A320neo: initial details

After a period of uncertainty, Airbus has re-launched the A320 family with two new engine choices. These new powerplants, the CFMI LEAP-X and PW1100G, are expected to deliver a 15% reduction in fuel burn and 50% reduction in NOx emissions. The engines are also claimed to have lower maintenance costs than current engines powering the A320 family.

The launch of the A320neo family has received mixed reactions from the industry. This is the first time that a commercial aircraft has been re-launched with new powerplants. A similar move was possible from Boeing with the 737NG, but the manufacturer claims a re-engining programme is not needed for the 737.

The A320neo applies to the A319, A320 and A321 models. It provides the aircraft with a choice of two new engines: the CFM International LEAP-X and the Pratt & Whitney PW1100G. In addition to new engine offerings, the A320neo will have wingtips, known as 'sharklets', and will also have higher hull and maximum take-off weights (MTOWs). Hull weights for LEAP-X-equipped aircraft will be 1.7t higher than current A320s, while those for PW1000G-powered aircraft will be 1.8t heavier. The MTOW will be 1t higher across the A320 model range.

The overall objective of re-enginging the A320 family aircraft is to reduce fuel burn, noise, emissions and engine-related maintenance costs. Airbus claims that these reductions will be achieved through the new engine offerings. The main saving is through lower fuel burn, which is targeted to be about 15% lower than on current A320 models.

As a result of these improvements, the aircraft's list price will be $6 million higher than that of current A320 family members. This will be equal to a higher lease rate of about $60,000 per month at typical lease rate factors.

The A320neo variants will enter service in 2016. In the interim, the A320 will be offered with the sharklet wingtips from 2012. These are expected to achieve a 3.5% fuel burn reduction.

The A320neo has already attracted interest, with a launch order for 30 aircraft from Virgin America. Indian airline IndiGo has tentatively signed for 150 aircraft. If confirmed, the A320neo will clearly have received a quick endorsement from airlines. Some lessors are concerned, however, that the A320neo will have a negative impact on the residual value of current A320s in their portfolios.

Both Virgin America and IndiGo are still due to choose an engine type, and it is the performance characteristics of the engines that will determine the A320neo's ability to deliver its performance and operating cost targets.

The PW1000G has been developed by Pratt & Whitney in response to the limitations of current two-shaft turbofan engine designs. One of these limits is that the tips of fan blades cannot exceed supersonic. This means that the wider the fan diameter, the lower the revolutions per minute (RPM) of the fan. The fan is driven by the low pressure turbine (LPT), and the two are mounted on the same low pressure shaft, and so turn at the same rate of RPM. Turbines operate at lower efficiency at low RPMs, so they are less efficient on engines with wider intake fans. The desire for wider fan intakes comes from a need to achieve higher bypass ratios. Higher bypass ratios lead to high propulsive efficiency, which leads to lower fuel burn and lower noise emissions.

Conventional two-shaft turbofans are therefore limited by how much their fan diameters and bypass ratios can be increased before the LPT loses efficiency to the point where no overall improvement in fuel burn, noise and maintenance cost can be realised.

Pratt & Whitney's solution to this is to utilise a gearbox between the low pressure shaft and intake fan. This allows the LP shaft and LPT to turn at higher RPMs, and so operate more efficiently than LPTs in conventional turbofans. The high pressure compressor (HPC) is also mounted on the LP shaft, and so can also turn at higher RPMs when a gearbox is employed. As a result the LPT should require fewer stages, leading to fewer parts and a positive effect on maintenance costs. The gearing system also allows the fan diameter to be increased so that higher bypass ratios are reached.

The PW1000G has already been selected for three other airframes: the Mitsubishi MRJ, the Bombardier C Series, and the Irkut MC-21 airliner family. The PW1100G for the A320neo will be rated at 24,000-33,000lbs, which is similar to engines powering the current A320 family. The PW1100G will have a fan diameter of 81 inches, three inches wider than the PW2000 powering the 757. The PW1100G will have a bypass ratio of more than 12:1. This compares to a bypass ratio in the order of 5:1 on the CFM56-5B and V2500 engines powering the current A320 family

The A320neo has attracted launch orders from Virgin America and IndiGo. With two new powerplants to choose from, the aircraft is expected to have 15% lower fuel burn and 50% lower NOx emissions compared to current A320 family members.

The PW1100G powering the A320neo will have a fan diameter of 81 inches and bypass ratio of 12:1. This compares to the V2500-A5's fan diameter of 63.5 inches and bypass ratio of 4.9:1

models.

The main objective of this ultra-high bypass ratio is that the fuel burn of A320neo family members will be about 15% lower than that of current models. On a typical 650nm route, with a flight time in the region of 30 minutes, a 15% reduction in fuel burn will save 170-210 US Gallons (USG) for the three A320 family members. This will be equal to 315,000-380,000USG in fuel per year at typical rates of utilisation. This saving in fuel burn will equate to a cost reduction of about $950,000, or close to $1 million at current fuel prices. The saving in fuel will therefore exceed the higher aircraft lease rental or financing costs by $230,000-280,000 per year.

In parallel with lower fuel burn, the aircraft will also have lower noise and gaseous emissions. The lower fuel burn will result in a commensurate reduction in CO2 emissions, as well as predicted 50% lower nitrogen oxide emissions. The engine's high bypass ratios will decrease the aircraft's footprint by 50%. These lower emissions will generate further savings in cash operating costs, although these will vary according to an operator's route network and the tariffs charged by different airports.

There is potential for further savings with respect to maintenance costs. Relative to current engines powering the A320 family, the PW1000G will achieve maintenance cost savings if it has longer removal intervals between shop visits, and lower shop visit costs. The most important element in shop visits is the cost of parts and materials, and their rate of consumption in shop visits. Another element is the number and cost of engine life limited parts (LLPs).

The potential for lower maintenance costs on the PW1100G compared to the V2500 and CFM56-5B is unclear. The higher RPMs at which the LP shaft, and consequently the LPT and LPC, can turn means that these modules require fewer stages compared to a conventional two-shaft engine. This translates into the PW1100G utilising fewer blades and vanes, with a direct consequence on maintenance costs.

PW claims the engine will have longer on-wing intervals due a high exhaust gas temperature (EGT) margin, but the PW1100G will have a two-stage high pressure turbine (HPT). Since HPT blades are the most expensive parts in the engine, the number of HPT stages and blades has one of the largest influences on engine maintenance costs. Like all other PW engines, the PW1000G will benefit from having LLPs with uniform lives, which will contribute to simplifying engine management with respect to LLP replacement.

The CFM International LEAP-X is a new engine to succeed the CFM56 family. CFMI has opted for the design philosophy of an engine that is an improved and optimised conventional two-shaft turbofan, after evaluating and rejecting other design options of open rotor and geared fan engines.

The LEAP-X has several new features. The first is a two-stage HPT, which will work together with a 10-stage high pressure compressor (HPC) that develops an overall engine pressure ratio of 20:1. The HPC has one additional stage to the CFM56-5B series.

The cash operating cost, emissions and performance improvement targets for the LEAP-X are similar to the PW1100G. The LEAP-X will also utilise 3-D woven composite fan blades. The fan will have an intake diameter of 71 or more inches, which compares to 68.3 inches for the CFM56-5B. As a consequence, the LEAP-X will have a bypass ratio of 10:1. This compares to about 5.5:1 for the CFM56-5B. The engine is expected to provide a 15% lower fuel burn compared to engines powering the current A320 family members.

The LEAP-X will also feature a lean-burn combustor and have higher combustion temperatures than the CFM56-5B. The LEAP-X will also have 3-D aerodynamic blades and advanced cooling in the HPC and HPT modules.

The higher combustion temperature, higher engine thermal efficiency and advanced 3-D blades will all contribute to the LEAP-X having 15% lower fuel burn than current engines. The 15% lower fuel burn translates into savings in fuel costs and overall cash operating costs that are similar to those generated by the PW1100G. The lower fuel burn also translates into lower CO2 emissions. The engine is also predicted to have 50% lower nitrous oxide emissions than the CFM56-5B.

The LEAP-X's higher bypass ratio of 10:1 will also lead to 15-decibel lower noise emissions, and so the aircraft will have overall lower emissions that should generate similar savings to those that the PW1100G is able to provide.

The design philosophy behind the LEAP-X is to achieve lower maintenance costs through focusing on the high pressure modules: the HPC and HPT. These two modules account for the majority of an engine's maintenance costs. The main design difference with the CFM56, is that the LEAP-X will have two HPT stages. New materials and cooling technologies will be utilised to account for the engine's higher combustion temperatures. The LEAP-X will therefore have a similar EGT margin to the CFM56-5B, so the two should therefore have similar removal intervals.

The effect of other factors, such as material consumption and cost of parts, LLPs and their lives and costs, is not yet clear. Even though the LEAP-X may be able to achieve similar removal intervals for shop visits to the CFM56-5B, the use of 3-D blades and other advanced materials is likely to escalate material costs. AC

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