The PW4000 112″

Technical Development

When Boeing proposed the Boeing 777 series in 1980, all three main engine manufacturers tendered an engine variant. Of the three products, the P&W engine has the biggest intake section area.

During the first part of the sales campaign, all three manufacturers were equally sharing the market. Later, GE was selected as the sole engine for the 777-300ER and the -200LR aircraft. From that moment, GE took the lead of new orders: at this present time an estimated 69% of orders are GE-powered. The current market is 38% to Rolls Royce, 32% to GE and 28% to P&W.

The PW4000 112″ variant has a thrust range from 77,000 lbs to 98,000 lbs. The engine has two spools, but the design is completely different to the 94″ and 100″ variants, the main content of the engine being:

Module	Content
LPC	One fan stage, mid span shroud Five primary stages
HPC:	15 stages Five stages of variable vanes
Combustor:	Anular combustion chamber
HPT:	Two stages
LPT:	Five stages

First production engines were rated at 77,000 lbs on the 777-200 model. As flight hours were accumulated and P&W gained experience, the engine thrust was increased to the limit of 98,000 lbs on the 777-300 variant. All engine versions are FADEC and there are no non-FADEC engines to be aware of as with the CF6-80C2 engines. Engine performance is engine pressure ratio controlled.

The surge problems affecting the 94″ variant has affected the 112″ variant as well. During take-off, some engines were prone to stall. In most cases, the engine did not suffer internal damage, but the event would create operational burdens. Compared to the 94″ model, no stability and on wing test was requested to operators. No major design changes nor fleet campaigns have been accomplished or are envisaged by the manufacturer.

The main problems affecting this engine model are located in the high pressure section:

– The engine has been suffering high pressure compressor (HPC) Stage 5 Knife Edge fracture, with several events reported to date. A solution is being introduced;
– High pressure turbine (HPT) Stage 1 and 2 Blades were showing internal sulfidation. P&W is proposing new blades to operators and on-wing monitoring of the condition of the blades;
– HPT Stage 2 were suffering stress corrosion. P&W will provide operators with a final, definitive solution soon;
– HPT Stage 1 Inner Airseal is fracturing. A solution has been determined and can be introduced at shop level.

IASG believes these are well-publicised problems affecting this engine model, but there are also additional smaller issues affecting older in-service engines. P&W is working together with the main operators to provide a final solution for these issues. IASG is aware of the importance of these factors and how important it is for investors and operators alike to ensure that they are fully conversant with the critical modifications and if they have been incorporated on a particular engine.

Application and Operators

The PW4000 112″ variant can be installed on the 777 series, with the following thrust ratings:

Engine Model	Thrust (lbs.)	Number of engines	Aircraft Model
PW4074	74,000	38	777-200
PW4090	90,000	10	777-200
PW4090	90,000	128	777-200ER
PW4090	90,000	28	777-300
PW4098	98,000	8	777-300

The engine is certified as ETOPS and has accumulated in excess of three million hours and 900,000 cycles. A total of 10 airlines with 130 aircraft are currently operating the engine on various aircraft applications:

Maintenance Costs

Because of the installed base of engines, not many engine shops are certified to repair this model. Additionally, as the engine does not have a great commonality with other engines in the family, the switching costs from one model to another are sensitive. At this present time, P&W & United Services are certified to perform a full overhaul on this engine model.

Except for two operators, all aircraft are used on long-haul flights. The typical flight to cycle ratio is at eight. IASG has seen first run engines with an on-wing life of 15,000 flight hours to 17,000 flight hours. The typical first shop visit is a core performance restoration in the range of $3m to $4m. The second engine on-wing time is between 13,000 flight hours and 15,000 flight hours on average and the subsequent engine shop visit is a full refurbishment, in the range of $5m to $6.5m. Shop visits are highly dependent upon engine thrust utilisation, environment and engine standard. Due to the number of modifications available for the engine model there are a number of workscope variations that any owner or operator can carefully define and manage.

Maintenance reserves vary greatly from the PW4077 up to the PW4098 and based on the engine standard – as indicated in the above paragraph. Maintenance reserves for LLP are $435 per cycle. A full set of new LLP is in the range of $6m. It is eseential for lessors and operators to have flight hour reserves indexed to thrust ratings and sector lengths.

Ownership and Leasing

There are not many engines of this model available in the lease market. P&W has some engines in its portfolio, mainly used to support operators. IASG believes that spare engines can be made available on lease by United Airlines and Willis Lease Finance Corp. The engine is not suffering any major problem, thus the market for spare engines is quite stable and IASG does not foresee any major changes. The model is entering its mature phase and the number of spares is basically fixed. IASG believes that the market is tight due to the limited number of current operators and there may be few opportunities for new investors. In the event of a major engine shop campaign or airworthiness directives requiring shop visits opportunities may arise.

Engines could be leased for as low as $2,500 per day for reasonable duration term and credit. IASG expects the market to improve over the next 12 months.

This article is an abbreviated version from Paolo Lironi of IASG Powerplant Support Services who would be pleased to provide any advice or greater detail to any interested parties. Contact us on paolo@iasg.co.uk.