

# *European Aviation Safety Agency*

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**EASA**

## **TYPE-CERTIFICATE DATA SHEET**

Number : E.036  
Issue : 03  
Date : 11 November 2011  
Type : Rolls-Royce plc  
Trent 1000 series engines

Variants

Trent 1000 – A  
Trent 1000 – C  
Trent 1000 – D  
Trent 1000 – E  
Trent 1000 – G  
Trent 1000 – H

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## **I. General**

### **1. Type/Variants:**

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”.

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:**

30 April 2004

### **5. Certification Reference Date:**

30 September 2004

### **6. EASA Certification Date:**

07 August 2007

## **II. Certification Basis**

### **1. Airworthiness Standards and Environmental Requirements:**

- CS-E, issue 24 October 2003
- Emissions and Fuel Venting: CS-34 referencing Amendment 6 of Volume II of Annex 16 to the Chicago Convention as applicable on 20 November 2008.
- 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

## 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

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

### 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)	4769 (187.8)
Maximum Radius mm (ins)	1899 (74.8)

Length - tip of spinner to rear of cold nozzle  
Radius - from centre line, not including drains mast

#### 5. Dry Weight:

Maximum dry engine weight (kg)	Without SB 72-G319	5936
	With SB 72-G319	6018

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-C	Trent 1000-D	Trent 1000-E
Thrust, kN (lbf)	Take-off (net) (5 minutes)	307.8 (69,194)	331.4 (74,511)	331.4 (74,511)	265.3 (59,631)
	Equivalent Bare Engine Take-off	310.9 (69,885)	334.7 (75,239)	334.7 (75,239)	268.0 (60,253)
	Maximum Continuous (net)	287.9 (64,722)	309.3 (69,523)	309.3 (69,523)	261.8 (58,866)
	Equivalent Bare Engine Maximum Continuous	290.8 (65,382)	312.3 (70,217)	312.3 (70,217)	264.6 (59,481)

Rating		Trent 1000-G	Trent 1000-H
Thrust, kN (lbf)	Take-off (net) (5 minutes)	320.6 (72,066)	284.2 (63,897)
	Equivalent Bare Engine Take-off	323.7 (72,777)	287.1 (64,551)
	Maximum Continuous (net)	287.9 (64,722)	274.7 (61,758)
	Equivalent Bare Engine Maximum Continuous	290.8 (65,382)	277.6 (62,397)

Refer to Section VI Notes 1, 2 and 3.

#### 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:

### Fuel and Additives

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

### 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

NB "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 3, 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:

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	-

## 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

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:

	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

## 3. Oil Consumption Limits

Maximum allowable Oil Consumption - litres/hr (US Quarts/hr): 0.50 (0.53)

## 4. Maximum Permissible Rotor Speeds:

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)

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.

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.

## 5. Installation Assumptions:

Refer to Installation Manual for details.

## 6. Time Limited Dispatch:

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

## 7. ETOPS Capability:

The engine has demonstrated eligibility for ETOPS 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 configuration or any special limitations. Note that ETOPS eligibility does not constitute airplane or operational level approvals necessary to conduct ETOPS flights.

## V. Operating and Service Instructions

Document	Trent 1000 all variants
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-A2201-00
Time Limits Manual	T-Trent-10RR
Service Bulletins	Trent 1000 — as required

## 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 variant approved at original certification was deleted at Issue 2 of TCDS E.036. No examples of this variant have been produced and this variant is no longer required.
10. Issue 2 of TCDS E.036 also updated the minimum build standard approved under the Type Certificate as refined 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.

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