

PW4000-100 & -112 series specifications

The PW4000-100 & -112 engines power A330s and 777s with thrust ratings varying from 64,500lbs to 99,040lbs.

Pratt & Whitney's (PW) PW4000-100 and -112 series engines are bypass, two-shaft turbofans. The -100 and -112 suffixes denote their intake fan diameters, which were developed from the smaller 94-inch fan PW4000-94 series.

The -100 series engines are rated at 64,500lbs thrust to 70,000lbs thrust, and power variants of the A330 family (see table, page 5). The -112 series are rated at 77,440lbs thrust to 99,040lbs thrust, and power variants of the 777 family.

PW aimed to maintain as much component and line replaceable unit (LRU) commonality between the three engine series as possible.

While developing the larger -112 series, a more efficient combustor was designed, which further reduced emissions, in particular NOx. Technology for Advanced Low NOx (TALON) on the PW4000-112 was then developed for the smaller PW4000 variants, and became an option in the late 1990s. A further

development, the TALON II low emissions combustor, went into service on the -100 in mid-2001.

As well as full authority digital engine controls (FADEC), the PW4000-100 and -112 use single-crystal superalloy materials for the high pressure turbine (HPT) blades. According to PW, the PW4000 uses the industry's lightest-weight and most advanced nacelle, as well as performance-enhancing technologies in materials, aerodynamics and controls.

All model series of the PW4000-100 and -112 meet future noise, CO2 and NOx emissions regulations. This is partly due to their advanced materials, high bypass ratios and the TALON combustor.

PW4000-100

The PW4000-100's engine configuration comprises: a 100-inch diameter intake fan; five low pressure compressor (LPC) stages; 11 high

pressure compressor (HPC) stages (including five variable stages); two high pressure turbine (HPT) stages; five low pressure turbine (LPT) stages; and an annular combustor.

There are three main thrust variants of the PW4000-100. These have the same core engine configuration and hardware, a bypass ratio of 5.1:1, and thrust rating is controlled via the FADEC. The three variants have a set of life limited parts (LLPs) that total 25 units. These have a list price of \$5.97 million.

The first variant is the PW4164, rated at 64,500lbs thrust (see table, page 5). It powers a small number of A330-300s, the first A330 variant in operation. Being the lowest rated engine, when new it had an exhaust gas temperature (EGT) margin of about 63 degrees centigrade.

The second variant is the PW4168, rated at 68,800lbs thrust. This powers the A330-300.

The PW4168A and PW4168A-1D, which were later variants of the PW4168, were both rated at 68,600lbs thrust. The PW4168A powers the smaller A330-200 and later build A330-300s, while the PW4168A-1D powers the A330-300.

The most recent variant is the PW4170. This is rated at 70,000lbs thrust and powers the A330-200F. The PW4170 is the newest PW4000-100 model. It is being marketed as the PW4170 Advantage70 or PW4170A, and aims to enhance performance, save fuel, increase durability and decrease maintenance costs with upgrades in certain areas.

PW states that the fuel savings will equate to \$140,000 per aircraft per year, a 1% reduction in fuel consumption compared to the standard PW4168A. This will then have the knock-on effect of reducing carbon emissions by roughly 1.5 million pounds per aircraft per year. The PW4170A is offered either as a new engine, or it can be incorporated into a current engine's overhaul as a package of technological enhancements. The main development is a new HPC ring case, as used on other PW4000 engines. This new engine development was available from the end of 2009 and will initially be available to power the A330-200 freighter.

The PW4170 will share the same specifications as all the other PW4000-100 engines, except that it has a higher



The PW4000-100 powering the A330 family and the -112 series powering the 777 family have had similar success. Pratt & Whitney recently launched a new variant; the PW4170. This has a higher take-off thrust rating and higher EGT margin than earlier variants.

PW4000-100 & -122 SPECIFICATIONS TABLE

Engine Model	Fan-tip diameter (inches)	Take-off thrust lbs	Flat-rate temperature deg. C (ISA+15)	EGT red-line deg. C	EGT margin new engines	Aircraft application
PW4164	99.8	64,500	30	645	63	A330-321
PW4168	99.8	68,800	30	645	50	A330-322
PW4168A	99.8	68,600	30	645	50	A330-223/-323
PW4168A-1D	99.8	68,600	30	645	65	A330-323
PW4170*	99.8	70,000	30	645	55	A330-223/-224F
PW4074	112	77,440	30	625	55	777-200
PW4077	112	79,960	30	625	40	777-200/-200ER
PW4077D	112	79,960	30	675	75	777-200/-200ER
PW4084	112	86,760	30	625	40	777-200/-200ER
PW4084D	112	86,760	30	675	75	777-200/-200ER
PW4090	112	91,790	30	675	50	777-200/-200ER/-300
PW4098	112	99,040	30			777-300

*No active engines yet in service

take-off thrust of 70,000lbs. The EGT margin is higher than might otherwise be expected for the highest thrust-rated engine in the model series at 55 degrees centigrade.

The PW4168A-1D is in fact a de-rated version of the PW4170 variant. The main difference is that the PW4168A-1D's EGT margin is 65 degrees centigrade, an increase of 15 degrees centigrade compared to the other PW4168 variants, which have a new engine EGT margin of just 50 degrees centigrade.

Each variant is flat rated at 30 degrees centigrade, which means that each variant maintains its full thrust rating up to an outside air temperature of 30 degrees centigrade. The EGT red line temperature for each variant is 645 degrees centigrade.

The long-range cruise speed of A330s powered by PW4000-100 engines is Mach 0.82, while the maximum cruise speed is Mach 0.86.

The PW4000-100 entered service at the end of 1994, with a 90-minute Extended-range Twin engine Operations (ETOPS) approval already in place. ETOPS has since been extended to 180 minutes for all variants.

The PW4164 powers eight early-build A330-300s operated by Thai Airways International.

The PW4168/4168A/4168A-1D is the most popular engine model of the PW4000-100 series, and powers 157 A330-200s and -300s.

The PW4168A is the most popular, and powers 129 aircraft. The largest operator is Delta Airlines, with 32 A330-223s and -323s. The PW4168A-1D powers just two A330-323s.

PW4000-112

The PW4000-112 has a wide intake fan diameter of 112 inches. There are five main variants: the PW4074, PW4077,

PW4084, PW4090 and the PW4098.

These have thrust ratings of 77,440lbs to 99,040lbs thrust. All variants have a bypass ratio of 6.4:1 (see table, this page).

The first four variants have a six-stage LPC, while the PW4098 had one more LPC stage added to take the engine to its highest rating of 99,040lbs thrust. All variants have an 11-stage HPC, a two-stage HPT and a seven-stage LPT. All variants are flat rated at 30 degrees centigrade.

The PW4000-112 series has 33 LLPs which have a list price of \$9.26 million. LLP lives for the PW4074 and PW4077 are 20,000EFC, while they are 15,000EFC for the other three variants.

The first variant is the PW4074, and is rated at 77,440lbs thrust. This powers 21 examples of the lightest gross weight model of the 777-200, and is operated only by All Nippon Airways and Japan Airlines. The EGT red line temperature is the lower 625 degrees centigrade; new engines had an EGT margin of 55 degrees centigrade.

The next variant is the PW4077, with a thrust rating of 79,960lbs, which powers 30 777-200s. The basic PW4077 had an EGT margin of about 40 degrees centigrade, and a red line temperature of 625 degrees centigrade. The PW4077D has a higher EGT red line temperature of 675 degrees centigrade, and consequently a higher EGT margin of 75 degrees centigrade. It is actually a de-rated PW4090 standard engine, predominantly found in Asia Pacific, and powering a total of 28 aircraft.

The PW4084 has only three operators (United Airlines, Vietnam Airlines and ANA) and powers 11 aircraft. The engine is rated at 86,760lbs thrust, and was the variant that gained 180-minute ETOPS prior to entering service.

There are two sub-variants, the basic model and the 'D' variant. These have the same EGT red line and similar EGT margins as the PW4077 and PW4077D

(see table, this page).

The PW4084D variant, which is again a de-rated PW4090, has the highest new-engine EGT margin for the whole of the PW4000-100 and -112 series engines, of about 75 degrees centigrade. The basic PW4084 has an EGT margin of about 40 degrees centigrade, which is the lowest EGT margin of both the -100 and -112 series.

An increased-gross-weight version of the 777 is powered by the PW4090, which is rated at 91,790lbs thrust. It powers the 777-200, -200ER and -300, the most common being the -200ER.

The PW4090 has a higher level of EGT red line temperature of 675 degrees centigrade, while the EGT margin is 50 degrees centigrade. There are 100 PW4090-powered aircraft in operation, most with fleets in the Asia Pacific.

The final and most powerful variant is the PW4098, and is rated at 98,000lbs thrust. This powers the 777-300 with a maximum take-off weight of 660,000lbs. The engine is only used to power four 777-300s for Korean Air.

The 777 powered by all variants of the PW4000-112 has a long-range cruise speed of Mach 0.84, and a maximum cruise speed of Mach 0.89.

The -112, like the PW4000-100, had ETOPS approval already in place when it entered service, this time for 180 minutes. In 2000 it went on to become the first engine to be approved for 207-minute ETOPS.

The PW4000-112 uses hollow titanium, shroudless fan blades. Recent improvements have involved the incorporation of durability upgrades into the HPT, which has meant an improvement for operators' on-wing times and therefore lower maintenance costs. 

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