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**GTER**

A Report Series

**Gas Turbine Engineering Report - Performance**

B Report Number

**GTER 13845**

C Issue

**1**

D Title

**Industrial Trent 60: 50Hz DF WLE engine 55 pass-off performance results – Centrax/Gas de France**

E Author(s)

**L Leclerc**

Tel Number

**X 7524**

F SUMMARY

A Customer Witness Test (CWT) was performed on the 2<sup>nd</sup> October 2009 on ESN055. This engine is a 50Hz Industrial Trent DF WLE and is to be packaged by Centrax for Gas De France. It had previously passed all internal RR PAT performance criteria when tested from 30<sup>th</sup> September to 2<sup>nd</sup> October.

The CWT baseload data was referred to site reference conditions and RR PAT reference conditions using the ratio method and eTrent version 7.0.2. The results are presented in this report for formal declaration and communication to the customer. They show that ESN055 meets the customer guarantees and the PAT performance criteria. The key results are presented in the tables below.

	GAS WET				LIQUID WET			
	Engine 55 corrected	Guarantees	Diff.	STATUS	Engine 55 corrected	Guarantees	Diff.	STATUS
Electrical Power (kW)	58000	58000	0.0%	<b>PASS</b>	58000	58000	0.0%	<b>PASS</b>
Electrical Heat Rate (KJ/kWhr)	8792	9002	-2.3%	<b>PASS</b>	8741	9109	-4.0%	<b>PASS</b>

Engine 55 performance relative to contract guarantee

	GAS WET				LIQUID WET			
	Engine 55 corrected	PAT acceptance	Diff.	STATUS	Engine 55 corrected	PAT acceptance	Diff.	STATUS
Shaft Power (kW)	56381	53908	4.6%	<b>PASS</b>	55567	53965	3.0%	<b>PASS</b>
Shaft Heat Rate (KJ/kWhr)	8711	8975	-2.9%	<b>PASS</b>	8737	9107	-4.1%	<b>PASS</b>

Engine 55 performance relative to PAT acceptance limits

Note 1: Negative heat rate margin means lower fuel consumption.

Note 2: The 0% margin against contract guarantee power shows the test was conducted at this power limit.

G Additional Keywords

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Date: 23<sup>rd</sup> October 2009

H Engine Type

**Industrial Trent 60**

J Ref. No.

K Date

**23 Oct 2009**

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N

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**Gas Turbine Engineering Report**

**Continuation Sheet**

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**REVISION LEVEL**

<b>Issue</b>	<b>Reason</b>	<b>Date</b>
1	Original issue	23 Oct 2009

**Note:** Changes made between the current and previous revision levels are indicated by vertical change bars.

<b>Title</b> Industrial Trent 60: 50Hz DF WLE engine 55 pass-off performance results – Centrax/Gas de France D 23 Oct 2009 RRGTE-101 / 6	<b>Report Number</b> GTER13845 B	<b>Issue</b> 1 C	<b>Page 2</b> Of 17 P
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**1.0 Summary and Conclusions**

A Customer Witness Test (CWT) was performed on the 2<sup>nd</sup> October 2009 on ESN055. This engine is a 50Hz Industrial Trent DF WLE and is to be packaged by Centrax for Gas de France. It had previously passed all internal RR PAT performance criteria when tested from 30<sup>th</sup> September to 2<sup>nd</sup> October.

The CWT baseload data was referred to site reference conditions and RR PAT reference conditions using the ratio method and eTrent version 7.0.2. The results are presented in this report and show that ESN055 meets the customer guarantees and the PAT performance criteria. This report formally declares this performance, previously communicated in LGT3711.

**2.0 Test data & results**

ESN055's CWT took place in Test Cell 7 on 2 October 2009, to the Industrial Trent 60 WLE Dual Fuel – Customer Witness Test procedure, (GTES 10760 issue 2, reference 1).

**2.1 Inputs and Method**

**Raw data:**

A full output of the raw data taken in the CWT and used in the analysis is provided in Appendix A. The engine was fully stabilized at baseload.

The following table summarises storage location, time, power and ambient temperature.

	ALICE Experiment	Scan	Test Date	Time	TCELL (K)	Generator Power (kW)
Gas Wet	90155010	59	02/10/2009	16h33	288.0	58076
Liquid Wet	90155010	62	02/10/2009	17h25	287.2	58077

**Emissions:**

Emission were recorded during the test. The reports are attached in Appendix B:

NOx recorded during the tests:

Gas Wet: NOx = 24.3 vppm

Liquid Wet: NOx = 42.5 vppm

**Diesel Analysis:**

A sample of Diesel was taken during the test. The result of the sample analysis is attached in appendix C. The Lower Heating Value of the Diesel during the test was 18502BTU/lb.

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**Generator efficiency:**

To obtain shaft power the generator efficiency curve below is interpolated (linearly) at the generator power obtained during the test. Then a factor of 0.985 is applied to the value obtained. This was derived from cross-calibration with Test Cell #3 where measurements were taken with a torque meter calibrated to traceable standards.

Power (HP)	Gen. Effy
0	0
530	0.2528
1745	0.7685
7143	0.9387
13894	0.9639
27386	0.9789
40878	0.9839
54376	0.9863
67876	0.9877
81371	0.9887
100000	0.9887

Note: 1HP = 0.7457 kW

**Installation losses assumptions:**

The assumptions for the installation losses for testcell 7 are as follows:

Temp (C )	-0.67
Inlet (mm H2O)	27.94
Exhaust (mm H2O)	309.88

**Analysis Method:**

The CWT data was analysed using the ratio method (see attachment in Appendix D for a fuller description) and eTrent 7.0.2.

The spreadsheets containing the calculation details are attached in Appendix E, tables 1 to 4. A summary of the results of referral to contract and PAT reference conditions are provided in sections 2.2 and 2.3.

Note: The emissions used in the analysis came from the lab reports. However eTrent version 7.0.2 can not be run to specified NOx. For the analysis, the NOx of the test were assumed to be 24.3vppm for Gas and 42vppm for Diesel.

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## 2.2 Results of referral to Contract Reference Conditions

The contract reference conditions and performance guarantees are summarized in the tables below. They are for gas wet and liquid wet applications.

### Ambient conditions

	Saint-Brieuc
Tamb (C )	11
Pamb (kPa)	99.418
RH (%)	80
Generator efficiency (%)	98.3
<b>Installation losses losses</b>	
Temp (C )	11
Inlet (mm H2O)	125
Exhaust (mm H2O)	125

### Fuel properties:

Gas Properties	
<b>Gas Composition</b>	
Methane (%)	92.40%
Ethane (%)	5.30%
Propane (%)	1.60%
n-Butane (%)	0.00%
i-Butane (%)	0.50%
Nitrogen (%)	0.20%
Carbon Dioxide (%)	0.00%
Gas LHV (kJ/kg)	49397
Gas temperature (C )	50

Diesel Specification	
Carbon Atoms	-
Hydrogen Atoms	-
Cp (BTU/lbF)	-
LHV (kJ/kg)	41900
Fuel temp (C )	15

### NOx control:

Gas	24.3
Diesel	42

### Performance Guarantees:

	GAS	DIESEL
Electrical Power (kW) - Gas	58000	58000
Electrical Heat Rate (kJ/kW.hr) - Gas	9002	9109

The results from the analysis of the CWT, shown in summary below, demonstrate that the engine meets contractual guarantees.

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	Engine 55 corrected	Guarantees	Diff.	STATUS	Engine 55 corrected	Guarantees	Diff.	STATUS
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Electrical Heat Rate (KJ/kWhr)	8792	9002	-2.3%	<b>PASS</b>	8741	9109	-4.0%	<b>PASS</b>

Note 1: Negative heat rate margin means lower fuel consumption.

Note 2: The 0% margin against contract guarantee power shows the test was conducted at this power limit.

### 2.3 Results of referral to PAT reference conditions

#### Pass-off Test Acceptance:

##### Ambient conditions:

Ambient Pressure	101.325 kPa
Ambient Temperature	25 °C
Ambient Relative Humidity	60%
Intake Total Pressure Loss	0 mm H2O
Exhaust Total Pressure Loss	0 mm H2O
Fuel Temperature	100 °C
Frequency	50Hz

##### Fuel properties:

eTrent North American Natural Gas Specification	
Component:	Value (mol %)
Methane	95.527
Ethane	2.064
Propane	0.117
i-Butane	0
n-Butane	0.01
Nitrogen	1.942
Carbon Dioxide	0.34
Fuel Temperature	373.15 K (212°F)

Diesel Fuel Specification	
Component:	Value
Carbon Atoms	12.9
Hydrogen Atoms	23.9
Cp (BTU/lbF)	0.4538
LHV (BTU/lb)	18315
Fuel Temperature	288.15 K

##### NOx control:

Gas	24.3
Diesel	42

Note: the reference temperature is 25°C, above the kink point, where the engine is operating on the T30 limiter.

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The results from the analysis of the CWT, shown in summary below, demonstrate that the engine meets PAT criteria.

	GAS WET				LIQUID WET			
	Engine 55 corrected	PAT acceptance	Diff.	STATUS	Engine 55 corrected	PAT acceptance	Diff.	STATUS
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Shaft Heat Rate (KJ/kWhr)	8711	8975	-2.9%	<b>PASS</b>	8737	9107	-4.1%	<b>PASS</b>

Note : Negative heat rate margin means lower fuel consumption.

### 3.0 References

- 1. GTES 10760/2 Industrial Trent 60 WLE Dual Fuel – Customer Witness Test Procedure  
H Ko, N Budeanu 4 September 2009

### 4.0 Appendices

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## Appendix A: Raw data used for analysis

	<b>GAS</b>	<b>DIESEL</b>	
SCAN	59	62	
WS_PRES	14.6699	14.6695	Ambient pressure (PSI)
WS_TEMP	13.3982	12.95	Ambient temperature (C )
WS_HUM	55.8999	57.8785	Relative Humidity (%)
TCELL	288.03	287.199	Average inlet temperature (K)
UPOWERV	58.0764	58.0771	Generator power (MW)
NL	3002	3002	LP Speed (RPM)
NI	6777	6769	IP Speed (RPM)
NH	10146	10136	HP Speed (RPM)
UT30V	592.00	592.33	T30 average
LMETHANE	96.6125	-	Gas Composition (% vol)
LETHANE	1.15437	-	
LPROPANE	0.0702	-	
LIBUTANE	0.005772	-	
LN BUTANE	0.00546	-	
LPENTANE	0	-	
LNPENTAN	0	-	
LC6PLUS	0.001519	-	
LNITRO	1.59739	-	
LCO2	0.550176	-	
LFT_0101	23890.5	-	Gas Fuel flow
LTE_0101	35.6	-	Gas Fuel Temperature
ULIQT1	-	26.4226	Diesel Temperature
FT0210	-	26559.9	Diesel fuel flow
FT0314	31386.6	32532.1	Water flow
UWIMST1	17.6082	17.5671	Water temperature (C )
UTGTV	748.208	757.115	TGT average
NOx from lab (vppm)	24.3	42.5	
Diesel LCV from lab	-	18502	BTU/lb
Diesel LCV from lab	-	43035	kJ/kg

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Appendix B

02/10/2009_RRC TB7_TRENT DF WLE 55 CUSTOMER WITNESS														PAGE 1 of 1		
Emissions from jet pipe probes and oration tube (No.10)														Note:		
Measurements taken with FT000 CEMS														1) Emissions calculations by: COEMISV1.DLL (Version 1.0)		
Units: CO <sub>2</sub> and O <sub>2</sub> %; balance ppm														2) Emissions data handling by: COEMIS 2.EXE (Version 2.0)		
Fuel analysis: (Meth)														3) Observe scale changes in report		
Methane														4) Analyst: MARYSE DUBOIS, KURT NORMANDIN (DE)		
Ethane																
Propane																
Butane																
Pentane																
Hexane																
Carbon dioxide																
Nitrogen																
Time	CO DRY	CO <sub>2</sub> DRY	O <sub>2</sub> DRY	HC WET	NOx DRY	NO DRY	O <sub>2</sub> adj. NOx	HW	SSE	PSI	Probe	APR	Em	T30	FUEL	WF
GAS WET																
15:42:18	94.4	3.218	15.38	11.4	22.7	13.8	24.3	58	10393203	517	10	56.27	99.883	592	23843	1.30
15:49:43	94.1	3.214	15.38	11.6	22.6	13.7	24.2	58	10393204	517	10	56.54	99.883	592	23843	1.30
15:59:53	93.3	3.202	15.40	11.1	22.7	13.9	24.4	58	10393205	517	10	56.58	99.885	592	23843	1.30
16:09:17	93.0	3.193	15.41	11.0	22.7	13.8	24.4	58	10393206	517	10	56.71	99.885	592	23843	1.30
16:15:40	92.6	3.201	15.39	10.8	22.9	14.0	24.5	58	10393207	520	10	56.57	99.887	594	23852	1.30
16:29:19	94.2	3.199	15.39	11.8	22.5	13.6	24.1	58	10393208	522	10	56.60	99.887	594	23852	1.30
16:34:10	93.9	3.195	15.42	12.0	22.6	13.5	24.3	58	10393209	522	10	56.84	99.881	593	23864	1.30
LIQUID WET																
17:07:16	7.3	4.268	15.27	0.0	40.4	31.6	42.3	58	30220001	521	10	42.83	99.991	591	26597	1.19
17:15:07	7.1	4.264	15.27	0.0	40.6	31.7	42.6	58	30220002	522	10	42.87	99.992	591	26627	1.19
17:24:08	7.1	4.261	15.28	0.0	40.5	31.6	42.6	58	30220003	522	10	42.90	99.992	591	26627	1.19

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Appendix C: Diesel analysis



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**CERTIFICATE OF FUEL TESTING - DIESEL**

TO: **R. Inose, N. Budeanu**

ENGINE: **ITRENT LIQUID WET PERF CURVE**

ESN: **55**

DATE RECEIVED: **October 5, 2009**

This certifies that a representative fuel sample used in the performance testing of the above engine has been analyzed by the RRC Laboratory in accordance with the following ASTM methodology:

Calorific Value           D 4809  
 Specific Gravity         D 1250 - 80  
 Kinematic Viscosity    D 445 - 96  
 Dissolved Water Content D 6308

The following results were obtained:

LABORATORY I.D.       **D24**  
 TEST BED I.D.         **RH-1 2009-F-014**  
 SPECIFIC GRAVITY @ 60°F **0.8304**   kg/L  
 CALORIFIC VALUE       **18502**     BTU/lb  
 VISCOSITY @ 0°C       **5.42**       cSt  
 VISCOSITY @ 30°C      **2.60**       cSt  
 WATER CONTENT        **35**         ppm

DATE OF FUEL ANALYSIS: **October 5, 2009**

**George Zoni**

RRGTE Form No. 540-013 Rev. 5 2005

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Appendix D: Ratio method presentation



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## Trent 60 DF WLE Method to correct to Guarantee conditions or to PAT conditions

**Louise Leclerc**

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Private - Rolls-Royce Data

### Site data correction

- In field the engine runs to a limiter (Power, T30 or TGT) or a defined parameter, eg. Power, depending on ambient conditions and/or needs of customer.
- To properly assess the performance of the engine, the data need to be corrected for ambient conditions and if necessary for TGT and T30 margin.
- Rolls-Royce standard way to analyse the performance of DF WLE engines is to use the « ratio Method » and to refer the data to a specific condition, e.g. the guarantee point, cf. diagram.
- The « ratio method » is done using eTrent.
- The procedure is different if the referral point is above or below the kink point, i.e. limited by Power or T30.

Private - Rolls-Royce Data

Ratio Method presentation

Slide 2

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**The "Ratio Method" to guarantee conditions (below kink point)**

- 1 - Run eTrent at same conditions as engine on test
  - Guarantee Expected Limit Parameter, GELP (measured generator power)
  - Same ambient conditions
  - Same installation losses
  - Same fuel
- 2 - Calculate the ratios of actual power, TGT, T30 and heatrate to eTrent predictions (power ratio will be 1.0 as eTrent was run to test power)
- 3 - Run eTrent at guarantee conditions and GELP at the guarantee condition (power of 58MW gross)
- 4 - Multiply TGT and T30 (absolute temperatures) from 3. by ratios from 2.
- 5 - If both corrected TGT and T30 are below the control limits:
  - Achievement of guaranteed power assured
  - Calculate heatrate at guarantee condition by Multiplying heatrate ratio from 2. to heatrate from 3.
- 6 - If either corrected TGT or corrected T30 are above the control limits (meaning the engine fails guarantee on Power):
  - Repeat 1 to 5 using TGT or T30 as the GELP to determine heatrate at guarantee conditions, and also power shortfall.

**The "Ratio Method" to PAT conditions (above kink point)**

- 1 - Run eTrent at same conditions as engine on test
  - Guarantee Expected Limit Parameter, GELP (measured T30)
  - Same ambient conditions
  - Same installation losses
  - Same fuel
- 2 - Calculate the ratios of actual shaft power and Heat rate to eTrent predictions (T30 ratio will be 1.0 as eTrent was run to test T30)
- 3 - Run eTrent at reference conditions and GELP at the reference condition (T30 limit – 876K)
- 4 - Multiply Shaft Power and Heat Rate from 3 to ratios from
- 5 - Compare Corrected Shaft Power and Heat Rate to PAT acceptance values.

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**Appendix E:**

Trent 60 DFWLE Engine Serial Number 055 Build1  
 Measured and Corrected Performance Data From Factory Test  
 Rolls-Royce Canada, Montreal, Test Bed #7, October 2, 2009

Experiment	90155010
Extract	59
Time	9:25 PM

Standard_DFWLE_ITRST606		Model at Test Conditions at test power	Engine Test Data	Ratio Engine to Model	Model at Guarantee Conditions (at Power Limit)	Engine Corrected to Guarantee Conditions	Project Guarantee	Difference to Project Guarantee
Ambient Pressure	kPa	101.15	101.15		99.42		99.42	
Ambient Temperature	C	14.88	14.88		11		11	
Relative Humidity	%	58.9	58.9		90		90	
Inlet Loss	mmH <sub>2</sub> O	27	27		125		125	
Exhaust Loss	mmH <sub>2</sub> O	305	305		125		125	
LP Speed	rpm	3000	3002		3000		3000	
Shaft Power	MW	59651	59650	1.000	59003	59002	59003	
Gross Electrical Power	kW		58076		58000	58000	58000	0.0%
Generator efficiency			97.36%			98.3%	98.3%	
Shaft Heatrate	kJ/MWh.hr	8815	8806	0.986	8761	8643	8849	
Gross Electrical Heatrate	kJ/MWh.hr	9054	8932		8813	8792	9002	-2.3%
Fuel Composition								
	Methane	98.6129	98.6129		92.4		92.4	
	Ethane	1.1544	1.1544		5.3		5.3	
	Propane	0.0702	0.0702		1.6		1.6	
	i-Butane	0.0058	0.0058		0.5		0.5	
	n-Butane	0.0055	0.0055		0		0	
	i-Pentane	0	0		0		0	
	n-Pentane	0	0		0		0	
	Hexane	0.0015	0.0015		0		0	
	Nitrogen	1.5974	1.5974		0.2		0.2	
	Carbon Dioxide	0.5502	0.5502		0		0	
	LCV	47886.8			49397			
Fuel Temperature	C	35.6	35.6		50.0			
LPT Entry Temperature (TGT)	C	767.2	748.2	0.975	760.8	741.9	LIMIT 762.6C	
HPC Exit Temperature (T30)	K	866.4	866.2	0.999	856.0	857.6	LIMIT 876K	
NOx (Corrected to 15% O <sub>2</sub> , dry)	ppm	24.3	24.3		24.3			
Compressor Water Flow	kg/hr	14171	14237	1.005	14065	14130.4		
Compressor Water Temperature	C	17.6	17.6		15			

Table 1: Gas Wet referred to Guarantees

<b>Title</b>	<b>Report Number</b>	<b>Issue</b>	<b>Page</b>
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**Rolls-Royce**

**Gas Turbine Engineering Report**

**Continuation Sheet**

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Trent 60 DPWLE Engine Serial Number 055 Build1  
 Measured and Corrected Performance Data From Factory Test  
 Rolls-Royce Canada, Montreal, Test Bed #7, October 2, 2009

Experiment	9015501C
Extract	69
Time	9:25 PM

Standard_DPWLE_T1RST688		Model at Test Conditions at Test T30	Engine Test Data	Ratio Engine to Model	Model at PAT Conditions (at T30 Limit)	Engine Corrected to PAT Conditions	PAT Limits	Difference to PAT Limits
Ambient Pressure	kPa	101.15	101.15		101.33		101.325	
Ambient Temperature	C	14.88	14.88		26.0		26.0	
Relative Humidity	%	55.9	55.9		60		60	
Inlet Loss	mmH2O	27	27		0		0	
Exhaust Loss	mmH2O	302	302		0		0	
LP Speed	rpm	3000	3002		3000			
Shaft Power	MW	59184	59850	1.008	59850	59381	53905	4.6%
Gross Electrical Power	MW		58078		55078			
Generator efficiency			97.36%		96.35%			
Shaft Heatrate	kJ/MWh hr	8520	8696	0.966	8938	8711	8975	-2.0%
Gross Electrical Heatrate	kJ/MWh hr	9069	8932		8983			
Fuel Composition								
Methane	vol%	96.6128	96.6135		95.527		96.527	
Ethane		1.1544	1.1544		2.064		2.064	
Propane		0.0702	0.0702		0.117		0.117	
i-Butane		0.0058	0.0058		0.000		0.000	
n-Butane		0.0058	0.0059		0.010		0.010	
i-Pentane		0.0000	0.0000		0.000		0.000	
n-Pentane		0.0000	0.0000		0.000		0.000	
Hexane		0.0015	0.0015		0.000		0.000	
Nitrogen		1.5974	1.5974		1.942		1.942	
Carbon Dioxide		0.6502	0.6502		0.340		0.340	
LCV		47868.5	47986.5		47825		47825	
Fuel Temperature	C	35.6	35.6		100.0		100.0	
LPT Entry Temperature (T57)	C	787.2	748.2	0.9752	773.2	754		
HPC Exit Temperature (T30)	K	865.2	865.2	1.000	876	876		
NOx (Corrected to 15% O2, dry)	ppm	24.3	24.3		24.3			
Combustor Water Flow	kg/hr	14027	14237	1.015	13484			
Combustor Water Temperature	C	17.8	17.5		15			

Table 2: Gas Wet referred to PAT

Title	Report Number	Issue	Page 15
Industrial Trent 60: 50Hz DF WLE engine 55 pass-off performance results – Centrax/Gas de France	GTER13845	1	Of 17
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Trent 60 DFWLE Engine Serial Number 055 Build1  
 Measured and Corrected Performance Data From Factory Test  
 Rolls-Royce Canada, Montreal, Test Bed #7, October 2, 2009

Experiment	90155010
Extract	59
Time	9:25 PM

Standard_DFWLE_ITRST#08		Model at Test Conditions at test power	Engine Test Data	Ratio Engine to Model	Model at Guarantee Conditions (at Power Limit)	Engine Corrected to Guarantee Conditions	Project Guarantee	Difference to Project Guarantee
Ambient Pressure	MPa	101.14	101.14		99.42		99.42	
Ambient Temperature	C	14.05	14.05		11		11	
Relative Humidity	%	57.9	57.9		80		80	
Inlet Loss	mmH2O	27	27		126		126	
Exhaust Loss	mmH2O	306	306		125		125	
LPT Speed	rpm	3000	3002		3000		3000	
Shaft Power	MW	59002	59651	1.009	59003	59002	59003	
Gross Electrical Power	MW		58077		58000	58000	58000	0.0%
Generator efficiency			97.36%		98.30%	98.30%		
Shaft Heatrate	kJ/kWh.hr	8924	8892	0.974	8822	8522	8854	
Gross Electrical Heatrate	kJ/kWh.hr	9166	8927	0.974	8974	8741	9109	-4.0%
Fuel Composition								
LCV		43035	43035		41900			
Fuel Temperature	C	26.4	26.4		15.0			
LPT Entry Temperature (TGT)	C	767.2	767.1	0.987	774.9	784.8	LIMIT 782.80	
HPC Exit Temperature (T30)	K	884.2	885.5	1.001	858.4	856.7	LIMIT 876K	
NOx (Corrected to 15% O2, dry)	ppm	42.0	42.5		42.0			
Compressor Water Flow	kg/hr	15001	14758	0.984	13024	12811.7		
Compressor Water Temperature	C	17.6	17.0		15			

Table 3: Liquid Wet referred to Guarantees

Title	Report Number	Issue	Page 16
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Trent 60 DFWLE Engine Serial Number 055 Build1  
 Measured and Corrected Performance Data From Factory Test  
 Rolls-Royce Canada, Montreal, Test Bed #7, October 2, 2009

Experiment	90100010
Extract	59
Time	8:25 PM

Standard_DFWLE_ITRST606		Model at Test Conditions at test T30	Engine Test Data	Ratio Engine to Model	Model at PAT Conditions (at T30 Limit)	Engine Corrected to PAT Conditions	PAT Limits	Difference to PAT Limits
Ambient Pressure	kPa	101.14	101.14		101.325		101.325	
Ambient Temperature	C	14.05	14.05		25.0		25.0	
Relative Humidity	%	57.9	57.9		60		60	
Inlet Loss	mmH <sub>2</sub> O	28	27		0		0	
Exhaust Loss	mmH <sub>2</sub> O	308	308		0		0	
LP Speed	rpm	3000	3002		3000			
Shaft Power	kWe	60128	59551	0.992	56011	55567	53665	3.0%
Gross Electrical Power	kWe		56077		55087	-		
Generator efficiency			97.36%		98.35%			
Shaft Heatrate	kJ/kWh.hr	8916	8952	0.975	8966	8737	9107	-4.1%
Gross Electrical Heatrate	kJ/kWh.hr	9161	8927		9149	-		
Fuel Composition								
LHV		43035	43035		42600		42600	
Fuel Temperature	C	26.4	26.4		15.0		15.0	
LPT Entry Temperature (T57)	C	767.2	757.1	0.9868	786.5	778		
HPC Exit Temperature (T30)	K	666.5	660.5	1.000	676	676		
NOx (Corrected to 15% O <sub>2</sub> , dry)	ppm	42.0	42.5		42.0			
Compressor Water Flow	kg/hr	18159	14756	0.974	13796			
Compressor Water Temperature	C	17.6	17.6		15			

Table 4: Liquid Wet referred to PAT

Title Industrial Trent 60: 50Hz DF WLE engine 55 pass-off performance results – Centrax/Gas de France D 23 Oct 2009 RRGTE-101 / 6	Report Number GTER13845	Issue 1	Page 17 Of 17
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