# B767 FMS STEP CLIMB

Step climb calculations depend upon prior calculation of the required profile for the current cruise altitude and the active route. This profile is based on scheduled speeds and cost index, beginning with current gross weight.
If no wind or temperature forecast is entered, it is based on still air and zero ISA deviation prior to takeoff. In flight, the currently measured ISA deviation is extrapolated to all waypoints in the flight plan through the end of the flight. The actual wind is resolved into a headwind or tailwind component which is washed out to half its value in 200 NM during cruise or in 5000 ft during climb or descent. Beyond these points it continues to wash out exponentially.

Entering wind forecasts will make the active flight plan profile prediction more precise. This can be done in two ways; An overall average wind entered on the PERF INIT page will be treated as a forecast of cruise wind. A wind forecast entered opposite a cruise waypoint on the RTE DATA page overrides the overall wind forecast from that waypoint on.
In fact, it is retained for the remainder of the cruise segment until the next waypoint with a wind forecast entry. Therefore, wind forecasts can be precisely reflected in the FMC by entering winds opposite the cruise waypoints they take effect. They need not be entered at each waypoint, only those where there is a significant change in the forecast. These entries affect only the active or provisional route fuel/cost predictions.

If no descent wind forecast is entered, the cruise wind at top of descent is assumed to decrease linearly to zero at ground level. Forecast winds can be entered for up to four flight levels on the DES FORECAST page. Wind is assumed to vary linearly from top of descent cruise wind to each of the entered forecast at the specified altitudes.

In flight, actual wind is washed out as described above except that it is washed out to the appropriate forecast value instead of still air. In all cases, the forecast winds are entered as a direction and magnitude. The FMC resolves them into components along the specified route.

ISA deviation can be forecast during preflight by entering either an ISA deviation or an OAT at top of climb. This forecast is superseded by the propagation of current ISA deviation described above when the aircraft is approximately midway through the climb.

In summary the profile prediction for the active route and cruise altitude can essentially be made as precise as the forecasted data permits.

The best step climb point is computed by determining the distance along the route at which a step climb to the STEP TO altitude would provide maximum savings in cost for the ECON schedule, or in fuel for LRC or crew selected speed schedule. This saving is relative to the cost or fuel associated with the active profile prediction. In order to keep crew entry of forecast wind at the STEP TO level manageable, provisions are made for a single wind entry only. This EST WIND on the CRZ page is assumed to apply to the entire remaining cruise segment flown at the higher altitude. If an estimated wind is not entered, the measured (actual) wind adjusted by fore cast cruise wind, using the above described function, is used.

The wind assumed for the STEP TO level is resolved into an along track component by averaging top of step climb and top of descent track angles.
The winds used for predicting the fuel used at the present altitude from the present position to the step point are a prediction based on the present wind.

Time and fuel adjustments are made to account for the additional climb and descent segments. The best step point is found by minimizing cost or fuel for the step profile for step points ranging from top of climb to a point 200 NM prior to top of descent. It is blanked on the CDU when it is more than 999 NM away or when the STEP TO altitude is above the maximum attainable altitude.

The savings/penalty is calculated by comparing the trip cost (ECON) or fuel (LRC or selected speed) for the step profile with that for the active profile. For short-haul straight-line flights, the value will be as accurate as the forecast wind entered. However, it can be compromised if the EST WIND entered (or the measured wind) is not a reasonable average for the remaining cruise segment.
A long-haul routing containing large track changes, such as might be the case when flying great circle tracks or in areas where ATC places restrictions on direct tracking, can introduce a significant error in EST WIND component because of the track angle averaging. A track angle adjusted wind direction helps to alleviate this problem.
This would be accomplished by entering a wind which would best reflect the wind relative to a track angle which is the vector average of the top of step climb and top of descent tracks. Since relatively minor changes can dramatically move the best step point and measurably affect the savings/penalty, inconsistent wind forecasting will be the most likely cause of apparent step climb anomalies.

The optimum altitude displayed on the CRZ page does not account for winds, flight plan constraints or trip length (for trips over about 400 NM). It may therefore appear to disagree with the best step point when a significant wind change exists.

In summary, the step climb function will work correctly for normal short-haul routings when there is no large track changes around top of step climb and top of descent and when reasonable care is used in entering forecast winds and estimated step climb wind.

On a typical long-haul routing, where forecasted winds have been entered, a much better method of estimating the effects of a step climb is to enter the STEP TO altitude in the CRZ ALT position on the CRZ page, without executing the change. The FMC will then calculate each route segment at the STEP TO altitude individually, using the forecasted wind entered on the cruise data page. When the calculation is complete it will be presented as a new ETA and a new remaining fuel at destination. The pending mode can then be erased.

The third alternative is of course to fall back on the JETPLAN calculated step point and to verify this by use of climb tables.