737 MAX: Initial assessment

Although there are limited details, Boeing claims the 737 MAX will offer a 7% operating cost advantage over competing aircraft. The ways in which this is could be achieved are examined.

Boeing's response to the A320neo has been a simple re-engining programme for three of the four variants of the 737NG family. The 737 MAX has been launched with apparent commitments for 498 aircraft from five airlines. American Airlines has ordered 100, but the identity of the other airlines has not been revealed.

The 737 MAX revolves around re-engined versions of the 737-700, -800 and -900 through utilisation of CFMI's LEAP-1B engines; a variant of the LEAP-X. This is clearly a similar strategy to Airbus's re-engined A320 programme; the A320neo. Neither manufacturer is clearly in the position to launch an all-new aircraft programme. This is probably explained by the lack of a clear vision of what aircraft configuration the industry will require in the future, in addition to a fundamentally new powerplant configuration not yet being available.

Boeing claims the 737 MAX, which will first enter service in 2017, is expected to burn 16% less fuel than the current A320 family members, and 4% less fuel than the A320neo family members; which are powered by either the Pratt & Whitney PW1100G, or a variant of the CFMI LEAP-X. The A320neo is scheduled to enter service just one year earlier than the 737 MAX.

The LEAP-X is an optimised two-shaft turbofan which will have variants with thrust ratings similar to the CFM56-5B series. The LEAP-X has optimised a conventional two-shaft configuration by generating a high core pressure ratio of 20:1, which increases the combustion inlet temperature. This high pressure ratio and high combustor inlet temperature allows the engine to turn a 78-inch diameter fan; which is 10 and 17 inches wider than that used by the CFM56-5B and -7B series. The LEAP-X's fan also utilises wide-chord swept fan blades and turns at a low speed, and so overall is expected to achieve a bypass ratio of 12:1. The LEAP-1B will have either a 66-inch or 68-inch fan diameter. Either of these fan diameters means the aircraft will not require any change to its landing gear to maintain satisfactory ground clearance with the engine nacelle. Some modification will be needed to the airframe, however, because of the effect of the larger engine on increased drag.

The overall effect of the LEAP-X's design configuration is to achieve an expected 15% lower fuel burn than the CFM56-powered A320 and 737NG families. The LEAP-1B is expected to have a 10-12% lower specific fuel consumption (sfc) over the CFM56-7B-powered 737NG.

This partially explains Boeing's expectation that the three 737 MAX family members will have a 16% lower fuel burn than their counterparts in the current A320 family; the A319, A320 and A321. The 737 is also likely to have some modifications to parts of the fuselage to effect a reduction in drag.

The lower fuel burn would also translate into an increase in range with fuel capacity maintained.

The LEAP-X's high bypass ratio will naturally translate into lower noise emissions, and so the 737 MAX and A320neo will both benefit from low noise emissions, as will the PW1100G-powered A320neo. The LEAP-X's high combustion temperatures also means its NOx gaseous emissions will also be lower than current generation engines.

The three 737 MAX variants will be the MAX 7, MAX 8 and MAX 9. These will retain the fuselage and seat capacities of the 737-700, -800 and -900 models.

Besides the expected reduction in fuel burn, the only major possible reduction in operating costs could come from maintenance costs. The LEAP-X's configuration could compromise its maintenance costs in relation to the CFM56. The LEAP-X will have one more high pressure compressor, one more high pressure turbine (HPT), and two more low pressure turbine stages than the CFM56-5B and -7B. These additional engine stages will cause the engine to flex more, and lead to blade tip rub and a faster rate of deterioration, and so in turn lead to compromised removal intervals.

The LEAP-X's higher combustion temperature is another cause for concern in relation to engine-related maintenance costs. CFMI says it can mitigate these high combustion temperatures with improved HPT blades and cooling. The larger number of engine stages will also increase the number of airfoils in the engine, and so result in higher material costs at engine shop visits.

While the choice of the LEAP-1B will influence engine-related maintenance costs, Boeing has the opportunity to effect a reduction in maintenance costs.

Boeing has claimed that overall the 737 MAX will deliver a 7% advantage in operating costs over competing aircraft; of which the A320neo is the most important. Boeing has only said that the 737 MAX will have a more efficient structural design and lower maintenance requirements.

The A320neo will not provide any changes to the A320 family airframe design. The A320 has, however, had a change in its maintenance programme. This is an extension of the basic C check interval to 24 months, and this will allow the system of a cycle of eight base checks to be condensed into a cycle of six checks.

The possibilities for the 737 MAX to provide a reduction in airframe-related maintenance costs will be through utilising some of the same technologies used by the 787. The 737 MAX could also adopt some of the same design philosophies as the 787. This would allow the 737 MAX to have an approved maintenance programme with fewer maintenance tasks, and tasks with longer intervals compared with the 737NG.

The 787 will have 763 maintenance planning document (MPD) tasks compared to about 1,500 for the 767 and 1,400 for the 777. The 787 benefits, for example, from fewer structures tasks compared to its older twin-engined counterparts.

Although operators can group tasks into their own check packages, base check intervals would nominally be at 12,000 flight hour (FH) and 26 months. The base check cycle would further be a system of four checks, with the heaviest base check at a 12-year and 24,000 flight cycle (FC) interval.

If the some of the same design and maintenance programme philosophy could be utilised in the 737 MAX's design, then it will clearly be able to affect a reduction in airframe maintenance costs.

While Boeing has said that the 737 MAX will have a more efficient structural design, it has also said that changes to the 737's structure and design will be minimal, however.

Other possibilities are for the 737 MAX to incorporate on-board maintenance terminals that will allow mechanics to access all maintenance manuals and documentation, and so effect a reduction in line maintenance costs. Furthermore, the 737 MAX could also incorporate an electronic technical log (ETL), which would also improve the efficiency of line maintenance. AC