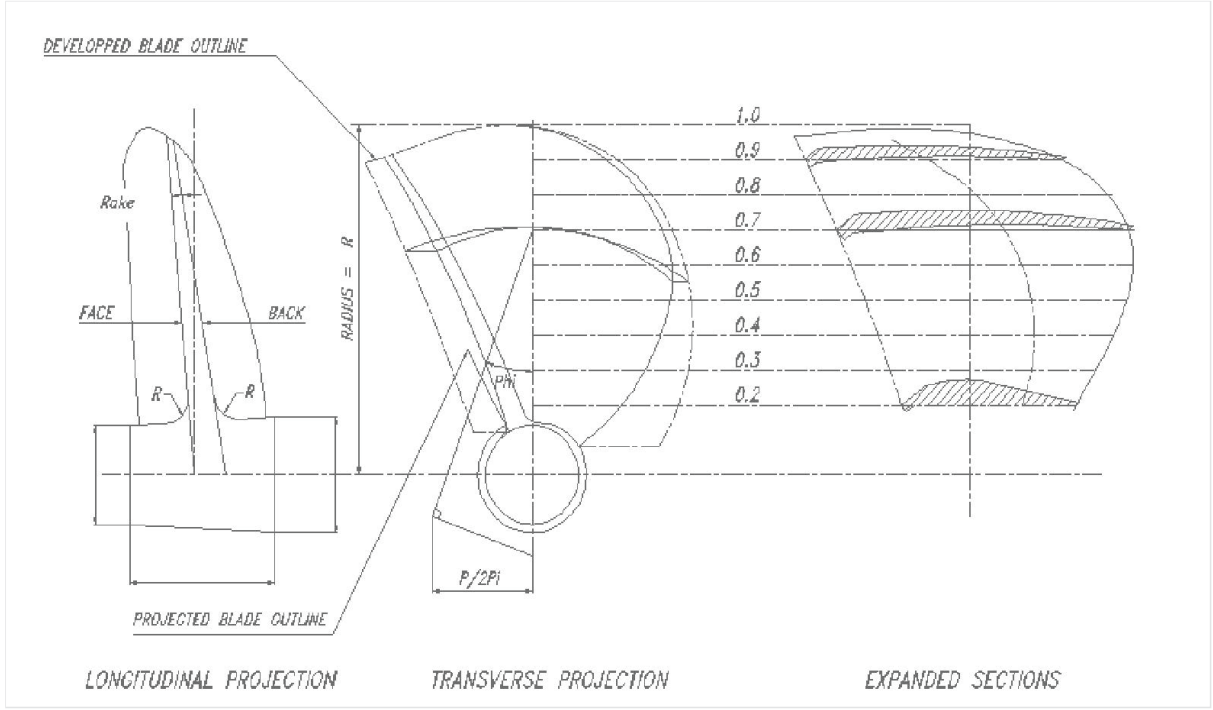
SDS surface drive system

9,75 m RIB 2 x VGT 500



BUREAU VERITAS

ABS
TYPE APPROVAL PROGRAM

trimable surface drive

date 11/6/2013

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HULL DATA

mono(1) cat(2)	1.00	
disp.light	4.90	
disp.full load Δ	6.00	
L.O.A	9.75	
L.W.L	8.29	
transom beam	2.00	
draft	0.60	
deadrise angle	20.00	LOWER THAN
LCG	3.00	3,13 ←
transom angle	7.00	
transom level	1.00	
bow level	1.50	
spray rail	0.00	
max deck beam	2.72	m
transom thickness	65.00	mm
spray rails	n	yes/ no
superstructure	n	Yes/no

CONSTRUCTION DATA

hull material	GRP

ENGINE DATA

MD

nb of engine	2	
nb of cylinders	8	
min hp	50	
max hp	500	
min revs	600	
max revs	3500	

GEARBOX DATA

brand	ZF	
model	ZF 350 A	
minimum ratio	1.47	
gear box ratio	1.77	ok

SURFACE PIERCING PROPELLER

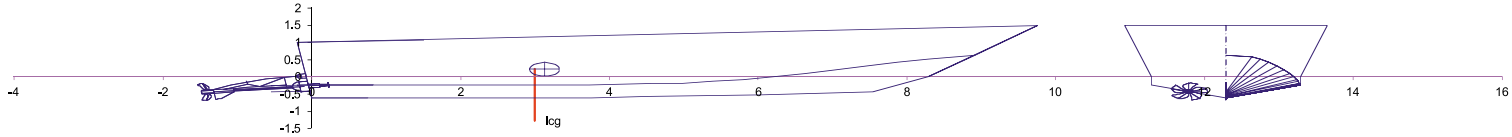
blade nb (4,5,6)	5	
drive trim	0	degres
steering angle	20	(max 20)
propeller efficiency	0.71	
immersion % R	0	

INSTALLATION DETAILS

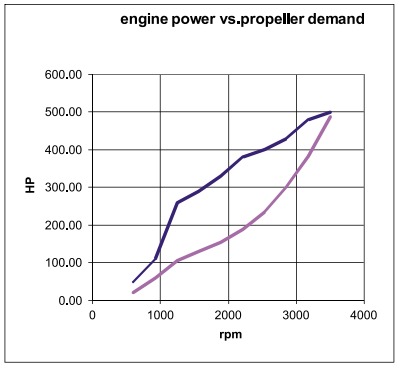
cardan length	600	mm
engine offset	30	mm
num stations	1	
engine distance	1	M
steering	2	(elec 1)(hydro 2)
voltage	24	VOLTS
otal fuel capacity	1000	liters

FLAPS

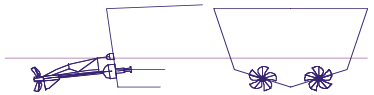
nb of faps	2,00	
flaps angle	3,00	deg
length	0.50	m
cord 1	0.50	m
cord 2	0.30	m
flaps lift	37.22	kgs



revs	available HP	kw	EHP
600	**50.00**	36.8	20.36
922	**110.00**	80.96	60.35
1244	**260.00**	191.36	108.76
1567	**290.00**	213.44	136.40
1889	**330.00**	242.88	162.13
2211	**380.00**	279.68	197.58
2533	**400.00**	294.4	247.60
2856	**430.00**	316.48	315.12
3178	**480.00**	353.28	402.60
3500	**500.00**	368	**512.41**



ok

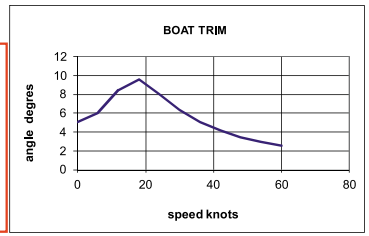


top speed 60 knots

SDS model SDS2

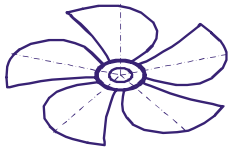
INSTALLATION OPTIONS

- ☐ AUTOMATIC TRIM CONTROL ATC
- ☐ FLYING BRIDGE
- ☐ CARDAN SHAFT
- ☐ ELECTRIC STEERING
- ☐ COMMISSIONING
- ☐ STEERING JOYSTICK



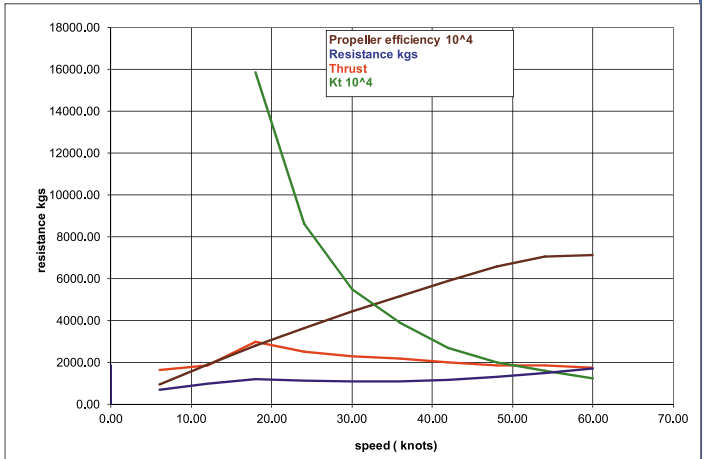
PROPELLER

DIAMETER	19.58
PITCH	40.00
propeller slip	11%



external factors for calculation

water density	1.025	t/m3
air density	0.0012	kg/m3
sea state	1	1 to 6
machine Air temp	25	° celcius
sea water temp	20	° celcius
vawe level	0.1	m
wind speed	5	knots
air resistance	0.08	tons
power loss	0	hp
power loss	0.00	hp



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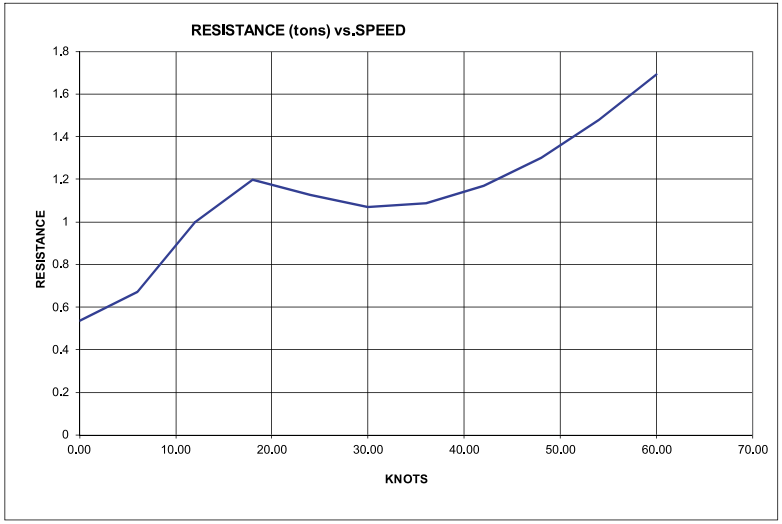
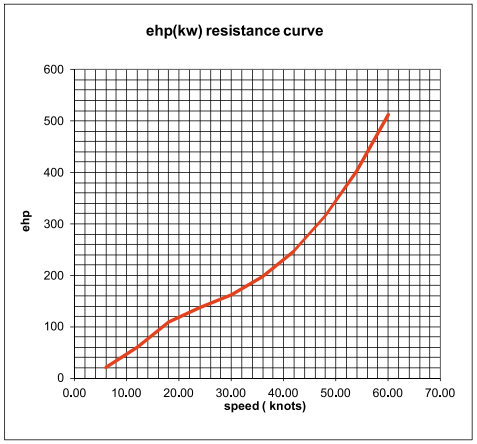
HULL AND APPENDAGES RESISTANCE (tons)

0

speed kts.	speed m/s	Hull	water scoop	air resistance	shaft and fin	total resistance
0.00	0.00003048	0.525343065	1.02203E-14	7.58089E-14	7.46207E-15	0.535849926
6.00	3.086798419	0.657348116	0.000131315	0.000777511	7.65325E-05	0.672257949
12.00	6.173566357	0.96985539	0.000776532	0.003110014	0.000306127	0.996555185
18.00	9.260334296	1.157346606	0.002090858	0.006997509	0.000688783	1.197268198
24.00	12.34710223	1.075126566	0.003471969	0.012439996	0.001224502	1.12620556
30.00	15.43387017	1.004897109	0.005109535	0.019437475	0.001913282	1.070892818
36.00	18.52063811	1.001433128	0.007394276	0.027989945	0.002755124	1.087591081
42.00	21.60740605	1.056412721	0.010700767	0.038097408	0.003750029	1.168186586
48.00	24.69417399	1.157904341	0.015421445	0.049759862	0.004897995	1.300901592
54.00	27.78094193	1.297310953	0.021984407	0.062977308	0.006199023	1.477395217
60.00	30.86770987	1.468930008	0.030860225	0.077749746	0.007653113	1.692321438

total thrust **1.74** tons





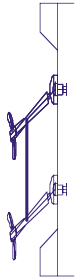
frictionnal coefficient	**0.00040**	(0.00036- 0.00045)according to hull dirtiness
opc	**0.68**	
propeller efficiency	0.71	
hull efficency	0.99	
drive efficiency	0.99	
gear efficiency	0.975	
quasi propulsive coefficient	**0.51**	

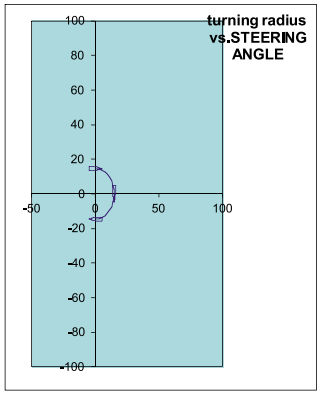
block coeff **block coeff too high, check weight**

lcg position **lcg ok**

boat **need flaps** **to get on plane**

lenght/ beam ratio **4.15**





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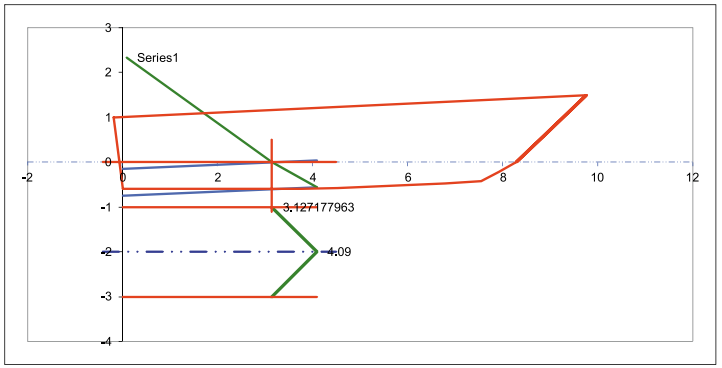
SPRAY RAILS

Trim angle at full speed	2.59	deg
wetted lenght at full speed	4.08	m
output of stagnation line	3.13	m
angle of deflection	59.98	deg

quarter buttock spray rails	n	
quanty ty per side	2	
% of lenght from bow	70	
Lenght from bow	5.803	m

spray rail width	0.05	m
position of spray rail from center	0.33	m

INSIDE INSTALLATION



CALCULATION FOR RANGE AND FUEL CONSUMPTION

ENGINE POWER MAX 368 kw @ 3500 rpm

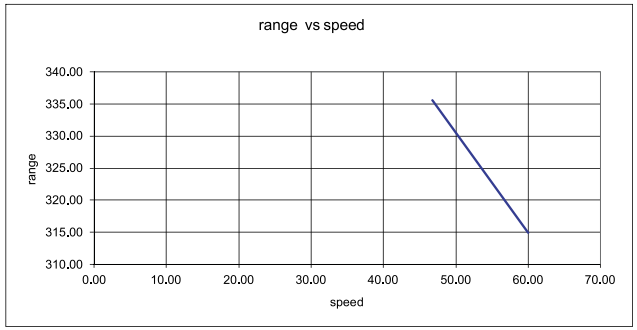
specific fuel consumption 220 gram/KW/hour

check cruising speed enter rpm 2800

propeller demand 316.59 kw

ON BOARD FUEL CAPACITY 1000 liters

	knots	rpm	liters	trim	range Nm
top speed	60.00	3500	190.494118	0	314.97
CRUISING SPEED	46.74	2800	164	-3	335.53



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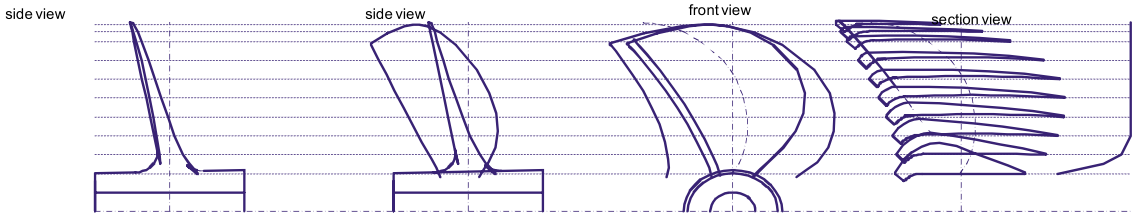
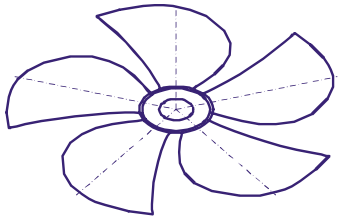
PROPELLER





PROPELLER DATA

DIAMETER	19.58	inches
PITCH	40.00	inches
P/D ratio	2.04	
RAKE	10.00	degres
SKEW	21.80	degres
BLADE	5	
PD. in water	1.48	KG/M.
PROPELLER FREQUENCY	164.78	hertz
HUB	SDS2	
WEIGTH	19.19	kilogram
PD. in air	1.19	KG/M.

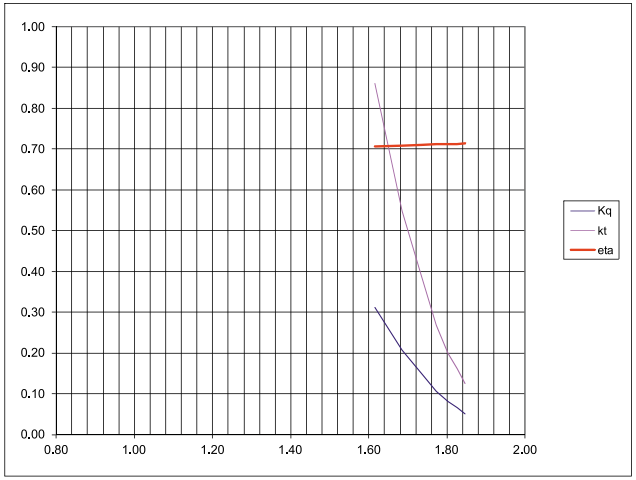
propeller slip 11.00 %

CALCULATION FOR PROPELLER BALANCING TOLERANCE

ACCORDING TO ISO RULES

	grade of required balancing quality G	
ACCORDING TO RPM G =	2.5	
Propeller weigth	19.19	kg
propellers revolutions	1977	rev/mn
balancing tolérance	0.98	Grammes
at maximum propeller radius	163.81	mm
angular velocity	207.07	rad/s
radius	249	mm
balancing tolérance	12.64	grammes.metre

J	eta	Kq	kt
1.509916817	0.701364028	0.542425947	1.585954697
1.614770823	0.706693149	0.312193303	0.860009851
1.684977418	0.709352198	0.206661559	0.547630203
1.735274681	0.710854748	0.150421005	0.387865347
1.773079812	0.711823765	0.106371426	0.268799859
1.802532648	0.712526742	0.080486381	0.2002628
1.826125756	0.713085101	0.065611568	0.161269023
1.845449636	0.713557164	0.051422289	0.125152011



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VERTICAL ACCELERATIONS (DNV rules)

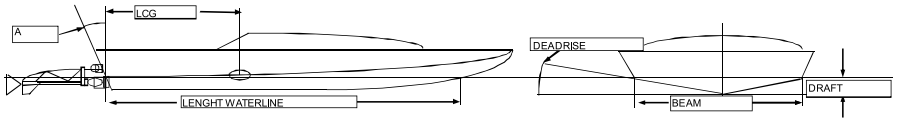
PROJECT HSB 1900

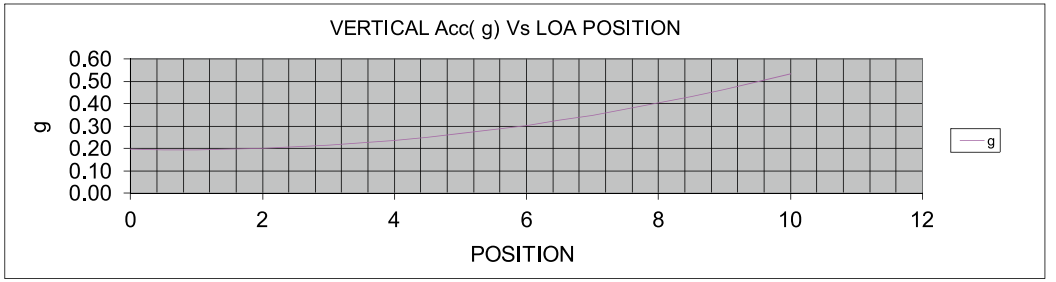
INPUT

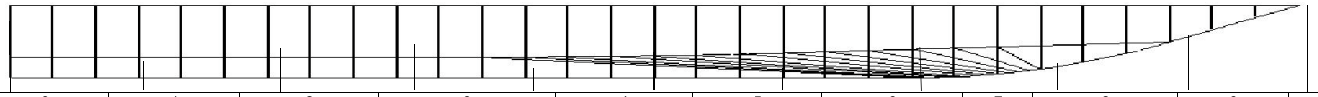
Loa	9.75	craft length m
Lwl	8.29	m
Bwl	2	total breadth hull ö m
T	0.6	draught at L/2in m
Bcg	20	deadrise in LCG (min 10 max 30)
Weight	6	tons
speed	63.89	knots
block coeff	0.60	

Hs	0.1	significant wave height in m
tau	2.59	trim angle of boat when running (4 to 7)

SEA STATE 1







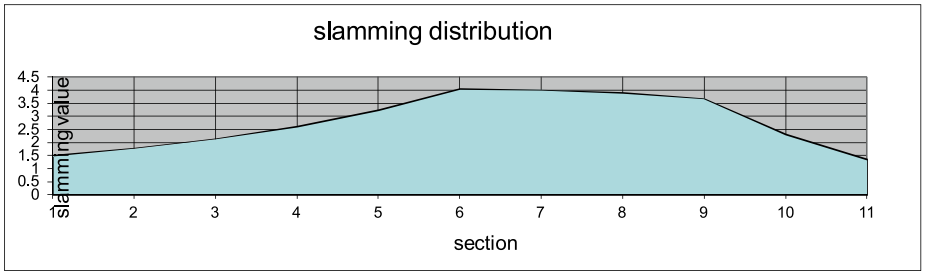
section	0	1	2	3	4	5	6	7	8	9	10
Acc m/s$_{.}$	1.93	1.91	1.97	2.11	2.32	2.61	2.98	3.43	3.95	4.55	5.23
g	0.20	0.20	0.20	0.21	0.24	0.27	0.30	0.35	0.40	0.46	0.53
kN/m$_{.}$	1.503657338	1.786459351	2.147739656	2.62369316	3.250514766	4.064399379	4.019396653	3.90997	3.687867837	2.313375402	1.356287692

HULL DESIGN SLAMMING PRESSURE (DNV rules)
AT SPECIFIC SECTION AND PANEL SIZE

INPUT

x	6	section n°
A	1	design load area for element considered in m$_{.}$
Bx	22	deadrise angle at the middle of the load
l	1	length of panel
w	2	width of panel

SLAMMNG PRESSURE	4.02	KN/M2	at considered section
TOTAL PRESSURE ON THE PANEL	8.04	KN on PANEL	



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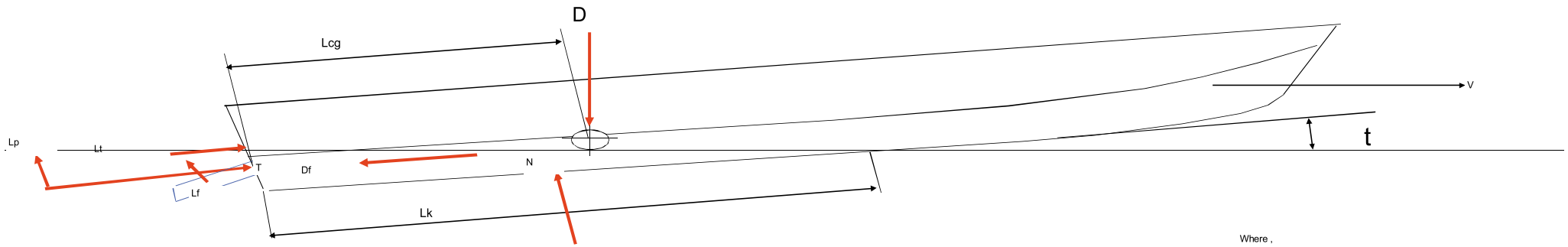
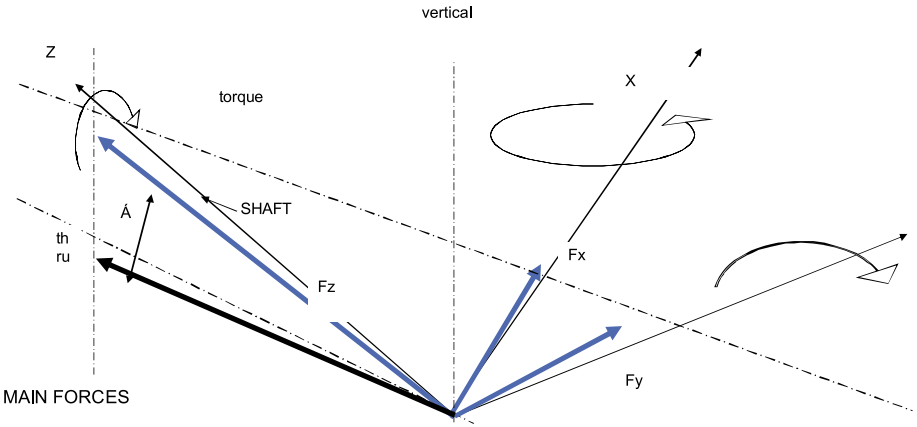
FORCES ACTING ON THE HULL AT FULL SPEED



FORCES ACTING ON THE PROPELLER AT FULL SPEED



Fz	1.61	
Fx	0.00	
Fy	0.321383716	

Y horizontal

D Displacement	6.00	tons
lcg	3.00	m
Lk	4.09	m
Lt	0.00	tons
Lp	0.00	tons
Df	1.61	tons
N	2.04	tons
T	1.61	tons
Torque	181.10	kg/m

SECONDARY FORCES

Vertical force ratio = Fx / T	0.00
Side force ratio = Fy / T	0.20

Where ,

LCG Center of gravity
Lt Trim force
Lp Propeller lift
Lf Flap lift
Df Boat resistance
Lk Wetted boat length
NBoat lift force
TPropeller trust
DBoat weigth
VBoat speed (knots)

Fz ,Fx,Fy ,thrust and torque and vertical force are the main force generated by the propeller.

Thrust = Fz cosA – Fx sinA (equation a) 1.61 tons

Vertical force is derived from equation a

Vertical force = Fz sinA+ Fx cosA (equation b) 0.00 tons

When A = 0 Thrust become maximum

That figure show the importance of using a trimable shaft drive.

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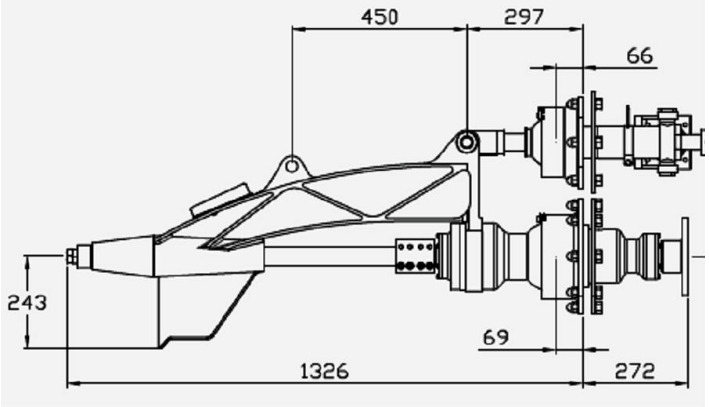
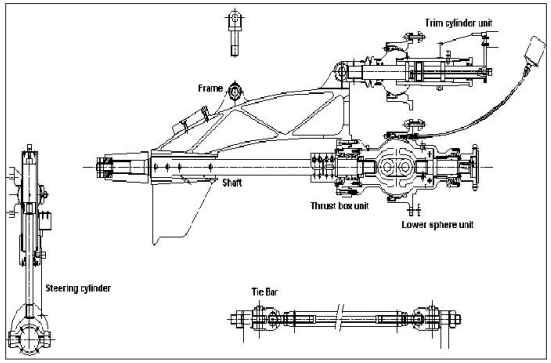
INSTALLATION





MECHANICAL COMPONENTS

Scope of supply quantity	designation
2	drives
2	steering cylinder
2	grease cartridge
2	coupling flange
1	mechanical tie-bar
2	zinc anode
2	propeller nut
2	oil reservoir
2	schock absorber
1	emergency hydraulic power pack
2	cross flow valve
1	control dashboard
1	elecric relay box
1	set of electric cabling wire
3	position sensor for SDS system
3	postion sensors for MTU system
1	installation manual
1	maintenance manual
1	installation temeplate
1	tools set
2	propellers
note:	oil and hydraulic hoses are not included

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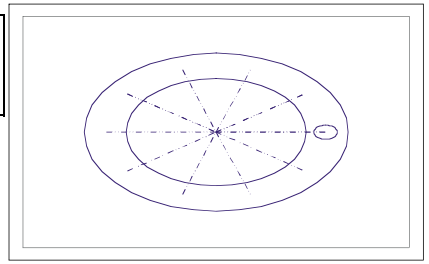
OPERATIONAL CHART

	percentage	power hp	speed Kn.	thrust bearing timelife	
MANOVERING	5	50	12.0	829861.55	
CRUISING	70	400	46.7	179329.59	
FULL SPEED	25	500	60.0	33307.01	
total	100			1042498.14	hours

GEARBOX COUPLING FLANGE

EXTERNAL R	205
HOLES CENTERING DIAMETER	170
HOLES R	18.3
FLANGE CENTERING R	140
holes number	10
angle between holes	36



ROLLER BEARING TIMELIFE CALCULATION FOR SDS DRIVE AT FULL SPEED FULL TIME

SDS DRIVE TYPE SDS2

ROLLER BEARING CALCULATION FORMULAS

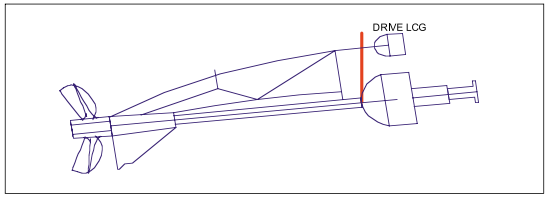
L = (C/P)^k	Time life in 10^6 rotation
Lh = (16666/n) * L	Time life in hours
P = X*Fr + Y*Fa	X radial factor, Y axial factor

engine power	500	
engine revolutions	3500	
gear ratio	1.77	
propeller efficiency	75	%
BOAT SPEED	63.89	KNOTS
PROPELLER THRUST	8419	N (axial load)
Radial force due to propeller and shaft forces	631	N (radial load)

Data bearing supplied by manufacturer

Ref		C (kN)	X	Y
JLM104948-JLM104910		75.2	0.31	1.97

Fa	8419	Propeller thrust en Equivalent to dynamic axial load
Fr	631	Radial load
n (rpm)	1977	rpm or tr/min of the propeller shaft
C	306	Dynamic load of roller bearing kN
X	0.31	Radial factor
Y	1.97	Axial fator
k	3.33	3 for roller bearing, 3,33 for cylinder bearing
P	16.8	kN
Safety factor	18.2	computed
L	15807.3	life time in 10^6 rotation
Lh	133228.0	theoritical life time in hours



	hours		
Minimum MTBF	3000	margin	130228.0 hours

DRIVE LCG -150.370742 from transom
without propeller

weight table

drive	150.00
steering cylinder	18.00
oil tank	2.50
shock absorber	8.00
hydraulic power unit	30.00
propeller	19.19
tie bar	10.00
weight per unit	150.00
total weight	387.69 for a pair

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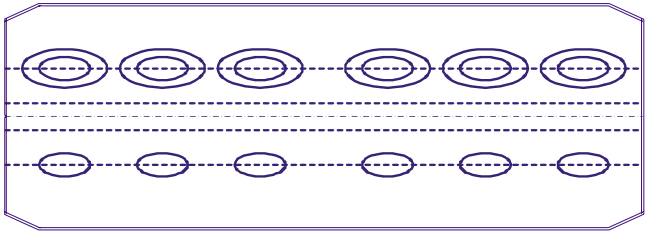
SAFETY CALCULATION FOR 2 PART COUPLING

INTERNAL SHAFT R	50	mm
EXTERNAL COUPLING R	116	mm
WEIGHT	9.12	kg
Nb of bolts	12.00	
Thightening force of the bolts	610725.61	N
ENGINE TORQUE	2748.27	N/M
coupling torque	1777.151378	N/M
frictionnal coefficient Nibral/ stainless steel	0.18	



SAFETY CALCULATION FOR GEARBOX/ ENGINE CARDAN SHAFT

WORKING ANGLE 2.86 degres

SAFETY ELECTROLYSIS PROTECTION

Mass of anode to install in the drive area 7.75 kgs
drives must be connected together to an external anode

SAFETY ELECTRICAL PROTECTION

VOLTAGE REMAINING ON DRIVES MUST BE LESS THAN 0.7 VOLTS

CALCULATION FOR VIBRATIONS LIMITS

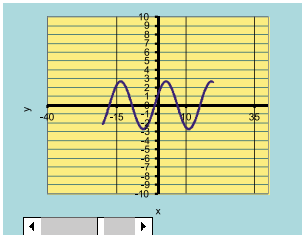
propeller frequency 164.78 hertz

for 8 hours run
acceleration 5.84 acceleration ok

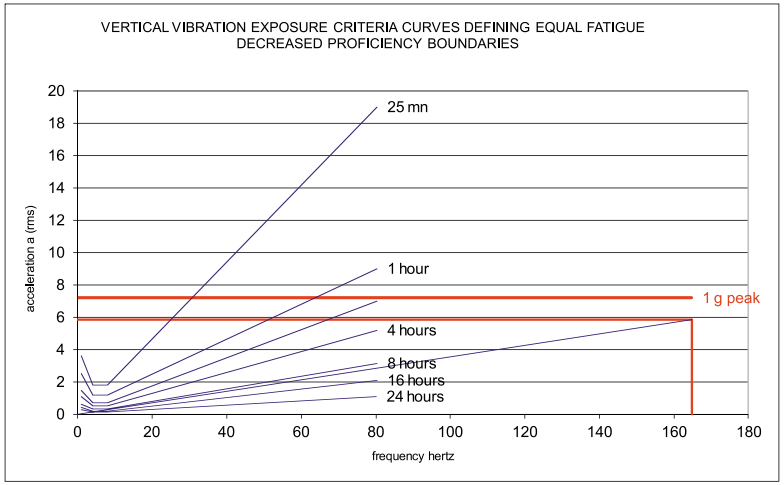
limit of exposure 11.68 rms

reduced comfort boundary 1.85

the level of acceleration is good for comfort



g en RMS	Acc RMS m/s,	V RMS m/s	D m RMS
5.84	0.5953	9.3356	0.0027



CALCULATION FOR SHAFT SAFETY FACTOR

SHAFT DIAMETER	50	mm
Quadratic moment	613592	mm^4
Max Stress calculation	174	N.mm,
Security coeficient UTS	5	
Security coeficient YTS	3	

SAFETY CALCULATION RESULTS

2 PART COUPLING	ok	SAFETY COEFFICIENT	1.55		
Shaft fatigue in 10^5 cycles	ok	Safety coeficient UTS	2.47	Safety coeficient YTS	7.98
Shaft torsionnal resistance	ok	Safety coeficient UTS	4.55	Safety coeficient YTS	2.96
CARDAN SHAFT working angle	ok	angle	2.86	deg	
ROLLER BEARING time life	ok	time life	133228	hours	
Human body vibration acceptance	ok		5.84	g in Rms	
Slaming vertical accelerations	ok		0.27	g	
whirling	there is no whirling				

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WHIRLING CALCULATION

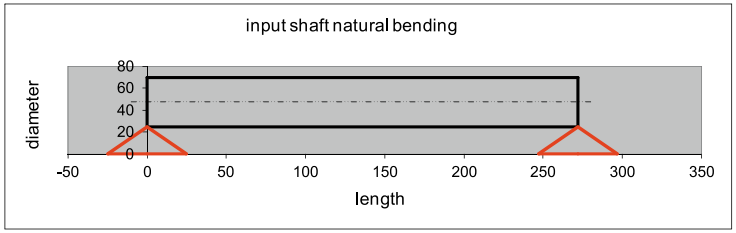
SURFACE DRIVE TYPE SDS2 RUNNING @ 1977 RPM at propeller

Input shaft length	232	mm
intermediate shafy length	274	
propeller shaft length	902	

input shaft weight	2.5
intermediate shaft weight	4
propellller shaft weight	12.5

distance between support 686 mm

J input shaft	0.002
J intermediate shaft	0.001
J propeller shaft	0.004

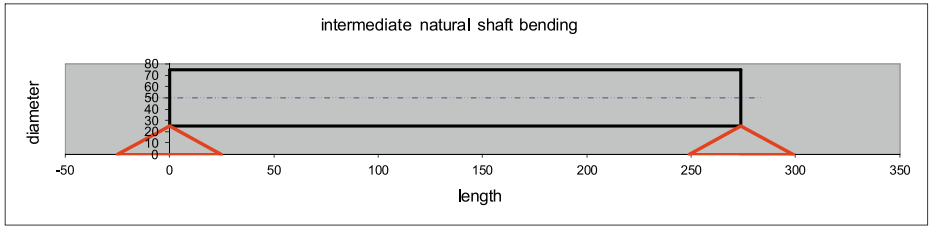


P	24.525	N
L	232	mm
E	210000	Mpa
D	45	mm
Igz	201186.9141	mm4
bending	0.000	mm

critical revolution by Harmrock method

76966 RPM

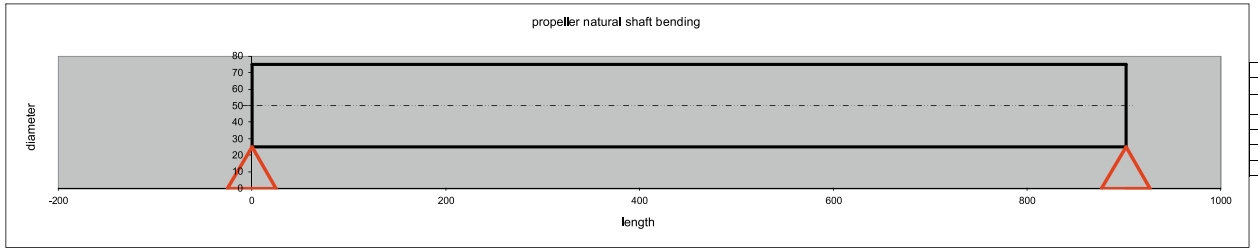
1977 MAXIMUM PROPELLER RPM



P	39.24	N
L	274	mm
E	210000	Mpa
D	50	mm
Igz	306640.625	mm4
bending	0.000	mm

58528 RPM

1977 MAXIMUM PROPELLER RPM



P	122.625	N
L	902	mm
E	210000	Mpa
D	110	mm
Igz	7183240.625	mm4
bending	0.001	mm

26829 RPM

1977 MAXIMUM PROPELLER RPM

maximum shaft revolutions	1977.40113	rpm
maximum allowed rpm to avoid whirling	26829	rpm

no shaft whriling

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REQUIRED HYDRAULIC PUMP DRIVEN BY ENGINE PTO or by GEARBOX PTO

	Quantity	flow rate	MAX PRESSURE	flow liter / mn
MAIN PUMP	0	15 cm^3 / turn	140 BAR	29
LUBRICATION PUMP	0	0	15 BAR	

input pump flow in cm3/ turn	5.8
input max pump input rpm	5000

OIL RECOMMENDATION

LOWER SPHERE	SAE 90	FOR APPLICATION WITHOUT COOLER
LOWER SPHERE	SAE40	FOR APPLICATION WITH COOLER
HYDRAULIC SYTEM	HYDRO 32	

oil piping circuit installation

power need

flow liter /mn	29
pressure differential	60
powqer needed in KW	2.90

flow calculation

Viscosity mm /s		45.30	
pipe internal R		19.00	input
flow speed m/s		1.70	
Re		715	
laminar flow			

losses

Masse volumique en Kg/m3		863.00	
circuit length m		15.00	input
flow speed m/s		1.70	
pressure losses in joules/kilo		88612	
pressure losses in Kw		0.61	

#REF!

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