TYPE CERTIFICATE DATA SHEET Nº EM-2018T05

Type Certificate Holder:

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EM-2018T05-00

SHEET 01

ROLLS-ROYCE PLC.

Trent7000-72 and Trent7000-72C

28 NOVEMBER 2018

Engines of models described herein conforming with this data sheet, which is part of Type Certificate No. 2018T05, meet the minimum standards for use in certificated aircraft in accordance with pertinent aircraft data sheets and applicable portions of the Brazilian Aeronautical Regulations provided they are installed, operated, and maintained as prescribed by the approved manufacturer's manuals and other instructions.

TYPE

The Trent 1000 engine is a three shafts high bypass ratio, axial flow, turbofan with Low Pressure, Intermediate Pressure and High Pressure Compressors driven by separate turbines through coaxial shafts. The LP Compressor fan diameter is 2.85m with a swept fan blade and OGV's. The combustion system consists of a single annular combustor with 18-off fuel spray nozzles. The LP and IP assemblies rotate independently in an anti-clockwise direction, the HP assembly rotates clockwise, when viewed from the rear of the engine. The Compressor and Turbine have the following features:

Compressor	Turbine
LP – Single stage	LP – 6 stage
IP – 8 stage	IP – single stage
HP – 6 stage	HP – single stage

The engine control system utilises an EEC (Electronic Engine Controller) which has an airframe interface for digital bus communications. An EMU (Engine Monitor Unit) is fitted (to provide vibration signals to the aircraft).

RATINGS

(See Note 1)

MODELS

Trent7000-72, Trent7000-72C

Static Thrust, at sea level, kN (lbf)	**Trent7000-72 Trent7000-72C**
- Takeoff (net)- 5 min	324.0 (72,834)
- Takeoff Bare Engine - 5 min	327.9 (73,718)
- Maximum Continuous (net)	289.2 (65,005)
- Equivalent Bare Engine Maximum Continuous	292.8 (65,830)

ENGINE CONTROL SYSTEM

The engine is equipped with a Full Authority Digital Engine Control (FADEC) system and an Engine Monitoring Unit (EMU). Refer to the Installation Manual and Operating Instructions for further information. See Note 5.

COMPONENTS AND CONFIGURATION

For details of equipment included in the type design definition refer to the Installation manual. For details of equipment supplied by the Airframe TC holder, refer to the installation manual. A thrust reverser unit is not part of the engine type design and is certified as part of the aircraft type design. The engine is approved for operation with a thrust reverser unit. See Note 6.

FUEL TYPE

See Engine Operating Instructions for approved fuels and additives.

OIL TYPE	See Engine Operating Instructions for approved oils.	
OIL CONSUMPTION	Maximum 0.48 U.S. Quarts per hour.	
REFERENCE PRESSURE RATIO	The ratio of the mean total pressure at the last compressor discharge plane of the compressor to the mean total pressure at the compressor entry plane when the engine is developing take-off thrust rating in ISA sea level static conditions.	45.4
TEMPERATURE LIMITS	For engine indicated turbine gas temperature limits, see Note 2.	
PRESSURE LIMITS	For fuel and oil pressure limits, see Note 3.	
ROTOR SPEEDS	For engine rotational speed limits, see Note 12.	
AIR BLEED	For maximum permissible air bleed extraction, see Note 13	
DIMENSIONS AND WEIGHT	Trent7000-72, Trent7000-72C	
	Overall LENGTH, mm (in.)	4775 (188.0)
	Maximum Radius mm (in.)	1837 (72.3)
	Dry WEIGHT, kg (lb.) Not to exceed	6,445 (14,209) The engine weight is defined as the weight of the basic engine, including nacelle EBU items certified as part of the engine but not including fluids
CENTER OF GRAVITY	Engine only, nominal weight, mm. (in.)	
	Station (Axial) - Offset from the center of front engine mount (power plant station 3000mm).	764.5 (30.1)
	Offset from Horizontal Centerline	33 (1.3)
	Offset from Vertical Centerline	-86.4 (-3.4)

IMPORT REQUIREMENTS

Each engine imported separately and/or spare parts must be accompanied by an Export Airworthiness Approval through the EASA Form 1, Authorized Release Certificate, certifying that the engine is in compliance with the ANAC approved Type Design, defined by the Brazilian Type Certificate Data Sheet No. EM-2018T05-00, dated 28NOV2018, or further revisions, is in condition for safe operation and has undergone a final operational check. The original Authorized Released Certificate should be sent with the engine and a copy remains with the issuing organization. The ANAC type design corresponds to the EASA approved type designs, as stated in ANAC report number V.33-1082-00, dated 28NOV2018, or further revisions.

CERTIFICATION BASIS

Brazilian Type Certificate No. 2018T05 issued on 28NOV2018 is based on RBAC 21.29 including the following requirements:

Airworthiness Standards

- RBAC 33 (Requisitos de aeronavegabilidade: motores aeronáuticos), Amendment 28; which corresponds to 14 CFR Part 33, effective 01 February 1965, as amended by 33-1 through 33-28, including;
- Based on RBAC 21.29(a)(1)(ii) the following Equivalent Level of Safety (ELOS) findings are applicable, which correspond to Equivalent Safety Findings (ESF), raised by EASA:
  - CS-E 740 (h)(1)- 150 Hour Endurance Test, see CRI-T28;
  - CS-E 740 (b)(1)- 150 Hour Endurance Test, see CRI-T1;
  - CS-E 740(f)- Non declaration or display of Maximum Continuous Speed Limitation, see CRI-T2;
  - CS-E 790- Ingestion of Rain and Hail, see CRI-T8 and
  - CS-E 840 and CS-E 850- HP Shaft Prime Reliability, see CRI-T11.

Emissions Standards:

- RBAC 34 (Requisitos para drenagem de combustível e emissões de escapamento de aviões com motores a turbina, Amendement 05; corresponding to 14 CFR Part 34, effective 23 October 2013, amendment 5A, inclusive (see Note 14 for further information about certification basis for fuel venting and exhaust emissions);
- Additionally, based on RBAC 21.29(a)(1)(ii) the following requirements are applicable: ICAO Annex 16, Vol. II, third edition, July 2008, including Amendment 8, effective 01JAN2015, as applicable to turbofan engines. NOx standards in accordance with Part III, Chapter 2, Section 2.3.2.e (CAEP/8), for emissions.

Model	Application	Issued TC/Amended
Trent7000-72	06NOV2017	28NOV2018
Trent7000-72C	06NOV2017	28NOV2018

PRODUCTION BASIS

Rolls-Royce plc, CAA Production Organisation Approval Certificate, Reference: UK.21G.2003, revision 06/17, dated 21JUN2017.

NOTES

NOTE 1 ENGINE RATING

a) The Equivalent Bare Engine Take-off and Maximum Continuous thrusts quoted are derived from the approved Net Take-off and Net Maximum Continuous thrust by excluding the losses attributable to the inlet, cold nozzle, hot nozzle, by-pass duct flow leakage and the after body.

b) The Ratings are based on having no power offtakes to aircraft accessories nor air bleeds.

c) The take-off rating and the associated operating limitations may be used for up to 10 minutes in the event of an engine failure.

NOTE 2 TEMPERATURE LIMITS:

- Trimmed Turbine Gas Temperature (TGT), °C (°F):

Takeoff - 5 minutes:	900 (1652)
Maximum continuous:	850 (1562)
Maximum over-temperature (20 second limit):	920 (1688)
Maximum during Inflight Starts	900)1652)
Maximum during Ground Starts and shutdown:	700 (1292)

Obs.: a) The maximum exhaust gas over temperature limit is approved for inadvertent use for the periods specified without requiring maintenance action. The cause of the over temperature must be investigated and corrected.

b) Turbine Gas Temperature is measured by thermocouples positioned at the 1st stage Nozzle Guide Vane of the LP Turbine.

- Fuel Pump Inlet Temperature, °C (°F):

Minimum fuel temperature: (at, or below 4,450 m ∴14,600ft)	-44 (-47)
Minimum fuel temperature: (above 4,450 m ∴ 14,600 ft)	-54 (-65)
Maximum fuel temperature:	55 (131)

Refer to the Installation Manual for additional information.

- Oil Temperature, °C (°F):

Combined oil scavenge temperature:

Limit	Fuel Inlet Temperature
Maximum	
Continuous Operation	191 (376)
Transient (15 minutes)	196 (385)
Minimum (Cold Start)	-20 (-4)

NOTE 2 CONT…	Minimum for acceleration to power	40 (104)	For fuel inlet temperature minus 11°C and higher
		Varies linearly from 40 to 77 (104 to 171)	For fuel inlet temperature between minus 11°C and minus 54°C

NOTE 3 FUEL AND OIL PRESSURE LIMITS:

Fuel Pressure Limits

Minimum absolute inlet pressure (measured at engine pump inlet):

	kPa	psi
Steady state conditions with engine running:	34.5 + Vapour Pressure	5 + Vapour Pressure

Refer to the Installation Manual for additional information.

Maximum pressure at inlet (measured at the pylon interface):

	kPa	psi
Steady state conditions with engine running:	276	40
Transient conditions with engine running (2 seconds):	689	100
Static after engine shut down:	689	100

- Oil Pressure Limits:

	kPa	psi
Ground idle to 74% IP rpm	207	30
Between 74% and 100% IP rpm	Varies linearly from 207 to 621	Varies linearly from 30 to 90
Above 100% IP rpm	621	90

NOTE 4 ACCESSORY DRIVE CHARACTERISTICS

The engine's accessory gearbox may be fitted with an Integrated Drive Generator (IDG) and two Hydraulic Pumps to provide electrical and hydraulic power to the aircraft. These units are part of the airframe, and certified under Aircraft Airworthiness Standards. The Engine Installation Manual details installation and operational requirements, including torque and power limitations.

NOTE 5 ENGINE CONTROL SYSTEM: SOFTWARE AND EMI/HIRF/LIGHTNING CAPABILITIES

The control and monitoring system software meets the following levels:

- EEC is designated EUROCAE ED-12B/RTCA DO178B Level “A”.
- EMU is designated EUROCAE ED-12C/RTCA DO178C Level “C”.

Refer to Installation Manual for details of Electro-Magnetic Interference (EMI), High Intensity Radiated Fields (HIRF) and Lightning capability.

NOTE 6 COMPATIBLE SYSTEM ASSEMBLIES

THRUST REVERSER

The engine models Trent7000-72 and Trent7000-72C are approved for use with the Safran thrust reverser system:

Thrust Reverser - Left C-Duct Unit - P/N	BKL0011-07-0
Thrust Reverser – Right C-Duct Unit - P/N	BKL0051-07-0

NOTE 7 SPECIAL REQUIREMENTS

ETOPS

The engine is approved for ETOPS capability in accordance with CS-E1040 amendment 3, which corresponds to the requirements §§ 33.4 (A33.3(c)), 33.71(c) (4) and 33.201, by EASA Certificate 10067382, dated 09 November 2018 for a Maximum Approved Diversion Time of 180 minutes at Maximum Continuous thrust plus 15 minutes at hold thrust. ETOPS is restricted to engines of a life of less than 500 EFC, and incorporating MB72-K203. ETOPS does not require any other special engine limitation, marking, placard, or configuration. Engine Condition Monitoring is required.

TIME LIMITED DISPATCH CRITERIA

These engine models have been approved for Time Limited Dispatch in accordance with CS-E 1030. The maximum rectification period for each dispatchable state is specified in the Installation Manual.

ICING OPERATION

The Trent7000-72 and Trent7000-72C engine models supply compressor air to the airframe for the purpose of cabin ventilation (“Cabin Bleed”); also, they supply compressor air for the purpose of anti-icing of airframe components (“Nacelle Anti-Ice Bleed”). The anti-icing bleed flow demand is modulated via a regulating valve. See Note 13 about maximum bleed air extraction.

NOTE 8 SPECIAL OPERATING PROCEDURES –

The take-off rating and its associated operating limitations may be used for up to 10 minutes in the event of engine out contingency, but their use is otherwise limited to not more than 5 minutes.

Engine models are approved for 2-minute transient overtemperature within 5-minute time limit associated with the take-off rating when engine is accelerated to take-off from a cold state.

The engine is approved for a maximum exhaust gas overtemperature of 920oC for inadvertent use due to abnormal operation for periods up to 20 seconds without requiring rejection of the engine from service or maintenance action other than to correct the cause. The cause of the overtemperature must be investigated and corrected.

NOTE 9 The applicable Installation, Operating and Time Limits Manuals are:

- Installation Manual - EDNS01000696188;
- Operating Instructions – EDNS01000696186 and
- Time Limits Manual - T–T7000–1RR.

Or later approved Issues or Revisions.

Instructions for Continued Airworthiness (ICA): Installation Manuals, Specific Operating Instructions, Engine Shop Manuals, Service Bulletins, Overhaul and Maintenance Manuals, Repair Manuals, Vendor Manuals, and Design Changes which contain a statement that the document is EASA approved or approved under authority of DOA No. EASA.21J.035 are accepted by the ANAC and considered ANAC approved. Repair data and related instructions are considered ANAC approved or accepted as applicable. These approvals pertain to the type design only. The Trent7000-72 and Trent7000-72C ICA includes:

1) Engine Manual - E-Trent-10RR;
2) Maintenance Manual – see Airbus A330 Customer Aircraft Maintenance Manual and
3) Service Bulletins (SB): Trent 1000 as published by Rolls-Royce plc.

Note: The Maintenance Manual is compiled by the Airframer.

NOTE 10 N/A

NOTE 11 CRITICAL ENGINE PARTS

The EASA approved Airworthiness Limitations Section of the Instructions for Continued Airworthiness is published in the applicable “Time Limits Manual”.

NOTE 12 MAXIMUM PERMISSIBLE ENGINE ROTOR SPEEDS

When maintenance running is performed above idle thrust with the aircraft static, the control system automatically applies a temperature dependent LP speed Keep Out Zone. Refer to the Maintenance Manual for details.

Engine models Trent7000-72 and Trent7000-72C:

Rotor	**HP**	**IP**	**LP**
Reference speeds, 100% rpm	13391	8937	2683
Maximum for Take-off (5 minutes limit, refer to Note 1 (c))	101.5%	103.5%	101.5%
Maximum Continuous *	99.5%	100.8%	101.5%

(Data makes allowance for instrumentation accuracies)

* The Maximum Continuous Speed limitations defined in this Data Sheet are not displayed as limitations on the Aircraft flight deck. Non-display of these limitations was agreed during the certification programme.

NOTE 13 MAXIMUM PERMISSIBLE BLEED AIR EXTRACTION

Engine Bleed Air System (EBAS) offtakes for Normal and Abnormal operation

EBAS comprises both the Environmental Control System (ECS) for cabin ventilation and bleed air for aircraft anti-ice purposes. It is fed either from IP compressor stage 8 (IP8) or from HP compressor stage 6 (HP6).

%W26 represents the percentage of air mass-flow through the core of the engine at the HPC entry. Bleed flows vary linearly between the points listed.

Engine Power Setting TET (K)	Maximum **Normal** ECS Bleed Schedule %W26	Bleed Source
Idle to 1260	15.8	HP6
1260 to 1600	15.8 to 5.6 (linear)	HP6
1600 to 1708	5.6 to 4.3 (linear)	IP8
1708 to 1740	4.3 to 3.2 (linear)	IP8
1740 to 1835	3.2 to 2.35 (linear)	IP8
Above 1835	2.35	IP8

NOTE 13 CONT...	Engine Power Setting TET (K)	Maximum **Abnormal** ECS Bleed Schedule %W26	Bleed Source
	Idle to 1500	16.9	HP6
	1500 to 1655	16.9 to 11.3 (linear)	HP6
	1655 to 1708	11.3 to 9.5 (linear)	IP8
	1708 to 1725	9.5 to 7.2 (linear)	IP8
	1725 to 1835	7.2 to 4.95 (linear)	IP8
	Above 1835 to redline	4.95	IP8

NOTE 14 EXHAUST EMISSIONS AND FUEL VENTING

The following emissions standards promulgated in RBAC 34, amendment 05, which corresponds to 14 CFR Part 34, Amendment 5A, effective October 23, 2013, have been complied with for the engine models Trent7000-72 and Trent7000-72C.
– Fuel Venting Emission Standards: RBAC 34.10(a) and 34.11, which correspond to 14 CFR 34.10(a) and 34.11;
– Smoke Number (SN) Emission Standards: RBAC 34.21(e)(2), which corresponds to 14 CFR 34.21 (e)(2);
– Carbon Monoxide (CO) Emission Standards: RBAC 34.21(d)(1)(ii), which corresponds to 14 CFR 34.21(d)(l)(ii);
– Hydrocarbons (HC) Emission Standards: RBAC 34.21(d)(1)(i), which corresponds to 14 CFR 34.21(d)(1)(i);
– Oxides of Nitrogen (NOx) Emission Standards: RBAC 34.23(b)(1), which corresponds to 14 CFR 34.23(b)(l);
The engine manufacturer has declared that the ICAO emissions standards identified in Annex 16, Volume II, Third Edition, Part III, Chapter 2, Section 2.2.2 for SN, Section 2.3.2 for CO and HC, Section 2.3.2.e.2(i) for NOx (also known as CAEP/8), and Part II Chapter 2 for fuel venting have also been demonstrated.

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