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Engine Test Protocol

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

TEST PROTOCOL

Project:	LANGSTEN 189
Number:	21303
Type:	W6L32
Date(s):	7.11.2001 8.11.2001
Class. Soc.	DNV

Installation Data

ENGINE DATA

Customer: LANGSTEN SLIP & BÅTBYGGERI A/S
Type: W6L32
Manufacturing number: 21303
Nominal output [kW]: 2760
Nominal speed [rpm]: 750
Rotation direction: 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: 21303
 Engine type: W6L32
 Test run date(s): 07.11.2001
 08.11.2001

Time: Start Stop	Dur. [min]	Speed [rpm]	Shaft load [%]	Engine power [kW]	η	Load power [kW]	Fuel	Oper. data	Notices
16:00 16:05	5	750	0				MDF		Verification of HT-water and OIL stops.
16:05 16:25	20	750	0 25				MDF		
16:25 16:45	20	750	25	690	93,4	644	MDF	X	
16:45 16:50	5	750	0				MDF		
16:50 17:10	20	750	0 50				MDF		
17:10 17:30	20	750	50	1380	95,5	1318	MDF	X	
17:30 17:35	5	750	0				MDF		
17:35 17:55	20	750	0 75				MDF		
17:55 18:15	20	750	75	2070	96,5	1998	MDF	X	
18:15 18:20	5	750	0				MDF		
7:30 8:05	35	750	0 100				MDF		08.11.2001
8:05 9:05	60	750	100	2760	97,3	2685	MDF	X	
9:05 9:35	30	750	110	3036	97,4	2957	MDF	X	
9:35 9:50	15	774	110	3036	97,4	2957	MDF	X	
9:50 10:50	60	710	85	2346	96,9	2273	MDF	X	
10:50 11:20	30	681	75	2070	96,5	1998	MDF	X	
11:20 11:50	30	595	50	1380	95,5	1318	MDF	X	
11:50 12:20	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	16:35	17:20	18:05	08:45	09:15	09:45	10:30	11:00
Fuel	MDF	MDF	MDF	MDF	MDF	MDF	MDF	MDF

Ambient Data									
Total barometric pressure	hPa	989	989	989	989	990	990	991	991
Temperature of intake air	°C	23,0	25,0	26,8	26,0	27,0	28,0	27,8	26,0
Relative humidity of intake air	%	13,0	11,0	9,6	8,7	7,6	7,4	7,7	8,7

Alternator Data									
Alternator efficiency		93,4	95,5	96,5	97,3	97,4	97,4	96,9	96,5
Alternator output	kW	644	1318	1998	2685	2957	2957	2273	1998
Alternator voltage, nominal	V	11000	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	427.8

Engine Data									
Power	kW	690	1380	2070	2760	3036	3036	2346	2070
Speed	rpm	750	750	750	750	750	774	710	681
Load indicator position		3,5	5,2	7,0	8,5	9,1	9,1	7,5	7,0
Fuel rack position, A-bank	mm	17,0	27,0	38,0	48,0	52,0	53,0	42,0	38,0
Turbocharger speed, A-bank	rpm	13143	19232	23973	27526	28838	29096	25004	23161
Exh. gas temp, cylinder A1	°C	289	321	352	405	431	435	387	376
Exh. gas temp, cylinder A2	°C	299	347	367	414	438	451	397	400
Exh. gas temp, cylinder A3	°C	301	349	374	413	442	448	398	393
Exh. gas temp, cylinder A4	°C	297	346	381	418	453	457	410	403
Exh. gas temp, cylinder A5	°C	289	332	364	398	427	428	384	382
Exh. gas temp, cylinder A6	°C	303	345	374	412	445	454	406	407
Mean value	°C	296	340	368	410	439	446	397	394
Main bearing temp, bearing 0	°C	84	84	86	87	88	89	85	84
Main bearing temp, bearing 1	°C	82	82	82	83	83	84	82	81
Main bearing temp, bearing 2	°C	82	85	86	89	90	91	86	85
Main bearing temp, bearing 3	°C	83	85	86	89	90	91	87	85
Main bearing temp, bearing 4	°C	89	90	91	94	94	95	91	89
Main bearing temp, bearing 5	°C	84	85	87	89	90	91	87	85
Main bearing temp, bearing 6	°C	83	85	87	90	91	92	87	86
Main bearing temp, bearing 7	°C	84	85	86	87	88	89	86	84
Mean value	°C	84	85	86	89	89	90	86	85
Exh. gas temp. bef. TC, A-bank	°C	389	440	457	491	524	530	476	479
Exh. gas temp. aft. TC, A-bank	°C	330	349	324	320	341	346	327	355
Charge air temp. in air receiver	°C	33	36	41	49	52	53	43	40
HT-water temp. bef. engine	°C	92	81	93	91	91	91	89	88
HT-water temp. aft. engine	°C	94	84	96	96	96	96	94	92
LT-water temp. bef. CAC	°C	33	32	33	33	32	33	33	33
LT-water temp. aft. CAC	°C	33	35	39	42	43	44	39	38
LT-water temp. bef. LOC	°C	33	35	39	42	43	44	39	38
LT-water temp. aft. LOC	°C	36	39	42	47	48	49	44	42
Lub. oil temp. bef. LOC	°C	71	73	75	79	80	80	77	76
Lub. oil temp. aft. LOC	°C	61	62	62	63	63	64	62	62
Fuel oil temperature	°C	50	47	45	35	34	34	40	42
Firing pressure, cylinder A1	bar			146	177			162	152
Firing pressure, cylinder A2	bar			147	175			162	154
Firing pressure, cylinder A3	bar			152	179			165	156
Firing pressure, cylinder A4	bar			153	179			165	157
Firing pressure, cylinder A5	bar			147	178			162	153
Firing pressure, cylinder A6	bar			146	174			162	153
Mean value	bar			149	177			163	154
Charge air pressure	bar	0,32	0,94	1,81	2,61	2,83	2,80	2,08	1,70
HT-water pressure	bar	2,80	2,80	2,70	2,90	2,90	2,90	2,70	2,60
LT-water pressure	bar	2,60	2,70	2,70	2,70	2,70	2,70	2,70	2,70
Lubricating oil pressure	bar	4,40	4,30	4,30	4,20	4,20	4,30	4,10	4,10
Fuel oil pressure	bar	8,10	8,10	7,70	7,50	7,50	7,50	7,70	7,80

Operation Data

Mode		
Loadpoint: Power/ Torque	50	25
Time	11:30	12:00
Fuel	MDF	MDF

Ambient Data		
Total barometric pressure	hPa	991 992
Temperature of intake air	°C	26,0 26,0
Relative humidity of intake air	%	9,1 8,9

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	30,0 19,0
Turbocharger speed, A-bank	rpm	18092 11966
Exh. gas temp, cylinder A1	°C	385 316
Exh. gas temp, cylinder A2	°C	405 324
Exh. gas temp, cylinder A3	°C	396 323
Exh. gas temp, cylinder A4	°C	397 326
Exh. gas temp, cylinder A5	°C	384 321
Exh. gas temp, cylinder A6	°C	402 336
Mean value	°C	395 324
Main bearing temp, bearing 0	°C	80 78
Main bearing temp, bearing 1	°C	80 79
Main bearing temp, bearing 2	°C	80 78
Main bearing temp, bearing 3	°C	81 78
Main bearing temp, bearing 4	°C	84 82
Main bearing temp, bearing 5	°C	81 79
Main bearing temp, bearing 6	°C	81 79
Main bearing temp, bearing 7	°C	81 79
Mean value	°C	81 79
Exh. gas temp. bef. TC, A-bank	°C	504 387
Exh. gas temp. aft. TC, A-bank	°C	414 432
Charge air temp. in air receiver	°C	35 34
HT-water temp. bef. engine	°C	90 91
HT-water temp. aft. engine	°C	94 95
LT-water temp. bef. CAC	°C	32 33
LT-water temp. aft. CAC	°C	34 34
LT-water temp. bef. LOC	°C	34 34
LT-water temp. aft. LOC	°C	37 36
Lub. oil temp. bef. LOC	°C	73 70
Lub. oil temp. aft. LOC	°C	61 61
Fuel oil temperature	°C	45 50
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	0,87 0,28
HT-water pressure	bar	2,30 2,30
LT-water pressure	bar	2,70 2,70
Lubricating oil pressure	bar	3,90 4,00
Fuel oil pressure	bar	8,30 8,20

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:	1,8
Stop for high HT-water temperature [°C]	110	No load value for the rack [mm]:	7,0
Tripping speed of pneumatic overspeed trip device [rpm]:	881	Fuel limiter [mm]:	-
Tripping speed of pneum. overspeed trip device (2) [rpm]:	894		

ADJUSTMENT OF FUEL PUMPS:

Fuel rack position, when	Work	Stop	Work	Delivery
Starting lever at:	Work	Stop	Work	commencem.
Governor lever at:	Min	Max	Max	before TDC
Safety device:	Not rel.	Not rel.	Released	
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)

Marine 20.11.2001
Quality Assurance, Projects

M. Merisaari, Quality Assurance Manager, Marine

Wärtsilä Finland Oy
Vaasa Factory

T. Lerstrand, Test Run Manager, Vaasa Factory

F. Jörgensen

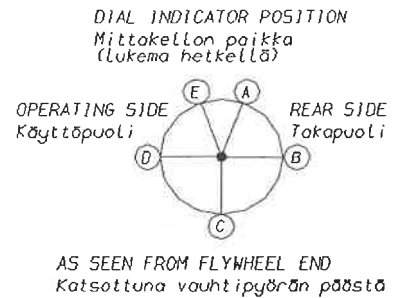
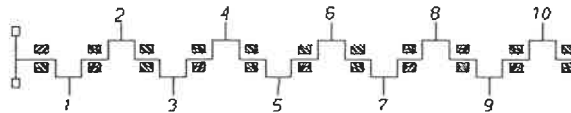
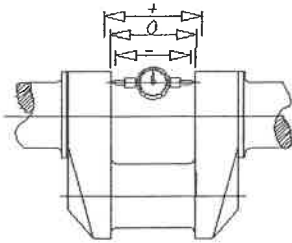
M. Håberg

On behalf of
Classification Society

MSA No. R-1456

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]: 20 °C

Initials:

AAG

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

Deviations 1/100 mm

Inspection of the Wärtsilä Engine

Project: LANGSTEN 189
Order number: 8242
Engine type: W6L32
Engine number: 21303
Classification society: DNV
Test run date(s): 07.11.2001
08.11.2001
Inspection date: 12.11.2001

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.	5	OK
Main bearing No.	4	OK
Thrust bearing	Yes	OK
Endoscope inspection	Yes	OK
Opening of covers	Yes	OK
Test of nozzles	Yes	Changed, No. 1 changed OK

The following corrections should be made before delivery:

Wärtsilä Finland Oy


WÄRTSILÄ

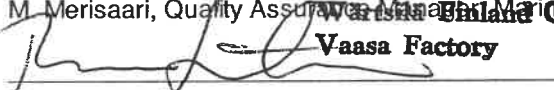
Customer(s)


M. Merisaari, Quality Assurance, Projects

Marine 26.11.2001
Quality Assurance, Projects

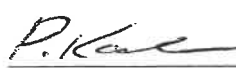


Kjell-Petter Fagerli


Vaasa Factory

T. Lerstrand, Test Run Manager, Vaasa Factory

On behalf of
Classification Society


MSA No. R-1456

P. Karhu, Det Norske Veritas

Fuel Oil Consumption According to ISO 3046/1

Engine number: 21303
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]: 22 350,0
Clean leak fuel [g/s]: 0,60
Mean time [s]: 180,0

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

Air pressure during test [hPa]: 991,0
Air temperature during test [°C]: 28 301 [K]
Charge air coolant temp. during test [°C]: 33 306 [K]

K: 0,956913
 α : 0,949373

Be: 189,6
BISO: 186,8