

# BILLERICA (M.A296.01) - EQUIPMENT SUPPLY CONTRACT

## APPENDIX D – GUARANTEED / MINIMUM PERFORMANCE LEVELS AND LIQUIDATED DAMAGES

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#### APPENDIX D – GUARANTEED / MINIMUM PERFORMANCE LEVELS AND LIQUIDATED DAMAGES

#### D1 LIQUIDATED DAMAGES

If Rolls-Royce achieves the Minimum Performance Levels specified in D2 below, but fails to meet the Guaranteed Performance Levels, or if Rolls-Royce fails to meet the Delivery Dates specified in the Contract and Appendix C, Rolls-Royce will pay the Customer the sums set out below, on a per Unit, pro rata basis, as liquidated damages in full and final settlement of claims arising therefrom, provided, that if Rolls-Royce fails to achieve the Minimum Performance Levels, Customer has the right to reject the Equipment.

Gross Power Output:	\$578 per kWe, subject to a cap of      of RR contract value.
Gross Heat Rate:	\$7,739 per BTU (LHV)/kWe.hr, subject to a cap of      of RR contract value.
Performance Aggregate Cap:	, of RR contract value.
Delivery Date (FOB Site):	\$8,000 per day, subject to a cap of      of RR contract value.
Aggregate Cap:	of RR contract value.

#### D2 MINIMUM PERFORMANCE LEVELS

Power Output:	98% of Guaranteed Gross Power Output
Heat Rate:	No more than 101.4% of Guaranteed Gross Heat Rate
NOx, CO, VOC, PM-10, Emissions	Guaranteed Level
Noise	85dB(A) average without the optional Acoustic Options (or Sound Abatelements) selected by the Customer and listed in Appendix A

If Rolls-Royce fails to achieve the Minimum Performance Levels, Customer has the right to reject the Equipment.

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## D3 GUARANTEED PERFORMANCE LEVELS

### D3.1 PERFORMANCE GUARANTEES DEFINITIONS

PERFORMANCE DEFINITIONS	
<b>1 - Gross Power Output</b>	The Gross Unit power output when operating at the defined guarantee conditions and fuel specification is guaranteed to be no less than the value stated. Gross Unit Power is taken to mean the output at generator terminals, net of excitation losses and exclusive of power for continuously running Unit essential auxiliary loads.
<b>2 - Gross Heat Rate</b>	The average gross heat rate when operating at the defined guarantee conditions and fuel specification is guaranteed to be no greater than the value stated. The gross heat rate is defined as (fuel heat input [LHV basis] / Gross Unit Power Output)
<b>3 - NOx Emissions</b>	Gas Turbine Emissions in the gas turbine exhaust when operating at the defined guarantee condition, for operating conditions and fuel specification is guaranteed to be no greater than value stated.
<b>3-7 - NOx Emissions / CO Emissions / VOC Emissions / PM10 Emissions / NH3 slip</b>	Gas Turbine Emissions in the gas turbine exhaust when operating at the defined condition, for operating conditions and fuel specification should be no greater than value stated. The air exhaust emissions guaranteed above are NET based on the composition of the air at the inlet.
<b>8 - Auxiliary Power</b>	The Unit essential auxiliary loads when operating at the defined guarantee conditions and fuel specification is guaranteed to be no greater than the value stated. Unit essential auxiliary loads include the power for continuously running Unit essential auxiliary loads for a single Unit at baseload conditions.
<b>9 - Start Time</b>	The Unit start-up period from cold condition is guaranteed to be no greater than the value stated from the start of the gas turbine start cycle, with all permissives met, to base load operation.
<b>10 - Acoustics</b>	The near field A-weighted sound pressure level for one Unit, when operating at the defined ISO baseload conditions in a free field environment is guaranteed to be no greater than the value stated. When measured at a horizontal distance of 3.3 feet from major equipment surfaces or their acoustic enclosures at a height of 5 ft. above the grade. Intermittent noise sources are excluded from this value.

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## D3.2 NATURAL GAS PERFORMANCE GUARANTEES

The following performance parameters supersede all previously issued guarantees, and are guaranteed at a the Reference Conditions for Guarantee Performance described in this document, unless otherwise stated in the conditions column.

Parameter	Unit	Value	Conditions	Flg	Definition
Gross Power	kWe	58,000	New and Clean, Base load operation	-	1 - Gross Power
Gross Heat Rate (LHV)	BTU/kWe.hr	8,592	New and Clean, Base load operation	-	2 - Gross Heat Rate
NOx Emission	vpmd @ 15% O2	2.5	9 deg F to 91 deg F, 100% to 50% load	-	3 - NOx Emissions
CO Emission	vpmd @ 15% O2	5.0	9 deg F to 91 deg F, 100% to 50% load	-	4 - CO Emissions
NH3 slip	vpmd @ 15% O2	5.0	9 deg F to 91 deg F, 100% to 50% load	-	5 - CO Emissions
VOC Emission	vpmd @ 15% O2	2.5	9 deg F to 91 deg F, 100% to 50% load	-	6 - VOC Emissions
PM-10 Emission	lb/hr	15	9 deg F to 91 deg F, 100% to 50% load	-	7 – PM-10 Emissions
Auxiliary Load	kWe	600	GenSet essential auxiliary loads	-	8 – Auxiliary Power
Start Time	minutes	10	Excludes all Balance-of Plant	-	9 - Start Time
Near Field Noise Level	dB(A)	85	Average, Peak 90 dB(A) - 1 GenSet	-	10 - Acoustics
REFERENCE CONDITIONS					
Site Conditions					
Ambient temperature (Dry Bulb)	°F	59	Methane (CH4)	% mol	94.311
Relative Humidity	%	60	Ethane (C2H6)	% mol	2.880
Ambient pressure	psi	14.927	Propane (C3H8)	% mol	0.652
Altitude - For Information only	ft asl	130	i-Butane (C4H10i)	% mol	0.096
Electrical System					
Power Factor at generator terminals	-	1.0	n-Butane (C4H10n)	% mol	0.080
Generating frequency	Hz	60	i-Pentane (C5H12i)	% mol	0.029
Generating voltage at generator terminals	kV	13.8	n-Pentane (C5H12n)	% mol	0.020
Gas Turbine					
Gas Turbine	-	Trent 60	Hexane (C6H14)	% mol	0.043
Combustion System	-	WLE	Nitrogen (N2)	% mol	0.891
Configuration	-	Dual Fuel	Carbon Dioxide (CO2)	% mol	0.997
Operation	-	Base continuous	Fuel LHV	BTU/lb	20,535
Condition	-	New and Clean	Fuel Supply / Water Supply		
Operating Hours	hr	< 200 fired	Fuel Gas Pressure (Guarantee Point)	psi (g)	799.6
Design Temperature	°F	59 (Gas Fuel)	Fuel Gas Temperature (Guarantee Point)	°F	122
Inlet Installation Losses (Guarantee Point)	in H2O	5	Water Pressure (Water Injection)	psi (g)	50
Exhaust Installation Losses (Guarantee Point)	in H2O	10	Water Temperature (Water Injection)	°F	60
Inlet Cooling	-	Evap Cooler	Water Pressure (Evap Cooler)	psi (g)	50
Inlet Cooling Operational	-	No	Water Temperature (Evap Cooler)	°F	68
Performance Deck	-	eTrent v6.1.3	Performance Guarantees Definitions		
Performance Test					
Protocol	STP No. G.7.Q		Definitions	Performance Definitions – Appendix D	
Correction Curves	eTrent Method		Units	English Units	
Instrument Tolerance:	ASME PTC19.1		Natural Gas Quality	Interface Definition - Appendix B	
			Ambient Air	Interface Definition - Appendix B	
			Water Quality	Interface Definition - Appendix B	

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## D3.3 LIQUID FUEL PERFORMANCE GUARANTEES

The following performance parameters supersede all previously issued guarantees, and are guaranteed at a the Reference Conditions for Guarantee Performance described in this document, unless otherwise stated in the conditions column.

Parameter	Unit	Value	Conditions	Fig	Definition
Gross Power	kWe	58,000	New and Clean, Base load operation	-	1 - Gross Power
Gross Heat Rate (LHV)	BTU/kWe.hr	8,677	New and Clean, Base load operation	-	2 - Gross Heat Rate
NOx Emission	vppmd @ 15% O2	5.0	9 deg F to 91 deg F, 100% to 50% load	-	3 - NOx Emissions
CO Emission	vppmd @ 15% O2	5.0	9 deg F to 91 deg F, 100% to 50% load	-	4 - CO Emissions
NH3 slip	vppmd @ 15% O2	5.0	9 deg F to 91 deg F, 100% to 50% load	-	5 - CO Emissions
VOC Emission	vppmd @ 15% O2	4.5	9 deg F to 91 deg F, 100% to 50% load	-	6 - VOC Emissions
PM-10 Emission	lb/hr	15.0	9 deg F to 91 deg F, 100% to 50% load	-	7 - PM-10 Emissions
Auxiliary Load	kWe	710	GenSet essential auxiliary loads	-	8 - Auxiliary Power
Start Time	minutes	10	Excludes all Balance of Plant	-	9 - Start Time
Near Field Noise Level	dB(A)	85	Average, Peak 90 dB(A) - 1 GenSet	-	10 - Acoustics
REFERENCE CONDITIONS					
Site Conditions			Liquid Fuel		
Ambient temperature (Dry Bulb)	°F	59	CITGO Ultra Low Sulfur Diesel (ULSD) Specification attached below		
Relative Humidity	%	60	bat Docur		
Ambient pressure	psi	14.627			
Altitude - For Information only	ft asl	130			
Electrical System					
Power Factor at generator terminals	-	1.0			
Generating frequency	Hz	60			
Generating voltage at generator terminals	kV	13.8			
Gas Turbine					
Gas Turbine	-	Trent 60			
Combustion System	-	WLE			
Configuration	-	Dual Fuel			
Operation	-	Base continuous			
Condition	-	New and Clean	Fuel LHV	BTU/lb	18,223
Operating Hours	hr	< 200 fired	Fuel Supply / Water Supply		
Design Temperature	°C	59 (Gas Fuel)	Liquid Fuel Pressure (Guarantee Point)	psi (g)	50
Inlet Installation Losses (Guarantee Point)	in H2O	5	Liquid Fuel Temperature (Guaran. Point)	°F	59
Exhaust Installation Losses (Guarantee Point)	in H2O	10	Water Pressure (Water Injection)	psi (g)	50
Inlet Cooling	-	Evap Cooler	Water Temperature (Water Injection)	°F	60
Inlet Cooling Operational	-	Yes	Water Pressure (Evap Cooler)	psi (g)	50
Performance Deck	-	eTrent v6.1.3	Water Temperature (Evap Cooler)	°F	68
Performance Test			Performance Guarantees Definitions		
Protocol	STP No. G.7.Q		Definitions	Performance Definitions -- Appendix D	
Correction Curves	eTrent Method		Units	English Units	
Instrument Tolerance:	ASME PTC19.1		Liquid Fuel Quality	Interface Definition - Appendix B	
			Ambient Air	Interface Definition - Appendix B	
			Water Quality	Interface Definition - Appendix B	

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**D3.4 SITE PERFORMANCE TEST PROTOCOL**

The power output and thermal efficiency of the Equipment are to be determined by testing generally within the framework of ASME PTC-22 per RR Test Procedure attached below. The Guaranteed Performance Levels are on natural gas and ultra low sulfur diesel at the Site Reference Conditions indicated above for each fuel and the guaranteed minimum natural gas supply pressure.

Performance Test Procedure: STP G.7.Q – Power Generation Package Site Performance Test

STP G.7.W – Emission and Enthalpy Test

STP G.7.AH – Package Site Noise Testing

**D3.5 PERFORMANCE TEST MANPOWER**

The performance tests will be carried out by the Customer's manpower or third party authorized institution at the Customer's expense, Rolls-Royce will provide technical direction services detailed in Appendix A (Scope of Work) to witness and assist with the performance test.

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