

3**Engine Test Protocol**

This chapter contains a copy of the factory Test Protocol signed by the receiver of the engine end ELAPP Authority.

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TEST PROTOCOL

Project:	LANGSTEN 189
Number:	21304
Type:	W6L32
Date(s):	12.11.2001
Class. Soc.	DNV

Installation Data

ENGINE DATA

Customer: LANGSTEN SLIP & BÅTBYGGERI A/S
Type: W6L32
Manufacturing number: 21304
Nominal output [kW]: 2760
Nominal speed [rpm]: 750
Rotation direction: counter-clockwise

INSTALLATION

Type: Main Engine
Name: LANGSTEN 189
Number: 8242

LOADING: Alternator

Type: LSA 58U12
Manufacturer: LEROY SOMER
Number: 160937-1
Current [A]: 427,8
Voltage [V]: 11000
Output [kVA]: 8150
Frequency [Hz]: 50

FUEL

Quality	Density at [kg / l]	Temp. [C°]	Viscosity at [mm2 / s]	Temp. [C°]	Lower Heating value
MDF	0,84	15	2,9	40	43,07

LUBRICATING OIL

Quality: Shell Argina T 40

Test Program for LANGSTEN 189

Test Bed 1

Order number: 8242
 Engine number: 21304
 Engine type: W6L32
 Test run date(s): 12.11.2001

Time: Start Stop		Dur. [min]	Speed [rpm]	Shaft load [%]	Engine power [kW]	η	Load power [kW]	Fuel	Oper. data	Notices
8:40	8:45	5	750	0				MDF		Verification of HT-water and OIL stops.
8:45	9:05	20	750	0 25				MDF		
9:05	9:25	20	750	25	690	93,4	644	MDF	X	
9:25	9:30	5	750	0				MDF		
9:30	9:50	20	750	0 50				MDF		
9:50	10:10	20	750	50	1380	95,5	1318	MDF	X	
10:10	10:15	5	750	0				MDF		
10:15	10:35	20	750	0 75				MDF		
10:35	10:55	20	750	75	2070	96,5	1998	MDF	X	
10:55	11:00	5	750	0				MDF		
11:00	11:35	35	750	0 100				MDF		
11:35	12:35	60	750	100	2760	97,3	2685	MDF	X	
12:35	13:05	30	750	110	3036	97,4	2957	MDF	X	
13:05	13:20	15	774	110	3036	97,4	2957	MDF	X	
13:20	14:20	60	710	85	2346	96,9	2273	MDF	X	
14:20	14:50	30	681	75	2070	96,5	1998	MDF	X	
14:50	15:20	30	595	50	1380	95,5	1318	MDF	X	
15:20	15:50	30	595	25	690	93,4	644	MDF	X	

Check of overspeed devices

Operation Data

Mode								
Loadpoint: Power/ Torque	25	50	75	100	110	110	85	75
Time	09:15	10:00	10:45	11:45	12:45	13:15	13:30	14:30
Fuel	MDF	MDF	MDF	MDF	MDF	MDF	MDF	MDF

Ambient Data								
Total barometric pressure	hPa	985	986	987	987	3	988	989
Temperature of intake air	°C	23,0	23,0	26,0	27,0	27,0	27,0	28,0
Relative humidity of intake air	%	11,0	11,0	9,0	8,3	7,7	8,0	7,9

Alternator Data								
Alternator efficiency		93,4	95,5	96,5	97,3	97,4	97,4	96,5
Alternator output	kW	644	1318	1998	2685	2957	2957	1998
Alternator voltage, nominal	V	11000	11000	11000	11000	11000	11000	11000
Alternator current, nominal	A	427.8	427.8	427.8	427.8	427.8	427.8	427.8

Engine Data								
Power	kW	690	1380	2070	2760	3036	3036	2346
Speed	rpm	750	750	750	750	750	774	710
Load indicator position		3,5	5,2	6,8	8,5	9,2	9,2	7,6
Fuel rack position, A-bank	mm	17,0	27,0	37,0	48,0	52,0	52,0	42,0
Turbocharger speed, A-bank	rpm	13288	19191	23753	27241	28559	28858	24892
Exh. gas temp, cylinder A1	°C	299	343	372	411	436	439	396
Exh. gas temp, cylinder A2	°C	318	349	367	394	417	424	386
Exh. gas temp, cylinder A3	°C	277	332	360	393	414	422	375
Exh. gas temp, cylinder A4	°C	290	335	369	404	431	437	391
Exh. gas temp, cylinder A5	°C	293	342	374	407	430	431	388
Exh. gas temp, cylinder A6	°C	291	335	367	415	446	447	395
Mean value	°C	295	339	368	404	429	433	389
Main bearing temp, bearing 0	°C	84	87	87	87	87	87	86
Main bearing temp, bearing 1	°C	82	84	86	87	88	89	85
Main bearing temp, bearing 2	°C	77	80	83	86	87	87	83
Main bearing temp, bearing 3	°C	80	83	86	89	90	90	86
Main bearing temp, bearing 4	°C	82	84	86	89	89	90	86
Main bearing temp, bearing 5	°C	82	85	87	90	91	91	87
Main bearing temp, bearing 6	°C	80	83	86	88	89	90	85
Main bearing temp, bearing 7	°C	84	86	87	88	89	90	86
Mean value	°C	81	84	86	88	89	89	86
Exh. gas temp. bef. TC, A-bank	°C	393	448	461	494	344	525	476
Exh. gas temp. aft. TC, A-bank	°C	332	354	326	327	521	346	331
Charge air temp. in air receiver	°C	30	35	40	47	50	50	42
HT-water temp. bef. engine	°C	91	93	91	93	93	90	89
HT-water temp. aft. engine	°C	92	96	94	97	98	95	93
LT-water temp. bef. CAC	°C	33	33	33	33	33	33	33
LT-water temp. aft. CAC	°C	33	35	37	40	42	42	38
LT-water temp. bef. LOC	°C	33	35	37	40	42	42	38
LT-water temp. aft. LOC	°C	35	37	40	44	46	46	41
Lub. oil temp. bef. LOC	°C	68	72	74	77	78	79	75
Lub. oil temp. aft. LOC	°C	61	61	61	62	63	63	61
Fuel oil temperature	°C	36	49	51	49	47	47	51
Firing pressure, cylinder A1	bar			152	176			166
Firing pressure, cylinder A2	bar			150	175			163
Firing pressure, cylinder A3	bar			150	178			166
Firing pressure, cylinder A4	bar			149	175			163
Firing pressure, cylinder A5	bar			150	178			164
Firing pressure, cylinder A6	bar			149	176			163
Mean value	bar			150	176			164
Charge air pressure	bar	0,33	0,94	1,76	2,54	2,79	2,75	2,06
HT-water pressure	bar	3,10	3,00	3,00	2,90	3,00	3,10	2,80
LT-water pressure	bar	3,20	3,30	3,30	3,30	3,30	3,30	3,40
Lubricating oil pressure	bar	4,70	4,70	4,60	4,60	4,50	4,60	4,50
Fuel oil pressure	bar	5,60	5,30	5,40	5,30	5,30	5,10	5,20

Operation Data

Mode		
Loadpoint: Power/ Torque	50	25
Time	15:00	15:30
Fuel	MDF	MDF

Ambient Data		
Total barometric pressure	hPa	989 989
Temperature of intake air	°C	26,0 24,0
Relative humidity of intake air	%	8,7 10,2

Alternator Data		
Alternator efficiency		95,5 93,4
Alternator output	kW	1318 644
Alternator voltage, nominal	V	11000 11000
Alternator current, nominal	A	427.8 427.8

Engine Data		
Power	kW	1380 690
Speed	rpm	595 595
Load indicator position		5,8 3,8
Fuel rack position, A-bank	mm	31,0 19,0
Turbocharger speed, A-bank	rpm	18151 12048
Exh. gas temp, cylinder A1	°C	404 335
Exh. gas temp, cylinder A2	°C	408 353
Exh. gas temp, cylinder A3	°C	380 306
Exh. gas temp, cylinder A4	°C	393 320
Exh. gas temp, cylinder A5	°C	399 320
Exh. gas temp, cylinder A6	°C	395 332
Mean value	°C	397 328
Main bearing temp, bearing 0	°C	83 82
Main bearing temp, bearing 1	°C	80 78
Main bearing temp, bearing 2	°C	77 75
Main bearing temp, bearing 3	°C	80 77
Main bearing temp, bearing 4	°C	80 78
Main bearing temp, bearing 5	°C	80 78
Main bearing temp, bearing 6	°C	79 77
Main bearing temp, bearing 7	°C	81 80
Mean value	°C	80 78
Exh. gas temp. bef. TC, A-bank	°C	515 436
Exh. gas temp. aft. TC, A-bank	°C	432 391
Charge air temp. in air receiver	°C	1 33
HT-water temp. bef. engine	°C	91 92
HT-water temp. aft. engine	°C	97 94
LT-water temp. bef. CAC	°C	33 32
LT-water temp. aft. CAC	°C	34 33
LT-water temp. bef. LOC	°C	34 33
LT-water temp. aft. LOC	°C	37 34
Lub. oil temp. bef. LOC	°C	71 69
Lub. oil temp. aft. LOC	°C	60 60
Fuel oil temperature	°C	53 54
Firing pressure, cylinder A1	bar	
Firing pressure, cylinder A2	bar	
Firing pressure, cylinder A3	bar	
Firing pressure, cylinder A4	bar	
Firing pressure, cylinder A5	bar	
Firing pressure, cylinder A6	bar	
Mean value	bar	
Charge air pressure	bar	0,88 0,29
HT-water pressure	bar	2,30 2,40
LT-water pressure	bar	3,30 3,30
Lubricating oil pressure	bar	4,30 4,30
Fuel oil pressure	bar	5,60 5,50

Inspection of the Wärtsilä Engine

Project: LANGSTEN 189
Order number: 8242
Engine type: W6L32
Engine number: 21304
Classification society: DNV
Test run date(s): 12.11.2001

Inspection date: 13.11.2001

It has been agreed that the following openings and inspections are to be carried out at the delivery test run attended by the buyer and / or the representative of the classification society.

Inspections:		Results:
Big end bearing No.	3	OK
Main bearing No.	5	OK
Thrust bearing	Yes	OK
Endoscope inspection	Yes	OK
Opening of covers	Yes	OK
Test of nozzles	Yes	OK

The following corrections should be made before delivery:

Wärtsilä Finland Oy


WÄRTSILÄ

Customer(s)

Marine 26.11.2001
Quality Assurance, Projects


M. Merisaari, Quality Assurance Manager, Marine
Wärtsilä Finland Oy
Vaasa Factory

T. Lerstrand, Test Run Manager, Vaasa Factory



Kjell-Petter Fagerli

On behalf of
Classification Society


P. Karhu, Det Norske Veritas

MSA No. R-1456

Fuel Oil Consumption According to ISO 3046/1

Engine number: 21304
Project: LANGSTEN 189
Order number: 8242
Engine type: W6L32
Output/100% [kW]: 2760
Speed [rpm]: 750

K = ratio of indicated power
 α = power adjustment factor
 P_x = barometric pressure during test [hPa]

P_{ra} = standard reference barometric pressure [1000 hPa]
 m = 0,7 exponent
 T_{ra} = reference air temperature [298 K]
 T_x = air temperature during test [K]
 n = 1,2 exponent
 T_{cr} = reference charge air coolant temperature [298 K]
 T_{cx} = charge air coolant temperature during test [K]

s = 1 exponent
 Mek = mechanical efficiency
 Q_{test} = lower heating value of the fuel oil during test [MJ / kg]
 Q_{ISO} = lower heating value of the fuel oil (ISO) [MJ / kg]
 Be = fuel oil consumption on test bed [g / kWh]
 $BISO$ = fuel oil consumption according to ISO [g / kWh]
 M = measured fuel quantity [g]
 MLS = flow of clean leak fuel [g / s]
 P = output [kW]
 S = time [s]
EDP = engine driven pumps [g / kWh] (calculated with or without EDP according to the contract)

$$K = \left(\frac{P_x}{P_{ra}} \right)^m \cdot \left(\frac{T_{ra}}{T_x} \right)^n \cdot \left(\frac{T_{cr}}{T_{cx}} \right)^s$$

$$\alpha = K - 0,7 \cdot (1 - K) \cdot \left(\frac{1}{Mek} - 1 \right)$$

$$Be = \frac{(M - S \cdot MLS)}{P \cdot S} \cdot 3600 \Rightarrow [g / kWh]$$

$$BISO = \frac{\alpha}{K} \cdot Be \cdot \frac{Q_{test}}{Q_{ISO}} - EDP \Rightarrow [g / kWh]$$

Calculations:

Load [%]: 85
Fuel: MDF
Output [kW]: 2346
Measured fuel quantity [g]: 22 240,0
Clean leak fuel [g/s]: 0,60
Mean time [s]: 180,0

Air pressure during test [hPa]: 988,0
Air temperature during test [°C]: 26 299 [K]
Charge air coolant temp. during test [°C]: 33 306 [K]

Lower heating value during test [MJ/kg]: 43,07
Lower heating value (ISO) [MJ/kg]: 42,70
Mechanical efficiency: 0,80
Engine driven pumps [g/kwh]: 3,00

K: 0,961787
 α : 0,955099

Be: 188,7
BISO: 186,0

ADJUSTMENT OF STOP SWITCHES:

Alarm for low prelubricating oil pressure [bar]:	0,5	Tripping speed of mechanical overspeed trip device [rpm]:	-
Stop for low lubricating oil pressure [bar]:	2,0	No load value for the governor:	2,0
Stop for high HT-water temperature [°C]:	-	No load value for the rack [mm]:	8,0
Tripping speed of pneumatic overspeed trip device [rpm]:	854	Fuel limiter [mm]:	-
Tripping speed of pneum. overspeed trip device (2) [rpm]:	878		

ADJUSTMENT OF FUEL PUMPS:

Fuel rack position, when				Delivery
Starting lever at:	<i>Work</i>	<i>Stop</i>	<i>Work</i>	commencem.
Governor lever at:	<i>Min</i>	<i>Max</i>	<i>Max</i>	before TDC
Safety device:	<i>Not rel.</i>	<i>Not rel.</i>	<i>Released</i>	
Cylinder:				
A1	1	0,5	0,5	9,5
A2	1	0,5	0,5	9,5
A3	1	0,5	0,5	9,5
A4	1	0,5	0,5	9,5
A5	1	0,5	0,5	9,5
A6	1	0,5	0,5	9,5

GOVERNOR TEST

Load Application:

% - % n - min n - nom dn sec

Load Reduction:

% - % n-max n - nom dn sec

AIM OF THE TEST

The aim of the test run performed was to check the general quality of the production and to prove that the engine performance values fulfill the prescribed requirements.

PRESENT AT THE TEST RUN

Wärtsilä Finland Oy

WÄRTSILÄ

Customer(s)

M. Merisaari Marine 20.11.2001
 Quality Assurance, Projects

M. Merisaari, Quality Assurance Manager, Marine

Kjell-Petter Fagerli

Kjell-Petter Fagerli

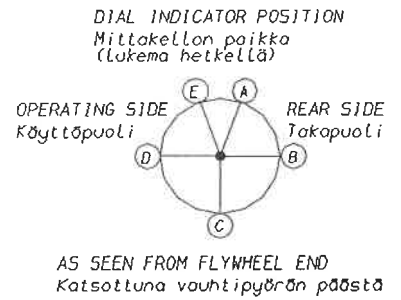
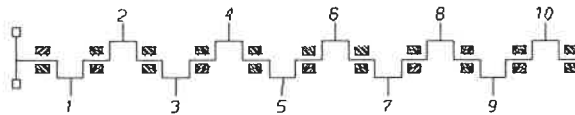
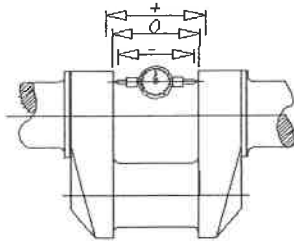
T. Lerstrand
 T. Lerstrand, Test Run Manager, Vaasa Factory

On behalf of
 Classification Society

MSA No. R-1456

P. Karhu
 P. Karhu, Det Norske Veritas

Crankshaft Measurements



HOT ENGINE

Room temperature when values were measured [°C]:

Initials:

Engine running continuously before indicating [h]:

The time between stop and indicating [min]:

Temperature of lubricating oil [°C]:

Temperature of cooling water before engine [°C]:

Gauge Position	Cylinder									
	1	2	3	4	5	6				
Rear side top Takasivu ylhäällä										
Rear side Takasivulla										
Bottom Alhaalla										
Operating side Käytösivulla										
Operating side top Käytösivu ylhäällä										

Deviations 1/100 mm

Measurement of crankshaft alignment in main assembly

COLD ENGINE

Room temperature when values were measured [°C]: 21 °C

Initials:

J.M

Gauge Position	Cylinder									
	1	2	3	4	5	6				
Rear side top Takasivu ylhäällä	0	+0,5	+0,5	+0,5	0	0				
Rear side Takasivulla	-1	+3	+4	+3	+2	+1,5				
Bottom Alhaalla	-3,5	+5	+6	+5	+4	+2				
Operating side Käytösivulla	-2	+2	+2	+2	+2	+1				
Operating side top Käytösivu ylhäällä	0	0	0	0	0	0				

Deviations 1/100 mm