B737 NG CBT - FMS - DESCENT

COURSE OUTLINES

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COURSE START

1-The material contained in this training program is based on the information obtained from current national, international 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- DESCENT

2-This chapter deals with the FMS operation in descent. Here is the outline: * Introduction * Descent forecast page * Descent pages * Early descent * Descent modifications * Unforecast winds

INTRODUCTION

3-The descent is the phase of the flight between the top of descent point and the end of descent point.

4-The FMC constructs the descent path upward, beginning at the end of descent point up to the final cruise altitude

5-The end of descent is the last waypoint with an altitude constraint in the descent, the runway threshold or the missed approach point for approaches without a runway waypoint.

6-The FMC computes the initial segment of the path based on the approach vertical angle coded in the navigation database.

7-With the approach segment computed, the FMC constructs a vertical profile for a descent with idle thrust, flaps and gear up and speed brakes retracted to determine a top of descent point.

8-The FMC then refines the descent profile and top of descent for the airport speed restrictions, waypoint speed and altitude constraints, temperature, the forecast descent wind inputs and forecast use of anti-ice.

9-There are two types VNAV descent: path descent and speed descent.

10-The path descent is the most economical descent method. The autopilot flight director system controls the pitch to hold the FMC descent path. The autothrottle sets the thrust to idle. You must monitor the descent and adjust the speed when necessary.

11-The speed descent is more flexible, but less economical than path descent. During the speed descent, the autopilot flight director system controls the pitch to maintain the FMC target descent speed. The autothrottle sets the thrust to idle. You must monitor the descent and adjust the rate of descent to stay on the desired descent path when necessary.

12-Note that both path and speed modes comply with altitude and speed restrictions in the flight plan.

13-Planning for the descent phase starts during cruise. You use the DESCENT page and DESCENT FORECASTS page for

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pre–descent planning.

14-You can access the descent page by selecting the DESCENT function key.

15-During cruise, the descent page is used to revise or select the descent mode or to initiate an early descent when needed. The page also lets you access to descent forecast page. Let's first take a look at descent forecast page.

DESCENT FORECAST PAGE

16-You push the line select key next to the FORECAST prompt to select the descent forecast page. The page allows you to enter forecast data to refine the FMC descent path calculation.

17-The transition level line normally shows flight level 180 as the default descent transition level. The display changes automatically when an arrival procedure with a different stored value is entered.

18-The thermal anti-ice line lets you enter the altitudes at which anti–icing is expected to be turned on and off.

19-This line shows the predicted cabin rate of descent required by the flight plan descent profile.

20-Other entries that can be made are ISA deviation, QNH, and wind direction and speed for up to three descent altitudes.

21-Let's put in an ISA deviation and QNH. The page title changes to modified and the execute light comes on. Note that you cannot enter a QFE altimeter setting.

22-Now, enter the wind data for flight level 240. Put the forecast wind direction and speed in the scratchpad and move it to the related data line. You may enter up to 3 winds in any sequence. With your entries complete, execute the modification.

23-When you go back to the cruise page, you will see that the distance to the top of descent has changed because the FMC has modified the descent profile.

DESCENT PAGE

24-As it is mentioned earlier, one of the uses of the descent page during cruise is to review and select the descent mode. The page title displays the mode. These are the available descent modes: economy path descent, economy speed descent, manual speed descent and RTA descent.

Path descent

25-The ECONOMY PATH is the default descent mode. As you recall, in this mode the FMC controls the pitch to stay on the descent path. Note that the path descent is available only when there is a defined end of descent point.

26-You must initiate a path descent while within the allowable cross–track error for LNAV. However, during the descent, it

is possible to disengage LNAV while remaining in the path mode.

27-During cruise, when you are five miles from the top of descent, the scratchpad message RESET MCP ALTITUDE shows.

28-After receiving the ATC clearance, you reset the MCP altitude.

29-With the MCP altitude reset, when you reach the top of descent point, the FMC commands idle thrust and pitch mode remains in VNAV PATH to track the descent path. The cruise page automatically changes to descent page.

30-The page title shows active to indicate that the descent phase is active. The end of descent altitude is displayed here. If path descent is not available, the display is blank.

31-The end of descent altitude is the altitude restriction for the end of descent waypoint.

32-If an approach with a runway waypoint is selected, the end of descent altitude will be runway elevation plus threshold crossing height.

33-The target speed line shows command Mach and airspeeds as the airplane proceeds through the descent path.

34-The vertical deviation line displays present deviation in feet high or low from the computed descent path.

35-During a path descent, if you are above the descent path and the FMC predicts that the restrictions at the next waypoint cannot be achieved, the CDU message DESCENT PATH UNACHIEVABLE shows. This does not affect the LNAV and it remains engaged; but you need to modify the restrictions.

36-The next waypoint with altitude constraint is displayed here. The constraint data comes from the ROUTE LEGS page. If there is no altitude constraints, the display is blank and a path descent is not available.

37-This line shows the estimated time of arrival at and distance to go to the constrained waypoint.

38-The waypoint/altitude line shows the waypoint and altitude for which the vertical path data displayed on the next line.

39-On the vertical path data line, the flight path angle shows the current flight path angle being flown.

40-The vertical bearing indicates the required flight path angle if you are flying direct to the waypoint/altitude on the upper line.

41-The vertical speed displays the required vertical speed in feet per minute to achieve the vertical bearing value indicated.

42-The speed restriction line displays the speed restriction at the destination airport.

43-The navigation display shows you where the deceleration will start and stop to meet the speed restriction.

44-Note that the FMC targets a speed 10 knots less than airport speed restriction value. This provides a protection for small airspeed changes.

45-When you are close to the destination airport, the line shows flaps up maneuvering speed followed by the word FLAPS.

46-When the flaps are extended, the line shows the appropriate speed for the flap position. The flap speed overrides any other speed restriction

47-If you are performing an ILS approach, upon capture of the glide slope, the VNAV disengages and the speed display on the MCP opens.

Rta descent

48-If there is an RTA waypoint in descent, you select the RTA descent pages. On the RTA descent pages, the distance and time is replaced by the time error. The target speed displays computed RTA target speed.

Speed descent

49-Another descent mode is the ECONOMY SPEED. Since the FMC defaults to a PATH descent, you usually have to select it when a speed descent is necessary.

50-Note that with no end of descent point specified, the speed descent is the only descent mode available.

51-You push the line select key next to SPEED prompt to select the speed descent. The page title shows MODIFIED ECONOMY SPEED DESCENT. Execute the modification.

52-With the MCP altitude reset, when you reach the top of descent, the FMC automatically commands a speed descent.

53-The thrust is set to idle and the pitch mode changes to VNAV SPEED.

54-The speed descent page is mostly the same as the path descent page. However, the descents are different.

55-In speed descent, the FMC holds a fixed speed by controlling the pitch. It does not attempt to maintain the path; thus it is your responsibility to stay on the path. You can control the path using speedbrakes or thrust when necessary.

56-You don't have to be close to the LNAV path in order to initiate a VNAV speed descent. It can be flown with any roll mode.

57-When you are at waypoint with an altitude constraint, the FMC commands level flight until you pass the waypoint. The trust temporarily increases to keep the target speed and the pitch mode temporarily changes to VNAV PATH. Thus, although speed descent complies with altitude constraints, it will not guarantee the airplane reaches the altitude

restriction at the required point.

58-The FMC commands lower speeds for approach and flap extensions as it does in path descent.

Manual speed descent

59-In some cases, you may need to modify the descent speed schedule. The FMC then computes a new descent path and top of descent.

60-To change the descent speed, select the descent page and key–in the desired speed in the scratch pad. Then push line select key next to the TARGET SPEED line. Execute the modification

61-The page title reflects the selected descent speed. The target speed line shows the selected speed.

62-The FMC calculates a new VNAV descent path. Since a slower descent speed is selected in this example, the top of descent moves closer to you.

EARLY DESCENT

63-An early descent is a descent in VNAV started before the top of descent point.

64-You can initiate a VNAV early descent by setting a lower altitude and then pushing the altitude intervention switch on the MCP. This method is discussed in a different lesson.

65-Other method to initiate an early descent is to use DESCENT NOW prompt on the DESCENT page.

66-If ATC asks you to descend before the top of descent point, set the clearance altitude in the MCP altitude window. Then select the descent page.

Early vnav path descent

67-In this example, the descent page shows that a VNAV path descent is planned. Now, push the line select key next to descent now prompt.

68-With the modification executed, the FMC commands a 1000 feet per minute descent until the planned idle descent path is captured. The autothrottle mode is FMC SPEED and the pitch mode is VNAV PATH.

69-When the planned idle descent path is captured, the FMC commands idle thrust while maintaining VNAV PATH for the pitch mode to follow the path.

Early vnav speed descent

70-Let's now initiate an early VNAV speed descent. With the MCP altitude reset and descent page displayed, select speed descent before initiating the early descent.

71-Next, select the descent now prompt. When you execute the modification, the FMC commands an idle thrust normal rate of descent. As you see, this path is not intended to capture the planned descent path, but to hold the target speed.

72-The pitch mode changes to VNAV SPEED while the autothrottle maintains idle thrust.

VNAV DESCENT MODIFICATIONS

73-Now, let's take a look at how you can modify the speed and/or altitude restrictions in the descent profile, when needed.

Deleting waypoint speed /altitude restriction

74-You can delete the altitude constraint on the DESCENT page or the ROUTE LEGS page. Let's use the DESCENT page to delete the constraint.

75-Push delete key to enter DELETE in the scratch pad. Then select the line select key adjacent to the constraint. Execute the modification.

76-The ROUTE LEGS page also shows the deletion. Now, the FMC calculates a new descent path.

Changing speed and/or altitude restriction

77-Now let's change the speed and/or altitude restriction during descent.

78-With the new speed/altitude restriction put in the scratchpad, push the line select key next to the speed restriction line. Execute the modification. Now, the descent profile is modified in accordance with the new speed restriction.

UNFORECAST WINDS DURING VNAV DESCENT

79-During a VNAV descent, an unforecast headwind or tailwind will affect the descent performance. Let's first see effect of unforecast tailwind on VNAV descent.

Unforecast tailwind

80-In this example, a path descent is in progress and target speed is the active controlling speed.

81-If an unforecast tailwind starts to blow, the FMC commands pitch to maintain the descent path, but the airspeed will be higher than the target speed.

82-When the speed increases 10 knots or more above FMC target speed or within 5 knots of Vmo/Mmo, the scratchpad message DRAG REQUIRED is displayed.

83-You can use the speedbrakes to increase drag and reduce the airspeed to the target.

84-Now consider the case where the unforecast tailwind blows when the speed restriction is the active controlling speed.

85-If you let the airspeed exceed the speed restriction by more than 15 knots, VNAV disconnects.

86-The OVERSPEED DISCONNECT message shows on the scratchpad. You should manually reduce speed and reengage the VNAV.

87-Now, let's look at unforecast tailwind condition for a VNAV speed descent.

88-The FMC commands pitch to maintain the target speed; but the tailwind pushes the airplane above the descent path. You can use the speedbrakes to return the VNAV path.

Unforecast headwind

89-If an unforecast headwind starts to blow during a VNAV path descent, the FMC commands pitch to keep the descent path, but the airspeed will go below the target speed. You can use thrust to increase airspeed back to target

90-In the event of unforecast headwind during a speed descent, FMC commands pitch to keep target speed, but the headwind causes the airplane to go below the VNAV path. You can use the thrust to recapture the path.

COURSE END

91-End of course.