

European Aviation Safety Agency

EASA TYPE-CERTIFICATE DATA SHEET

Number : E.036
Issue : 05
Date : 27 March 2014
Type : Rolls-Royce plc
Trent 1000 series engines

Models

Trent 1000-A	Trent 1000-A2
Trent 1000-C	Trent 1000-C2
Trent 1000-D	Trent 1000-D2
Trent 1000-E	Trent 1000-E2
Trent 1000-G	Trent 1000-G2
Trent 1000-H	Trent 1000-H2
	Trent 1000-J2
	Trent 1000-K2
	Trent 1000-L2

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I. General

1. Type/Models:

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H.

Engines incorporating SB 72-G319 are identified by Build Standard "/01".
Engines incorporating SB 72-G893 are identified by Build Standard "/01A".

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2.

These engine models are approved for use on Large Aeroplanes at the ratings and within the operating limitations specified below, subject to compliance with the powerplant installation requirements appropriate to approved installations.

2. Type Certificate Holder:

Rolls-Royce plc
PO Box 31
Derby DE24 8BJ
United Kingdom

DOA ref.: EASA.21J.035

3. Manufacturer:

Rolls-Royce plc

4. Certification Application Date:

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H.

Application Date 30 April 2004

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2 .

Application Date 16 May 2012

5. Certification Reference Date:

30 September 2004

6. EASA Certification Date:

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H Engine Models:

07 August 2007

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2 Engine Models :

10 September 2013

II. Certification Basis

1. Airworthiness Standards and Environmental Requirements:

Engine Models

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H

- CS-E: original issue, dated 24 October 2003
- Emissions and Fuel venting: ICAO Annex 16, Volume II, Part III (3rd Edition, July 2008), Amendment 6
- Time Limited Dispatch : CS-E 1030 amendment 3
- ETOPS: CS-E 1040 amendment 3

Engine Models

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2

- CS-E: original issue, dated 24 October 2003
- Emissions and Fuel Venting: ICAO Annex 16, Volume II, Parts II & III (3rd Edition, July 2008), Amendment 7 dated 17 November 2011
- Time Limited Dispatch : CS-E 1030 amendment 3
- ETOPS: CS-E 1040 amendment 3

2. Special Conditions:

None

3. Deviations:

None

4. Equivalent Safety Findings:

- CS-E 740 150 Hour Endurance Test
- CS-E 740(f) Non declaration or display of Maximum Continuous Speed Limitation
- CS-E 790 Ingestion of Rain and Hail
- CS-E 840 and CS-E 850 HP Shaft Prime Reliability

III. Technical Characteristics

1. Type Design Definition:

The minimum standard of Engine Type Design for operation in accordance with the Trent 1000 Type Certificate Data Sheet are defined in the following documents:

Model	Engine Type Definition
Trent 1000-A	DIS 2286 Issue 3
Trent 1000-C	DIS 2287 Issue 3
Trent 1000-D	DIS 2288 Issue 3
Trent 1000-E	DIS 2289 Issue 3
Trent 1000-G	DIS 2291 Issue 3
Trent 1000-H	DIS 2292 Issue 3
Trent 1000-A2	DIS 2327 issue 3
Trent 1000-C2	DIS 2328 issue 3
Trent 1000-D2	DIS 2329 issue 3
Trent 1000-E2	DIS 2330 issue 3
Trent 1000-G2	DIS 2331 issue 3
Trent 1000-H2	DIS 2332 issue 3
Trent 1000-J2	DIS 2333 issue 3
Trent 1000-K2	DIS 2334 issue 3
Trent 1000-L2	DIS 2335 issue 3

Changes to the Engine Type Design are introduced by approved Service Bulletins (SB). See note 12.

2. Description:

The Trent 1000 engine is a three shaft 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).

3. Equipment:

For details of equipment included in the type design definition: refer to Installation Manual

For details of equipment and nacelle hardware supplied by the Airframe TC holder that may be mounted on or driven by the engine: refer to Installation Manual.

Note: The engine is certified for use with an operable Thrust Reverser Unit. Note that the Thrust Reverser Unit does not form part of the engine type design and is certified as part of the aircraft type design.

4. Dimensions:

Overall Length mm (ins)	4771 (187.8)
Maximum Radius mm (ins)	1899 (74.8)

Length - tip of spinner to rear of the tail bearing housing inner plug flange.
Radius - from centre line, not including drains mast

5. Dry Weight:

Engine Models

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H

Maximum dry engine weight (kg)	Without SB 72-G319	5936
	With SB 72-G319	6033

Including nacelle EBU items certified as part of the engine but not including fluids.

Engine Models

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2,
Trent 1000-K2, Trent 1000-L2

Maximum dry engine weight (kg)	5947
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Including nacelle EBU items certified as part of the engine but not including fluids

6. Ratings:

The ISA sea-level static thrust ratings are:

Rating		Trent 1000-A	Trent 1000-AE	Trent 1000-C	Trent 1000-CE
Thrust, kN (lbf)	Take-Off (net) (5 minutes)	307.8 (69,194)	307.8 (69,194)	331.4 (74,511)	331.4 (74,511)
	Equivalent Bare Engine Take-Off	310.9 (69,885)	310.9 (69,885)	334.7 (75,239)	334.7 (75,239)
	Maximum Continuous (net)	287.9 (64,722)	287.9 (64,722)	309.3 (69,523)	309.3 (69,523)
	Equivalent Bare Engine Maximum Continuous	290.8 (65,382)	290.8 (65,382)	312.3 (70,217)	312.3 (70,217)
Applicable Engine Models		Trent 1000-A	Trent 1000-A Trent 1000-A2	Trent 1000-C	Trent 1000-C Trent 1000-CE

Rating		Trent 1000-D	Trent 1000-E	Trent 1000-G	Trent 1000-H
Thrust, kN (lbf)	Take-Off (net) (5 minutes)	331.4 (74,511)	265.3 (59,631)	320.6 (72,066)	284.2 (63,897)
	Equivalent Bare Engine Take-Off	334.7 (75,239)	268.0 (60,253)	323.7 (72,777)	287.1 (64,551)
	Maximum Continuous (net)	309.3 (69,523)	261.8 (58,866)	287.9 (64,722)	261.8 (58,866)
	Equivalent Bare Engine Maximum Continuous	312.3 (70,217)	264.6 (59,481)	290.8 (65,382)	264.6 (59,481)
Applicable Engine Models		Trent 1000-D Trent 1000-D2	Trent 1000-E Trent 1000-E2	Trent 1000-G Trent 1000-G2	Trent 1000-H Trent 1000-H2

Rating		Trent 1000-J	Trent 1000-K	Trent 1000-L
Thrust, kN (lbf)	Take-Off (net) (5 minutes)	347.5 (78,129)	347.5 (78,129)	331.4 (74,511)
	Equivalent Bare Engine Take-Off	350.9 (78,886)	350.9 (78,886)	334.7 (75,239)
	Maximum Continuous (net)	319.5 (71,818)	319.5 (71,818)	309.3 (69,523)
	Equivalent Bare Engine Maximum Continuous	322.6 (72,519)	322.6 (72,519)	312.3 (70,217)
Applicable Engine Models		Trent 1000-J2	Trent 1000-K2	Trent 1000-L2

Refer to Section VI Notes 1, 2 and 3.

The Trent 1000-A and Trent 1000-C engine models have the option to include enhanced ratings that are incorporated by Service Bulletins 73-H046 and 73-H093 respectively. These two ratings become Trent 1000-AE (SB 73-H046) and Trent 1000-CE (SB 73-H093).

7. 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.

Refer to Section VI Notes 4 and 5.

8. Fluids:

8.1. Fuel and Additives

Refer to the Operating Instructions for information on approved fuel and additive specifications.

8.2. Oil

Refer to the Operating Instructions for information on approved oil specifications.

9. Aircraft Accessory Drives:

The engine's accessory gearbox may be fitted with two Variable Frequency Starter Generators (VFSG) and one Hydraulic Pump 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.

10. Maximum Permissible Air Bleed Extraction:

The Trent 1000 does not supply compressor air for airframe ventilation (Cabin Bleed), but does supply compressor air for the purpose of preventing ice build-up on the engine nacelle (Cowl Thermal Anti-Ice (CTAI)).

The nacelle thermal anti-icing flow demand is modulated via a regulating valve.

Cowl Thermal Anti-Icing Bleed Off takes for Normal and Abnormal operation

Engine Power Setting TET (K)	Maximum Cowl Thermal Anti Ice Flow % Core Mass Flow (W26)
Idle to 1430	2.67
1430 to 1785	2.67 to 1.25 varying linearly
1785 to 1820	1.25 to 0.54 varying linearly
1820 and above	0.54

"W26" represents the air mass flow through the core of the engine.

IV. Operating Limitations

1. Temperature Limits:

1.1 Climatic Operating Envelope

The engine may be used in ambient temperatures up to ISA +40°C. Refer to the Installation Manual for details of the Operating Envelope, including the air inlet distortion at the engine inlet.

1.2 Turbine Gas Temperature – Trimmed (°C)

Maximum during ground starts and shutdown:	700
Maximum during in-flight relights:	900
Maximum for take-off (5 min. limit):	900
Maximum Continuous (unrestricted duration):	850
Maximum over-temperature (20 second limit):	920

Refer to Section VI Notes 6 and 7.

1.3 Fuel temperature (°C)

Minimum fuel temperature:	minus 45
Maximum fuel temperature:	65

Refer to the Installation Manual for additional information.

1.4 Oil temperature (°C)

Combined oil scavenge temperature:

Engine Models

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H

Limit	Without SB 72-G319	With SB 72-G319	Fuel Inlet Temperature
Minimum for engine starting	Minus 40		-
Minimum for acceleration to power	40		For fuel inlet temperature minus 23°C and higher.
	Varies linearly from 40 to 77		For fuel inlet temperature between minus 23°C and minus 45°C.
Maximum for unrestricted use	196	193	-
Maximum transient (15 minutes)	205	201	-

Engine Models

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2

Limit		Fuel Inlet Temperature
Minimum for engine starting	Minus 40	-
Minimum for acceleration to power	40	For fuel inlet temperature minus 23°C and higher.
	Varies linearly from 40 to 77	For fuel inlet temperature between minus 23°C and minus 45°C.
Maximum for unrestricted use	193	-
Maximum transient (15 minutes)	201	-

2. Pressure Limits:

2.1 Fuel pressure (kPa)

Minimum absolute inlet pressure (measured at engine inlet):

	kPa	psi
Steady state conditions with engine running:	34.5 + Vapour Pressure	5 + Vapour Pressure
Transient conditions with engine running (2 seconds):	13.8 + Vapour Pressure	2 + Vapour Pressure

For engine operation with the aircraft boost pumps inoperative the engine minimum fuel pressure limit is reduced down to 3.4 psi at altitudes of up to 35000 feet for up to 600 minutes.

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:	483	70
Transient conditions with engine running (2 seconds):	966	140
Static after engine shut down:	1172	170

2.2 Oil pressure (kPa)

Minimum oil pressure:

Engine Models

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H

	Without SB 72-G319		With SB 72-G319	
	kPa	psi	kPa	psi
Ground idle to 74% IP rpm	207	30	207	30
Between 74% and 100% IP rpm	Varies linearly from 207 to 517	Varies linearly from 30 to 75	Varies linearly from 207 to 621	Varies linearly from 30 to 90
Above 100% IP rpm	517	75	621	90

Engine Models

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2

	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

3. Oil Consumption Limits

Maximum allowable Oil Consumption - litres/hr (US Quarts/hr): 0.60 (0.63)

4. Maximum Permissible 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

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H

Rotor		HP	IP	LP
Reference speeds, 100% rpm		13391	8937	2683
Without SB 72-G319	Maximum for Take-off (5 minute limit, refer to Section VI Note 3)	98.6%	100.8%	101.4%
	Maximum Continuous (refer to Section VI Note 8)	97.8%	99.5%	101.4%
With SB 72-G319	Maximum for Take-off (5 minute limit, refer to Section VI Note 3)	100.2%	103.5%	101.5%
	Maximum Continuous (refer to Section VI Note 8)	99.2%	100.8%	101.5%

(Data makes allowance for instrumentation accuracies)

For engines without SB 72-G319, LP speed must not exceed 96.5% during any aircraft operation with an apparent tailwind, ie tailwind greater than aircraft forward speed. This limitation does not apply to an engine with SB 72-G319.

Engine Models

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2, Trent 1000-K2, Trent 1000-L2

Rotor	HP	IP	LP
Reference speeds, 100% rpm	13391	8937	2683
Maximum for Take-off (5 minute limit, refer to Section VI, note 3)	101.0%	103.5%	101.5%
Maximum Continuous (Refer to Section VI, note 8)	99.5%	100.8%	101.5%

(Data makes allowance for instrumentation accuracies)

5. Installation Assumptions:

Refer to Installation Manual for details.

6. Time Limited Dispatch:

The engine has been approved for Time Limited Dispatch in accordance with CS-E1030. The maximum rectification period for each dispatchable state is specified in the Installation Manual.

7. ETOPS Capability:

Engine Models

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H
Trent 1000-A2, Trent 1000-C2, Trent 1000-D2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2,
Trent 1000-K2, Trent 1000-L2

The engine is approved for ETOPS capability in accordance with CS-E1040 for a Maximum Approved Diversion Time of 330 minutes at MCT thrust plus 15 minutes at hold power. ETOPS does not require any special engine limitation, marking, placard, or configuration. This approval does not constitute an approval to conduct ETOPS operations

V. Operating and Service Instructions

Engine Models

Trent 1000-A, Trent 1000-C, Trent 1000-D, Trent 1000-E, Trent 1000-G, Trent 1000-H

Document	Document Reference
Installation Manual including Engine Control System Dispatch Statement	DNS 130613
Operating Instructions	OI-Trent 1000-B787
Engine Manual	E-Trent-10RR
Maintenance Manual	B787-81205-Axxxx
Time Limits Manual (for engines without SB 72-G319 fitted)	T-Trent-10RR
Time Limits Manual (for engines with SB 72-G319 fitted)	T-Trent-10RRB
Service Bulletins	Trent 1000 — as required

Engine Models

Trent 1000-A2, Trent 1000-C2, Trent 1000 D-2, Trent 1000-E2, Trent 1000-G2, Trent 1000-H2, Trent 1000-J2,
Trent 1000-K2, Trent 1000-L2

Document	Document Reference
Installation Manual including Engine Control System Dispatch Statement	DNS193530
Operating Instructions	OI-Trent 1000-B787C1
Engine Manual	E-Trent-10RRC
Maintenance Manual	B787-81205-Axxxx
Time Limits Manual	T-Trent-10RRC
Service Bulletins	Trent 1000 — as required

Note: The Maintenance Manual is compiled by the Airframer and is specific to Aircraft Operators, "xxxx" denotes the Airlines customer code.

VI. Notes

1. The Equivalent Bare Engine Take-off and Maximum Continuous thrusts quoted in Section III sub level 6 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.
2. The Ratings are based on having no power offtakes to aircraft accessories. MTO ratings are based on having no air bleed for Cowl Thermal Anti Icing (CTAI) but MCT ratings include the effect of CTAI.
3. The take-off rating and the associated operating limitations may be used for up to 10 minutes in the event of an engine failure.
4. The control and monitoring system software meets the following levels according to EUROCAE ED-12B/RTCA DO178B:
 - EEC is designated Level "A".
 - EMU is designated Level "E", except that the flight deck vibration display is Level "C".
5. Refer to Installation Manual for details of Electro-Magnetic Interference (EMI), High Intensity Radiated Fields (HIRF) and Lightning capability.
6. 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.
7. Turbine Gas Temperature is measured by thermocouples positioned at the 1st stage Nozzle Guide Vane of the LP Turbine.
8. 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.
9. The Trent 1000-Z Model approved at original certification was deleted at Issue 2 of TCDS E.036. No examples of this Model have been produced and this model is no longer required.
10. Issue 2 of TCDS E.036 also updated the minimum build standard approved under the Type Certificate as defined in Section III paragraph 1. Only engines complying with the new minimum build standard can be operated. Examples of the earlier build standard are no longer approved and must be reworked to comply with the new minimum build standard prior to service operation.
11. Reserved.
12. Trent 1000-E model Engine type definition always embodies SB 72-G319.
