777-200/-300 modification programmes

The major modification & upgrade programmes for the 777 include a performance improvement programme, a drag reduction modification, engine upgrades and avionic enhancements.

There have been a number of modifications and upgrades that have taken place on the 777. The majority have been Airworthiness Directives (ADs) and Service Bulletins (SBs). There have also been optional improvements. One option, which is regularly taken up by most passenger airlines, is the reconfiguration and improvement of their cabin environments and interior layouts. Another option has been the improvement of certain aspects of the 777's operational costs. This particular improvement is offered by Boeing as the Performance Improvement Package (PIP).

Performance improvement

The 777-200LR has enhancements in its design that were not in place for previous models. These improvements in weight, drag, and therefore fuel burn, have provided operators with cost savings. These enhancements were then included on all new 777-300ER aircraft delivered after November 2005, with Air France taking delivery of the first aircraft with the improvements. The developments on the 777-200LR and freighter, which trickled down to the all-new -300ER, will shortly be available as a PIP for older 777s. This includes the earlier built -300ERs.

Older 777-300ERs had already shown an improvement of up to 2% in fuel burn by operators with aircraft in revenue service, compared to what had been expected prior to delivery. The new -300ERs have an overall efficiency improvement of 1.4% due to the PIP, in addition to the initial 2% improvement.

The -300ER package involves modifying the vortex generators and the air induction systems for the environmental control systems in order to reduce the amount of drag caused by the aircraft's shape. In addition, the aircraft's weight has been reduced by the utilisation of lighter materials for internal structures such as the maindeck floor panels. The 1.4% improvement in fuel efficiency, according to Boeing, equates to an annual fuel saving of at least 200,000 US Gallons (USG). For a fuel price of $2 per USG, an annual saving of $400,000-500,000 per aircraft can be made.

These improvements form the basis of the PIP, which will provide each aircraft 1% more efficiency, thereby enabling older models to perform more like younger ones.

Boeing began offering the PIP at the start of 2008, and it is expected to be certified by the Federal Aviation Authority (FAA) and to be in operation by April 2009. It has been taken up by at least 13 airlines, including many of the larger 777 operators. British Airways (BA) is one of the latest operators to order the PIP modification for all its older 777s. BA and Boeing believe that the PIP will provide an annual fuel saving of at least $200,000 per aircraft (assuming a crude oil price of $70-100 per barrel), which represents a potential saving of over $8 million per year across the whole 777 fleet.

Boeing has stated that the changes will reduce carbon dioxide emissions by 3 million lbs per aircraft per year. The potential reduction in both fuel consumption and carbon dioxide emissions has gone a long way to encouraging operators to order the PIP.

The PIP includes low-profile vortex generators, an enhanced ram air system and drooped ailerons. Boeing has said that it is still looking at further modifications to add to the PIP. Dan da Silva, vice president of sales at Boeing Commercial Aviation Services, has stated that "the 777 is among the most efficient, environmentally progressive airplanes in operation, but we must continue to pursue these performance gains". If fitted to all 777-200, 200ER and -300 aircraft,

The 777-300ER had a 2% better fuel burn performance than predicted when it first entered service, and the performance improvement programme realises a further 1.4% reduction in fuel consumption.

While the 777 has had various ADs and SBs issued, it has not yet had any major ADs issued that incur high costs or are serious safety-related issues.

that would amount to over 500 aircraft. This excludes the older -300ERs.

Airframe modifications

Reduction in drag of any aircraft is important and on the 777 this has been improved, in part through the PIP, by modifying the aircraft's vortex generators. Vortex generators are small extensions that maintain steady air flow over the wing surface. Changing their size or location can seriously help or hinder an aircraft's aerodynamics.

Another change to come from the PIP is on the environmental control systems. The air induction systems are modified to reduce drag. By drooping the outboard ailerons even more when flaps are extended, drag is again reduced. Although ailerons control an aircraft's banking movements, they also affect the lift on take-off and landing.

A major aspect of any aircraft design is reducing its overall weight while increasing its power and payload ability. Since the 777 first entered service, lighter parts have been developed to further reduce the weight of the 777. The predominant aspect has been the increased use of composite materials such as aluminium alloys and titanium. The maindeck floor panels can now be replaced with much lighter panels without losing strength, and the ducts of the environmental control system are now made from lighter materials too.

Engine modifications

While developing the GE90-94B, and with the GE-115B in mind, General Electric (GE) developed a PIP for the GE90-90B. This package was offered at GE's facility in South Wales and could be integrated during normal maintenance. The advanced 3-D aerodynamic components of the -115B were included in the package along with new seals and turbine technology to improve the engine's performance and the thrust in particular. This all came together to produce a 1.6% fuel burn improvement and an additional exhaust temperature margin of more than 20 degrees Celsius. Other improvements included longer on-wing times, increased payloads and reduced maintenance costs.

GE developed the GE90-115 for the 777-300ER and de-rated the engine design for the -200LR and 777F. Developments included aspects that improve fuel efficiency, thrust and the noise levels of the engines. The improved combustor means that the engine is producing no more than 50% of the carbon dioxide levels currently allowed by international standards.

Two major Service Bulletins (SBs) were issued with regard to the thrust reverser V-blade. The first, SB777-78-0061, required the inspection and change, if necessary, of the outer V-blade. The second, SB777-53-0042, refers to the splice plate assembly change of floor panels.

Avionics

The first major avionics upgrade since 1995 involved the introduction of an improved Airplane Information Management System (AIMS) called Aims-2. This upgrade promises to be smaller, faster, less expensive and easier to use than the original system.

There have been six major SBs issued affecting the Electronic Flight Bag (EFB) and associated flight deck technology.

SB777-78A requested the installation of a class 3 EFB dual display system.

SB777-46-0015 requested the installation of an on-board network server, software and terminal wireless LAN unit.

SB777-46-0018 then dealt with the installation of hardware, such as Ethernet ports and personal computer (PC) power outlets. As passenger airlines have had to tighten up security, on-board security has also been increased, with items such as cockpit door surveillance systems. SB777-23-0231 involved the de-modification of the system. The communications systems have been upgraded by the installation of a single HSD Satcom transceiver and 3-channel Satcom system as referred to in SB777-23-0257.

SB777-34-0132 dealt with back-up and requested the installation of an integrated standby flight display system.

Airworthiness Directives

The 777 has had ADs issued against four main areas since it entered service.

The first one is SB777-27A-0073, which involved modifications to the flight controls, trailing edge flaps and outboard flap support gimbal plate change.

The second AD is SB777-27A-0071, which related to the flap pin. Modifications were made to the trailing edge flap support pin, ball set and bushing replacement.

The third AD, SB777-57-0054, related to the torque tube. Modifications were made on the wing, trailing edge and trailing edge devices. The inboard flap and inboard support were replaced.

The fourth area involved the thrust reverser and incorporated SB777-78A-0065 and SB777-53A-0044. Both of these involved inspections, the first covering the inner-wall thermal insulation blanket and its associated panel. The second inspection, for corrosion, was of the fuselage skin panels on Section 43 and section 46. Preventative measures were to be undertaken if necessary. AC