APPENDIX 11: Performance Guarantees and Minimum Performance Standards

As provided in the Agreement and specifically outlined below, the Equipment's Performance Guarantees are as provided below, as adjusted in Appendix 7A (Engine Performance Test Guidelines).

EQUIPMENT PERFORMANCE GUARANTEES AND MINIMUM PERFORMANCE STANDARDS

Contractor hereby guarantees the performance of the Equipment as follows:

A. Plant Net Electrical Capacity Guarantee (LPG)

Gross Electrical Capacity Guarantee. Once the Mechanical Completion Certificate has been executed and commissioning of the Plant has been completed, Contractor shall conduct a four hour gross electrical capacity test on the Engine Generator in accordance with the Final Test Procedure ("Plant Net Electrical Capacity Test - LPG"). Contractor guarantees that during the Electrical Capacity Test, the Plant's net electrical capacity @ HV transformer low voltage terminal shall be no less than 34,330 kWe while utilizing fuel as described in Appenidix 11 , Annex A

B. Plant Net Electrical Capacity Guarantee (LFO)

Gross Electrical Capacity Guarantee. Once the Mechanical Completion Certificate has been executed and commissioniong of the Plant has been completed, Contractor shall conduct a four hour gross electrical capacity test on the Engine Generator in accordance with the Final Test Procedure ("Plant Net Electrical Capacity Test - LFO"). Contractor guarantees that during the Electrical Capacity Test, the Plant's net electrical capacity @ HV transformer low voltage terminal shall be no less than 34,456 kWe while utilizing fuel as described in Appenidix 11 , Annex A .

C. Gross Heat Rate Guarantee (LPG & LFO)

Gross Heat Rate Guarantee. Once the Mechanical Completion Certificate has been executed and commissioning of the Plant has been completed, Contractor shall conduct a four hour gross heat rate test on the Engine Generator in accordance with the Final Test Procedure ("Gross Heat Rate Test"). Contractor guarantees that during the Gross Heat Rate Test, the Engine Generator's average gross heat rate shall be no greater than 8,226 BTU/kWh LHV @ generator terminals, while utilizing fuel as described in Appenidix 11 , Annex A

D. Exhaust Emissions Guarantee

Exhaust Emissions Guarantee. Once the Mechanical Completion Certificate has been executed and commissioning of the Plant has been completed, Contractor shall conduct an exhaust emission test on the Engine Generator in accordance with the Final Test Procedure ("Emission Test"). Contractor guarantees that during the Emission Test, the exhaust emission levels on the Engine Generator shall be no greater than the levels set forth in this Appendix 11, Annex A 5, while utilizing the project fuel as provided for in Appendix 11 – Annex A.

E. Noise Emissions Guarantee

Noise Emissions Guarantee. Once the Mechanical Completion Certificate has been executed and commissioning of the Plant has been completed, Contractor shall conduct a noise emission

test on the Plant in accordance with the Final Test Procedure ("Noise Test"). Contractor guarantees that during the Noise Emission Test, the noise emission levels shall be no greater than 75 dB(A) outside plant boundary as measured at points identified in Appendix 7A.

F. Reliability Test

Reliability Test. Once the Mechanical Completion Certificate has been executed and commissioning of the Plant has been completed, Supplier shall conduct a 48 hour reliability test on the Plant in accordance with the Final Test Procedure ("Reliability Test"). Contractor guarantees that during the Reliability Test, each genset reliability shall be 95% or greater as defined in Appendix 7A.

G. Minimum Performance Standards

The Engine Generator's minimum performance standards during the Gross Electrical Capacity Test, Gross Heat Rate Test, and the Emission Test ("Minimum Performance Standards") shall be as follows:

Gross Electrical Capacity – The Engine Generator's minimum performance standards regarding average gross electrical capacity shall be no less than 8550 kWe per engine, measured at the generator terminals, while utilizing the project fuel.

Gross Heat Rate. The Engine Generator's minimum performance standards regarding the average heat rate shall be no greater than 8638 BTU/kWh LHV, while utilizing the project fuel.

Exhaust Emissions – The Engine Generator's minimum performance standards regarding exhaust emissions shall be to meet the Exhaust Emissions Guarantee, while utilizing the project fuel.

Noise Emissions – The Engine Generator's minimum performance standards regarding noise emissions shall be to meet the Noise Emissions Guarantee, while utilizing the project fuel.

Supplier has the right to test the Engine Generator, including the right to re-conduct any Performance Test until the Engine Generator meets the Performance Guarantees or the Minimum Performance Standards. Contractor shall be required to make modifications to meet minimum performance standards shown in this Exhibit. Should the Engine Generator meet the Minimum Performance Standards, Contractor may at any time opt to stop conducting any Performance Test and pay the applicable Net Electrical Capacity Liquidated Damages, and/or Gross Heat Rate Liquidated Damages, as applicable.

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Organisation:	Wärtsilä Energy Business		
Project:	– WAPA Phase 2 LG engines (OP633469)		

This document provides flue gas emissions, i.e. maximum average values for emissions measured over a period of minimum 60 minutes. The emissions are based on the site conditions, gas and liquid fuel composition and measurement methods specified in this document.

Engine: Wärtsilä® 20V32LG, 720 rpm (constant speed), 9000 kW_{el} (generator terminals)

Site conditions:

Altitude	up to 100 m above sea level
Ambient temperature	20-35 °C
Humidity ratio	6-25 $g_{water}/kg_{dry\ air}$

LPG composition:

Emissions are valid within the limits of the LPG composition given in the table below, note that some emission related limits are stricter then the corresponding maximum and minimum limits for fuel characteristics for the Wartsila W32LG engine. It is understood that variations in the fuel composition inside this specification will occur and are permitted; however sudden extreme changes in the composition are not allowed.

Property	Unit	Limit
Methane (CH_4) + Ethane (C_2H_6) content, max.	% v/v	20
C_3 to C_{20} as individual components	% v/v	0 – 100
C_{20}+ components	% v/v	Not allowed
Hydrogen sulphide (H_2S) content, max.	mg/kg	5.0
Total sulphur, max S	mg/kg	50
Water, max	% v/v	0.30
Chlorine + Fluorine content, max.	mg/kg	25

Total Silicon based compounds, as Silica, max.	mg/kg	2
Total, incombustible, particles or solids, max.	mg/kg	30
Copper strip corrosion, max.	Rating	No. 1

Impurities resulting from the operation and maintenance of the fuel delivery systems are not allowed.

Concentrations of Silica based compounds demonstrated by the following detection methodology: SMA11m (ATDGCMS analysis).

Pilot and backup fuel:

ULSD (Ultra Low Sulphur Diesel) with max sulphur content of 15 ppm and max 0.010 wt % ash.

Lubricating oil quality according to Wärtsilä specifications for gas engines, in accordance with Appendix 25.

Maximum start-up emissions per engine during start-up period (30 min):

VOC (as C_3H_8): 2 lb/start

NO_X (as NO_2): 100 lb/start

Flue gas emissions after emission control system[1] for any operating hour at any and all loads between 50 and 100% per engine with above specified fuels:

Load	**%**	**100**
Nox (as NO2)	**lb/h**	**10.5**
CO	**lb/h**	**5.48**
VOC (as C3H8)	**lb/h**	**1,01**
PM10 (total)	**lb/h**	**2.92**

Flue gas emissions after emission control system for stable part loads per engine with above specified fuels:

Load	**%**	**75**	**50**
NOx (as NO2)	**lb/h**	**7.99**	**5.50**
CO	**lb/h**	**4.17**	**2.87**
VOC (as C3H8)	**lb/h**	**0.77**	**0.52**
PM10 (total)	**lb/h**	**2.22**	**1.53**

[1] Emission control system is RTO (Recuperative Thermal Oxidizer) and SCR (Selective Catalytic Reduction with a water solution of 40% urea as reagent, technical grade). Minimum allowed engine load equipped with emission control system is 50%.

Time to reach compliance

Compliance with emission data in this document will be reached within 30 minutes from start signal. The emission data in this document are given for stable load operation at the continuous operating loads specified in this document.

Measurement methods

Emission data provided in this document is based upon the emission measurement methods listed below and an approved EPA protocol.

Emission data assumes that individual compounds identified above the sensitivity limit, but at concentrations below the lower limit of detection are reported as maximum one-half of the daily lower-limit of calibration. Measurements shall be performed so that minimum feasible detection limits are achieved if this is required for determining compliance with emission guarantees.

The flue gas stack emission measurements will be performed at steady operating condition of the engine. Prior to the start of the flue gas emission (stack) measurements, the engine shall have reached steady state operating conditions and the flue gas temperature measured after the emission control system shall be allowed to reach normal operating temperature.

Compliance with the emissions limits will be based on an approved EPA protocol consisting of the EPA reference methods listed below and sampling for at least three 1-hour periods at 50, 75 and 100% loads for all pollutants.

Oxygen (O_2): EPA Method 3A (USA): Determination of Oxygen and Carbon Dioxide Emissions from Stationary Sources.

Nitrogen oxides (NOx): EPA Method 7E (USA): Determination of nitrogen oxides from stationary sources.

Carbon monoxide (CO): EPA Method 10 (USA): Determination of carbon monoxide emissions from stationary sources.

VOC (Non-Methane, Non-Ethane Hydrocarbons): USA EPA Method 25A: Determination of total gaseous organic concentration using a flame ionization analyzer. None Methane None Ethane Hydrocarbons are defined as total hydrocarbons (THC) excluding methane and ethane.

PM_{10} (total): Total PM_{10} is defined as the sum of the particulate matter measured with a combination of EPA 5B and 202 methods. USA EPA Method 5B (front half): Determination of particulate emissions from stationary sources USA EPA Method 202 Determination of condensable particulate matter from stationary sources.

Based upon mutual written consent, evaluation of emission levels can be made using alternative methods.

Power Plant Performance Figures

WÄRTSILÄ

VIWAPA, USVI, 4 x W20V32LG, with VOC

Guaranteed Performance @ LPG,100% load		W32 LG
Altitude	m	100
Ambient temperature	°C	27
Ambient temperature	F	81
Relative humidity	%	79%
Frequency	Hz	60
Fuel LHV	MJ/kg	42.7
p.f. at generator terminals		0.85
Engines running		4
Engine output @ generator terminal	kW	9,000
Engine heat rate @ generator terminal (LHV)	Btu/kWh	8,226
Engine heat rate @ generator terminal (HHV)	Btu/kWh	8,775
Plant output @ generator terminals *	kW	36,000
Plant heat rate @ generator terminals (LHV)	**Btu/kWh**	**8,226**
Efficiency gross (LHV)	%	41.5%
Guaranteed plant own consumption % **	%	4.6%
Plant own consumption	kW	1,670
Guaranteed Plant net output @ HV transformer *	**kW**	**34,330**
Plant heat rate net @ HV transformer (LHV)	Btu/kWh	8,626
Plant heat rate net @ HV transformer (HHV)	Btu/kWh	9,202
Efficiency net (LHV)	%	39.6%

**** Plant guarantee point***

Made by:JAN002
Date: 31.03.2020

Values valid at the following conditions:
Ambient conditions and other data stated above
Engines with radiators
Engines with +/- 0% tolerance
Generator voltage 13,8kV
Values valid for standard layout and equipment

Heat rate as HHV converted from Heat rate as LHV using HHV/LHV ratio 1,0873

Power Plant Performance Figures

VIWAPA, USVI, 4 x W20V32LG, with VOC

Guaranteed Performance @ LFO,100% load		W32 LG
Altitude	m	100
Ambient temperature	°C	27
Ambient temperature	F	81
Relative humidity	%	79%
Frequency	Hz	60
Fuel LHV	MJ/kg	42.7
p.f. at generator terminals		0.85
Engines running		4
Engine output @ generator terminal	kW	9,000
Engine heat rate @ generator terminal (LHV)	Btu/kWh	8,226
Engine heat rate @ generator terminal (HHV)	Btu/kWh	8,775
Plant output @ generator terminals	**kW**	**36,000**
Plant heat rate @ generator terminals (LHV)*	**Btu/kWh**	**8,226**
Efficiency gross (LHV)	%	41.5%
Guaranteed plant own consumption % **	%	4.3%
Plant own consumption	kW	1,544
Guaranteed Plant net output @ HV transformer	**kW**	**34,456**
Plant heat rate net @ HV transformer (LHV)	Btu/kWh	8,595
Plant heat rate net @ HV transformer (HHV)	Btu/kWh	9,168
Efficiency net (LHV)	%	39.7%

**** Plant guarantee point***

Made by:JAN002

Date: 31.03.2020

Values valid at the following conditions:

Ambient conditions and other data stated above

Engines with radiators

Engines with +/- 0% tolerance

Generator voltage 13,8kV

Values valid for standard layout and equipment

Fuel LFO

Heat rate as HHV converted from Heat rate as LHV using HHV/LHV ratio 1,0667

FUEL CHARACTERISTICS

1. Limit values for fuel characteristics

The Wärtsilä® 32LG engine is designed and developed for continuous operation on fuels with the characteristics specified hereafter.

The specification for low viscosity fuels has been prepared in-house, while the distillate fuel specification is based on the ISO 8217:2017(E) standard with some internal modifications. Pilot fuel qualities fulfilling the distillate fuel specification included in this document are only allowed to use.

In addition to the limit values stated in the tables included hereafter, it has to be taken into account concerning both specified fuel qualities (Low viscosity fuels, Distillate fuels) that:

- The fuel shall not contain any additive at the concentration used in the fuel, or any added substance or chemical waste that jeopardizes the safety of installation or adversely affects the performance of the machinery or is harmful to personnel or contributes overall to additional air pollution.
- For maximum fuel temperature before the engine, see the Installation Manual.

Low / Ultra low viscosity fuels:

Low / Ultra low viscosity fuels include a wide range of both commercially available fuels, like Liquefied Petroleum Gas (LPG) qualities based on various standards, naphtha, kerosene as well as gas and oil condensates with wide hydrocarbon distribution.

Low / Ultra low viscosity fuel specification (liquid phase):

Characteristics	Unit	Limit	Test method reference
Kinematic viscosity at 20 °C and before main injection pumps, min.	mm^2/s [a]	0,10	ISO 3104
Kinematic viscosity before main injection pumps, max.	mm^2/s [a]	6,00	
Density at 25 °C, min.	kg/m^3	490	ASTM D1657 or D2598 ISO 3675 or ISO 12185
Sulphur, max. [b]	% m/m	1,0	ISO 8754 or ISO 14596
Hydrogen sulfide, max.	mg/kg	5,00	IP 570
Acid number, max.	mg KOH/g	3,0	ASTM D664
Total sediment by hot filtration, max.	% m/m	0,10	ISO 10307-1
Carbon residue, micro method, max.	% m/m	0,30	ISO 10370
Pour point (upper), max. [c]	°C	report	ISO 3016
Cloud point, max. [c]	°C	report	ISO 3015
Cold filter plugging point, max. [c]	°C	report	IP 309 or IP 612

Water, max. Water bef. engine, max.	% v/v	0,30 0,30	ISO 3733 or ASTM D6304-C
Methane (CH_4) + Ethane (C_2H_6) + C_{18+} content. max.	% m/m	3,0	ASTM D1945, D6730
Hydrogen (H_2) content. max.	% m/m	traces [d)]	ASTM D1945, D6730
Content of hydrocarbons from C_3 to C_{18} at any ratio, min.	% m/m	97,0	ASTM D1945, D5134, D5443, D6730, D6839
Lower heating value, min.	MJ/kg	42,0	ASTM D240
Ash, max.	% m/m	0,010	ISO 6245 or LP1001 [e)]
Copper strip corrosion, max.	Rating	No. 1	ASTM D130
Used lubricating oil [f)] - Calcium, max. - Zinc, max. - Phosphorus, max.	 mg/kg mg/kg mg/kg	 30 15 15	 IP 501 or IP 470 IP 501 or IP 470 IP 501 or IP 500

a) 1 mm²/s = 1 cSt.

b) The purchaser shall define the maximum sulphur content in accordance with relevant statutory limitations.

c) Purchasers shall ensure that cold flow properties are suitable for the equipment at the plant / on board.

d) It's not allowed to have more than trace amounts of hydrogen as H_2 present in fuel. On the other hand it's neither expected that the above specified fuel types would contain hydrogen.

e) Ashing temperatures can vary when different test methods are used having an influence on the test result.

f) The fuel shall be free from used lubricating oil (ULO). A fuel shall be considered to contain ULO when either one of the following conditions is met:

- *Calcium > 30 mg/kg and zinc > 15 mg/kg OR*
- *Calcium > 30 mg/kg and phosphorus > 15 mg/kg*

Distillate fuel / Light fuel oil:

The fuel specification is based on the ISO 8217:2017(E) standard and covers the fuel grades ISO-F-DMX, DMA, DFA, DMZ and DFZ.

The distillate grades mentioned above can be described as follows:

- DMX: A fuel quality which is suitable for use at ambient temperatures down to –15 °C without heating the fuel. Especially in merchant marine applications its use is restricted to lifeboat engines and certain emergency equipment due to reduced flash point.
- DMA: A high quality distillate, generally designated MGO (Marine Gas Oil) in the marine field.
- DFA: A similar quality distillate fuel compared to DMA category fuels but a presence of max. 7,0 % v/v of Fatty acid methyl ester (FAME) is allowed.
- DMZ: A high quality distillate, generally designated MGO (Marine Gas Oil) in the marine field. An alternative fuel grade for engines requiring a higher fuel viscosity than specified for DMA grade fuel.
- DFZ: A similar quality distillate fuel compared to DMZ category fuels but a presence of max. 7,0 % v/v of Fatty acid methyl ester (FAME) is allowed.

Distillate fuel specification:

Characteristics		Unit	Limit	Category ISO-F					Test method(s) and references
				DMX	DMA	DFA	DMZ	DFZ	
Kinematic viscosity at 40 °C [j]		mm²/s [a]	Max	5,500	6,000		6,000		ISO 3104
			Min	1,400 [i]	2,000		3,000		
Density at 15 °C		kg/m³	Max	-	890,0		890,0		ISO 3675 or ISO 12185
Cetane index			Min	45	40		40		ISO 4264
Sulphur [b, k]		% m/m	Max	1,00	1,00		1,00		ISO 8754, ISO 14596, ASTM D4294
Flash point		°C	Min	43,0	60,0		60,0		ISO 2719
Hydrogen sulfide		mg/kg	Max	2,00	2,00		2,00		IP 570
Acid number		mg KOH/g	Max	0,5	0,5		0,5		ASTM D664
Total sediment by hot filtration [c, m]		% m/m	Max	-	-		-		ISO 10307-1
Oxidation stability [d]		g/m³	Max	25	25		25		ISO 12205
Fatty acid methyl ester (FAME) [e]		% v/v	Max	-	-	7,0	-	7,0	ASTM D7963 or IP 579
Carbon residue – Micro method on 10% distillation residue		% m/m	Max	0,30	0,30		0,30		ISO 10370
Carbon residue – Micro method		% m/m	Max	-	-		-		ISO 10370
Cloud point [f]	winter	°C	Max	-16	Report		Report		ISO 3015
	summer			-16	-		-		
Cold filter plugging point [f]	winter	°C	Max	-	Report		Report		IP 309 or IP 612
	summer			-	-		-		
Pour point [f]	winter	°C	Max	-	-6		-6		ISO 3016
	summer			-	0		0		
Appearance			-	Clear and bright [g]					-
Water [c, m]		% v/v	Max	-	-		-		ISO 3733, ASTM D6304-C [l]
Ash		% m/m	Max	0.010	0.010		0,010		ISO 6245
Lubricity, corr. wear scar diam. [d, h]		µm	Max	520	520		520		ISO 12156-1

a) *1 mm²/s = 1 cSt.*

b) *Notwithstanding the limits given, the purchaser shall define the maximum sulphur content in accordance with relevant statutory limitations.*

c) If the sample is not clear and bright, the total sediment by hot filtration and water tests shall be required.
d) If the sample is not clear and bright, the Oxidation stability and Lubricity tests cannot be undertaken and therefore, compliance with this limit cannot be shown.
e) See ISO 8217:2017(E) standard for details.
f) Pour point cannot guarantee operability for all ships in all climates. The purchaser should confirm that the cold flow characteristics (pour point, cloud point, cold filter plugging point) are suitable for ship's design and intended voyage.
g) If the sample is dyed and not transparent, see ISO 8217:2017(E) standard for details related to water analysis limits and test methods.
h) The requirement is applicable to fuels with a sulphur content below 500 mg/kg (0,050 % m/m).

Additional notes not included in the ISO 8217:2017(E) standard:

i) Low min. viscosity of 1,400 mm²/s can prevent the use of ISO-F-DMX category fuels in Wärtsilä® 32LG engine's in pilot fuel system unless a fuel can be cooled down enough to meet the specified min. injection viscosity limit.
j) Allowed kinematic viscosity before the main and pilot injection pumps for W32LG engine type is 1,50 – 6,00 mm²/s.
k) There doesn't exist any minimum sulphur content limit for Wärtsilä® 4-stroke diesel engines and also the use of Ultra Low Sulphur Diesel (ULSD) is allowed provided that the fuel quality fulfils other specified properties.
l) Alternative test method
m) Though the appearance of DMZ, DMA, DFA, DMB and DFB category fuels shall be clear and bright and the fuels shall thus not contain any sediment and water. However, in case sediment and / or water is detected from the fuel, the contents shall not exceed the limit values set for DMB and DFB category fuels, i.e. Total sediment by hot filtration: max, 0,10 % m/m and water content: max. 0,30 % v/v.