Designer's Guide

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DESIGNER'S



Designer's Guide

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Introduction

Marine Jet Power AB is a world leading supplier of jets. Several products are marketed by the company. This designers guide is for the CSU and DRB series suitable for vessels from 15 meters in length and powers from 500 kW per shaft.

Marine Jet Power CSU and DRB generates more thrust from installed power leading to higher ship speed and better acceleration as well as lower fuel consumption.

The product is very strong, made of duplex stainless steel and can be used in shallow and dirty waters without compromising the product or vessel. The steering and reversing units offer very good manoeuvring at high and low ship speeds.

Supported by a number of patents, design and engineering solutions a unique product has been created targeting low operational costs and easy maintenance and service. Among the many MJP customers around the world are Coast Guards, Yacht Builders and Commercial Operators.

The scope of supply includes one or several water jets and control system. Depending on hull design and material the intakes are made locally by shipyard or by MJP. Combining the MJP duplex stainless steel product with FRP intakes provides a very strong, efficient, corrosionfree product with a minimum of maintenance requirements. The control system comprises of hydraulics and mechanical or electronic controls and can include options for easier manoeuvring, additional steering stations, integration of rudders and/or interceptors (trim tabs) etc.

The Purpose of the MJP CSU and DRB Designer's Guide

The aim of the MJP Designer's Guide is to support operators, shipyards, consultants, project engineers and sales personnel:

- to better understand the principles of a jet propelled vessel
- to help in the planning of the layout of the vessel
- to design to the performances set up for the vessel
- to provide guidelines for the selection of appropriate jet unit
- to successfully integrate the propulsion system into the vessel
- to create awareness of the various possibilities and options in the MJP system

Why Marine Jet Power?

The design and application concept of MJP is based on a global approach to the reduction of operating costs. The main advantages of MJP are:

- Superior waterjet pump performance, thrust and cavitation margin.
- Waterjet propulsion efficiency is traditionally high at intermediate and superior at high ship speeds. By choosing a sufficiently large MJP Waterjet high efficiency can be achieved also at low ship speeds.
- In order to further enhance the course-keeping ability and maintain high thrust when operating in a seaway, heading control rudders can be integrated and offered in the MJP system
- Steering at high ships speeds can be made more efficient when integrated with interceptor system steering and MJP split steering function.
- Protected Propulsion keeps the propulsion equipment unaffected even after groundings and is actually cost-saving.
- The MJP design is made to withstand operation in extremely dirty conditions in very shallow waters.

- Low Vibrations both in forward and reverse operation as well as at high ship speeds greatly improve comfort on board.
- Superior Manoeuvrability allows excellent harbour manoeuvring and shortens turn around times. At maximum ship speed, the crash stop can effectively be used to avoid collision and thereby improve safety and control.
- At constant consumed power the jet unit rpm is little affected by ship speed and allows the engine to always operate in favourable conditions independent of loading of the vessel. This smooth engine load extends the service life of the diesel engine and offers lower engine service costs compared to traditional propeller installations. The jet unit can be used on vessels with extremely varying loads and ship speeds, from light ship to full load conditions without affecting or compromising the diesel engine.
- An interesting aspect of water jet propulsion is low waterborne noise, which is important for military applications or where the environment is concerned.



Selecting jet size and engine power

The jet range is presented in CSU and DRB product data sheets enclosed at the end of this Guide. The correct jet size is based on:

- · Vessel's design speed
- Vessel characteristics such as hull type, resistance data and curve shape.
- Jet pump cavitation margin.
- Engine power.
- Special requirements such as operation on single or reduced number of jets
- The MJP Performance Diagram calculates 3% transmission losses as standard.

Normally the resistance data is provided by the customers' ship designer. The best accuracy is achieved if the data is based on experienced values or bare hull resistance model tests.

It is noted that a larger jet will provide better cavitation margin and can be a better choice at lower ship speeds. In principle a larger jet will give better efficiency and acceleration. However for a very fast vessel a smaller jet with less weight is more advantageous.

Different characteristics can be achieved by varying the jet nozzle diameter. One nozzle gives less thrust but a better cavitation margin, etc. Therefore please always involve MJP in your performance predictions and power estimates.

Specific Performance Diagram with engine power, jet size, resistance data, selected nozzle diameter and gearbox ratio is made for each delivery. For enquiries a questionnaire is enclosed in the end of this guide.



Example performance diagram

The performance diagram calculated for a water jet propulsion system establishes a relation between water jet thrust, impeller shaft rpm (or engine output shaft rpm when the gearbox is selected and the gear ratio is fixed), engine power and vessel speed. The diagram presents two sets of curves: thrust curves in the lower section and shaft rpm curves in the upper. The curves are plotted for a number of different engine power values P1...P5 (P5 is the maximum value) in function of the vessel speed.

Superimposing a hull resistance curve onto the thrust curves will allow, using the intersection points of this system of curves, a variation of shaft rpm with vessel speed ('shaft rpm curve') that corresponds to given resistance. Let us consider an example of the use of this diagram. Let the vessel speed be V^{*}. When in steady motion, the value of the waterjet thrust, T^{*}, is equal to that of the resistance corresponding to the speed V^{*} on the performance diagram. The impeller shaft revolutions, RPM^{*}, are obtained from the shaft rpm curve for the same speed V^{*}. The power, P^{*}, engine to the waterjet is obtained by interpolating the values between the neighbouring curves (either thrust curves or shaft rpm curves can be used).

The maximum attainable speed is determined by the intersection point between the hull resistance curve and the thrust curve corresponding to the maximum power level P₅.



Gearbox

Function

The function of the gearbox is to match the optimum jet speed (rpm) to the engine speed (rpm) and power, please refer to the engine manufacturer's power/rpm diagram or data. The gearbox is also a clutch that enables disengaging of the jet.

Ratio

The MJP pump absorbs certain power at certain speed (rpm). The engine speed (rpm) is equal to the jet speed (rpm) times the gearbox ratio (i). The gearbox ratio (i) must be selected to match the jet power absorption to the engine power, see enclosed example graph. The ratio, i, is normally selected for 100% MCR (Maximum Continuous Rating) as follows: lowest allowed engine speed (rpm) corresponding to 100% MCR / jet shaft speed <= i <= highest allowed engine speed corresponding to 100% MCR / jet shaft speed.

Transmission losses

The MJP performance diagram estimates 3% transmission losses as experienced well proven standard value. The gearbox losses are normally 2 - 3% depending on type and size of gear.

Backflush

Optionally the reduction gearbox can be equipped with a reverse so called backflush gearbox. A gearbox running in reverse can clear debris stuck in the jet and intake. Typically losses in a backflushing gearbox are $\sim 0.5\%$ higher than in a non-reversing gear.





Gearbox ratio shall be selected to reach ideal design points. Too low or too high gearbox ratio will lead to engine overload or overspeed.

As an alternative to backflush, the vessel can reverse with one jet in back up mode to clear the other jet.



Intake material and design

The jet intake shape is an integral part of the jet pump design and a very important factor for the total performance and successful jet installation. MJP support the use of GRP/FRP in the intake structures since it reduces the maintenance requirements of intake and corrosion load on metallic hulls.

The DRB jet range is in smaller sizes equipped with a GRP intake as standard supplied by MJP and bolted or laminated to the hull structure. As an option, special intakes can be provided as agreed with yard designer's and to a shape designed by MJP experts. The yard may well produce the intake. Especially in FRP hulls, local yard-supplied integrated intake is strongly recommended since superior shape and structural strength can be achieved in a seamless installation.

The CSU jet range is made to meet free jet positioning. The designer's can optimize the design and performance of the vessel. The intake shape is designed by MJP to ensure jet pump performance. As a standard the aft section of intake is a MJP supplied GRP bend and the forward part of intake is made by the yard. As an option complete intakes can be provided by MJP. The purpose of the standard GRP bend is to insulate the jet unit from the intake structure, thus reducing the corrosion load. Hence the GRP bend cannot be replaced by, for example, steel or aluminum. The material and scantlings of the forward part of the intake shall correspond to the surrounding structures and lines to a shape designed by MJP experts. Scantlings are subject to global structural loads. Hence classification approval of intake scantlings are sought and secured by yard.

The area surrounding and forward of the intake must be made flush without any items protruding that can cause turbulence and disturbed flow into the jet intake thus affecting the performance. It is recommended that anodes be positioned on the stern as well as recessed and to the side of the intake. It is also preferred that the engine cooling intakes are positioned at side, aft, or well forward of the intakes. MJP experts can provide specific recommendations for each individual case.



Optionally complete GRP or FRP intakes can be selected. The major advantage is freedom of design and shape, giving performance as well as corrosion resistance-reducing maintenance. The options are:

Hull material	Option 1	Option 2	Option 3
Metal	GRP intake complete from MJP bolted to structure.	MJP provide intake pattern for yard-produced intake in FRP bolted to structure.	Yard-produced pattern and intake in FRP bolted to structure.
Composite	GRP intake complete from MJP laminated to structure.	MJP provide intake pattern for yard-produced intake in FRP integral with hull structure	Yard-produced pattern and intake in FRP integral with hull structure.

Note 1: The complete intake and surrounding structure is subject to scantling and approval ensured by yard. **Note 2:** The surrounding intake structure must be made uninterrupted load carrying and integral with the ship's structure.

Intake grid

MJP do not generally recommend intake grids for DRB and CSU series. However each vessel operates in different conditions and grids may be required due to extreme conditions such as in shallow waters, beaches or rivers. It is noted that smaller jets are more liable to be affected by debris. The MJP CSU and DRB jet unit is designed in duplex stainless steel and stands even extreme operating conditions in, for example, sandy and muddy waters. For vessels equipped with optional grids, MJP will make a specific intake grid drawing.



Shaft arrangement

First of all it is to be noted that al the thrust is taken in the MJP CSU and DRB jet unit. Hence no thrust block is required inside the hull or gearbox. Another great advantage of the MJP system is the "floating" drive shaft. It allows as standard the MJP Waterjet drive shaft to run all the way up to the gearbox flange without the need of additional support bearings, couplings or intermediate shafts. The limiting factors are the unsupported MJP drive shaft length and the distance from the stern to the gearbox flange. The unsupported MJP drive shaft length can be maximum 25 times its diameter. The final shaft arrangement is subject MJP and of course classification approvals.

Model	Jet shaft Ø	25 times jet shaft Ø
MJP 350	Ø 65	1625
MJP 400	Ø 75	1875
MJP 450	Ø 85	2125
MJP 500	Ø 95	² 375
MJP 550	Ø 105	2625
MJP 650	Ø 120	3000
MJP 750	Ø 130	3250
MJP 850	Ø 160	4000
MJP 950	Ø 180	4500
MJP 1050	Ø 205	5125
MJP 1150	Ø 220	5500
MJP 1350	Ø 260	6500
MJP 1550	Ø 280	7000

- A standard delivery consists of:
- Jet drive shaft (floating)
- Shaft seal (floating)
- Coupling and spacer adapted to the gearbox flange.

If the distance from outside stern to the gearbox flange exceeds 30 times the jet drive shaft diameter an optional intermediate shaft is needed.

The following items are added to the above arrangement:

- Support bearing on the jet drive shaft
- Additional coupling or intermediate drive shaft

As an option, hollow bore shafts are available that improve weight and strength of the jet and intermediate steel drive shafts.

Alternative and individual arrangements including composite solutions are offered separately. For each project or design MJP makes an individual shaft arrangement drawing.

MJP need the gearbox flange drawing for designing the spacer.



Standard shaft arrangement with drive shaft up to gearbox flange

- Transom
- Impeller housing
- Intake
- MJP Drive Shaft
- MJP Drive Shaft Seal
- Coupling and spacer with flange to gearbox flange

Standard intermediate shaft arrangement

- Transom
- Impeller housing
- Intake
- MJP Drive Shaft
- MJP Drive Shaft Seal
- Support bearing (split type)
- Coupling
- Intermediate shaft
- Coupling and spacer adapted to gearbox flange

Alternative intermediate shaft arrangement with composite shaft

- Transom
- Impeller housing
- Intake
- MJP Drive Shaft
- MJP Drive Shaft Seal
- Combined Support bearing and bulkhead seal
- Composite intermediate shaft arrangement with coupling and spacer adapted to gearbox flange.









Designer's Guide





Definition of jet position

In MJP CSU and DRB series the position of the jet shaft is relatively free, but it is strongly recommended to keep the height of the water jet intake as small as possible to reduce power lost in lifting water and to reduce the weight of water in the duct, which is included in the overall weight and affects the vessel performance. In addition, careful consideration must be taken in priming the jet pump, the reversing jet stream and service access.

Priming

It is important to select a jet drive shaft position to ensure priming of the jet pump when the clutch is engaged. When the jet shaft is high in the water the priming rpm is also higher as shown in enclosed graph. The general recommendation is to position the jet unit drive shaft in the waterline at light ship forward trim condition.

Reversing jet stream

To ensure reversing performance the jet stream must not touch the hull. The general recommendation is to position the centre of the shaft no higher than 0.9 times the intake diameter above hull measured at centre of jet. For exact measurement please refer to drawing of each jet size and/or consult MJP.





Example of combined lubrication and hydraulic tank unit.

Hydraulic and lubrication system

Each jet unit has its own hydraulic and lubrication circuits. The purpose of the hydraulic circuit is to offer steering and reversing control of the jet unit. The purpose of the lubrication circulation tank unit is to offer head and to monitor the level and quality of the hub unit oil. According to classification rules, tank units must not be combined on vessels with two jets to avoid comprimising redundancy.

The hydraulic system is designed and delivered individually to each project. Tank units can be customised to customer requirements for example, trim flaps or interceptors as well as rudders can be fully integrated in both hydraulic and electric controls. Tank units can be made separated or compact in combined tanks and in stainless steel material to suit, for example, yacht applications.

In MJP CSU and DRB series the hydraulic and hub unit tank circuits. The main reason is easy operation and service. The hydraulic system is driven by a load-sensing pump fitted on a gearbox or engine PTO. The hub unit lubrication oil is circulated by a gear pump. As standard the MJP hydraulic system is made all mechanical, no other power on board than 24V DC is needed to operate the complete MJP system. Electrical back up pumps can be provided as an option.



The all mechanical system with PTO hydraulic pump and piggy back fitted lubrication circulation pump







Mechanical hydraulic system with PTO pump and electrical driven lubrication circulation unit



Mechanical system with PTO hydraulic pump and electrical back up pump and piggy back fitted mechanical lubrication circulation pump

The hydraulic tank unit should be positioned above and close to the PTO pump in order to minimize the wear of the PTO pump and diameter of the suction pipe diameter.

The lubrication tank unit should be positioned above the jet unit to offer head to the hub unit and allow operation even if the circulation pump is down.





Control system

The MJP Electronic Control System offers complete control of the jet position and engine rpm control, thereby controlling all vessel motions in steering, reversing, side movements, rotation or crash stop, that is all the manoeuvring that makes a jet boat so efficient compared to propeller-driven vessels. As each customer or group of applications have different preferences, we have developed three main alternatives that cover a wide range of applications and requirements.



ACS Azimuth control system

Two Azimuth levers and one second steer tiller. Each Azimuth lever controls its dedicated jet. The system can operate in Separate or Common mode, with Autopilot or with the second steer tiller conveniently positioned in the armrest. This system requires more of the captain to efficiently operate the vessel.



VCS Vector Control System

This system offers operation with a joystick and steering tiller (or wheel). The computer translates the steering commands, optimises the jet positioning and rpm to make the boat move as requested by the captain for convenient and easy control. The VCS system helps the Captain quickly become an expert in controlling the vessel. The system accepts Autopilot steering signal.



CSW

Combinator and steering wheel

CSW includes combinator with two levers, steering wheel and a VCS joystick. The combinator levers controls the jet buckets and engine rpm, the steering wheel controls steering just like on a traditional boat.

Especially on fast vessels it is appreciated to steer with a steering wheel and control the rpm with the combinator levers. The VCS joystick offers full and computerised control of the vessel in a harbour or at slow speed operation. Clutch control is most often included as well as Autopilot.

ALL SYSTEMS HAVE THE NECESSARY COMMAND, ALARM AND INDICATION PANELS.

For all types of control systems the following options can be considered:

- Clutch Control Panel with or without "backflush" (reversing gearbox).
- · Additional steering stations, indoors or outdoors
- Interceptor or trim tab control panels
- Integration of external trim tab system
- Rudder control panel and indicator
- Split steering
- Bow thruster integration
- Interface to shipboard ship alarm system
- Interface to so called "Black Box" Voyage Data Recorder, VDR

The control system is set via a terminal or with a standard lap top connected to the system.



It is important to note that the high-speed heading control rudders in this example do not increase the vessel draught.

Steering options

The steering performance of a water-jet-driven vessel can be improved by split steering and interceptors (trim flaps). A significant innovation offered by MJP is the use of balanced-type rudders of comparatively small area intended to control the vessel's heading after reaching a certain speed. These rudders improve the vessel's maneuverability and course keeping at high-speed operation, especially in heavy following seas without compromising the thrust capability.

Split steering

When a vessel is making course-keeping steering corrections, ship speed is only higher if the inner jet is steering. The outer jet is kept standing still. The result is higher ship speed during steering. If a full steering command is made both jets will automatically steer normally. The Split steering function is a standard feature in the MJP Electronic Controls System. The parameters are set individually on each vessel during start up.

Interceptors

Different loading conditions of a vessel can be compensated by an interceptor or trim flap systems. An interceptor/ flap system can also be used to enhance steering if it is integrated with the MJP Control System. Parameters for the automatic steering commands are set in the MJP software at sea trials. MJP can also integrate hydraulically yard or externally supplied systems. The MJP electronic control system is set to fit the interceptor/flap system and the helmsman will automatically appreciate enhanced steering command and higher ship speed. MJP can supply interceptor systems as an option, for more details please contact MJP.

Rudders

Rudders improve steering as well as course stability. In the MJP system, rudders can be fully integrated in the MJP hydraulic and electronic controls.

The electronic control system is set individually for every vessel to the best performance. The captain is using his normal controls and will experience improved steering performance and course keeping.

The design of the rudders is customised to each application, designed ship speed, draft requirements etc. For instance, in a high speed application the rudder area can be made small and in slow speed application the area can be made larger.

This permits to completely renounce using the waterjet steering nozzles as means of heading control during high-speed operation, which substantially increases operating efficiency of the waterjet units since steering nozzles remain in the neutral position and no thrust is lost due to their deflection. At full steering commands both rudders and steering nozzles are used to provide the superior maneuvering typical for a MJP equipped vessel.



Rules and classification

The MJP are designed to international standards. Each delivery is individually approved by the Classification Society. To match the approval to the actual vessel, the yard application identification number should be given to MJP. Where no Classification Approval is required, jet systems are delivered with Inspection Certificate type 3.1 per EN10204. Please however note that a classification approval for a jet cannot be obtained after delivery (post factum). The intake structure approval is sought by the shipyard. The hydraulic system is approved after installation on board.

The following items can be delivered with classification certificates:

- a Jet unit(s) with Hydraulic Actuators
- **b** Drive shaft(s)
- c Coupling(s)
- d PTO pump(s)
- e Control System.



Shipyard installation requirements

The impeller housing is fitted on the stern so that its centreline is aligned with that of the gearbox output shaft. The alignment can be made either by machining the stern face or by the use of Chockfast resin. Method of installation must be selected when making drive shaft arrangement drawing defining drive shaft length. The installation alignment requirement of the jet pump and drive shaft is +/- 0.05 degrees. During operation the MJP jet shaft is allowed to float up to +/- 0.25 degrees without affecting the installation. The impeller play is set from factory and is not changed during operation following for instance hull flexibility and or resiliently mounted gearbox.

For each and individual project a detailed installation instructions procedure is provided.





Expert level

The water jet thrust is generated by the reaction force of the discharged jet of water. The thrust value can be determined from the momentum equation using the parameters of water entering the water intake and that discharged through the water jet nozzle.

The water jet thrust thus increases with volume flow rate Q and water jet discharge velocity Vj.

When a ship moves through the water, a flow retardation zone due to viscosity forces arises on its bottom. This zone is called the boundary layer. Because of that zone, the average flow velocity in the water intake is less than the ship's speed. When determining the water jet thrust, this circumstance is accounted for by introducing the wake factor **w** into the equation.

The flow is accelerated by the water jet pump using the mechanical power supplied by the propulsion engine. Besides this, the mechanical power supplied by the engine has to overcome unavoidable hydraulic losses in the water jet, inlet duct and to lift the flow through the duct.

As a precaution MJP calculates the so called thrust deduction factor **t** as zero. The effect of thrust deduction (or negative thrust deduction factor) is hullrelated and cannot generally be accounted for.

Your choice of Waterjets

Jets with CSU, Compact Steering Units, are available in sizes from the MJP 450 up to the 1550. Our floating drive shaft facilitates installation and is one reason behind the excellent pump performance that offers lower fuel consumption, a longer range and higher top speeds. From the MJP 550 and up, the hub unit is accessible from the aft, greatly improving the ease of service of the large jets. Our duplex stainless steel design offers superior resistance to wear and corrosion.



SIZE	kW	А	В	С	D	E	F	G	Н	Steerable (Kg)	Booster (Kg)	Intake V Litres
450	1500	428	1247	708	450	2125	3100	570	470	540	350	300
550	2500	560	1412	866	550	2625	3790	630	505	1100	650	470
650	3000	665	1680	1020	650	3000	4510	750	600	1600	1050	840
750	4000	765	1900	1133	750	3250	5180	860	690	2300	1450	1290
850	6000	880	2100	1370	870	4000	5890	990	765	3700	2200	2020
950	9000	1010	2460	1480	970	4500	6590	1100	915	4350	2800	2790
1050	12000	1240	2970	1640	1080	5125	6500	1300	1000	5400	3150	3100
1150	15000	1370	3200	1890	1180	5500	7630	1350	1090	7000	5400	5020
1350	18000	1540	3650	2300	1360	6500	8000	1650	1250	12000	8300	7690
1550	21000	1825	4080	2460	1550	7000	9700	1970	1460	17700	9700	11600

 ** Maximum power for continous operation.
** Weight per unit [kg] including hydraulics, excluding shafting and intake.
*** Approximate volume [litres] depending on adaptation to hull lines. ***

The DRB, Double Reverse Bucket jet series is available in sizes MJP 350 to 950 and powers up to 9000 kW per shaft. This is a very attractive and unique product that combines our famous high performance MJP pump technology with the heavy-duty, all stainless steel design and optionally MJP or yard supplied maintenance-free composite intakes





iumen		composite	intukes.									
SIZE	kW	А	В	С	D*	E*	F*	G*	Steerable (Kg)	Booster (Kg)	Intake V Litres*	
350	1000	800	800	480	315	1625	2200	720	310	170	140	
400	1250	IIIO	800	440	360	1875	2500	820	590	300	250	
450	1500	1020	1000	600	405	2125	2800	920	740	350	300	
500	2000	1130	1100	550	450	2375	3100	1020	850	460	350	
550	2500	1550	1100	600	495	2625	3400	1120	1200	650	470	
650	3000	1500	1040	780	585	3000	4100	1320	1600	1050	840	
750	4000	1700	1200	900	675	3250	4700	1530	2300	1450	1290	
850	6000	1900	1360	1020	765	4000	5300	1700	3700	2200	2020	
950	9000	2200	1550	1200	873	4500	6100	1980	4350	2800	2790	

*Dimensions may vary in each project

nquiry	date:
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Propulsion Application Checklist for MJP CSU and DRB

Customer	Company									
	Contact									
	Address									
	Telephone					Email				
Input Data Hull resistance Lines Drawing a Classification re G. A. Drawing a Shaft position	attached attached equired attached details attach	ned	Yes No Yes No Yes No Yes No Yes No		Architect/Designer					
Customer ex	xpected pe	rforman	ce							
Max speed at I	lightship disp	lacement	[knots]		Max sp	eed at laden displacement [k	nots]			
Cruising speed	d at lightship	displacem	ent [knots]		Cruisin	g speed at laden displacemer	nt [knots]			
Engine and	gear specif	fication	(if available)							
Engine make a	and model (fu	III designa	tion)							
Rated power			kW at		rp	m				
Gearbox make	and model (f	ull design	ation), gear ratio	(if available)						
Number of ste Number of boo	eerable jets oster jets	On On	e 🗌 Two 🗌 Th e 🗌 Two 🗌 Th	ree 🔄 Four 🗌 ree 🗌 Four 🗌						
Input for M. (*) mandatory	JP Perform	ance Di	agram (PD)							
(*) Number of engines/jets						ine power [kW]				
(*) Target ship speed [knots]						sel length [m]				
Engine speed [rpm]						l length at target speed [m]				
Reduction gea	ar ratio				Waterj	Waterjet size				
Numl	ber of jet in		Trailing mode							
Intake grid	No (stan	dard) 🗌	Shaft locked mo							
	NO (Stan				· · · · · · · · · · · · · · · · · · ·					
Vessel resist	tance data	Lata As per attachment File name:								
		As p	er table example b	elow (please comple	te table w	ith several displacements, con	ditions, ship speeds and resistance data)			
Resistance cu	Irve 1				Resista	Ince curve 2				
Identification	1 label				Identif	ication label				
Vessel speed [knots] Resistar			ance [kN]		Vessel speed [knots]	Resistance [kN]				
							Page 1 of 2			

Input data for MJP CSU and DRB quote

split steering. (Option)



Preferred steering unit (tick appropriate box)	Control system options
CSU, Compact Steering Unit	Cabled from wheelhouse to engine room
(available in models 450, 550, 650, 750, 850, 950, 1100, 1350 ,1550)	
DRB, Double Reverse Bucket	Clutch panel (Note: standard for CSW) (tick appropriate box):
	without backflush (Standard)
Intake (tick appropriate box)	with backflush
GRP bend + drawing for intake made by yard in the same	Interceptor / Trim tab to provide steering assistance and trim and
material as hull (Standard CSU)	roll control (tick appropriate box):
Complete intake from MJP made of GRP (Standard DRD)	Hydraulic and electric integration of yard supplied arrangement,
Drawing for yard (local) manufacturing of intake in FRP (Option)	giving steering assistance, trim and roll control.
	MJP supply of electric inteceptor system integrated with MJP
Shaft arrangement (tick appropriate box)	control system giving steering assistance.
Distance from transom to gear flange < 30 x jet shaft	Integration of external system, please specify:
diameter = MJP standard drive shaft arrangement.	
\Box Distance from transom to gear flange > 20 x shaft diameter	
intermediate shaft arrangement is required: (Optional)	Rudder (tick appropriate box)
By yard, please specify preferred shaft interface	Hydraulic and electric integration of yard supplied rudder
Steel by MJP	Design assistance for yard manufactured rudder arrangement
Composite by MJP	Active rudder control (supplied by MJP, incl. rudder assembly)
Shaft arrangement drawing is included and the following items	Staaring indicator on sing your
are requested in MJP supply e.g. (Optional)	
shaft split support bearing	Steering wheel replacing second steering tiller (ACS) or
bulkhead seal	steering tiller (VCS) (tick appropriate box)
combined support bearing and bulkhead seal	
Hydraulic and oil circulation system (tick appropriate box)	Bridge wing station (tick appropriate box)
Separate tanks	Wing stations with controls, transfer and command panel
Main PTO driven hydraulic pump with piggy back mounted lube	(tick appropriate box):
oil circulation pump. (Standard)	Indoors, 2 fixed wing stations
Main PTO driven hydraulic pump with electric driven lube oil	Ely bridge a fixed fly bridge station
circulation pump, start and control box. (Option)	Portable, 1 portable station
Main PTO driven hydraulic pump with electric driven back up and piggy back mounted lube oil circulation pump.	
start and control box. (Option)	Optional fixed bridge wing station equipment (tick appropriate box)
	Clutch
Combined tank	Indicator
Main PTO driven hydraulic pump with piggy back mounted lube oil circulation pump. (Option)	Additional stations please specify:
Main PTO driven hydraulic pump with electric driven lube oil	
circulation and back up pump, start and control box. (Option)	
Control system (tick appropriate box)	
CSW, combinator and steering wheel with VCS Joystick. Basic system	
with single CU, cabled in wheel house, acombined alarm and command	
panel with clutch, terminal, dial type indicator, back up panel push	
button control, autopilot interface, split steering. (Standard)	Classification:
VCS, Vector Control System with one VCS joystick and a steering	Works certificate
tiller. Basic system with double CU, cabled in wheelhouse, terminal,	Classification certificate
led bar indicator, back up with joy stick, autopilot interface,	Society:
spilt steering. (Option)	Classification notation:
ACS, Azimuth control system with two Azimuths and a second steer	
tiller. Basic system with double CU, cabled in wheelhouse, terminal,	
led type indicator, back up with joy stick, autopilot interface,	













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