B737 NG CBT - FLIGHT INSTRUMENTS & DISPLAYS

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 four parts: Part 1- Standby instruments, clocks and recording systems Part 2- Common display system, Part 3 – Primary flight display, and Part 4- Navigation display.

STANDBY FLIGHT INSTRUMENTS, CLOCKS AND RECORDING SYSTEMS

3-This first part introduces you to the operation of airplane standby flight instruments, clocks, and recording systems. Here is the outline: Standby flight instruments Clocks Flight data recorder Aircraft condition monitoring system

STANDBY FLIGHT INSTRUMENTS

4-Standby flight instruments consist of a standby attitude indicator, a standby altimeter/airspeed indicator and a standby radio magnetic indicator on the center instrument panel to the left of the upper display unit.

5-However, in most B737-800s, standby attitude indicator and standby altimeter/airspeed indicator are replaced by an integrated standby flight display.

6-A standby magnetic compass is on the center post above the glareshield.

STANDBY ATTITUDE INDICATOR

7-The standby attitude indicator is an alternate source of airplane pitch and roll attitude information. It operates independently of the air data inertial reference system.

8-The indicator is powered by the battery bus. After the loss of all normal AC power, the indicator remains powered as long as battery power is available.

9-A bank scale is on the top of the indicator case. The bank indication shows with marks at 0, 10, 20, 30, 45, and 60 degrees.

10-A pitch scale is on the face of the attitude ball. The pitch angle shows with marks at each five degree increment.

11-The fixed airplane symbol is on the case of the indicator and does not move.

12-You pull and hold the CAGE knob to align the horizon with the airplane symbol

13-The approach mode selector lets you control the approach information displayed.

14-The selector has three positions. With the selector in the OFF position, no localizer and glideslope data is show on the

indicator

15-When you set the selector to APPROACH position, the localizer and glideslope data shows if the number 1 navigation receiver is tuned to an ILS frequency.

16-When you select BACK COURSE, the localizer deviation pointer sensing is reversed for the back course approach. The glideslope deviation pointer is not in view during back course approaches.

17-The standby attitude indicator also incorporates failure flags to tell the flight crew if there is an ILS or indicator failure.

18-The GYRO failure flag is displayed whenever the attitude indication is not reliable

19-During an approach or back course approach if localizer receiver malfunctions, the LOCALIZER flag comes in view, the localizer pointer is removed.

20-When localizer and/or glideslope signals become too weak or unusable, the localizer and glideslope deviation pointers go out of view.

STANDBY ALTIMETER/AIRSPEED INDICATOR

21-The standby altimeter/airspeed indicator shows barometric altitude and indicated airspeed on a single indicator.

22-The standby altimeter gets static air pressure from the alternate static ports and shows barometric altitude.

23-The digital altitude display shows barometric altitude from -1000 to 50000 feet. A pointer indicates altitude in hundreds of feet

24-The barometric setting control lets you set the barometric pressure reference. You turn the control to select a barometric reference value.

25-The standby airspeed indicator gets pitot air pressure from the alternate pitot probe and static air pressure from the alternate static ports

26-The indicator shows the indicated air speed from 60 to 450 knots.

27-The standby altimeter/airspeed indicator has no failure flags. Thus, you must compare the indications to other instruments to detect a failure

STANDBY RADIO MAGNETIC INDICATOR

28-The standby radio magnetic indicator, or RMI, shows airplane magnetic heading and bearing to VOR/ADF stations.

29-The standby radio magnetic indicator is powered by the AC standby bus. After the loss of all normal AC power, the indicator remains powered as long as battery power is available.

30-The standby radio magnetic indicator receives digital heading data from the air data inertial reference units. The heading data sets the compass card to the magnetic heading of the airplane.

31-The standby radio magnetic indicator receives digital bearing data from the VOR and ADF receivers. The bearing data is used to set the position of the bearing pointers.

32-The radio magnetic indicator has two controls to select the VOR or ADF display.

33-The ADF/VOR number 1 bearing pointer selector controls the bearing source to position number 1 ADF/VOR pointer. The ADF/ VOR number 2 bearing pointer selector controls the bearing source to position the number 2 ADF/VOR bearing pointer

34-In this example, both selectors are set to show VOR bearings.

35-If you turn a bearing selector, say number 1 bearing selector, to ADF, the respective pointer shows the ADF bearing to the station tuned on the number 1 ADF receiver. The other pointer continues to show the VOR bearing tuned on.

36-The standby radio magnetic indicator has three failure flags. The heading flag shows when heading input from air data inertial reference system fails.

37-The bearing pointer 1 warning flag comes into view when electrical power is lost, or ADF 1 or VOR 1 bearing input fails.

38-The bearing pointer 2 warning flag comes into view when electrical power is lost, or ADF 2 or VOR 2 bearing input fails.

STANDBY MAGNETIC COMPASS

39-A standby magnetic compass has a circular heading indicator card which floats in a case filled with liquid.

40-A compass correction card with heading correction factors is located near the compass.

INTEGRATED STANDBY FLIGHT DISPLAY(ISFD)

41-The integrated standby flight display, or ISFD, computes and shows the information of attitude, airspeed, altitude, localizer/glideslope deviation and magnetic heading.

42-The display is powered by the battery bus. After the loss of all normal AC power, it remains powered as long as battery power is available.

43-The integrated standby flight display uses its internal inertial sensors to compute and display the attitude information.

44-The display receives pitot air pressure from the alternate pitot probe and static air pressure from the alternate static ports to compute and show airspeed and altitude.

45-The Localizer and Glideslope deviation data is supplied by the number1 multi-mode receiver.

46-The display shows the magnetic heading as provided by the number 1 ADIRU. You must confirm the heading indication by comparing it to the standby magnetic compass.

47-Note that magnetic heading information is not available in Polar Regions.

CONTROLS AND ANNUNCIATIONS

48-The approach switch lets you select the approach information displayed. The approach mode annunciation shows the approach mode selected.

49-With the approach mode annunciation blank, when you push the APPROACH switch, the green APPROACH mode annunciator comes on; localizer and glideslope data shows if the number 1 multi-mode receiver is tuned to an ILS frequency.

50-With the APPROACH mode annunciated, if the switch is pushed, the BACK COURSE approach mode is selected. The green BACKCOURSE mode annunciator comes on; the localizer deviation pointer sensing is reversed for the back course approach. The glideslope scale and deviation pointer are removed when back course mode is selected.

51-With the BACK COURSE mode annunciated, if you push the approach switch, the approach mode annunciation blanks and approach data is removed.

52-The integrated standby flight display shows the barometric reference setting in units of inches of mercury or hectopascals on the top right side of the display.

53-The hectopascal/Inch switch lets you change the units of the barometric reference setting

54-Push the switch to change the unit from hectopascal to inch. Push the switch again to change the unit to hectopascal.

55-You rotate the Barometric Selector to change the barometric reference setting and set barometric corrected altitude.

56-When you push the barometric selector, the barometric pressure reference changes to standard. The display shows STANDARD for the barometric reference setting

57-With STANDARD displayed, if you push the selector again, the standard setting is removed and the preselected barometric reference is set.

58-You use Attitude Reset Switch to reset the attitude or to start a new alignment sequence on the ground

59-The Display Brightness Switches are used to increase or decrease the display brightness. Push the switch with the plus sign to increase brightness. You push the switch with the minus sign to decrease the display brightness.

60-The Ambient Light Sensor automatically adjusts display brightness for ambient lighting condition.

Alignment and messages

61-When the battery switch is selected ON, the integrated standby flight display goes through the alignment process. The airplane should not be moved during alignment.

62-The ATTITUDE and INITIALIZATION 90 seconds message shows during alignment.

63-The integrated standby flight display takes 90 seconds to align the pitch and roll attitude. When the attitude alignment is complete, the integrated standby flight display shows the attitude information.

64-When excessive airplane movement is detected during the alignment, the alignment process will stop. The alignment will resume when the airplane movement is acceptable for alignment.

65-If the alignment is not complete within six minutes, the ATTITUDE RESET message shows on the display.

66-With the airplane stationary, push the attitude reset switch for a minimum of 2 seconds to start a new alignment sequence. The display shows the message ATTITUDE 10 seconds to indicate a 10 second attitude realignment is in progress.

67-On the ground and during flight, when integrated standby flight display inertial sensors detect a momentary out-of-limit condition, the attitude display blanks and the wait attitude message shows. No crew action is required against the wait attitude message as it shows a temporary self-correcting loss of attitude. The integrated standby flight display removes the message and shows the attitude information when the condition returns to normal.

68-If the out-of-limit condition continues more than 10 seconds, the ATTITUDE RESET message shows on the display. You must operate the attitude reset switch in response to the ATTITUDE RESET message.

69-Before operating the reset switch ensure that airplane is in level and non-accelerated flight. Push the attitude reset switch for a minimum of 2 seconds to make the integrated standby flight display begin an attitude alignment. The display shows the message ATTITUDE 10 seconds.

70-Maintain the airplane in straight and level flight for 10 seconds. After 10 seconds, the attitude information is displayed.

71-If the reset attempt is unsuccessful, the attitude reset message remains displayed and the display does not enter normal operation.

Failure flags

72-The failure flags on the integrated standby flight display tell the flight crew if there is an ILS or indicator failure.

73-The display blanks completely and shows the OUT OF ORDER annunciation when a total integrated standby flight display system failure occurs.

74-When the ILS localizer fails, the localizer flag comes into view.

75-The glideslope flag comes into view when the ILS glideslope fails,

76-The airspeed information goes off and the display shows the airspeed flag if the integrated standby flight display cannot calculate the indicated airspeed,

77-When the altitude cannot be calculated, the altitude tape and the altitude display go off. The display shows the altitude flag.

78-Failure of the attitude function causes attitude information to be removed and the display shows the attitude flag.

79-The display removes the compass rose and shows the heading flag if the magnetic heading data input fails.

CLOCKS

80-The clocks are located on the Captain’s and First Officer’s instrument panels

81-Although they may have slightly different appearances depending on the airplane model, the clocks serve the same purpose: to give time reference to the flight crew and other airplane systems.

82-Each clock is powered by the battery bus. When the power from the battery bus is not available, the clock shifts to standby power from the hot battery bus. The standby power lets the clocks keep the time base, but does not provide power for the display, buttons, or output of clock data.

83-The clocks are GPS compatible. When the airplane is powered up and a valid GPS signal is restored, the clock will initialize to Coordinated Universal, or UTC, time.

84-Each clock has a digital time/date display and an elapsed time/ chronograph display

85-An LCD sweep second hand only works with the chronograph function of the clock.

86-The time/date pushbutton controls the time/date function through four modes in the following order. UTC time, UTC date, manual time and manual date.

87-You push the time/date pushbutton once to see the UTC time which comes from the GPS. The word UTC shows on the upper right part of the LCD display

88-Select the pushbutton again to see UTC date which comes from the GPS.

89-When you select the pushbutton again, the display shows the manual time which comes from the clock. The word MAN shows on the upper right part of the display

90-Select the pushbutton again to see the manual date which comes from the clock. Now let’s see how you can manually set time and date

91-To set a manual time, say 12:51, push the time/date pushbutton to manual. When you see MANUAL time, then you can set the time.

92-Push the SET button once. Hours start to flash.

93-Now use the plus or minus pushbutton to adjust the hours.

94-Push the SET pushbutton again. The minutes start to flash.

95-Use the plus or minus pushbutton to adjust the minutes.

96-Push the SET pushbutton again to run the time

97-To set a manual date, you should push the time/date pushbutton to select manual date mode. The date displayed is 29 October 2014. Let’s change the date to 12 January 2015.

98-Push the SET button once. The day starts to flash.

99-Now use the plus or minus pushbutton to adjust the day.

100-Push the SET pushbutton again. The month starts to flash.

101-Use the plus or minus pushbutton to adjust the month.

102-Push the SET pushbutton again. The year starts to flash.

103-Use the plus or minus pushbutton to adjust the year.

104-Push the SET pushbutton again to run the date

105-You use the elapsed time pushbutton to stop and start the elapsed time.

106-The elapsed time display shows the elapsed time in hours and minutes.

107-Push the elapsed time pushbutton once to run the elapsed time. The word RUN shows on the lower left part of the display.

108-After one minute has elapsed, the display shows 1.

109-You can push the elapsed time pushbutton again to hold the elapsed time. The word HLD shows on the lower left part of the display. You can reselect elapsed time pushbutton to resume the elapsed time operation.

110-You should select the reset pushbutton to reset the elapsed time to 0. The elapsed time display blanks after 5 seconds.

111-The chronograph pushbutton lets you start, stop, and reset the chronograph function.

112-The chronograph display shows only minutes, because the chronograph function does not calculate hours.

113-The sweep second hand indicates the chronograph seconds

114-You use the chronograph function when you need more accurate timing, such as during non-precision approaches.

115-When needed, push the chronograph pushbutton to start the chronograph. The chronograph time replaces elapsed time. The sweep second hand begins to show seconds. The elapsed time continues to run internally while the chronograph operates.

116-Push the chronograph pushbutton again to stop the chronograph.

117-You need to push the chronograph pushbutton once more to set the sweep second hand to zero and display the elapsed time.

FLIGHT DATA RECORDER

118-The Digital Flight Data Recorder records and preserves the airplane operational and system data including time, heading, altitude, airspeed, acceleration, attitude, engine thrust, and flight control surface position.

119-The flight data recorder starts to record operational and systems information automatically whenever it is powered.

120-The system incorporates a flight data acquisition unit, a digital flight data recorder and a flight recorder test module.

Flight data acquisition unit

121-The flight data acquisition unit is in the electronic equipment compartment. It collects mandatory flight data from many airplane systems and sensors and sends the data to flight data recorder in a standard digital format.

Flight data recorder

122-The crush and fire resistant flight data recorder, or FDR, is located in the aft cabin overhead.

123-The flight data recorder continuously records the most recent flight data fed by flight data acquisition unit. It is capable of retaining the most current data recorded during the last 25 hours of operation.

124-The recorder can survive deep sea pressures to 13451 feet or 4100 meters.

125-An underwater locator beacon fitted to the unit helps find the flight data recorder in water. It can operate under water for a minimum of 30 days.

126-A receptacle allows downloading and copying recorded data for analysis.

Flight recorder test module

127-The flight recorder test module is on the aft overhead panel.

128-The module gives the flight crew visual indications of the flight recorder operation.

129-The flight recorder test module incorporates a two position switch. The switch is guarded to the NORMAL position.

130-The amber OFF light illuminates when the flight recorder is not in operation or when there is critical malfunction of the system.

131-On the ground, with the switch in the normal position and electrical power available, when either engine is started the flight data recorder automatically operates.

132-On the ground, when the engines are not running, you can power the flight recorder system by positioning the switch to the TEST position for preflight test of the system.

133-In flight, the flight data recorder operates as long as the switch is in the normal position and the electrical power is available.

Flight data recorder preflight test

134-Now let’s see how you can perform a flight data recorder test during preflight

135-Lift the guard and set the switch to the TEST position.

136-If the OFF light extinguishes, the test is satisfactory

137-With the test satisfactory, close the guard to return the switch to NORMAL. The OFF light illuminates. This completes the test.

138-If the OFF light remains illuminated after you set the switch to TEST position, the test is unsatisfactory.

139-With the test failed, both master caution lights and the OVERHEAD caution annunciator illuminate

AIRCRAFT CONDITION MONITORING SYSTEM

140-The purpose of the Aircraft Condition Monitoring System or ACMS, is to provide the operator with useful reports on the condition of the airframe, engines, trends monitoring, and maintenance

141-The system incorporates flight data acquisition unit which collects mandatory flight data for the flight data recorder, as we have seen earlier. The flight data acquisition unit also collects non-mandatory aircraft condition monitoring system data for airline use.

142-Aircraft condition monitoring system software embedded in the flight data acquisition unit selects input data to monitor. The data is then changed to a digital format and retained in the flight data acquisition unit’s memory until it is

downloaded

143-The flight data acquisition unit generates maintenance reports for printing or transmitting to the ground via ACARS.

144-The unit also sends the data to the quick access recorder which provides maintenance crew with quick access to stored data.

COMMON DISPLAY SYSTEM

145-This part is intended to introduce you to the common display system. Here is the outline: * Overview * Display units * Display electronic units * Display brightness control * EFIS control panels * Control panel select switch * Display source selector * Display select panels * Common display system non-normal operation

OVERVIEW

146-The purpose of the common display system (CDS) is to supply performance, navigation and engine information to the flight crew in many different formats in the flight compartment.

147-The system also lets the flight crew control the display units.

DISPLAY UNITS

148-The common display system uses six identical, flat panel, liquid crystal display units.

149-The display units are the Captain’s outboard, Captain’s inboard, First Officer’s outboard, First Officer’s inboard, upper and lower.

150-The outboard display units present all primary flight information.

151-The inboard display units show all navigation information.

152-The upper display unit normally shows primary engine parameters and fuel data

153-The lower display unit is usually blank or shows secondary engine data under certain conditions

DISPLAY ELECTRONIC UNITS

154-The common display system has two display electronics units, or DEUs.

155-The display electronics units collect data from airplane systems and change the data to a video signal to show on the display units.

156-Normally, the number 1 display electronics unit supplies display data to the Captain’s outboard, Captain’s inboard and upper display units.

157-The number 2 display electronics unit supplies display data to the First Officer outboard, First Officer inboard and

lower display units.

158-If a DEU fails, the remaining DEU automatically supplies data to all six displays.

DISPLAY BRIGHTNESS CONTROL

159-The brightness of the displays is controlled either automatically or manually.

160-The automatic brightness control function uses inputs from both the remote light sensors on the glareshield and the bezel light sensors on the individual DUs.

161-Two brightness control panels on the instrument panel let the flight crew set the brightness of displays manually.

162-Each pilot has individual controls to set the brightness of the corresponding outboard and inboard display units.

163-You rotate the outboard display unit brightness control to adjust the brightness of related outboard display unit.

164-The controls for the inboard display units are dual controls.

165-You use the outer knob to control the overall brightness of the respective inboard display unit.

166-The inner knob lets you adjust weather radar and terrain display brightness.

167-The Captain’s panel also has brightness controls for the upper and lower display units.

168-The control for the lower display unit is a dual control. The outer knob adjusts lower display unit brightness. The inner knob adjusts the weather radar and terrain display brightness on the lower display unit.

EFIS CONTROL PANELS

169-There are two electronic flight instrument system or EFIS control panels on the glareshield.

170-The EFIS control panels control the information that shows on the display units. The features of the EFIS control panels are discussed in a different section.

CONTROL PANEL SELECT SWITCH

171-The CONTROL PANEL select switch is located above the Captain on the forward overhead panel.

172-The control panel select switch lets you select which EFIS control panel controls the outboard and inboard display units.

173-The switch has three positions. When the switch is in the NORMAL position, the Captain’s EFIS control panel controls the Captain’s displays and the First Officer’s EFIS control panel controls the First Officer’s displays.

174-When the switch is set to the BOTH ON 2 position, the First Officer’s EFIS control panel controls both pilots’ displays.

175-With the switch in the BOTH ON 1 position, the Captain's EFIS control panel controls both pilots' displays

DISPLAY SOURCE SELECTOR

176-The DISPLAY SOURCE selector is located on the forward overhead panel.

177-The selector lets you select the DEU that controls the displays.

178-When the selector is in the AUTO position, the DEU 1 controls the Captain's and upper display units and DEU 2 controls the First Officer's and the lower display units.

179-With the selector in AUTO, if a DEU fails, the remaining DEU automatically supplies data to all six displays.

180-When the selector is set to the ALL ON ONE position, DEU 1 controls all six display units.

181-When the selector is set to the ALL ON TWO position, DEU 2 controls all six display units. Note that the source selectors are normally used while the aircraft is on the ground for maintenance purposes.

DISPLAY SELECT PANELS

182-The display select panels are on the left and right forward panels above the pilot's display units.

183-Each display select panel has two selectors that let you control the data which shows on the display units.

184-The MAIN PANEL display units selector controls the data that shows on the respective inboard and outboard display units.

185-The LOWER display unit selector controls the data that shows on the lower display unit.

186-The MAIN PANEL display units selector has five positions. Normal, outboard primary flight display, inboard engine primary, inboard primary flight display and inboard multi-function display.

187-The LOWER display unit selector has three positions. Normal, engine primary and navigation display.

188-All selectors are usually in the Normal position.

189-With the selectors in the Normal position, the Captain's and First Officer's outboard displays show the primary flight data.

190-The inboard displays show the navigation data.

191-The upper display unit shows the primary engine and fuel data.

192-The lower display unit is normally blank.

193-The lower display unit shows the secondary engine parameters when common display system is first powered, selected on multi-function display, the secondary engine limits are exceeded or engine failure or shutdown occurs in flight

194-With the selectors in normal position, the common display system is also capable of automatic display switching when a display unit fails.

195-If an outboard display unit fails, the respective display blanks. The primary flight data automatically shows on the inboard display unit.

196-If an inboard display unit fails, the display unit blanks. The primary flight data remains displayed on the outboard display unit.

197-If the upper display unit fails, the upper display blanks. The primary engine display automatically moves to the lower display unit

198-If the secondary engine display is already displayed on the lower display unit, a compact engine display is then shown.

199-There is no automatic switching for a lower display unit failure.

200-You can also manually control the display switching with the display selectors.

201-When you set the MAIN PANEL displays unit selector to OUTBOARD PFD, the related outboard display unit continues to show the primary flight display. The inboard display unit will blank.

202-When the MAIN PANEL display unit selector is placed to the INBOARD ENGINE PRIMARY position, upper display unit blanks. Engine display moves to related inboard display unit. The outboard display unit shows the primary flight display.

203-If you select INBOARD PFD position, the primary flight display shows on the related inboard display unit. Outboard display unit blanks.

204-When a LOWER display unit selector is turned to ND, the lower display unit shows the navigation display.

205-If both the captain and the first officer set the lower display unit selector to ND, the captain navigation display shows on the lower display unit.

206-When you set a LOWER display selector to ENGINE PRIMARY, the primary engine display shows on the lower display unit. The upper display unit blanks.

207-MAIN PANEL displays unit selector’s INBOARD MFD position lets you show the multi-function display on the inboard display unit and lower display unit as selected with the MFD switches on the engine display control unit.

208-There are two multi-function display switches. Engine switch selects secondary engine information and system switch selects airplane system information to be displayed. If installed, a C/R switch cancels or recalls autoland status on the display.

209-If a MAIN PANEL displays unit selector is set to INBOARD MFD, the related inboard display blanks. The outboard display unit continues to show the primary flight display.

210-Now you can select engine or system switch to show engine secondary display or systems display on inboard display unit and lower display unit.

DISPLAY SYSTEM INFORMATION SOURCES

211-The DEUs receive flight display data from ADIRS. ADIRS supplies both inertial and air data to DEUs and other airplane systems. Inertial data supplied by ADIRS is discussed in Navigation section. Here we discuss air data.

212-The ADIRS incorporates two air data inertial reference units, or ADIRUs and four air data modules, or ADMs.

213-The air data modules receive total air pressure and static air pressure from the primary pitot probes and primary static ports respectively. Then, they convert pneumatic pressure to electrical signals and send these data to the ADIRUs.

214-The air data module connected to the Captain’s pitot probe supplies total air pressure data to the left ADIRU.

215-The air data module connected to the First Officer’s pitot probe supplies total air pressure data to the right ADIRU.

216-The air data modules connected to the Captain’s static ports and first officer static ports supply static air pressure data to the respective ADIRUs.

217-Two alpha vanes, one located on each side of the forward fuselage, measure airplane angle of attack relative to the air flow.

218-The alpha vanes give angle of attack data to the ADIRUs. The ADIRUs use the angle of attack to modify pitot and static values.

219-A total air temperature, or TAT, probe mounted on the left side of the fuselage measures the air temperature outside the airplane

220-The TAT probe supplies total air temperature to the ADIRUs. The ADIRUs use the total air temperature to compute true airspeed and static air temperature.

221-The ADIRUs computed static air temperature is displayed on the CDU PROGRESS page.

COMMON DISPLAY SYSTEM NON-NORMAL OPERATION

222-These are the common display system non-normal conditions. CSD fault, CSD maintenance, DEU failure in flight, EFIS

control panel failure, and display failure,

223-When there is a total DEU failure, the CDS FAULT message shows on the lower left corner of the primary flight display.

224-CDS FAULT message shows only when the airplane is on the ground and at least one engine is not running. Do not takeoff when CDS FAULT annunciates.

Csd maintenance

225-When there is a partial DEU failure, the CDS MAINT message shows on the lower left corner of the primary flight display.

226-CDS MAINT message shows only when the airplane is on the ground and at least one engine is not running. This is a dispatchable condition.

Deu failure in flight

227-In flight, when a DEU failure causes all the display units to get data from only one DEU, amber DISPLAY SOURCE message shows on the lower left corner of the primary flight display.

228-If a DEU fails on the same side as the engaged autopilot, you must select the opposite autopilot. Ensure correct flight director indications and flight mode annunciations are shown on the same side as the operating autopilot. If EEC alternate lights are illuminated, complete the EEC alternate mode checklist.

229-With the DISPLAY SOURCE annunciated, dual autopilot approach is not available.

Efis control panel failure

230-When an EFIS control panel fails, the DISPLAYS CONTROL PANEL annunciation shows on the lower right hand corner of the affected primary flight display.

231-The altimeter blanks and an amber ALTITUDE flag illuminates.

232-Set the CONTROL PANEL select switch to BOTH ON 1 or BOTH ON 2 as needed. Verify that the DISPLAYS CONTROL PANEL annunciation and ALTITUDE flag extinguish on the affected primary flight display.

Display failure

233-If a display in the common display system is failed and automatic switching has not occurred, you must set MAIN PANEL display units selector or LOWER display unit selector as needed.

234-In this example the captain primary flight display is failed and automatic switching has not occurred. You set the MAIN PANEL display units selector to INBOARD PFD to show the primary flight data on the inboard display unit.

235-In this example the First Officer's navigation display is failed and automatic switching has not occurred. Set the LOWER display unit selector to ND to show the navigation display on the lower display unit.

PRIMARY FLIGHT DISPLAY

236-In this part we will discuss the primary flight display. Here is the outline: * Overview * Airspeed indications * Attitude indications * Landing indications * Radio minimums and radio altitude indications * Altitude indications * Vertical speed indications * Heading and track indications * Primary flight display non-normal operation

OVERVIEW

237-The primary flight display, or PFD, normally shows on the outboard display units.

238-The Captain's and First Officer's primary flight displays show the same information. Let's take a look at information displayed on PFD

239-The primary flight display shows airspeed, attitude, altitude and vertical speed,

240-The primary flight display also shows the landing indications, heading and track data and flight mode annunciation. The flight mode annunciation is discussed in a different section.

241-The EFIS control panel lets you control various data displayed on the primary flight display.

AIRSPEED INDICATIONS

242-Airspeed is indicated on the left side of the primary flight display.

243-The speed tape shows the computed airspeed from the ADIRU on a moving scale. Current airspeed shows as a digital readout.

244-When the airspeed is below 45 knots, the display shows 45 knots.

245-The Mach number is displayed as digital readout below the speed tape when the current Mach number is more than 0.40.

246-When the airspeed decreases below 0.40 Mach, the current ground speed is displayed

247-An airspeed trend vector of variable length indicates predicted airspeed in the next 10 seconds based on the current airspeed and acceleration.

248-The airspeed indicator also incorporates a selected speed digital readout and a speed bug.

249-The selected speed display and speed bug show the target airspeed or Mach manually selected with the speed selector on the mode control panel.

250-When the indicated airspeed/MACH window is blank, both indicators show the target airspeed or Mach automatically computed by the FMC.

251-When the selected speed or Mach number is off the scale, only half of the bug shows at the top or the bottom of the speed tape.

252-The airspeed display also shows the speed limits.

253-The maximum speed display starts at the top of the speed tape. The bottom of the alternating red and black bar shows the maximum speed.

254-The maximum speed is the lowest of Vmo or Mmo, landing gear placard speed or flap placard speed.

255-With the flaps up, the bottom of hollow amber bar indicates the maximum maneuver speed. The bar appears to show the highest speed before the start of high speed buffet when operating at high altitude at relatively high gross weights.

256-In level flight at this speed, you can bank the airplane up to 40 degrees before high speed buffet starts.

257-With the flaps not up, the bottom of the amber bar indicates the next flap position limit speed which is the maximum speed for the next flap position. When the flap lever is moved to landing setting, the bar is removed.

258-The minimum speed display starts at the bottom of the speed tape. The top of the alternating red and black bar shows the minimum speed. It is the speed at which stick shaker occurs.

259-The top of amber bar indicates the minimum maneuver speed. The bar is displayed with the first flap retraction after takeoff or when a valid reference speed is entered

260-At this speed, you can bank the airplane up to 40 degrees while maneuvering in level flight before stick shaker occurs.

261-Decision speed “V1” and rotation speed “VR” are also indicated on the airspeed display as selected on the CDU TAKEOFF REF page or as set with the SPEED REFERENCE selector.

262-In some B737s, the airspeed display incorporates a VNAV speed band along the right edge of the speed tape. The band indicates the FMC target airspeed during VNAV PATH descents.

263-The top of the band shows the speed at which VNAV will change from VNAV PATH to VNAV SPEED. The bottom of the band displays the autothrottle wake-up speed.

Failure flags

264-Let’s take a look at failure flags that show on the airspeed display

265-If the selected airspeed data is invalid, the SELECTED SPEED flag shows and the speed bug is removed.

266-If the stick shaker or maximum operating speed has failed, the SPEED LIMIT failure flag shows. If the stick shaker warning has failed, the red and black stick shaker speed bar is removed. If the maximum operating speed has failed, the red and black maximum operating speed bar is removed.

267-On the ground, if both decision speed V1 and rotation speed VR are not valid or are set to less than 80 knots, the NO V SPEEDS failure flag is displayed.

268-If the airspeed indication is inoperative, the display shows the SPEED failure flag

Airspeed indications-preflight

269-We will discuss preflight airspeed settings and indications for two cases: the airspeed settings/indications with FMC operative and the airspeed setting/indications with FMC in-operative.

Airspeed indications with fmc operative

270-Airspeed Indications With Fmc Operative When power is first applied, the selected speed and speed bug set at the MCP default speed of 100 knots. The amber NO V SPEED flag is displayed.

271-With the FMC operative, after the gross weight is put into the CDU PERFORMANCE INITIALIZATION page, the FMC sets an UP bug at the flaps up maneuvering speed.

272-The UP bug is not indicated above approximately 20,000 feet altitude, because its value is out of the displayed range.

273-When V1 speed is selected on the CDU TAKEOFF REFERENCE page, the V1 speed bug is set. When the selected V1 speed is not within the displayed range, a green V1 with the numeric value of V1 speed is indicated at the top of speed tape.

274-When you select the VR speed on the CDU TAKEOFF REFERENCE page, VR bug is set.

275-With V1 and VR speeds set, the NO VSPEED failure flag is removed. The VR bug is not in view, since VR value is off scale right now.

276-When V2 speed is set on the CDU TAKEOFF REFERENCE page, there is no change to the airspeed display.

277-You should use the speed selector on the MCP to set V2 speed on the airspeed display.

278-When you turn the selector to select V2 speed, the speed bug moves to the top of the speed tape. The V2 plus 15 bug is set and is out of view.

279-When takeoff flaps are set, a bug is placed for the first flap retraction speed after takeoff. The bug is not in view during preflight.

Airspeed indications with fmc in-operative

280-Airspeed Indications With Fmc In-Operative When the FMC is inoperative, you use the SPEED REFERENCE selector on the engine display control panel to set the airspeed bugs for takeoff.

281-The speed reference selector is a dual control. The outer knob lets you select the type of reference airspeed bug to set on the airspeed display.

282-With the outer knob in AUTO and the FMC operative, the reference airspeeds and gross weight are supplied automatically through the FMC.

283-When the FMC is inoperative, you select V1, VR, GROSS WEIGHT, and V REFERENCE and Bug 5 positions to manually set reference airspeeds and gross weight.

284-On the ground, you may select V1, VR, and takeoff gross weight.

285-In flight, the V REFERENCE and landing gross weight may be selected

286-The inner knob is used to set the bug value. The bug value is indicated digitally on the airspeed display.

287-The inner knob is spring loaded to the center and has two slew speeds.

288-Slow slew changes the speed or weight in increments of 1 knot or 1000 pounds.

289-Fast slew changes the speed or weight in increments of 10 knots or 10000 pounds.

290-To set the reference airspeed bugs manually for takeoff, turn the SPEED REFERENCE selector outer knob to V1. The default speed of 80 knots is indicated on the airspeed display.

291-Now rotate the inner knob to select the V1 speed value. The V1 bug is indicated at the top of the speed tape when it is off the scale.

292-Turn the outer knob to VR. The default speed of 80 knots shows on the airspeed display.

293-Rotate the inner knob to select the VR speed value. The VR bug is set but is not in view when it is off the scale. The NO V SPEED flag is removed after both V1 and VR are set.

294-You use MCP speed selector to set V2 speed on the airspeed display.

295-When you turn the selector to select V2 speed, the speed bug moves to the top of the speed tape. The V2 plus 15 bug is set and is out of view.

296-Now set the speed reference selector outer knob to WEIGHT. The default weight of 70000 pounds or 32,000 kilograms is shown on the airspeed display.

297-Rotate the inner knob to select the takeoff gross weight. The UP bug is set at flaps up maneuvering speed, but is off the scale.

298-If you turn the outer knob to the V REFERENCE, the INVALID ENTRY message shows on the airspeed display. The approach V REFERENCE cannot be selected on the ground

299-If desired, you may select bug 5 position to set a spare bug.

300-When you place the outer knob to Bug 5, the default speed of 60 knots is displayed. Now, you can use the inner knob to set the speed as desired.

301-To complete the manual airspeed bug setting during preflight, move the outer knob to SET. The speed reference digital readout on the airspeed display is removed.

302-When the flap lever is set to the takeoff flap setting, a bug is placed for the first flap retraction speed after takeoff. The bug is not in view during preflight.

Airspeed indications-takeoff and climb

303-After lift- off, the V1 bug and VR bug are removed.

304-The minimum speed bar comes into view. The bug for the next smaller flap maneuvering speed shows

305-At flap retraction altitude, you start to retract the flaps. The V2 plus 15 bug goes out of view. The minimum maneuver speed bar is displayed.

306-When flaps are set to up, all bugs, except the UP bug, are removed. The UP bug moves as fuel is used and gross weight decreases.

Airspeed indications-approach and landing

307-Now let’s review airspeed indications during approach and landing when the FMC is operative and when the FMC is in-operative.

Airspeed indications with fmc operative

308-Airspeed Indications With Fmc Operative After the initial speed reduction for approach is started automatically by the FMS or manually by the pilot, the reference speed must be selected to tell the FMC the flap setting for landing.

309-You use the CDU APPROACH REFERENCE page to select the REFERENCE speed. The page shows the REFERENCE speeds for the three landing flap settings for the current gross weight.

310-To enter a V REFERENCE, say flaps 30 speed, copy the speed to the scratch pad by pushing the respective line select key. Then push the line select key again to set the speed in the CDU.

311-The REFERENCE speed is now shown in large characters on the CDU. The selected approach reference flap and speed setting are also displayed on line 4 right.

312-The green V reference bug and the white V reference + 20 bug are set. Right now, the bugs are not within the displayed scale. The reference speed is displayed at the bottom of airspeed display, when it is off the scale.

313-After you set the reference speed, if a large amount of fuel is used as a result of multiple landings or a change in the landing time, the gross weight will change. However, the set reference speed does not automatically change as the gross weight changes. In this case, you must reset the reference speed for the new gross weight.

314-To reset the reference speed, first delete the current reference speed. A new speed shows on the CDU.

315-Enter the new reference speed as you did before.

316-V reference bug and V reference + 20 bug are set at their new values. Again, the bugs are not within the displayed scale.

Airspeed indications with fmc in-operative

317-Airspeed Indications With Fmc In-Operative When the FMC is inoperative during approach, you use the SPEED REFERENCE selector to set the current gross weight and V reference speed bugs.

318-Set the speed reference selector outer knob to WEIGHT. The default weight of 70000 pounds or 32,000 kilograms is shown on the airspeed display.

319-Rotate the inner knob to select the current gross weight.UP bug moves to flaps up maneuvering speed for the new gross weight.

320-Now, place the outer knob to VREF. The default speed of 80 knots shows on the airspeed display.

321-Rotate the inner knob to select the reference speed. The green V REFERENCE bug and the white V REFERENCE + 20 bug are set. Right now the bugs are not within the displayed scale.

322-If you turn the outer knob to V1 or VR, INVALID ENTRY shows on the airspeed display. You cannot set V1 and VR in the flight.

323-If desired, you may select the bug 5 position to set a spare bug.

324-You move the outer knob to SET to remove the speed reference digital readout on the airspeed display.

325-Now let’s look at the airspeed indications with the FMC operative after you set the reference speed. In this example, the reference speed is 136 knots.

326-When the airspeed is decreased to flaps up maneuvering speed, set the flap lever to 1. The flaps 1 bug is displayed.

327-With airspeed decreased to flaps 1 speed, set the flap lever to 5. The flaps 5 bug is displayed.

328-Now, decrease the airspeed to the flaps 5 speed.

329-As you prepare for landing, set the landing gear down and set the flap lever to 15.

330-A flap bug is not displayed if calculated flap maneuvering speed is within 4 knots of the reference speed. In this example, flaps 15 speed is 139 knots and reference speed is 136 knots. Thus, flaps 15 bug is not in view.

331-If the flaps 15 bug is not displayed, reduce the airspeed to reference speed + 5 knots.

332-Set landing flaps 30 or 40 and hold the speed.

333-All numbered flap maneuvering speed bugs are removed when flap lever is moved to flaps 30 or 40. Now let's look at airspeed indications during a go-around

Airspeed indications-go-around

334-At go-around, with the TO-GA switch pushed, move the flap lever to 15.

335-Usually, the flaps 15 and flaps 5 bugs show on airspeed display. Remember, if flaps 15 airspeed is within 4 knots of reference speed, it is not indicated.

336-At flap retraction altitude, increase the airspeed to flaps up maneuvering speed.

337-When airspeed is increased to V REFERENCE + 20, set the flap lever to 5.

338-Increase airspeed to flaps 5 speed and set the flap lever to 1.

339-At flaps 1 speed move the flap lever to UP.

340-The numbered flap maneuvering speed bugs are removed when the flaps are up. The UP bug, reference speed +20 bug and reference speed bug remain in view.

ATTITUDE INDICATIONS

341-The attitude indicator shows the pitch and the roll attitude of the airplane.

342-Pitch and roll data comes from the air data inertial reference system. Let's look at indications that show in the attitude indicator

343-A bank scale provides the bank indication with marks at 10, 20, 30, 45, and 60 degrees.

344-A bank pointer shows the bank angle.

345-If the bank angle is 35 degrees or more, the pointer fills and changes to amber

346-The slip/skid indicator below the bank pointer displaces to indicate slip or skid.

347-The indicator is filled white at full scale deflection.

348-If the bank attitude is more than 35 degrees, the slip/skid indication changes to a filled amber.

349-The pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5 degree increments.

350-A pitch limit indication shows the limit that you can pitch the airplane before the stick shaker starts.

351-The pitch limit indication is displayed at all times when the flaps are not up. However, in some B737s, the pitch limit indication is displayed when the flaps are not up, or when flaps are up and airspeed approaches stick shaker activation for current flight conditions.

352-The flight director shows pitch and roll commands that come from the flight control computers. The steering commands is displayed when the flight director is on.

353-When you select FPV switch on the EFIS control panel, the attitude indicator shows the flight path vector symbol

354-The flight path vector symbol shows flight path angle above or below the horizon line and drift angle left or right of the display center.

355-The flight path vector symbol is bright when the flight director is not shown and there is no TCAS resolution advisory displayed.

356-The symbol is dim when either the flight director or a TCAS resolution advisory is displayed.

LANDING INDICATIONS

357-Now let’s look at landing indications on primary flight display.

358-The approach reference shows the selected ILS identifier or frequency, approach course set on the MCP and ILS/DME/FMC distance.

359-The localizer information shows at the bottom of the attitude indicator when an ILS frequency is tuned and received.

360-The localizer pointer shows the localizer position relative to the airplane.

361-The localizer scale indicates deviation from localizer course.

362-When the localizer is engaged and deviation is slightly more than half dot, the scale expands.

363-If the FCC detects an excessive localizer deviation, the scale turns amber and the pointer flashes.

364-The glideslope information shows on the right of the attitude indicator.

365-The glideslope scale appears when the localizer frequency is tuned.

366-The glideslope pointer shows glideslope position relative to the airplane when glideslope signal is received.

367-When the glideslope deviation is more than one dot, the scale turns amber and the pointer flashes.

368-The marker beacon indication shows when the airplane flies over an outer marker beacon, a middle marker beacon or an inner marker beacon.

RADIO MINIMUMS AND RADIO ALTITUDE INDICATIONS

369-When minimums reference selector on the EFIS control panel is set to RADIO, the radio altitude approach minimums are displayed near the bottom right of the attitude indicator.

370-With the selector in RADIO position, you turn the inner knob of the selector to set radio altitude approach minimums in feet above ground level.

371-The current radio altitude is displayed in the bottom center of the attitude indicator.

372-The radio altitude is displayed below 2500 feet above ground level. A white box shows around the indication for 10 seconds upon descent below 2500 feet.

373-When the airplane descends through the selected minimum altitude, the radio altitude display and approach radio minimum turn amber.

374-To reset the RADIO altitude alert, climb above the selected RADIO minimums.

375-Alternately, you can push the reset switch on the EFIS control panel to reset the alert.

376-The RADIO alert is also reset at touchdown.

377-In some models the radio altitude shows as a digital value from 1000 feet to 2500 feet at right side above the attitude indicator. Below 1000 feet, a round dial display replaces the digital display. The radio minimum altitude that you select shows as a green triangular bug on the radio altitude dial

378-A rising runway shows when the localizer pointer is in view and the radio altitude is below 2500 feet.

379-When the radio altitude is less than 200 feet, the rising runway moves up towards the airplane symbol.

380-The symbol touches the bottom of the airplane symbol at 0 feet radio altitude.

Failure flags

381-Let’s take a look at the failure flags that show on the attitude indicator.

382-When radio altitude data has failed, radio altitude display is removed and amber radio altitude flag shows.

383-If the flight director steering commands from the FCC fails, the flight director bars are removed and flight director flag shows.

384-When the flight path vector data from air data inertial reference system has failed, the flight path vector symbol is removed and FPV flag shows.

385-The pitch and roll comparator flags are displayed if the captain and first officer pitch or roll display values differ from each other by more than 5 degrees. The flags flash for 10 seconds then remain steady.

386-When localizer or glideslope deviation data from the ILS receiver fails, related deviation scale is removed and localizer or glideslope flag shows.

387-An amber DME flag is displayed when distance measuring equipment fails.

388-If the attitude data from air data inertial reference system fails, the attitude display is removed and the ATT flag shows

ALTITUDE INDICATIONS

389-Altitude is indicated on the right side of the primary flight display.

390-The altitude indication shows barometric altitude from the air data inertial reference system and other related altitude information from various systems.

391-The altitude tape shows the barometric altitude on a moving scale. The current altitude shows in a digital readout box.

392-For positive values of altitude below 10,000 feet, a green crosshatch symbol is displayed next to the current altitude digital readout.

393-The altitude indicator incorporates a selected altitude digital readout and a selected altitude bug.

394-The selected altitude digital readout and selected altitude bug show the altitude set in the MCP altitude window.

395-When the selected altitude is off scale, only the half bug shows at the top or bottom of the altitude tape.

396-When approaching the selected altitude, the selected altitude digital readout is boxed and the current altitude digital readout box becomes bold.

397-When you push the METERS switch on the EFIS control panel, the altitude information is displayed in meters.

398-You push the METERS switch again to remove the meters indications.

Barometric minimums and indications

399-With minimums reference selector on the EFIS control panel set to BARO, the barometric altitude approach minimums are displayed on altitude indicator.

400-The barometric minimum pointer and line shows the selected barometric approach minimum value on the altitude tape.

401-The selected barometric minimum altitude is also displayed as digital readout under the word BARO.

402-With the barometric minimums set, if you move the minimums reference selector to RADIO, the radio minimum digital display replaces the barometric minimum digital display. The barometric minimum pointer remains but there is no line

403-As the airplane descends through the selected BARO altitude, the barometric minimums bug and barometric minimums digital display change to amber.

404-The amber crosshatched area on the altitude tape shows the landing altitude for the destination or departure runway or airport from the FMC.

405-A landing altitude reference bar shows the height above touchdown. The bar is white from 1000 to 500 feet above the landing altitude. An amber bar is indicated from 500 feet to the landing altitude.

406-To reset the barometric altitude alert, climb above the selected barometric minimums.

407-Alternately, you can push the reset switch on the EFIS control panel to reset the alert.

408-The BARO alert is also reset at touchdown.

Barometric reference

409-You select the barometric reference from the EFIS control panel. It shows below the altitude tape.

410-With the barometric selector in the INCH position, the barometric reference value is indicated in inches of mercury.

411-When you select the HPA position, the barometric reference value shows in hectopascals.

412-When you push the standard switch, STD is displayed and standard barometric reference is set.

413-When standard barometric reference is displayed, you can preselect a barometric setting. The preselected setting shows below STD.

414-With a numeric barometric reference set, as the airplane climbs above the transition altitude, an amber box appears around the indicated barometric setting

415-If the standard barometric reference is set, the amber box is displayed when descending below transition flight level.

Failure flag

416-When the barometric altitude data from the air data inertial reference system fails, the altitude display is removed and the ALTITUDE flag shows

VERTICAL SPEED INDICATIONS

417-The vertical speed indication shows vertical speed from the air data inertial reference system (ADIRS).

418-The vertical speed shows with a white pointer against the speed scale from 0 to 6000 feet per minute.

419-If the rate of climb is more than 400 feet per minute, the vertical speed shows as a digital value above the vertical speed indication

420-When the rate of descend is more than 400 feet per minute, the vertical speed shows as a digital value below the vertical speed indication

421-A magenta bug indicates the vertical speed selected in the MCP vertical speed window when the vertical speed mode is engaged.

422-The vertical speed tape turns red to indicate prohibited vertical speed values during a TCAS.

423-Vertical speed pointer changes to red if it is within the prohibited vertical speed range.

Failure flag

424-If the vertical speed data from air data inertial reference system fails, the vertical speed display is removed and the VERTICAL flag shows

HEADING AND TRACK INDICATIONS

425-The heading and track indications show on a partial compass rose at the bottom of the primary flight display.

426-The current heading shows as a triangular pointer at the top of the compass rose.

427-The selected heading shows with a bug and a digital readout as selected on the MCP.

428-If the selected heading exceeds the display range, the bug moves in the direction of the shorter turn to the heading and parks on this side of the compass rose.

429-A track pointer that extends from the center of the compass rose shows the current track

430-The heading reference to true or magnetic north is shown with a MAG or TRU indication.

431-When the display is oriented to true north a white box is indicated continuously around TRU annunciation.

432-When the display orientation changes from true north to magnetic north, a green box shows around MAG annunciation for 10 seconds.

Failure flag

433-When the heading data from the ADIRS fails, the heading display is removed and the HEADING flag shows

PRIMARY FLIGHT DISPLAY NON-NORMAL OPERATION

434-These are the primary flight display non-normal conditions. The airspeed disagree altitude disagree, and the angle of attack disagree

Airspeed disagree

435-If the Captain’s and First Officer’s airspeeds disagree by 5 knots or more for 5 seconds, the AIRSPEED DISAGREE message shows at the bottom of the speed tape.

436-When the airspeed disagree alert is displayed, adjust the airplane attitude and thrust to maintain airplane control. Verify that the PROBE HEAT switches are ON. Crosscheck the AIRSPEED/MACH indicators. Crosscheck the IRS and FMC ground speed and winds to determine airspeed accuracy.

Altitude disagree

437-When the Captain’s and First Officer’s altitudes are different by more than 200 feet for more than 5 seconds, the ALTITUDE DISAGREE message shows at the bottom of the altitude tape.

438-When altitude disagree alert shows, check the barometric settings of all altimeters. If needed, set the correct the barometric setting for the phase of flight. If the ALTITUDE DISAGREE alert extinguishes, continue normal operation.

439-If the alert stays illuminated, you can use the standby altimeter; but the airplane cannot meet RVSM airspace requirements.

440-The transponder altitude transmitted to ATC may be unreliable.

441-You should maintain visual conditions if possible.

Angle of attack disagree

442-When the Captain’s and First Officer’s angle of attack values disagree by more than 10 degrees for more than 10 seconds, the ANGLE OF ATTACK DISAGREE message shows.

443-Indication of the ANGLE OF ATTACK DISAGREE message may cause the AIRSPEED DISAGREE alert and ALTITUDE DISAGREE alert to be displayed.

NAVIGATION DISPLAY

444-In this part we will discuss the navigation display. Here is the outline: * Overview * VOR mode * Approach mode * Map mode * Plan mode * Navigation display advisory messages * Vertical situation display

OVERVIEW

445-The navigation display, or ND, normally shows on the Captain’s and First Officer’s inboard display units.

446-The navigation display has four modes: VOR mode, APPROACH mode, MAP mode and PLAN mode.

447-You use the mode selector on the EFIS control panel to select the navigation display mode.

448-The center switch lets you select the VOR, APPROACH and MAP modes between an expanded mode and a centered mode.

449-The range selector is used to select desired display range in nautical miles for VOR, APPROACH, MAP or PLAN mode

450-The VOR/ADF switch shows VOR or ADF information on all navigation modes except in PLAN mode.

451-The traffic switch lets you display TCAS information on the navigation display. The weather radar switch allows the weather radar data to show on the display. The TERRAIN switch is used to display terrain data from the GPWS terrain database.

452-Note that weather radar, terrain and TCAS data only show on the expanded VOR, expanded APPROACH, expanded MAP and center MAP modes.

453-The map switches let you show additional map information in the MAP mode.

VOR MODE

454-The VOR mode is used when tracking or referencing VOR radio navigation signals.

455-With a valid VOR station entered, set the mode selector on the EFIS control panel to the VOR position to show the expanded VOR display which is indicated with a partial compass rose.

456-With the mode selector in the VOR position, you push the CENTER switch to show the centered VOR display which is indicated with a full compass rose.

457-If you push the center switch again, the display changes back to the expanded mode.

458-Both displays present the same information and are oriented to heading-up. Let’s see the information displayed on VOR displays.

459-These are the heading orientation, current heading and pointer, and heading reference.

460-The heading reference is normally magnetic.

461-However, at high latitudes and certain regions around the magnetic poles, heading reference automatically changes to true. In some models, a white highlight box is displayed around the true indication.

462-The current groundspeed and true airspeed are shown on the top left corner of the display. The current true airspeed is displayed above 100 knots.

463-The wind data shows digital wind direction and speed above an analog wind direction arrow.

464-The wind data is displayed when the wind is greater than 6 knots. The indication blanks until true airspeed is more than 101 knots.

465-The reference for the wind direction is the same as the compass reference.

466-The reference VOR receiver frequency or identifier is displayed on the upper right corner.

467-The green bearing pointers show when the related VOR/ADF switch is in the VOR position.

468-When you move the VOR/ADF switch to the ADF position, the cyan ADF bearing pointer shows.

469-The Number 1 VOR/ADF bearing pointers are thin. The Number 2 VOR/ADF bearing pointers are thick

470-The bearing pointer source indicators located lower left or right corner show positions of the VOR/ADF switches on the EFIS control panel

471-The VOR or ADF frequency or identifier is displayed below the bearing pointer source indicators.

472-The DME indications show the DME distance to the related navaid.

473-The expanded VOR display shows similar indications within 90 degrees of compass rose.

474-The white track line indicates current track.

475-The track line also indicates the drift angle on the compass rose. In this example, the airplane is experiencing a right drift of 10 degrees.

476-The selected heading bug shows the MCP selected heading. In extended display, a dashed reference line extends from the airplane symbol to the bug.

477-If you select a heading which is not within the range of extended display compass rose, the bug does not show.

478-The selected course pointer displays selected course as set by the related MCP course selector. In expanded display, a selected course line extends from the pointer to the compass rose.

479-The course deviation bar and scale shows VOR course deviation,

480-TO/FROM display indicates VOR TO or FROM indication. The center VOR display also incorporates a TO/FROM pointer.

481-If you select weather radar map, TERRAIN map or TCAS switches on the EFIS control panel, the range arcs are displayed on the expanded VOR display. Now, let’s look at what happens on VOR display when you tune navigation radios

482-In this example, you are instructed to intercept a VOR radial 100 outbound.

483-Tune the VOR on the number 1 VHF radio panel. The VOR frequency and DME distance show on the display.

484-After the VOR identifier is decoded, the decoded identifier replaces the frequency.

485-Set the course on the MCP. The selected course and deviation show on the display. Fly to intercept and track the course.

486-With an ILS frequency tuned, if you select VOR mode, the amber EFIS MODE/NAV FREQ DISAGREE message shows, the VOR course deviation bar is removed and the DME display and VOR frequency at the upper right corner display dashes.

Failure flags

487-Now, let’s see the failure flags shown on VOR display

488-The DME 1 or DME 2 flag shows when a DME system fails.

489-The VOR or ADF flag shows if VOR or ADF data is not valid.

490-When heading information fails, heading displays are removed and heading flag shows.

APPROACH MODE

491-You select the approach mode to show approach data on an expanded compass rose.

492-With the mode selector in APPROACH position, you push the CENTER switch to show the center APPROACH display

493-The VOR and APPROACH modes are almost the same. The reference ILS frequency or ident, course and DME distance

are indicated on the upper right corner.

494-The localizer deviation bar and scale shows ILS localizer deviation. The deviation bar also shows integrated approach navigation final approach course deviation, if installed.

495-The bar fills when the deviation is less than 2.5 dots from center.

496-The glideslope position and deviation is displayed with a pointer and a vertical scale. It also shows integrated approach navigation glide path position and deviation if installed.

497-If you select weather radar map, TERRAIN map or TCAS switches on the EFIS control panel, the range arcs are displayed on the expanded approach display.

498-With a VOR frequency tuned, if you select the APPROACH mode, the amber EFIS MODE/NAV FREQ DISAGREE message shows, the localizer deviation bar and glideslope pointer are removed and the DME display and ILS frequency at the upper right corner display dashes.

Failure flags

499-Localizer deviation bar is removed and localizer flag shows when ILS localizer course indication fails.

500-When the glideslope data fails, glideslope data is removed and the glideslope flag shows.

MAP MODE

501-The MAP mode is the normal navigation display mode for most phases of flight.

502-This mode shows a plan view of airplane position relative to the FMC route of flight against a moving map background.

503-The FMC calculated position shows at the top of airplane symbol.

504-When you set the mode selector on the EFIS control panel to MAP position, MAP display shows in expanded format.

505-As you see, the MAP mode has many of the same features as the VOR and APPROACH modes.

506-However, the MAP display orientation is usually different than that of VOR and APPROACH displays.

507-In most B737s, the MAP displays are track-up oriented displays.

508-The MAP mode track shows at the top of the display and the current track line is always vertical.

509-The current heading is shown with an unfilled triangle.

510-The wind direction is indicated with respect to display orientation and current track reference.

511-A map source annunciation shows which FMC is supplying display data.

512-In some B737s, the lateral actual navigation performance, ANP, and required navigation performance, RNP, are displayed below the airplane symbol in MAP, CENTER MAP, VOR and APPROACH mode.

513-The lateral path deviation distance is displayed in MAP and CENTER MAP mode only

514-Whenever the actual navigation performance exceeds the required navigation performance, the ANP and RNP labels and values change to amber

515-Now, let’s see FMC route data indicated on the MAP display.

516-This is airport and runway symbol. It is displayed when selected as the origin or destination and the selected range is 80 nautical miles or more.

517-When the selected range is 40 nautical miles or less, the selected origin or destination airport and runway airport is displayed with this symbol

518-In this example, after takeoff you fly the FMC route and then land at the same airport.

519-With the origin and destination entered the airport symbol appears on the map display.

520-When you put the runway number in the FMC, the airport symbol is displayed.

521-The active route is displayed with a continuous magenta line between waypoints. A modified route is indicated with white short dashes between waypoints. The inactive route is shown with cyan long dashes between waypoints.

522-The offset route selected through FMC is displayed with dot-dash line parallel to the active route. Now let’s go back to example.

523-When you enter the route, the route shows as a dashed cyan line until it is activated.

524-With the route activated, the route line changes to magenta.

525-The next waypoint on the active route of flight, or active waypoint, is magenta. Other waypoints on the active route are cyan.

526-The modified waypoints are displayed in white.

527-This white circle shows a conditional waypoint. The conditional waypoints are discussed in a different lesson.

528-The identifier of the active waypoint, calculated ETA at the active waypoint, and the distance to the active waypoint shows on the upper right corner.

529-The range selector on the EFIS control panel lets you see more or less of the map.

530-If you want to look at the route that is behind you, select center map mode by pushing the center switch.

531-The center map mode shows the data in the same total range as expanded map mode.

532-However, the forward range is reduced to one half of the expanded range.

533-During turns, the position trend vector predicts the position of the airplane.

534-Each segment of the vector shows where you will be at the end of 30 seconds.

535-The number of segments indicated depends on the display range selected. For a range more than 20 nautical miles, 3 segments will show.

536-With the display range selected to 20 nautical miles, two segments will be displayed.

537-If the selected display range is equal to or less than 10 nautical miles, one segment will show.

538-The map mode also shows vertical flight data.

539-The green circles indicate the approximate map position of FMC calculated top of climb, top of descent, end of descent and step climb.

540-This green circle and identifier shows beginning of a deceleration segment for a holding pattern, a waypoint speed restriction, or flaps up maneuvering speed.

541-A green circle with no identifier shows the airport speed restriction deceleration point

542-This symbol indicates intermediate top of descent point for level flight path segments during descent.

543-The vertical navigation path pointer and deviation scale symbol indicates the vertical deviation from the selected VNAV PATH only during descent.

544-The pointer shows the FMC calculated VNAV path in relation to the airplane position.

545-The scale shows plus/minus 400 feet deviation.

546-If the deviation is more than 400 feet, the pointer parks at the scale limit and a digital readout shows.

547-In some models, the VNAV path deviation display incorporates a path deviation band and the vertical actual navigation performance and required navigation performance values.

548-The path deviation band is symmetric about the pointer and indicates vertical required navigation performance.

549-Whenever the actual navigation performance exceeds the required navigation performance, the ANP and RNP labels and values change to amber.

550-The MAP mode also displays an altitude arc during climb and descent.

551-The altitude arc shows where you will reach the altitude selected from the MCP.

552-The position of the altitude arc is determined based on the current groundspeed and vertical speed. The altitude arc indication is independent of any FMC computed climb or descent path.

553-Now let’s take a look at additional data that shows on the MAP and center MAP displays when you operate the map switches. You can select more than one switch at a time

554-When you push the STATION switch, all FMC database navigation aids are displayed if the selected range is 40 nautical miles or less.

555-When the selected range is more than 40 nautical miles, only the high altitude navaids are displayed

556-The navaids which are not being used are indicated in cyan. The tuned navaids are green.

557-Manually tuned VORs are displayed in green, with selected course and reciprocal, regardless of the STATION map switch selection.

558-You push the STATION switch again to remove the station data

559-When the WAYPOINT switch is selected, the waypoints in the FMC database which are not in the flight plan route show if the selected range is 40 nm or less.

560-When you select AIRPORT switch, all FMC database airports within the viewable map area are indicated.

561-The DATA switch lets you display altitude constraint and estimated time of arrival for each route waypoint.

562-You use the position switch to display VOR and ADF bearing vectors which extend from the nose of the airplane symbol to the stations.

563-With the position switch selected, the GPS position and IRS position also shows.

564-When you select the weather radar switch, weather radar returns and weather radar data show on the display.

565-The terrain switch lets you display the GPWS terrain data.

Failure flags

566-Now, let’s look at the failure flags shown on MAP display

567-The failures of input data cause data to be blank and failure flags to show. These flags show in the both the MAP and center MAP modes.

568-The MAP flag shows when the related FMC generated map display has failed,

569-The VERTICAL flag shows, if the FMC vertical track data is not valid

570-The DME, VOR or ADF flags are displayed when the related navigation radio data is not available.

571-The TRACK or HEADING flag shows when the related data fails.

PLAN MODE

572-When you set the mode selector on EFIS control panel to the PLAN position, the PLAN mode shows.

573-The plan mode indicates the active flight route with true north at the top.

574-You usually select the PLAN mode during preflight to review the route entered. You also use plan mode to see details of the route that you cannot see in the map mode.

575-The wind arrow is not displayed in the plan mode.

576-You can use the station, waypoint, airport and data map switches to show additional data on the display as you did before in the MAP mode.

577-The plan mode does not show weather radar data, GPWS terrain data and TCAS traffic data

578-The nose of the airplane symbol shows your present position.

579-A route waypoint is always at the center. The display shows the active route within a circle whose radius is equal to one half of the selected range. Now let’s see how you can review a route during preflight.

580-Before you activate the route entered, select the route LEGS page on the CDU.

581-Now, change the MAP display to PLAN mode. A map center label and a STEP prompt shows on the CDU.

582-The map center label indicates which waypoint is at the center of the plan mode. The STEP prompt allows you to change the waypoint at the center.

583-When you push the STEP prompt key, the next waypoint shows at the center of display.

584-When the STEP prompt key is pushed again, the next waypoint now moves to the center of display.

585-You continue to push the STEP prompt key to review the entire flight route.

Failure flag

586-Failure of map data from the FMC causes the MAP flag to show on the display.

NAVIGATION DISPLAY ADVISORY MESSAGES

587-When a new range has been selected on the EFIS control panel and new map data is not received from the FMC, all map data is blanked and the amber MAP RANGE DISAGREE message shows.

588-When FMC actual navigation performance exceeds the displayed required navigation performance, unable required navigation performance message shows in the MAP modes.

589-If the amount of information sent to the navigation display exceeds the display capability, the message EXCESS DATA is displayed.

590-When this occurs, the system removes some data from the display. You can clear the excess data message by removing the unnecessary navigation information, or reducing range, or deselecting one or more of the EFIS control panel map switches.

591-The navigation display also shows advisory messages related to weather radar, GPWS terrain, TCAS and predictive wind shear. These messages are discussed in different lessons.

VERTICAL SITUATION DISPLAY

592-The vertical situation display, or VSD, presents a clear graphical picture of the airplane’s vertical flight path for enhancing the flight crew’s vertical situation awareness.

593-The vertical situation display shows in the lower portion of the center map display.

594-With the center map mode set, push the center switch to show the vertical situation display.

595-An altitude reference scale is located on the left side of the display

596-The horizontal distance scale at the bottom displays the range in nautical miles. The range shown is one half the range selected on the EFIS control panel.

597-Bottom of airplane symbol indicates current airplane altitude with reference to the altitude reference scale. In this example, the current altitude is 4700 feet.

598-The nose of the symbol indicates current airplane lateral position relative to terrain.

599-The selected altitude digital readout and selected altitude bug with dashed line show the altitude set in the MCP altitude window.

600-The baro minimums pointer and line shows the barometric minimums selected on the EFIS control panel.

601-After the pointer is set with the BARO position, if you select RADIO, the green line is removed and only the pointer remains,

602-The vertical flight path vector shows current flight path angle as a function of vertical speed and ground speed. The length of the vector is fixed at one half of the display range.

603-The active waypoint ident with an anchor line is displayed in magenta. Other waypoints on the active route within the selected range are displayed white.

604-Different altitude constraint symbols are indicated in accordance with restrictions programmed in the FMC route LEGS page. These are the examples of waypoint altitude constraints.

605-The enroute swath indicates the area of the map that is shown on the vertical situation display.

606-Only waypoints and terrain within the enroute swath lines are displayed.

607-In this example, DME03 is outside the enroute swath and therefore not displayed on the vertical situation display.

608-During turns, the swath edge on the inside of the turn opens in the direction of the turn. DME03 will now show on the vertical situation display.

609-The enroute swath display is inhibited both on takeoff and approach when the airplane is within 6 nautical miles of the runway and less than 3000 feet above field elevation.

610-When the MCP vertical speed mode is selected, the vertical speed is indicated by a magenta dotted line on the display.

611-The vertical speed line shows the target angle which helps you adjust the required rate of climb or rate of descent

Vertical situation display-terrain indication

612-The terrain profile line represents the highest terrain within the enroute swath. The Vertical Support Lines are placed at constant intervals along the terrain profile line.

613-Terrain behind the airplane is drawn equal to the terrain at the current position of airplane.

614-The vertical situation display terrain uses the same color coding that is used to depict the EGPWS.

615-The vertical situation display will always show terrain profile regardless of the TERRAIN map switch position on the EFIS control panel. This lets you select weather radar on the navigation display and still have terrain profile on the vertical situation display.

Vertical situation display-approach

616-The range to target speed dot indicates where the airplane will achieve the FMC or MCP target speed both during acceleration and deceleration.

617-In this example, the airplane will reach the target speed of 250 knots in 6 nautical miles.

618-The dot is blanked when the airspeed is within 5 knots of the target airspeed.

619-If the target speed will not be achieved within length of the vertical flight path vector line, the solid dot is replaced with an unfilled dot.

620-This is the selected runway symbol which shows the runway altitude.

621-When an approach has a designated approach angle, the FMC approach glide path angle line is indicated on the vertical situation display. The line extends 10 NM for situational awareness. The line is anchored to the missed approach waypoint, not the runway.

622-A cyan 3-degree reference line is displayed for approaches that do not have a designated FMC approach angle. This line also extends 10 NM, but is anchored to the runway.

623-Two decision gates are displayed on the FMC approach glide path angle line or 3 degree reference line.

624-The first white gate is at 1000 feet and the second amber one is at 500 feet above field elevation. The gates show suggested points where airplane should be path and speed stable on approach.

625-Decision gates which are below the missed approach waypoint altitude will not be displayed.

626-When the airplane descends below the selected barometric minimum altitude, the baro minimums pointer and line change to amber. You can reset the barometric minimum altitude with reset switch on the EFIS control panel.

Failure flags and advisory messages

627-Now, let’s review failure flags and advisory messages show on the vertical situation display

628-The VSD flag shows when the vertical situation feature has failed.

629-The RUNWAY DATA flag is displayed when the FMC runway data is not available.

630-The VSD TERRAIN flag shows to indicate EGPWS terrain data is not available,

631-When the TERRAIN INHIBIT switch is set to the INHIBIT position, the flag is replaced with the VSD TERRAIN INHIBIT

632-The route waypoints modification annunciation comes on when the FMC active route is being modified. In this case, only the active waypoint is displayed.

633-If the map range set on the EFIS control panel does not agree with the FMC map range, MAP RANGE DISAGREE message shows.

634-If the terrain range set on the EFIS control panel does not agree with the EGPWS terrain range, TERRAIN RANGE DISAGREE message is displayed.

635-If the range selected on the EFIS control panel does not agree with both FMC map and EGPWS terrain range, MAP/TERRAIN RANGE DISAGREE message is displayed.

COURSE END

636-End of course.