B737 NG CBT - FMS - ROUTE MANAGEMENT

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.

FLIGHT MANAGEMENT SYSTEM- ROUTE MANAGEMENT

2-In this part we will be discussing how you can use FMS for route management. Here is the outline: RTE LEGS page Entering waypoint speed and altitude constraints Deleting waypoints Adding waypoints Creating new waypoints Leg bypass Direct TO and course intercept function Fix information page Offset function Holding function

ROUTE LEGS PAGE

3-PAGE The ROUTE LEGS pages let you review the route data, manage route restrictions and modify the route. Let's first look at data displayed on the page.

4-The LEGS pages show route data in more detail. Each waypoint along the route is displayed.

5-The first row shows data for the active waypoint in the flight plan. The other 4 rows show data for the subsequent waypoints.

6-The magnetic course to waypoint is shown above the name of the waypoint.

7-If the leg is a constant heading leg to a conditional waypoint, the course will be shown with the suffix HDG.

8-A true course which is usually required at high latitudes, is displayed with letter 'T' following the course indication.

9-These are the waypoint identifiers. The conditional waypoints are displayed in parenthesis.

10-The next identifier line beyond the end of the route shows dashes.

11-For the active leg, the page shows the computed distance from airplane to the active waypoint.

12-For all other legs, the computed distance between the waypoints is indicated.

13-The speed or altitude constraint at the waypoint is displayed in large font. The FMC estimated waypoint speed or altitude shows in small font.

14-If you want to see additional information about the route, use the ROUTE DATA prompt key.

15-The route data page shows ETA for each waypoint. The page also displays forecast wind data for cruise waypoints. Now let's go back to LEGS page again.

16-With the LEGS page displayed, if you select the PLAN mode on the EFIS control panel, the MAP CENTER STEP prompt replaces ROUTE DATA prompt.

17-A map center label is automatically displayed for the first geographically fixed waypoint on the displayed page. The navigation display shows the map with this waypoint in the center of the display.

18-When the STEP prompt key is pushed, the center label moves to the next geographically fixed waypoint and the corresponding waypoint is now shown in the center of the navigation display. This function lets you step through the active flight plan and review the data for each waypoint.

ENTERING WAYPOINT SPEED AND ALTITUDE CONSTRAINTS

19-You can use the LEGS page to enter speed or altitude constraints on climb and descend legs. Let's first see how you can enter a speed constraint.

20-Key in a constraint speed followed by slash in the scratchpad. Put it in related waypoint line. Execute the modification.

21-There are four types of altitude constraints. ‘At altitude’ constraint have no letters. ‘At or above’ altitude constraints are identified by the letter A. ‘At or below’ altitude constraints are identified by the letter B. ‘Window’ altitude restrictions use an A for lower altitude and a B for higher altitude. Window altitude restrictions cannot put in manually as they automatically come from the database.

22-Now let's enter this altitude constraint in LEGS page.

23-Type the constraint altitude on the scratchpad. No slash is required. Select the related waypoint line. Execute the modification.

24-In this example we will enter two constraints at the same time.

25-With the speed and altitude put in the scratchpad, select the related waypoint line. Execute the modification.

26-To delete speed and altitude constraints, push the DELETE key. Then select the waypoint constraints to be deleted. Execute the modification.

27-The LEGS pages are also used to modify the lateral route. These modifications include deleting and resequencing waypoints, adding waypoints, and intercepting a course.

DELETING WAYPOINTS

28-There are two normal methods to remove a waypoint from the ROUTE LEGS page. Using the DELETE key and resequencing the waypoints.

Deleting waypoints using del key

29-ATC has removed a waypoint from your flight plan. Push the DELETE function key. Select the waypoint to be deleted. Execute the modification.

30-Removing a waypoint using the DELETE key creates a route discontinuity. If the discontinuity is not connected, the FMC cannot provide guidance after BERGO and the airplane continues on the same course of previous leg.

31-To connect the discontinuity, copy KONEN into the scratchpad. Put it into the boxes. Execute the modification.

32-The discontinuity is now removed and the course guidance is available after BERGO. Note that active waypoint and some conditional waypoints cannot be deleted by delete key.

Deleting waypoints by resequencing

33-Other method of deleting the waypoints is resequencing the route. This method has two advantages over the use of DELETE key. It does not create a route discontinuity and allows you to remove more than one waypoints at a time.

34-In this example, ATC has removed two consecutive waypoints from your flight plan. Let's delete these waypoints by resequencing the route.

35-To delete waypoints, copy BIG into scratchpad. Put it over the first waypoint to be deleted. Execute the modification. The waypoints are now removed without a route discontinuity. The waypoints below BIG moves up.

ADDING WAYPOINTS

36-A new waypoint can be added to the route whenever necessary.

37-You may add a waypoint which is already in the navigation database. In some cases, you may have to create the waypoint to be added. Let’s first see how you can add a new waypoint from the database to the route.

Adding a new waypoint from database

38-In this example, a new waypoint is required after DUGLA

39-With the new waypoint placed into scratchpad, push the line select key after the DUGLA to insert the waypoint into the route at the required sequence.

40-Adding a new waypoint creates a route discontinuity. This time, let's link the discontinuity before executing the modification.

41-Copy the waypoint that has to follow the new waypoint into scratchpad. Put it into boxes and execute the modification. The route now is the same as your clearance.

CREATING NEW WAYPOINTS

42-When the navigation database does not contain the desired waypoint, you have to define it manually.

43-You can define four types of waypoints on the ROUTE or ROUTE LEGS pages. These waypoints are stored in temporary navigation database for one flight only.

Creating waypoints by latitude and longitude

44-Let’s start with defining a waypoint by latitude and longitude.

45-In this scenario, ATC directs you to a new point and you preferred to define it by latitude and longitude. Put the latitude and longitude in the scratchpad by observing the rules described in FMS Navigation Management section.

46-Now, place your entry into the route appropriately. As you see, waypoints defined as a latitude and longitude are displayed in a five-character format. The first three characters are WPT followed by a two digit sequence number. The first waypoint created by latitude and longitude has a sequence number of 01. The second waypoint defined as latitude and longitude would have sequence number of 02.

47-Connect the route discontinuity as you did before and execute the modification.

48-Other three types of waypoints can be created by a reference to another waypoint.

Creating place-bearing/distance waypoints

49-The Place-Bearing/Distance waypoint is defined as a bearing from a place or reference waypoint already stored in the database and distance along the bearing.

50-In this example, ATC directs you to YAKLO after KONEN. From your aeronautical chart you find the waypoint is located on the 098 radial of the CNK VOR/DME at 36 nautical miles.

51-To create this place- bearing distance waypoint, enter the data as shown in the scratchpad.

52-Put your entry into appropriate route sequence by line selecting.

53-The place-bearing distance waypoints are identified by a five-character name. It uses the first three letters of the reference waypoint followed by a two-digit sequence number.

54-The first waypoint created from a reference waypoint is displayed with sequence number of 01. Second waypoint created from the same reference waypoint has a sequence number of 02. When the quantity of numbered waypoints exceeds 99, the identifier uses the first three letters of the reference waypoint followed by a three-digit sequence number. Now, let’s go back to our example.

55-Correct the discontinuity. Push the EXECUTE key to activate the route modification. Now your route is the same as ATC clearance.

Creating place-bearing/place-bearing waypoints

56-The Place-Bearing/ Place-Bearing waypoint uses two reference waypoints and the bearing from each waypoint.

57-Let's now use Place-Bearing/Place-Bearing method to create the same waypoint in the previous example.

58-From your aeronautical chart you see that YAKLO is also defined as the intersection of the CNK 098 radial and the BIG 210 radial.

59-To make a place- bearing/place -bearing waypoint, enter the data as shown in the scratchpad.

60-Put your entry into appropriate route sequence.

61-The first reference identifier entered in the scratchpad is used to name the created waypoint. For instance, if BIG was first put in, then the waypoint would be named BIG01.The sequence number assignment is the same as the Place-Bearing/Distance waypoint.

62-Now let's erase the modification and look at the last type of created waypoint.

Creating along track waypoints

63-Along-track waypoints are defined on the current route and do not create a route discontinuity. The reference waypoint must be part of the current active route.

64-These waypoints are defined using the reference waypoint identifier followed by slash. For a long track waypoints after the reference waypoint, distance with no sign must follow the slash. For points before the reference waypoint, a minus sign must be inserted in front of the distance.

65-Now, let's enter this along track waypoint

66-Put the data as shown in the scratchpad.

67-Insert the created waypoint over the reference waypoint. The FMC automatically places the created waypoint to appropriate position. Since along track waypoints are part of the existing flight plan, there is no route discontinuity.

68-Now, select execute key to activate the route modification.

LEG BYPASS

69-When an entered waypoint is very close to another route waypoint, it is impossible for the airplane to turn and capture the leg between these two waypoints. In this case, the FMC generates a bypass notification

70-Let's enter this place- bearing distance waypoint with reference to CNK VOR/DME and sequence it after KONEN. Put the data in the scratchpad and enter it into appropriate route sequence as you did before.

71-Now, connect the route discontinuity. A leg bypass notification is generated between entered waypoint and the next

route waypoint. This tells you that FMC bypasses the affected waypoint and uses alternative turn construction to intercept that leg

DIRECT TO AND COURSE INTERCEPT FUNCTION

72-The route legs page also lets you fly from your position to a waypoint or intercept a course.

Proceeding direct to a waypoint

73-To fly direct to a waypoint which is already in the active flight plan, copy the desired waypoint identifier into scratchpad and put it over the active waypoint.

74-The direct course from airplane current position to entered waypoint is shown here. The intercept course line shows FMC default leg direction to entered waypoint. The default leg direction is the original flight plan course to that waypoint and displayed in small font.

75-Now, push the execute key to fly direct course to entered waypoint.

76-In some cases, you may need to fly direct to a waypoint which is not in the active flight plan. To achieve this, key-in the waypoint identifier into scratchpad and put it over the active waypoint.

77-The direct course to entered waypoint again shows here; but the intercept course line displays dashes. Since the entered waypoint is not a part of active flight plan, a route discontinuity is created. Thus you must connect the route discontinuity and execute the modification.

78-Connect the route discontinuity as per ATC instruction. Execute the modification.

Intercepting a course to a waypoint

79-Now, let’s see how you can intercept a course to a waypoint.

80-In this example ATC has given you a course to a waypoint that you must intercept. To obey the clearance, you turn to a heading of 270

81-Next, enter given waypoint over the active waypoint as before.

82-ATC clearance refers to the 195 degree radial of the waypoint. Thus the inbound intercept course is 015 degree which is the reciprocal of the radial.

83-Put the inbound intercept course of 015 degree in the intercept course line. The intercept course now shows above CNK and intercept course line.

84-Now, connect the route discontinuity in accordance with ATC clearance.

85-As usual, the last step is to execute the modification.

86-Note that if you execute the modification before turning a heading within the LNAV capture criteria, LNAV disengages and NOT ON INTERCEPT HEADING scratchpad message is displayed. Then, you should adjust the heading as required and reengage the LNAV.

FIX INFORMATION PAGE

87-The fix information page is used to show the current bearing and distance from a selected reference point which can be a navaid, a waypoint, an airport or a runway from the navigation database.

88-The fix information page is accessed through FIX key. There are two identical fix information pages and you can identify a different fix in each page.

89-To identify a fix from navigation database, type the fix identifier in the scratchpad and put it in boxes.

90-The selected fix is displayed on the navigation display.

91-The radial and distance from the fix to the airplane is shown in this line. This information is continually updated as the airplane position changes.

92-When you select ABEAM prompt, the map displays a radial from the selected fix, which crosses the route leg perpendicularly.

93-The intersection of this radial and the route leg is the abeam point. The page shows estimated time of arrival, distance to go and altitude at the abeam point.

94-The radial distance entry prompts let you enter radials and/or distances from the selected fix.

95-When you enter only radial, it is shown on the navigation display as green dashed lines from the fix. If he radial intersects the active route, the estimated time of arrival, distance to go, and predicted altitude at the intersection are displayed on the fix information page.

96-You must insert a slash in front of your entry, if you put in only distance. When the distance is entered, it is shown on the navigation display as a dashed green circle around the fix. If the distance intersects the active route, the estimated time of arrival, distance to go, and predicted altitude at the intersection are displayed on the fix information page.

97-You can also enter both radial and distance. When you enter a radial and distance from the fix, the time, distance and altitude data are not displayed.

98-If desired, you can push the line select key next to any of the fix entries to copy it into the scratchpad. This lets you insert the fix into the route on the LEGS page as a waypoint.

99-Note that any entry made in the fix information page can be removed by using delete key.

OFFSET FUNCTION

100-The OFFSET function allows to fly parallel to the original track between two waypoints in a portion of the route. You may use offset function to avoid a weather condition or to obey offset flight track assignments from ATC.

101-These legs are invalid for offset.

102-You use lateral offset page to specify a lateral offset up to 99.9 nautical miles left or right of original course in 0.1 nautical mile increments.

103-The offset page can be accessed from the initialization reference page on ground and in flight. The page can also be accessed via route page in flight.

104-Let’s put in a lateral offset of 8 nautical miles left of the course between given waypoints.

105-Type the desired lateral offset distance and direction on the scratchpad and put it in the offset distance line. Start and end waypoint fields appear on the page.

106-Enter the waypoint where the offset will begin.

107-Next, enter the waypoint where the offset is to end.

108-Push the EXECUTE key to activate the offset route. The route page now shows active offset route.

109-If no start/end waypoint is entered, offset will begin and/or end at first/ last valid offset leg.

110-When FMC cannot construct a valid offset due to geometric limitations, the scratchpad message UNABLE TO OFFSET is displayed. Clear the message a change the route as required.

111-When the airplane begins to fly the offset route, the offset annunciator on the CDU comes on.

112-Two minutes before passing offset leg termination, the scratchpad message END OF OFFSET shows. You should confirm the clearance.

HOLDING FUNCTION

113-Holding is a predetermined maneuver that keeps airplane within a specified airspace while awaiting further clearance from ATC.

Overview

114-The FMC computed holding patterns have constant radius turns and are constructed based on current winds and FMC commanded airspeed.

115-The pattern size is limited to FAA or ICAO protected airspace which is directly proportional to the holding speed.

These are the ICAO and FAA maximum holding airspeeds designated for specific altitude ranges

116-Depending upon the angle between the flight plan leg into the holding fix and the holding inbound course, the teardrop, director parallel holding entry method can be used.

117-You start reducing to holding airspeed when you are 3 minutes from the holding fix. This lets the airplane cross the holding fix initially at or below the maximum holding airspeed and prevents overshooting the holding airspace limits.

118-Upon entering a holding pattern, the initial outbound leg is flown for 1 minute at or below 14,000 feet, and for 1.5 minutes above 14,000 feet. You should adjust timing for subsequent outbound legs as necessary to achieve proper inbound leg timing.

119-If the FMC holding speed is greater than the ICAO or FAA maximum holding speed,holding may be conducted at flaps 1, using flaps 1 maneuver speed; but this will increase the fuel consumption.

120-If holding speed is not available from the FMC and time does not permit immediate reference to the QRH, you can use following guidance to approximate holding speed until more accurate speed is obtained from the QRH. At low altitudes, use flaps up maneuver speed which provides minimum fuel burn speed. Above Flight level 250, use VREF 40 + 100 knots to provide at least a 0.3 g margin to initial buffet.

121-You use the HOLD page to modify, review or insert a holding pattern in the flight plan

122-If the active route does not contain a holding pattern, when the HOLD function key is pushed, the ROUTE LEGS page shows with HOLD AT line.

123-The HOLD AT line lets you make a holding pattern fix at the airplane's present position or any other waypoint.

Creating A Holding Fix At Present Position

124-Let’s make a holding fix at the airplane's present position.

125-Select present position prompt. The page changes to the HOLD page.

126-The FMC assigns PPOS as the holding fix identifier.

127-The page shows data for a standard holding pattern along your route. This line displays holding pattern quadrant and radial. These are the valid quadrant entries.

128-The holding pattern inbound course and turn direction are displayed here. The default inbound course is the flight plan course and FMC assumes right turns. The default inbound course and turn direction can be overwritten manually.

129-If no entry is made, the leg time line shows 1 minute at or below 14000 feet and 1.5 minutes above 14000 feet.

130-The leg distance line normally shows dashes. If a leg distance is manually entered, then leg time line displays dashes.

131-The speed and target altitude line shows the current speed and altitude in small font.

132-This line shows computed time for next passage over holding fix.

133-Expect Further Clearance Time line lets you enter the time at which the holding pattern is exited. This will help the FMC optimize performance computations.

134-The hold available line shows available holding time in hours + minutes remaining to reach the destination with the planned fuel reserves.

135-The computed best holding speed for the current altitude, gross weight and flap position is displayed here. You must verify that the speed obeys the ATC holding rules.

136-When you select the execute key, the airplane immediately turns to start holding.

137-The ERASE prompt is replaced by the NEXT HOLD prompt if the route contains less than five holding patterns and there is no route modification in progress. When the prompt is selected, the ROUTE LEGS HOLD AT page shows to let you enter a new holding fix.

Creating on route holding fix

138-Now, we look at making a holding fix that is in the active route.

139-Push the HOLD key. The missed approach holding pattern is shown because it is already in the active route.

140-Select the NEXT HOLD prompt to enter a different holding fix. Now, put the fix identifier into boxes.

141-Since the fix is a route waypoint, the FMC creates the holding pattern with the flight plan course to the fix. There is not a route discontinuity. Execute the modification.

142-To delete a holding pattern, push the delete key. Line select the HOLD AT waypoint.

143-Now, you must connect the route discontinuity. Execute the modification.

Creating off route holding fix

144-You can make a holding fix that is not in the active route.

145-Push the HOLD key to show route legs hold at page. Key in the fix identifier in the scratchpad and put it into HOLD AT boxes.

146-HOLD AT CNK message appears in the scratchpad. This is because the entered fix is not a waypoint in the active

route.

147-Now place the holding fix into the route in accordance with the ATC clearance. The page changes to hold page which shows the same data as the hold page that appears when creating holding fix at present position. The holding pattern dimension is small to prevent clutter.

148-nbound course is the same as the preceding leg to the fix, when there is no published holding pattern.

149-In this example, your clearance is to hold on the 144 degree radial. Thus, enter 324 degree into inbound course line. The FMC constructs a standard holding pattern with an inbound course of 324 degree. Use the execute key to activate the modification.

150-Now, let's go to the LEGS page. The entered holding fix is displayed as a new waypoint on the line you selected. The holding pattern is on the next line.

151-Entering a holding fix which is not on the existing route always creates a route discontinuity after holding. You must connect the discontinuity and execute.

152-Now let's go back to hold page. As you recall this line displays the best speed for holding which is moved by the FMC to speed line.

153-You can change the holding speed on the HOLD page or on the LEGS page by observing the ATC holding speed limits.

154-Let's put in a holding speed of 240 knots on the HOLD page. Execute modification.

155-Manual speed entry is displayed in large font and reflected to LEGS page.

156-When the airplane is 3 minutes away from the fix, the FMC starts to decrease airspeed to holding speed. Holding pattern expands to normal size on navigation display.

157-When you arrive at the fix, holding page becomes active

158-The FMC automatically computes the holding pattern entry method. In this example, direct entry method is computed.

159-Depending on the angle between the track to the fix and selected inbound course, FMC computes teardrop or parallel entry method as necessary.

Exiting holding pattern

160-When you are in the holding pattern, the HOLD page shows EXIT HOLD prompt.

161-With the hold departure clearance received, select the HOLD EXIT prompt. The prompt changes to EXIT ARMED. LNAV

route changes back to the holding fix via a shortened holding pattern.

162-When you push the execute key, EXIT ARMED prompt is highlighted. The airplane turns to the inbound leg, but stays in holding speed and altitude.

163-At holding fix the airplane departs from holding pattern, accelerates to cruise speed and continues the flight along the active route. ACTIVE ROUTE LEGS page appears after holding is exited.

COURSE END

164-End of course.