B737 NG CBT - WARNING SYSTEM

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.

WARNING SYSTEMS

2-This chapter deals with the warning systems which alert the flight crew to an abnormal system operation or an unsafe flight condition. Here is the chapter outline: * Introduction * Master caution system * Takeoff configuration warning * Landing gear configuration warning * Proximity switch electronics unit (PSEU) * Mach/airspeed warning system * Stall warning system * Ground proximity warning system (GPWS) * Traffic alert and collision avoidance system (TCAS) * Predictive windshear system * Tail skid

INTRODUCTION

3-B737 warning systems provide two functions: To draw the flight crew attention to a non-normal operational or airplane system conditions and to provide information related to nature of the non-normal conditions.

4-The warning systems uses visual, aural or tactile signals or any combination of them to alert the flight crew.

5-The red warning lights are used for the conditions which require the immediate corrective action by the flight crew.

6-These lights are in the area of the pilots' primary field of vision and illuminate to indicate engine, wheel well, cargo, or APU fires; autopilot and autothrottle disconnects; and landing gear unsafe conditions. The conditions which activate warning signals are discussed in related sections

7-The amber caution lights are used for conditions which require crew awareness and timely crew action. The conditions which activate caution signals are discussed in related sections

8-The blue lights are used for conditions which require flight crew awareness.

9-They come on to inform the flight crew of electrical power availability.

10-The blue lights also illuminate to show the position of valves. Lights are bright blue while valves move and dim blue when they are at the selected position

11-Other uses of blue lights are to show equipment status and interphone calls to the pilot.

12-Green lights indicate landing gear are down and locked, leading edge devices are extended, and speedbrakes are armed. Conditions which activate blue and green lights are discussed in related sections

13-An aural warning module in the flight deck provides various audio signals to alert the flight crew of incorrect airplane

system conditions.

14-Computer voices also call crew attention to unsafe flight conditions.

15-The control column shaker is a tactile alert which provides stall warning.

MASTER CAUTION SYSTEM

16-The master caution system consists of two master caution lights and left and right system annunciator panels on the glareshield panel.

17-When a caution level system malfunction occurs outside the pilots' normal field of vision, both master caution lights illuminate with related system annunciator light to provide a visual alert to the flight crew.

18-The system annunciator lights show you the malfunctioning airplane system and where to look to identify the problem.

19-The FLIGHT CONTROL, FUEL, ELECTRIC, APU, ANTI-ICE, HYDRAULIC, DOORS and AIR CONDITIONING annunciator lights tell you to look at the forward overhead panel. As you note the lights are arranged in the same sequence as the forward overhead panel.

20-When a caution light illuminates on the IRS mode select unit, the IRS annunciator light on the left system annunciator panel comes on. Illumination of a caution light on the engine panel causes the ENGINE annunciator light to illuminate on the right system annunciator panel.

21-The OVERHEAD annunciator light illuminates when equipment cooling exhaust or supply OFF light, or emergency exit not armed light on the forward overhead panel comes on. It also illuminates when flight recorder light, passenger oxygen ON light, ELT light or PSEU light on the aft overhead panel comes on.

22-The OVERHEAT/DETECTION light on the left system annunciator panel illuminates to indicate a caution light on overheat/fire protection panel has come on.

23-The DOORS annunciator light comes on when a door open caution light illuminates on the overhead door annunciator panel.

24-You push either MASTER CAUTION light to reset the master caution system for further cautions.

25-When one of the master caution lights is pushed, both master caution lights and system annunciator lights go off and remain off until a new fault occurs. Fault lights on the individual panels remain on if the panel still senses a fault.

26-The master caution system also has a recall function that shows the pilots which problems are not corrected.

27-When you push and hold the system annunciator panel, all twelve system annunciator lights illuminate. When you release the system annunciator panel, the system annunciator lights show only the systems which have faults.

28-Certain airplane systems, such as GPS, operate with two or more signal channels. Failure of the all channels causes the related system annunciator light to illuminate.

29-In case of single channel failure there is no annunciation. However, when you push the system annunciator panel for recall, the related system annunciator light and the fault light on the related panel come on.

30-Now you push MASTER CAUTION light to reset the system. Notify the maintenance about the fault when you land.

31-Here are the other systems with single channel fault annunciations.

TAKEOFF CONFIGURATION WARNING

32-The purpose of takeoff configuration warning system is to alert the flight crew during the initial portion of the takeoff roll, whenever the airplane is not in a configuration which would allow a safe takeoff.

33-The takeoff configuration warning is armed when the airplane is on the ground and either or both forward thrust levers are advanced to takeoff position.

34-Takeoff configuration warning is given with a sound of intermittent horn. In some B737s, the aural warning is accompanied by the red TAKEOFF CONFIGURATION warning lights on the left and right forward panel.

35-Takeoff configuration warning activates if any of these conditions occur: Speedbrake lever is not down

36-Ground spoilers have hydraulic pressure

37-The leading edge flaps and slats are not extended, or have an uncommanded motion

38-The trailing edge flaps are not in a takeoff position of between flaps 1 and 25, or are in a skew or asymmetry condition, or have an uncommanded motion.

39-Stabilizer trim is out of the green band.

40-Parking brake is set.

LANDING GEAR CONFIGURATION WARNING

41-The landing gear position indicating and warning system shows landing gear position and warns the pilots when the landing gears are not down for a landing.

42-A green landing gear light shows that the related landing gear is down and locked.

43-Red light illuminates when the position of the landing gear is not the same as the position of the control lever, which usually happens when the gear is in transit.

44-Red light also illuminates when landing gear is not down and locked with either or both forward thrust levers retarded to idle at an altitude below 800 feet above ground level.

45-When all lights are extinguished, it shows that all the landing gears are up and locked.

46-A continuous warning horn is provided to alert the flight crew whenever the landing gears are not down and locked for a landing.

47-There are three sets of conditions which cause the landing warning horn to activate.

48-In the first set of conditions, the horn sounds when all gears are not down and locked, flap position is from UP to 10 units, thrust levers are set for landing and radio altitude is between 200 and 800 feet. In this case you push the horn cutout switch near the flap lever to stop the horn.

49-If the radio altitude is less than 200 feet, you cannot stop the horn by horn cutout switch.

50-In the second set of conditions, the horn sounds at any altitude when all gears are not down and locked, flap position is from 15 to 25 units, and thrust levers are set for landing. In this case you cannot stop the horn by horn cutout switch. The warning indication is cancelled when the configuration error is corrected.

51-In the third set of conditions, the horn sounds at any altitude when all gears are not down and locked and flap position is more than 25 units, regardless of forward thrust lever position. In this case you cannot stop the horn by horn cutout switch.

PROXIMITY SWITCH ELECTRONICS UNIT (PSEU)

52-The proximity switch electronics unit, or PSEU, communicates the position of system components such as flaps, gears, doors to other airplane systems.

53-The PSEU monitors and controls the takeoff configuration warning, landing configuration warning, landing gear position indicating and air/ground sensing.

54-The amber PSEU light on the aft overhead panel illuminates when a fault occurs in the PSEU, or in its sensors and input signals.

55-When the PSEU light comes on, the MASTER CAUTION lights and OVERHEAD system annunciator also illuminate.

56-The PSEU light illuminates when the airplane is on the ground.

57-The light is inhibited from thrust lever advance for takeoff until 30 seconds after landing.

58-In some B737s, the PSEU light comes on only when a no-dispatch type of fault occurs. In this case, the PSEU light can only be reset when the fault is corrected.

59-If the fault is dispatchable, the PSEU light does not illuminate. However, when a system annunciator panel is pushed for recall, PSEU light and OVERHEAD system annunciator will illuminate.

60-In other B737s, even if a dispatchable PSEU fault occurs, the PSEU light , OVERHEAD system annunciator and MASTER CAUTION illuminate but only after landing.

61-When the engines are shutdown or the parking brake is set, the PSEU fault light goes off even though the dispatchable fault may still be present.

MACH/AIRSPEED WARNING SYSTEM

62-The 737 has an airspeed and a mach limit to protect the airframe. The mach/airspeed warning system supplies an aural warning to alert the flight crew when the airspeed is more than the mach or airspeed limit.

63-When the airplane is at or below an altitude of approximately 26,000 feet, the airplane is limited by maximum operating speed, or VMO, which is about 340 knots. Above this altitude, the airplane is limited by the maximum operating mach, or MMO, which is about 0.82.

64-The mach airspeed warning system gets the overspeed warning signal from an ADIRU. The signal activates the clacker sound in the aural warning module. The warning clackers can be stopped only by reducing airspeed below Vmo or Mmo.

65-The mach airspeed warning test switches on the aft overhead panel let you do a test of overspeed warning circuit in the left and right ADIRU.

66-When you push one of the test switches, the respective ADIRU makes the aural warning module operate the clacker. Note that the system can only be tested on ground.

67-A red and black bar and an amber bar on the airspeed indicator show high speed limits.

68-The bottom of the red/black bar indicates the maximum allowable airspeed or mach. The end of the amber band indicates maximum maneuver speed.

STALL WARNING SYSTEM

69-The purpose of the stall warning system is to warn the flight crew when the airplane is approaching a stall condition.

70-The stall warning is given by vibrating both control columns before a stall develops.

71-The stall warning system is armed in flight at all times. The system is deactivated on the ground.

72-The stall warning system incorporates two independent stall management yaw damper computers.

73-Each computer receives air and inertial data from ADIRUs, angle of airflow data from alpha vanes, -engine N1 and N2 RPM and anti-ice system status data from display electronics unit, air/ground status from PSEU, wing configuration data

and FMC outputs.

74-The stall management yaw damper computers process these inputs and produce output to operate control column stick shakers when necessary. The computers also send output signals to the pitch limit indicator and airspeed displays, and ground proximity warning system for windshear alert calculations.

75-The stall warning test switches on the aft overhead panel let you do a test of the stall warning system. The test requires that AC transfer busses are powered for up to 4 minutes.

76-When you push switch 1, the captain stick shaker activates. When you push switch 2, the first officer stick shaker operates. If there are faults, the control column shaker does not operate.

77-Note that the stall warning test is inhibited when the airplane is in the air.

GROUND PROXIMITY WARNING SYSTEM (GPWS)

78-The ground proximity warning system, or GPWS, alerts the flight crew of an unsafe condition when the airplane is close to the terrain.

Gpws basic function and alerts

79-The GPWS uses aural messages, visual messages, and displays to give alerts in the flight compartment.

80-The system has a ground proximity warning computer with a world-wide terrain database. The computer receives inputs from various airplane systems and compares the airplanes flight profile, flap and gear position, and terrain clearance to find if there is a warning condition.

81-The GPWS also includes a GPWS control panel and BELOW GLIDESLOPE lights in the flight deck.

82-The GPWS has basic function and enhanced function. Let’s first take a look at basic function and associated GPWS alerts.

83-The GPWS basic function provides radio altitude based alerts and is operative below 2500 feet AGL. These alerts are based on radio altitude and combinations of barometric altitude, airspeed, glide slope deviation, and airplane configuration.

84-There are seven radio altitude based alert modes: Excessive descent rate, excessive terrain closure rate, altitude loss after take-off or go-around, unsafe terrain clearance, descent below glide-slope, and bank angle and advisory callouts. The GPWS basic function also provides immediate wind shear alert.

85-Mode 1 gives alerts for large descent rates when the airplane is near the terrain. This mode is independent of flap or gear positions. The GPWS produces a repetitive soft aural alert of SINK RATE and makes red PULL UP words display on the attitude indicators.

86-If the descent rate becomes dangerous, a WHOOP WHOOP PULL UP hard aural alert sounds and red PULL UP words still show on the attitude indicators.

87-Mode 2 gives alerts when the closure rate to terrain as detected by the radio altimeter is too large. Mode 2 has two submodes, mode 2A and mode 2B.

88-Mode 2A activates for a large closure rate if the flaps are not in the landing configuration. The GPWS first gives the TERRAIN aural soft alert twice and red PULL UP shows on the attitude indicators.

89-If the condition is not corrected, the aural alert changes to the hard WHOOP WHOOP PULL UP and PULL UP annunciation still shows on the attitude indicators.

90-Mode 2B occurs for a large closure rate with the flaps in the landing configuration. Similar to the previous mode, the GPWS first gives the TERRAIN soft aural alert repeatedly and, if this condition continues, the WHOOP WHOOP PULL UP hard aural alert sounds. The red PULL UP annunciation shows on the attitude indicators

91-Mode 3 supplies alerts for a large barometric altitude loss during takeoff or during a go-around. The DON'T SINK aural alert sounds continuously and the red PULL UP annunciation shows on the attitude indicators.

92-Mode 4 supplies alerts when the airplane is too close to the terrain and the landing gear or flaps are not in the landing configuration. It has three submodes: 4A, 4B and 4C.

93-The Mode 4A occurs when the airplane flies close to the terrain at high airspeed with either landing gear not down or flaps not in landing position. The mode gives aural alert TOO LOW, TERRAIN continuously. The red PULL UP words show on the attitude indicators.

94-Mode 4B activates when airplane flies too close to the terrain at low airspeed with landing gear not down. The aural alert TOO LOW GEAR sounds continuously and red PULL UP annunciation shows on the attitude indicators.

95-Mode 4C occurs when airplane flies too close to the terrain at low airspeed with landing gear down but the flaps not in landing position. The aural alert TOO LOW FLAPS sounds continuously and red PULL UP annunciation shows on the attitude indicators.

96-The mode 5 occurs when the airplane goes excessively below the glideslope during approach. The GPWS gives the aural alert GLIDESLOPE continuously and the BELOW GLIDESLOPE light illuminates.

97-If the flight continues below glideslope, the volume and repetition rate of aural alert increases.

98-Mode 6 bank angle callouts occur when the bank angle exceeds 35 degrees, 40 degrees, and 45 degrees above 130 feet radio altitude. The aural alert is BANK ANGLE, BANK ANGLE.

99-Mode 6 also supplies aural callouts when the airplane descends through set altitudes during approach.

100-In some B737s, when descending below 500 feet radio altitude on approach, a FIVE HUNDRED callout is given if an approach other than ILS or GLS is used, or a backcourse approach is detected, or glideslope cancel is selected, or more than two dots ILS or GLS flight path deviation is detected.

101-Mode 7 occurs when the airplane is in a windshear during approach or takeoff below 1,500 feet radio altitude.The GPWS generates a two-tone siren followed by WINDSHEAR sound. The red WINDSHEAR message shows on the attitude indicators. Note that the WINDSHEAR alert has the highest priority.

Gpws enhanced function and alerts

102-The GPWS basic function with radio altimeter information, is only capable of seeing terrain directly below the airplane. When there is a rapidly rising terrain ahead of airplane, it cannot react quick enough to issue a warning in time. The GPWS enhanched function adds look-ahead capability to alert crew about the terrain threat forward of airplane

103-The look ahead capability lets the GPWS provide terrain awareness and terrain clearance floor functions.

Terrain awareness

104-TERRAIN AWARENESS The terrain awareness function uses an internal worldwide terrain database. The ground proximity warning computer compares airplane position and track with this database to generate proximate terrain display and a look-ahead terrain alert as necessary.

105-Note that the terrain data is not designed to be an independent navigation aid. In some B737s, terrain database may not contain man made obstructions.

Terrain display

106-Proximate terrain data and look-ahead terrain alerts show on the navigation display. Terrain more than 2,000 feet below airplane altitude or within 200 feet of nearest airport runway elevation does not show.

107-The terrain display uses dots with varying color and density to show the terrain ahead of the airplane.

108-The dotted green shows terrain from 2,000 feet below to 500 feet below the airplane current altitude. The dotted amber shows terrain 500 feet below to 2,000 feet above the airplane current altitude. The dotted red indicates terrain more than 2,000 feet above airplane current altitude.The dotted magenta is shown when no terrain data is available.

109-The terrain closer to your current altitude is shown with a denser dot pattern.

110-On some displays, you will see terrain elevation numbers in the bottom left of the navigation display for the highest and lowest terrain. These numbers show terrain in hundreds of feet above mean sea level. The color of the elevation number corresponds to the terrain elevation:

Look–ahead terrain alerts

111-There are two levels of look-ahead terrain alert: Terrain caution and terrain warning. These alerts are based on estimated time to impact which is determined by considering the required flight crew reaction time.

112-When the computer calculates that you are 40 to 60 seconds from a possible impact, the threat terrain changes from dots to a solid amber color. An amber TERRAIN message appears on the navigation display and CAUTION TERRAIN aural alert sounds.

113-When estimated time to impact reduces to 20 to 30 seconds, the threat terrain changes to a solid red color. A red TERRAIN message appears on the navigation display, PULL UP shows on the attitude indicator and TERRAIN TERRAIN PULL UP aural alert sounds.

114-You must pull up and climb immediately.

115-In B737s which have a terrain database with man-made obstructions, GPWS also provides obstacle caution and warning alerts for man-made obstacles of 100 feet and higher.

116-Obstacles show in the same way as terrain displays.

117-For a caution condition, amber OBSTACLE message shows on the navigation display and a CAUTION OBSTACLE aural alert sounds.

118-For a warning condition, the red OBSTACLE message appears on navigation display, PULL UP shows on the attitude indicator and OBSTACLE OBSTACLE PULL UP aural alert sounds.

Terrain clearance floor

119-The enhanced GPWS also contains an airport data base. The terrain clearance floor function uses airplane position and an airport database to find if there is a warning condition.

120-Terrain clearance floor function alerts the flight crew for a possible premature descent regardless of airplane configuration to prevent a controlled flight into terrain.

121-Terrain clearance envelope is designed around an airport. If the airplane descends through the floor of the envelope, aural alert TOO LOW TERRAIN will sound and PULL UP will show on the attitude indicator.

Gpws controls

122-GPWS CONTROLS The GPWS controls include a GPWS control panel, below glideslope light and EFIS control panels.

Efis control panel

123-The EFIS control panel lets you select the navigation display mode and terrain range.

124-When you push the TERRAIN map switch, look-ahead terrain display appears on the related navigation display. The cyan TERRAIN shows when terrain data shows. Push the switch again to remove the terrain data.

125-Terrain and weather radar cannot show together on a display.

126-If one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps.

127-While both pilots do not have the terrain display selected, if a look-ahead terrain alert occurs, TERRAIN display and terrain alert automatically show regardless of map switch position.

Below glide slope light

128-You push the below glideslope light to inhibit or cancel below glideslope alert.

Gpws control panel

129-The GPWS control panel provides the interface between the flight crew and the GPWS.

130-When a flaps up approach has to be made, you use ground proximity FLAP INHIBIT switch to inhibit TOO LOW FLAPS alert.

131-To use, lift the guard and raise the switch.

132-If an approach with gear up or partial gear down is necessary, you use ground proximity GEAR INHIBIT switch to inhibit TOO LOW GEAR alert.

133-If you set TERRAIN INHIBIT switch to inhibit position, terrain display, look-ahead terrain and terrain clearance floor alerts are not available. The amber TERRAIN INHIBIT message shows on both navigation displays.

134-The amber INOP light on the panel comes on when there is a failure of the GPWS computer or a critical input to the computer is invalid.

135-For preflight operations verify that ground proximity INOP light is extinguished and inhibit switch guards are closed.

Gpws test

136-GPWS TEST The system test switch lets you do a self-test of the GPWS. You start the test after IRS alignment is complete.

137-Push the test switch momentarily and verify the following.

138-GPWS INOP and BELOW GLIDESLOPE lights illuminate.

139-TERRAIN FAIL and TERRAIN TEST show on navigation displays.

140-PULL UP and WINDSHEAR alerts illuminate

141-GLIDESLOPE, PULL UP and WINDSHEAR aurals sound

142-Terrain display test pattern shows on navigation displays

143-CAUTION TERRAIN aural sounds and TERRAIN caution message shows on navigation displays.

144-This completes the GO/NO GO test. If you hold the test switch until the aurals begin, other GPWS aural warnings are tested.

145-GPWS test is inhibited in flight.

Gpws non-normals

146-Now let's see some non-normal GPWS displays.

147-When GPWS look-ahead terrain function has failed, TERRAIN FAIL shows on navigation display. The basic radio-altitude based function of the GPWS remains normal.

148-When the airplane position data is invalid, TERRAIN POSITION shows on navigation display.

149-When the GPWS range disagrees with the range selected on the related EFIS control panel, TERRAIN RANGE DISAGREE message shows on navigation display.

150-If the GPWS range, the related EFIS range, and the FMC range disagree, then MAP/TERRAIN RANGE DISAGREE message shows on navigation display.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)

151-The traffic alert and collision avoidance system, or TCAS,(Tee-Cas), helps the flight crew maintain safe air traffic separation from other transponder equipped airplanes.

152-TCAS operates independently of the ground based air traffic control systems.

153-The TCAS mainly consists of TCAS computer, TCAS directional antennas, and ATC/TCAS transponder panel.

154-The TCAS data shows on the Captain's and First Officer's attitude indicators and navigation displays

155-TCAS presents the traffic around your airplane on the navigation displays. Traffic advisories and alerts are also shown on the same displays.

156-TCAS also shows vertical flight path guidance commands on the attitude indicators.

157-Voice alerts are provided by loudspeakers on overhead.

Tcas operation

158-TCAS operates by interrogating the transponders of the nearby airplanes. The replies from these transponders enable TCAS to determine the range, altitude, and relative bearing of the responding airplane

159-TCAS measures the time elapsed between the transmisson of an interrogation and the reception of a response to determine the range of the other airplane.

160-The TCAS obtains other airplane altitude from the altitude report in the reply.

161-TCAS determines the relative bearing of the other airplane through its directional antennas.

162-TCAS uses these data and inputs from other onboard airplane systems to provide visual indications of the position of other airplanes and to supply visual and aural traffic avoidance alerts if necessary.

163-The TCAS scans a three dimensional airspace around the airplane. The dimensions of this airspace change constantly based on the closure rate with conflicting traffic.

164-TCAS can simultaneously track up to 45 transponder-equipped airplanes within a nominal range of 40 nautical miles. Airplanes in the surveillance volume are put into one of these four groups: Other traffic, proximate traffic, traffic advisory threat and resolution advisory threat.

165-The TCAS classifies another airplane as OTHER TRAFFIC if it is not identified as traffic advisory or resolution advisory threat, is at a range of more than 6 nautical miles or is at a relative altitude of more than 1200 ft.

166-The proximate traffic is the other airplane which is not a TA or RA threat, is at a range of 6 NM or less, or is at a relative altitude of less than 1200 ft.

167-When the other airplane is about 40 seconds from the closest point of approach to your airplane, it is considered a potential threat. TCAS generates traffic advisory, or TA, and aural TRAFFIC TRAFFIC alert sounds.

168-The traffic advisory is intended to assist the flight crew in sighting nearby airplane that may become a threat. No maneuvers shall be made by the crew in response to a traffic advisory.

169-If the time to closest point of approach reduces to about 25 seconds, the other airplane is considered a serious threat and a RESOLUTION ADVISORY, or RA, is generated.

170-The resolution advisory provides aural command and shows vertical maneuver guidance to maintain or increase separation from the traffic.

Tcas levels of protection

171-Airplanes without transponder are invisible to TCAS. Thus, TCAS provides no protection against airplanes that do not

have a transponder.

172-If the other airplane has Mode A transponder, TCAS can provide only traffic advisory.

173-If the other airplane has Mode C or Mode S transponder, TCAS provides both traffic advisory and resolution advisory.

174-If the other airplane has also TCAS, then TCAS provides traffic advisory and coordinated resolution advisory.

Tcas controls

175-TCAS controls include a transponder panel and EFIS control panels.

176-The mode selector on the transponder panel puts the TCAS in the TA ONLY or TA/RA mode.

177-TA ONLY mode enables the display of traffic advisory targets.

178-TA/RA mode lets the TCAS show traffic advisory and resolution advisory targets. TA/RA mode is the normal mode of operation.

179-Some transponder panels incorporate an altitude range switch which controls what traffic is displayed on the navigation display.

180-With the switch in NORMAL position, altitude coverage above and below your airplane is determined by the TCAS computer.

181-When you set the switch to above position, altitude coverage above the airplane extends upward and the coverage below the airplane is not reduced. This feature is usually used during a climb.

182-When the switch is set to below position, altitude coverage below the airplane extends downward and the coverage above the airplane does not change. This feature is usually used during descents.

183-The EFIS control panel incorporates a traffic switch on the range selector which is used to show or remove TCAS data on the navigation display. TCAS data is displayed on expanded approach, expanded VOR, expanded and centered MAP displays.

184-When you push the traffic switch, the cyan traffic message and the TCAS symbols of any targets show on the display. A second push of the traffic switch removes the TCAS data.

Tcas display and annunciations

185-The primary purpose of the traffic display is to aid the flight crew in the visual acquisition of other transponder equipped airplanes. Let’s see the symbology used to show traffic data on navigation displays

186-The other traffic is shown as open white diamond on traffic display

187-The proximate traffic is shown as solid white diamond on traffic display

188-When the other airplane is identified as TA, it is indicated with a solid amber circle on the traffic display. An amber TRAFFIC message appears and aural TRAFFIC TRAFFIC alert sounds.

189-When there is an RA threat airplane, it is indicated with a solid red square on the traffic display. A red TRAFFIC message also appears on the display.

190-Whenever a red TRAFFIC message appears on navigation display, an RA voice alert is heard and vertical guidance symbol is displayed on the attitude indicator.

191-A vertical arrow next to a symbol shows the vertical motion of the other airplane. It is the same color as the traffic symbol.

192-The arrow points down if the other airplane descends at a rate more than or equal to 500 feet per minute. The arrow points up if the other airplane is in a climb at a rate more than or equal to 500 feet per minute.

193-The vertical arrow does not show for rates less than 500 feet per minute.

194-Relative altitude is shown in hundreds of feet above the symbol with a plus sign for traffic above. If the traffic is below, the digits show below the traffic symbol with a minus sign.

195-The OFFSCALE message shows when there is an RA or TA traffic outside the navigation display range set on the EFIS control panel.

196-The OFFSCALE message shows in amber if a TA traffic is outside the navigation display range. The message shows in red for an RA traffic outside the navigation display range.

197-When you select an appropriate display range, OFFSCALE message changes to TRAFFIC annunciation and the threat airplane shows on the display.

198-In some instances, TCAS may lose the bearing of the RA or TA traffic. Since bearing information is used for TCAS traffic display purposes only, the lack of bearing information does not affect the ability of TCAS to issue TAs and RAs. In such cases, TA or RA alert is shown with a no–bearing text block.

199-This no-bearing test block shows red RA which tells you that the threat traffic is a resolution advisory. The RA traffic is 5.3 nautical miles away. It is 300 feet above your airplane and descending at a rate of more than 500 feet per minute.

200-The navigation display can only show two no-bearing traffics. In this example, the second no-bearing traffic is a traffic advisory. It is at a distance of 5.4 nautical miles, 2100 feet below your airplane and in a climb at more than 500 feet per minute.

201-When the separation from the first traffic is sufficient, RA changes to TA. When TCAS calculates that the first traffic is no longer a threat, it removes the no-bearing message and second alert moves to first line.

202-You can show TCAS and weather radar together on a display.

203-For instance, with the traffic display active, if you select the weather radar, weather radar returns show on the display without changing the traffic display.

204-When the transponder mode selector is in TA/RA or TA ONLY and both pilots do not have the traffic display selected, if a TCAS RA or TA occurs, traffic display automatically shows.

Tcas vertical guidance symbol

205-A resolution advisory requires evasive maneuver in vertical plane that must be performed by the flight crew.

206-When a resolution advisory occurs, a voice alert sounds to give a maneuver command depending on type of conflict. The attitude indicators show a red vertical guidance symbol to help pilots perform the given command.

207-You must adjust the pitch attitude out of the area outlined by the red vertical guidance symbol to avoid a possible collision with threat airplane.

208-To respond a RA, first disengage the autopilot. Then move the airplane quickly and smoothly out of the red outlined area.

209-Continue to adjust the pitch attitude and vertical speed as long as you stay out of the red outlined area. In case of visual acquisition of the traffic, (2) be aware that visually acquired traffic may not be the same traffic causing an RA. The visual perception of an encounter may be misleading.

210-Follow the flight director roll command. The flight director pitch command has nothing to do with the TCAS RA guidance. Thus, ignore the flight director pitch commands during an RA and move the airplane to stay outside the red outlined area.

211-The flight director pitch command has nothing to do with the TCAS RA guidance. Thus, ignore the flight director pitch commands during an RA and move the airplane to stay outside the red outlined area.

212-When the other airplane is no longer a serious threat, RA indications change to TA on navigation displays, a “Clear of conflict” annunciation is issued and vertical guidance symbol is removed from the attitude indicators,

Tcas resolution advisories

213-Then you are required to return to the initial clearance, unless otherwise instructed by ATC and engage the autopilot.

214-TCAS generates three types of resolution advisories: Preventive resolution advisory, corrective resolution advisory

and reversal resolution advisory.

215-The preventive RAs give command to maintain your current pitch attitude.

216-MONITOR VERTICAL SPEED tells you that your present pitch attitude is outside the red RA pitch command area. Continue to keep pitch attitude away from the red outlined area.

217-Other possible preventive RAs are: MAINTAIN VERTICAL SPEED, MAINTAIN and MAINTAIN VERTICAL SPEED, CROSSSING MAINTAIN.

218-The corrective RAs warn the flight crew to modify the pitch attitude to avoid a possible collision.

219-Here, the threat airplane is above you and you’re in a climb. When DESCEND DESCEND RA sounds, you must disengage the autopilot and descend at the displayed pitch out of the red area.

220-When you are clear of conflict go back to your assigned altitude and engage the autopilot.

221-Here is a condition where the threat airplane is below you and in a climb. DESCEND CROSSING DESCEND RA sounds to tell you that your flight path will cross through the traffic’s altitude. Disengage the autopilot and descend at the displayed pitch out of the red area.

222-When it is necessary to increase the descent rate required by the initial descend RA, you hear INCREASE DESCEND command. Increase your descend rate out of the red area.

223-The LEVEL OFF RA requires a reduction of vertical rate to zero feet per minute. You must level off promptly, not at the next standard flight level.

224-The level off RA may be issued as an initial RA or following an other RA when a safe separation between airplanes is achieved.

225-These are the possible corrective RA aurals and related recommended vertical maneuver.

226-Reversal RAs tell you to reverse an initially issued corrective RA.

227-In this example your TCAS has generated DESCEND DESCEND command in coordination with the TCAS on the threat airplane. If the threat airplane is not responding correctly to the RA, TCAS will give aural CLIMB CLIMB NOW command and vertical guidance on the attitude indicator changes to a climb.

228-These are the possible reversal RA aurals and related recommended vertical maneuver.

Pilot actions

229-Termination of resolution advisory is given by an aural message of “clear of conflict”.

230-Now let’s look at some recommended pilot actions for good TCAS operation

231-During preflight, set navigation range selectors as needed and push traffic switch to show TCAS data

232-You may set altitude range selector to ABOVE for takeoff and climb. NORMAL is selected during cruise and BELOW during descents.

233-During pushback, set the ATC function selector to STANDBY at airports that are capable of tracking airplanes on the ground.

234-At airports with ground tracking radars, set an active transponder setting, but not a TCAS mode until ready for takeoff.

235-Set ATC mode selector to TA/RA when you are ready for takeoff

236-Note that the reference for the TCAS traffic display is your airplane position. This may cause TCAS traffic display misinterpretation. For example, when two airplanes are converging at 90º, the crossing track appears to be converging at a 45º angle on the TCAS traffic display. Therefore, you must not interpret the horizontal track of a threat airplane solely upon the TCAS traffic display

Tcas inhibits

237-TCAS is normally operated in the TA/RA mode. However, it may be necessary to operate in the TA ONLY mode to prevent undesired RAs in some specific conditions such as operating in VFR conditions at a busy airport or on parallel runway approaches, or in case of an engine failure.

238-TCAS INHIBITS TCAS will not generate any aural TAs or RAs annunciations, when GPWS or windshear warning has been activated.

239-INCREASE DESCENT RAs are inhibited below approximately 1,500 feet radio altitude.

240-DESCEND RAs are inhibited below approximately 1,100 feet radio altitude.

241-All RAs are inhibited below approximately 1,000 feet radio altitude.

242-Below 1,000 feet if you select the TA/RA mode on the transponder panel, TA only mode is automatically enabled and the TCAS message TA ONLY shows on the navigation displays.

Tcas test

243-All TCAS aural alerts are inhibited below approximately 500 feet radio altitude.

244-TCAS TEST To start TCAS system test, select TEST with the reply selector in ON or AUTO position. TCAS TEST message shows on the navigation display. The traffic symbols show and cyan PASSED message appears on the display for

a short time. At the completion of the test, TCAS TEST OK or TCAS SYSTEM TEST OK aural message sounds to indicate that the TCAS is operative.

Tcas non-normals

245-If the test fails no traffic shows, the message TCAS TEST FAIL replaces the TCAS TEST message and TCAS TEST FAIL or TCAS SYSTEM TEST FAIL alert sounds.

246-TCAS non-normal conditions are indicated by several annunciations. The annunciations are intended to tell you about the system condition only and a crew procedure is not necessary.

247-If the transponder mode selector is in a position other than TA ONLY or TA/RA, TCAS is off and a TCAS OFF annunciation shows on the navigation displays. The message shows regardless of the position of traffic switch on the EFIS control panel.

248-When a TCAS mode is selected, the TCAS OFF annunciation disappears.

249-When the TCAS fails to supply traffic data on the navigation display or attitude indicator, TCAS FAIL message shows. The message shows only when the traffic switch on the EFIS control panel is ON.

250-In case of an engine failure, select TA ONLY to prevent receiving RA climb commands which can be beyond the airplane's single-engine performance.

WINDSHEAR

251-TA ONLY also tells other airplane you are limited to perform RA operations.

252-B737s have systems which provide windshear alerts during takeoff, approach and landing.

253-There are two types of windshear alerts: Reactive or actual windshear alert and predictive windshear alert.

254-An actual windshear is the situation where the airplane is in a windshear. The GPWS detects the actual windshear and generates associated reactive visual and aural alerts as we have seen earlier.

255-The predictive windshear describes a windshear condition ahead of the airplane. The predictive windshear is detected by the weather radar.

256-The doppler weather radar detects relative movement of air containing some level moisture or particulate matter to identify the windshear conditions ahead of the airplane.

257-The predictive windshear automatically turns on below 2300 feet radio altitude. However, the visual and aural alerts are issued when the airplane is below 1200 feet radio altitude.

258-The predictive windshear alert may be a warning or a caution.

259-On the ground, when thrust levers are set for takeoff, the doppler weather radar turns on automatically and gives a caution if it detects a windshear threat out to 3 nautical miles ahead of the airplane. The weather radar gives a warning if it detects a windshear threat within 3 nautical miles directly ahead of the airplane.

Predictive windshear display and annunciations

260-In flight, the weather radar gives a caution if it detects a windshear threat out to 3 nautical miles ahead of the airplane. A warning is given when a windshear threat is detected within 1.5 nautical miles directly ahead of the airplane.

261-The predictive windshear data shows on navigation displays. It is displayed on expanded approach, expanded VOR, expanded MAP and centered MAP displays

262-The red and black predictive windshear symbol shows location and approximate size of the windshear.

263-Predictive Windshear Symbol Radials extend from from the edges of the predictive windshear symbol to help identify location of windshear event

264-During a predictive windshear alert, normal weather radar returns are also shown.

265-While the display is showing data other than weather, if a predictive windshear threat occurs, the display automatically switches into weather mode for presentation of the predictive windshear symbol, radials, and weather radar returns.

Predictive windshear alerts

266-An amber PWS FAIL message shows on the display when there is a failure of the predictive windshear function

267-When a predictive windshear condition is detected in the caution region during approach or takeoff, an aural alert MONITOR RADAR DISPLAY sounds. On the navigation display, amber WINDSHEAR message and the predictive windshear symbol show.

268-If a predictive windshear condition is detected in the warning region during approach, an aural alert GO AROUND WINDHEAR AHEAD sounds. On the navigation display, red WINDSHEAR message and the predictive windshear symbol show. Red WINDSHEAR message appears on attitude indicator.

Predictive windshear inhibits

269-A predictive windshear condition detected in the warning region during takeoff causes an aural alert WINDHEAR AHEAD to sound. On the navigation display, red WINDSHEAR message and the predictive windshear symbol show. Red WINDSHEAR message appears on attitude indicator.

270-When the airplane enters a windshear condition, the predictive windshear alerts are inhibited by an actual windshear warning generated by GPWS.

271-The predictive windshear alerts are also inhibited by look-ahead terrain alerts, or radio altitude based alerts.

272-Predictive windshear system inhibits new windshear cautions during takeoff and approach, if airspeed is more than 80 knots and radio altitude is less than 400 feet.

Predictive windshear test

273-During approach and takeoff, new predictive windshear warnings are inhibited when airspeed is more than 100 knots and radio altitude is less than 50 feet. These inhibits do not remove a predictive windshear caution or warning that already exists.

274-If testing of the PWS system is desired, push WXR switch on the EFIS control panel. Select TEST mode on weather radar control panel. Verify the PWS FAIL message, amber WINDSHEAR caution and red WINDSHEAR warning annunciations display momentarily and then extinguish. The system is operating correctly.

TAIL SKID

275-If a windshear threat is detected while in TEST mode, the test stops and predictive windshear data and alert annuciations show on the display.

276-The tail skid protects the rear fuselage against a tail strike when the main landing gear shock struts are extended and the airplane rotates during takeoff.

277-The tail skid incorporates a wear shoe and a skirt fairing on the outside lower surface of the tail of the airplane.

278-When a tail strike occurs with a small force, the wear shoe rubs on the runway to absorb the force of the tail strike. Wear dimples on the lower surface of the shoe show when you must replace the wear shoe.

279-When a tail strike occurs with a large force,a cartridge assembly consists of a crushable honeycomb material absorbs the force of the tail strike.

COURSE END

280-The warning placard on the aft surface of the skirt fairing shows how much the cartridge has been crushed. The tail skid is serviceable when the placard shows both green and red. If you cannot see the green part of the placard, the cartridge must be replaced.