standby hydraulic pump and closes the trailing edge flaps bypass valve.

265-Then move and hold the alternate flaps position switch in the DOWN position. As trailing edge flaps are electrically driven to desired position, the standby hydraulic system moves leading edge flaps and slats to the full extended position.

266-To stop the extension of the trailing edge flaps, release the alternate flaps position switch.

267-During alternate operation, the trailing edge flaps extension is slow. It takes approximately 2 minutes and 39 seconds for the trailing edge flaps to fully extend or fully retract during alternate operation.

268-To retract the TE flaps, move the alternate flaps position switch to the UP position. The control switch has a detent at the UP position, thus, you do not have to hold the switch in the UP position. You cannot retract the LE devices using the alternate operation. Be careful. Extended leading edge devices generate additional drag which may cause your reserve fuel not to be sufficient to fly to an alternate airport.

ASYMMETRY AND SKEW DETECTION, PROTECTION AND INDICATION

269-The flaps/slat electronics unit (FSEU) monitors trailing edge flaps for a flap asymmetry condition and a flap skew condition. It also monitors the LE devices for improper position and skew conditions on slats 2 through 7.

270-A flap asymmetry is a condition where a flap on one wing does not align with the symmetrical flap on the other wing.

271-A skew is a condition where the inboard end of a flap or slat does not align with the outboard end.

272-If the FSEU detects a trailing edge flap asymmetry or skew condition, it closes the trailing edge flap bypass valve. This removes the hydraulic power from the flap drive unit and trailing edge flaps stop moving. The flap position indicator displays a needle split.

273-In the event of a skewed or asymmetrical trailing edge flap, do not attempt to use alternate flaps position switch to operate trailing edge flaps. There is no asymmetry or skew protection when the alternate flap drive system is used.

274-When the FSEU detects a leading edge device in an incorrect position or a leading edge slat skew condition, the LEADING EDGE FLAPS TRANSIT light stays illuminated.

275-And one of these indications will show on the leading edge devices annunciator panel: TRANSIT amber light comes on, incorrect EXTEND or FULL EXTEND green light comes on, or no lights come on.

276-Skew detection is not available for outboard slats, 1 and 8, and for the leading edge flaps.

277-Note that slat skew detection is inhibited during autoslat operations.

278-The FSEU also provides protection from uncommanded motion by the leading edge devices or trailing edge flaps.

279-Uncommanded motion for a leading edge device takes place when, with the flap LEVER in a detent or autoslats not commanded, two or more leading edge slats move on one wing or two leading edge flaps move on one wing.

280-If there is an uncommanded motion of the LE devices, amber LE FLAPS TRANSIT light comes on. FSEU closes the leading edge control. This prevents further movement of the leading edge device.

281-The FSEU monitors the trailing edge flaps position and compares it with the flap lever position to detect a flap uncommanded motion.

282-Uncommanded motion for TE flaps occurs when, with no flap lever or flap load relief command, the trailing edge flaps move away from the commanded position or flaps move in the opposite direction of the flap lever.

283-If there is an uncommanded motion of the trailing edge flaps, FSEU closes the flap bypass valve. This prevents further movement of the trailing edge flaps.

284-The only indication of an uncommanded motion of the trailing edge flaps is the disagreement between the flap LEVER position and the flap position indicator.

285-You cannot reset trailing edge bypass valve after an uncommanded flaps motion. You must use alternate flap system to control the trailing edge flaps. Remember that there is no asymmetry or skew protection when alternate flap system is used.

COURSE END

286-End of Course. ?