HamiltonJet

MARINE PROPULSION UNITS

Installation & Service Manual

MODEL 402

Part No. 82043

HAMILTON JET 16/11/94

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7. Drawings/ parts lists

NOTE: "C" indicates drawings may be found in Controls Drawings Section
"J" indicates drawings may be found in Jet Drawings Section
"F" indicates drawings may be found in retainer at front of folder.
Other drawings are in body of text.

8. Warranty statement

CHAPTER 1
DESIGN BASICS

Warning:

Not all hull shapes are suitable for propulsion by waterjets.

Some advice on suitable hull shapes, estimating performance and engine matching etc. is given in the :402/422 DESIGNER'S MANUAL.

If there is any doubt, consult CWF Hamilton & Co Ltd (or their appointed distributor) with all relevant information.

1.1 Mono hulled craft

(i) Aerated water generated by the craft's bow wave must not pass directly aft to the jet intake(s).

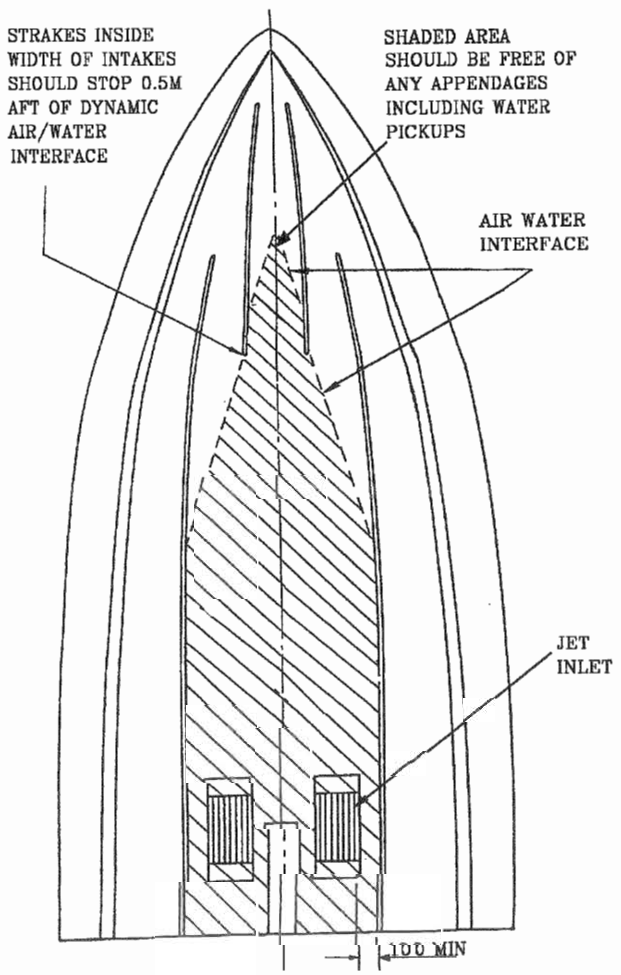
(a) A vee'd bow stem in conjunction with 10° minimum deadrise angle is recommended.

(b) Mount multiple jets as close to the keel line as possible ("staggered" engines recommended). refer to "Minimum Jet Centres" below.

(c) Planing strakes, keelsons, "plank keels" etc must be removed in front of and closer to keel than the jet intake(s).

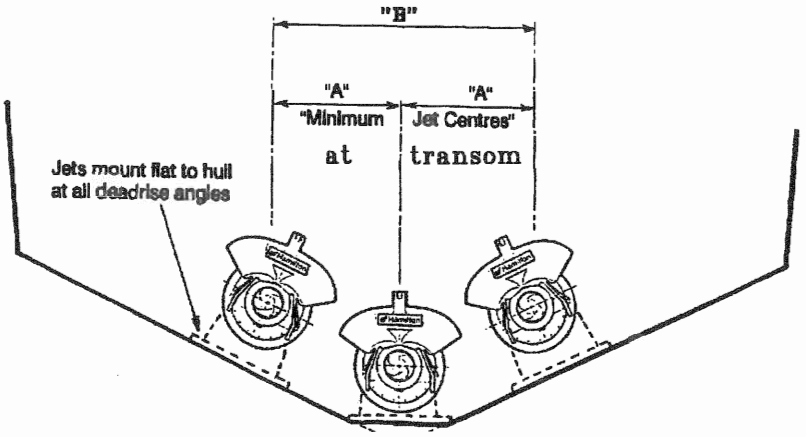
(iii) Displacement speed and warped plane (reducing deadrise going aft) hulls may need additional directional stability. Twin small bilge keels aft are normally sufficient (these do not increase draft or interfere with water flow into the jet).

(iv) **Immersion** - the jet must be immersed with the water line at least up to the underside of the mainshaft (at the impeller) in order to prime (pump water) when the engine is started.



Dimension "A" = 1100 for all deadrise angles for triple jets.

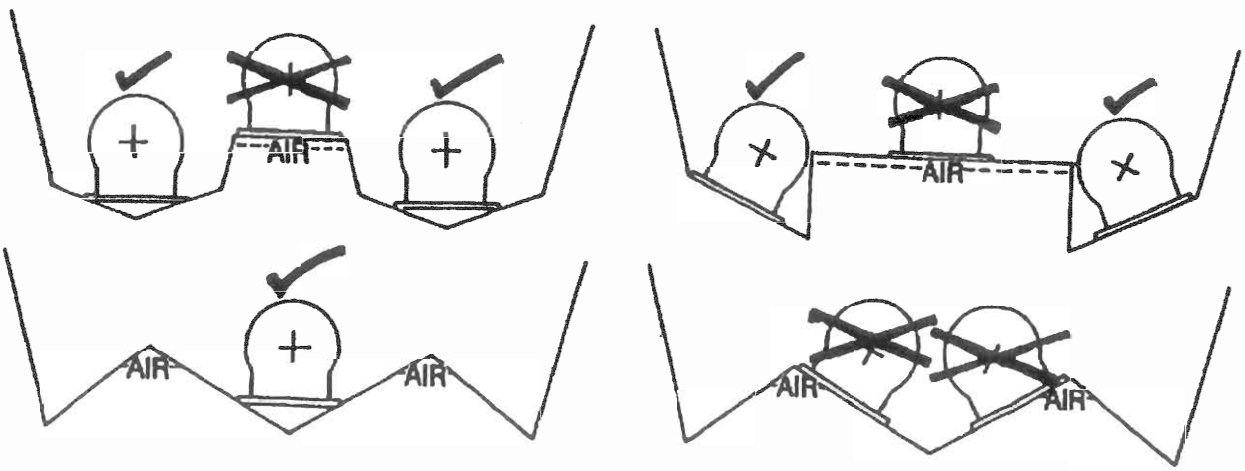
Dimension "B" = 1200 for all deadrise angles for twin jets.



1.2 Multi-hull (and air trapping) craft

Jets can be fitted in suitable catamaran or trimaran hulls. Air entrainment between the hulls occurs with these craft. Care must be taken that this entrained air does not enter the jet intake(s). This is minimised if the hulls are deep in relation to the air tunnels so that the jet(s) when mounted in the hull(s) sit well down in the water. The reverse duct of the jet, when in the "up" (ahead) position must not project beyond the sidewalls of a catamaran or trimaran hull otherwise substantial drag may be caused.

Refer full details to C.W.F. Hamilton & Co. in all cases if jets are proposed in these types of hulls.



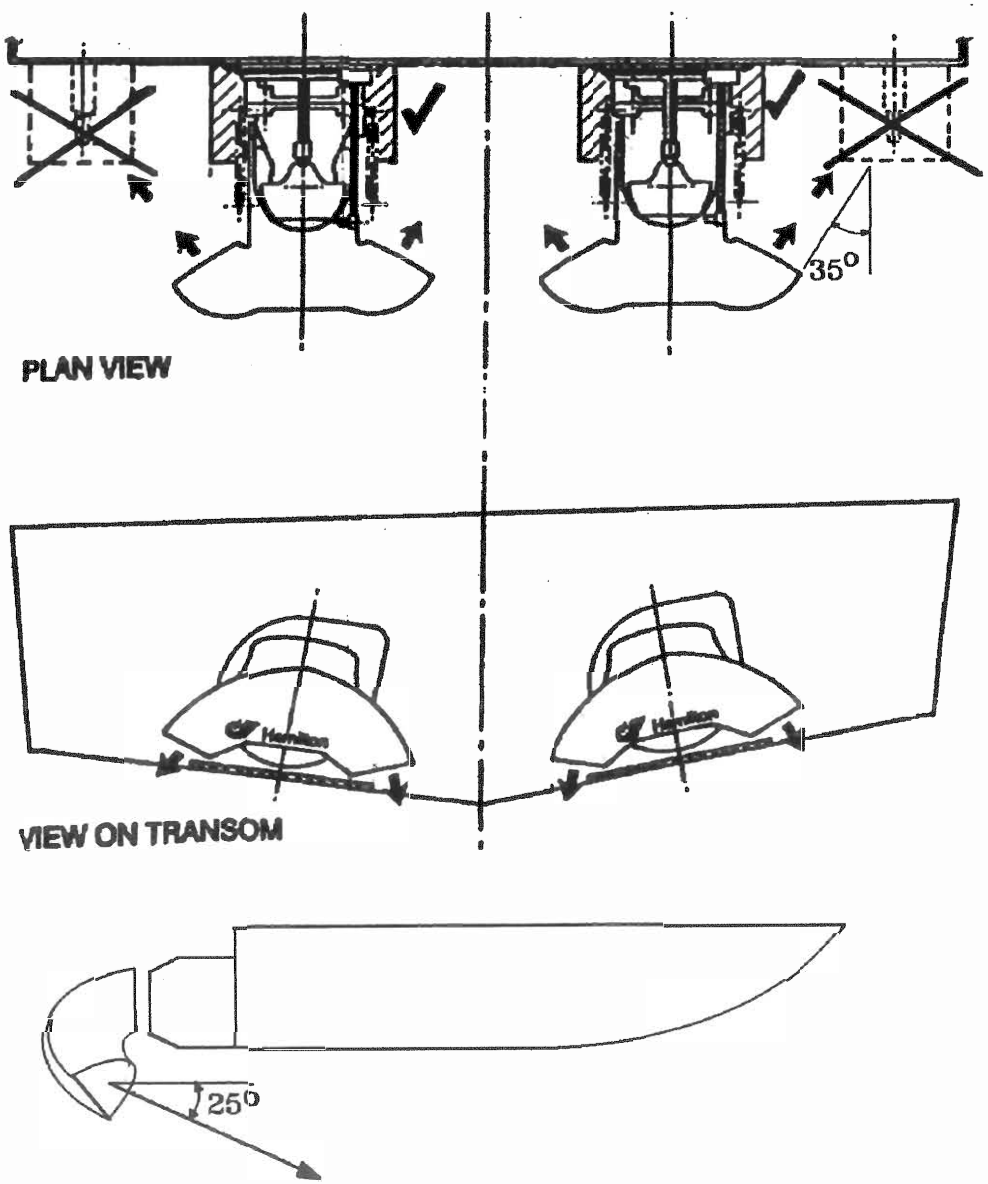
1.3 Trim tabs

Trim tabs cannot be mounted immediately to either side of the jet as water flow from the reverse duct will hit them and the reverse thrust will be reduced.

It is possible to mount tabs under the jet with a control cylinder either side of the jet tailpipe - again providing the water flow from the reverse duct outlets does not hit the tab.

Water flow directions are shown on the Dimensional Layout Drawing, section 7.

Another acceptable alternative is to mount the tabs in recesses under the hull so that they do not protrude behind the transom.



1.4 Jet Mainshaft Alignment (Port and Starboard Jets only).

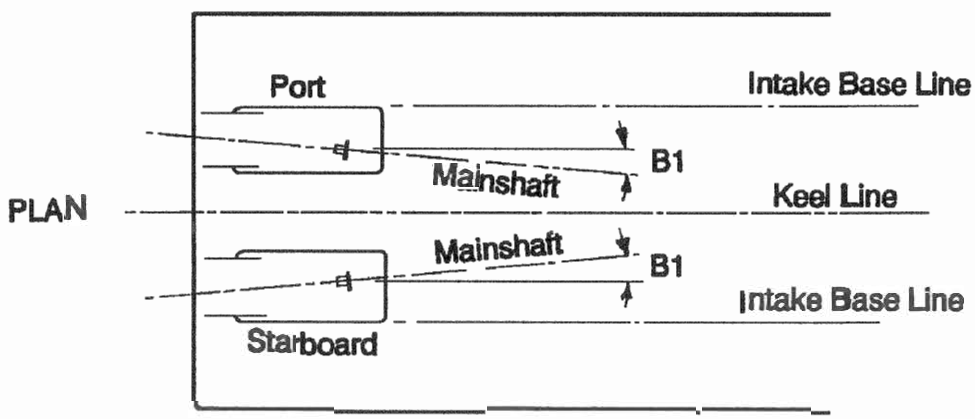
The Waterjet mainshaft is inclined at an angle of 5° to the intake base. When port and starboard jets are mounted at the hull deadrise angle, the jet mainshafts are no longer parallel to the keel line in plan. The following table lists the angle deviation of the jet mainshaft when the jet base is mounted parallel to the keel line:

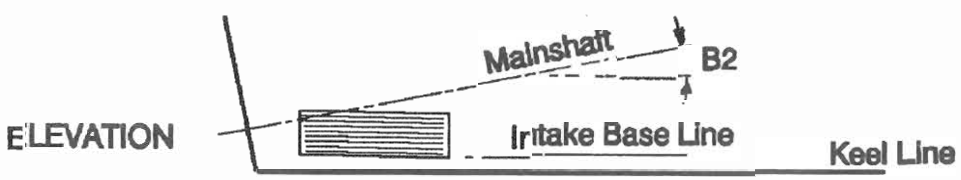
Angles (relative to keel line in degrees):-

Hull Deadrise	B1	B2
0	0	5.0
5	.4	5.0
10	.9	4.9
15	1.3	4.8
20	1.7	4.7
25	2.1	4.5
30	2.5	4.3

For intake Base parallel to Keel Line:

B1 = Shaft angle in Plan
B2 = Shaft Slope in Elevation.





1.5 Drive lines

1.5.1 WARNING

THERE IS A LIMIT TO THE RADIAL LOADS THAT CAN BE APPLIED AT THE JET COUPLING FLANGE. IN ALL CASES C.W.F HAMILTON & Co. MUST BE ADVISED OF DETAILS AND A CRITICAL SPEED ANALYSIS CARRIED OUT.

1.5.2 REQUIREMENTS OF DRIVELINE

i) **It must accomodate parallel and angular misalignment plus allow axial movement.**

ii) **It must transmit the torque input to the jet with an acceptable life expectancy.** It does not have to transmit thrust propulsion loads which are absorbed by the jet.

iii) **Torsional flexibility is required** - especially with diesel engines, A torsional vibration analysis must always be carried out.

(iv) **Provide electrical insulation between engine and jet** - for steel hulls only. Some Torsionally flexible couplings provide electrical insulation - check with supplier.

1.5.3 ENGINEERING CHECKS REQUIRED

All driveline component suppliers (including engine and jet suppliers) must be consulted with full driveline details to ensure suitability and compatability of components.

Check must include:

i) **Critical speed** check for whirling of **jet mainshaft** - consult C.W.F. Hamilton & Co. Ltd.

ii) **Critical speed** check for whirling of **driveshaft** - Consult driveline supplier.

iii) **Engine to jet alignment** - consult C.W.F. Hamilton & Co. Ltd.

iv) **Torsional Vibration Analysis** - Consult engine supplier. (Detail of the jet for this analysis are given in section 1.5.6).

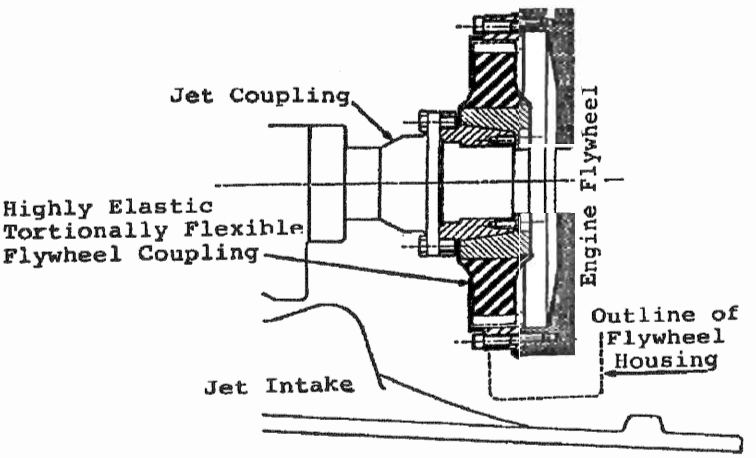
1.5.4 DRIVESHAFT OPTIONS

a)Single Element Highly Flexible Couplings - 100 - 150mm long.

Although there are very few suitable single element tortionally flexible couplings available (without a support bearing) some models can successfully be used to provide close coupling of the engine to the 400 series jet, eg "Centamax".

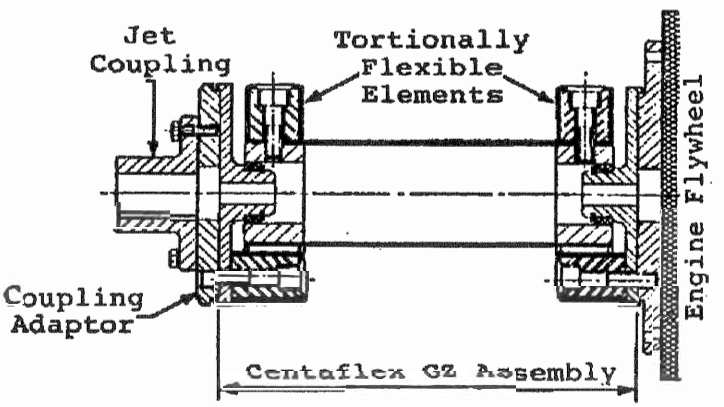
Models bolt directly to the engine flywheel (or gearbox flange if used) and jet coupling flange via adaptor plates. The engine must remain in-line with the water jet mainshaft and rigid engine mounts are recommended.

In all cases, when using this system,supply full details of proposed coupling to C.W.F. Hamilton & Co Ltd.



b)Double Element Tortionally Flexible Driveshaft - 300mm long or over.

Use a double element tortionally flexible driveshaft with support bearings such as the "Centaflex GZ" type illustrated. The engine is located in-line with the jet and can be flexibly mounted with this type of coupling.



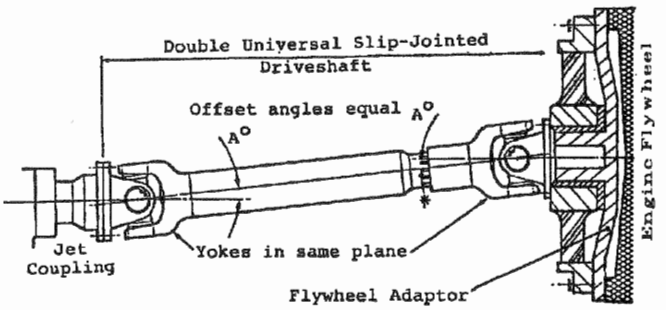
c) Double universal slip-jointed driveshaft- (600-2000mm long)

The usual method of coupling the engine to the jet is the double universal slip- jointed driveshaft (Cardan Shaft). It bolts directly to the jet coupling flange and to a suitable Torsionally Flexible Coupling (TFC) used between the universal driveshaft and the engine flywheel. The TFC must be of the type with a support bearing to support the universal driveshaft. "Vulkan" or "Centa" have suitable couplings for use with universal driveshafts.

Length - from approximately690mm upwards but **limited by the weight which can be allowed at the coupling (refer Critical Speed check)**

Notes :

- When a gearbox is used a torsionally flexible coupling should already be fitted between the engine and gearbox. However a Torsional Vibration Analysis must be carried out as in most cases an additional flexible coupling is required.
- The engine should be positioned so that the universal joints of the driveshaft each have equal offset angles of between 1.5 and 5 degrees - this is most important.
- Details of the driveshaft make, model and length should be supplied to C.W.F. Hamilton & Co Ltd for a critical speed check.



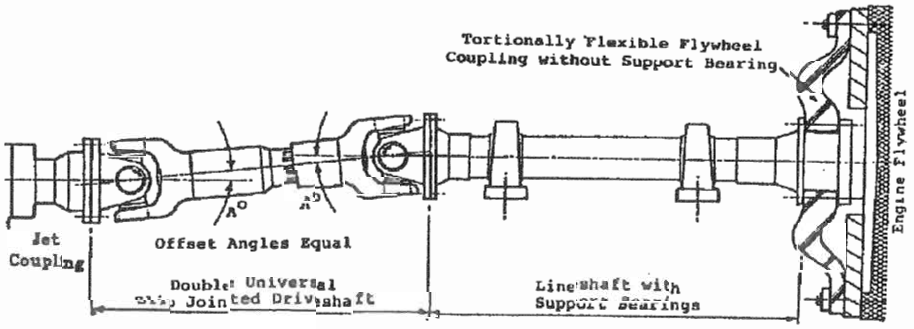
- Correct running length of shaft is with the shaft extended to half the total spline extension.
- The splined end of the driveshaft is the heavier end and should thus be installed at the gearbox and not the jet.
- The universal driveshaft must be assembled with yokes (forks) in the same plane and the engine should be positioned so that the universal joints of the driveshaft each have equal offset angles (A°) above) at each end. If not, cavitation of jet and machinery damage can result because the drive motion to the jet is not constant velocity.

Jet Coupling flanges are available to directly match the following driveshafts which can be suitable subject to the engineering checks listed in section 1.5.3

GWB 587-48 or 50 with 225 flange dia.
ELBE 0.122 with 225 flange dia.
If a gear coupling is used (such as a JAURE MSX) then one half should be bored to fit the jet mainshaft input end

d) Long driveshafts:- over 2000mm long

Where the distance between the engine flywheel and jet coupling flange exceeds 2000mm, a fixed lineshaft supported in pedestal bearings should be used in conjunction with a universal driveshaft and tortionally flexible couplings between (a) jet and lineshaft and (b) lineshaft and gearbox respectively. If a gearbox is fitted the lineshaft can be directly attached to the gearbox flange using normal propellor shafting criteria i.e. gearbox should be rigidly mounted to avoid misalignment.

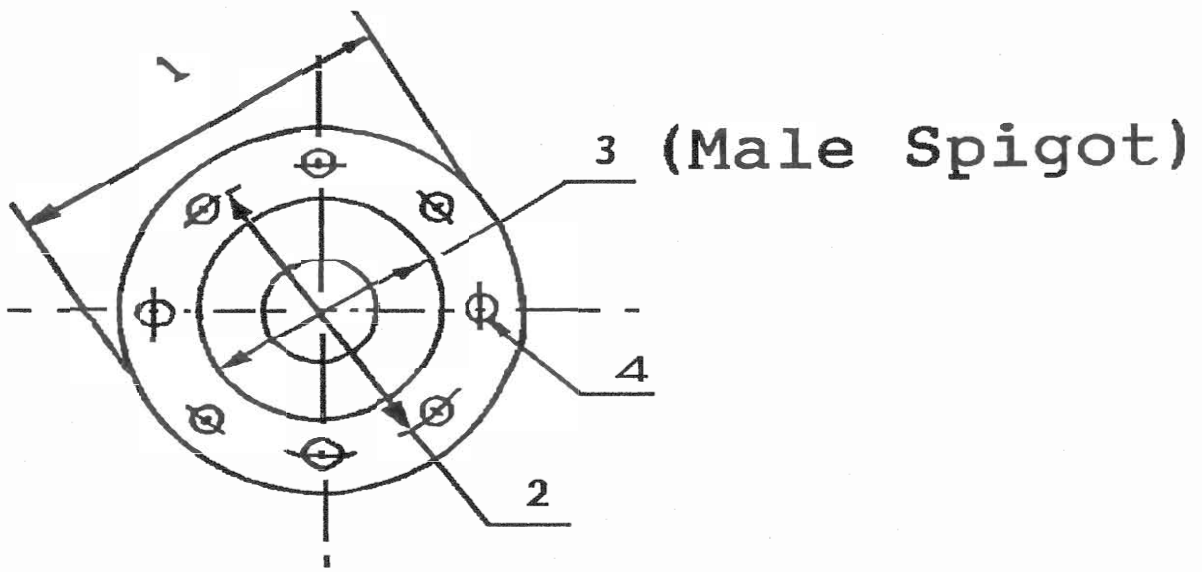


1.5.5 JET COUPLING FLANGE DETAILS :

Standard 8-Hole Coupling Flange dimensions - matches the following universal driveshafts with 225 mm flanges

Dimension G.W.B. 587-48, 587-50 or ELBE 0.122

Ref.	Dimension
1	225mm
2	196mm
3	140 H7x4 deep
4	8 Holes 16.25 dia.

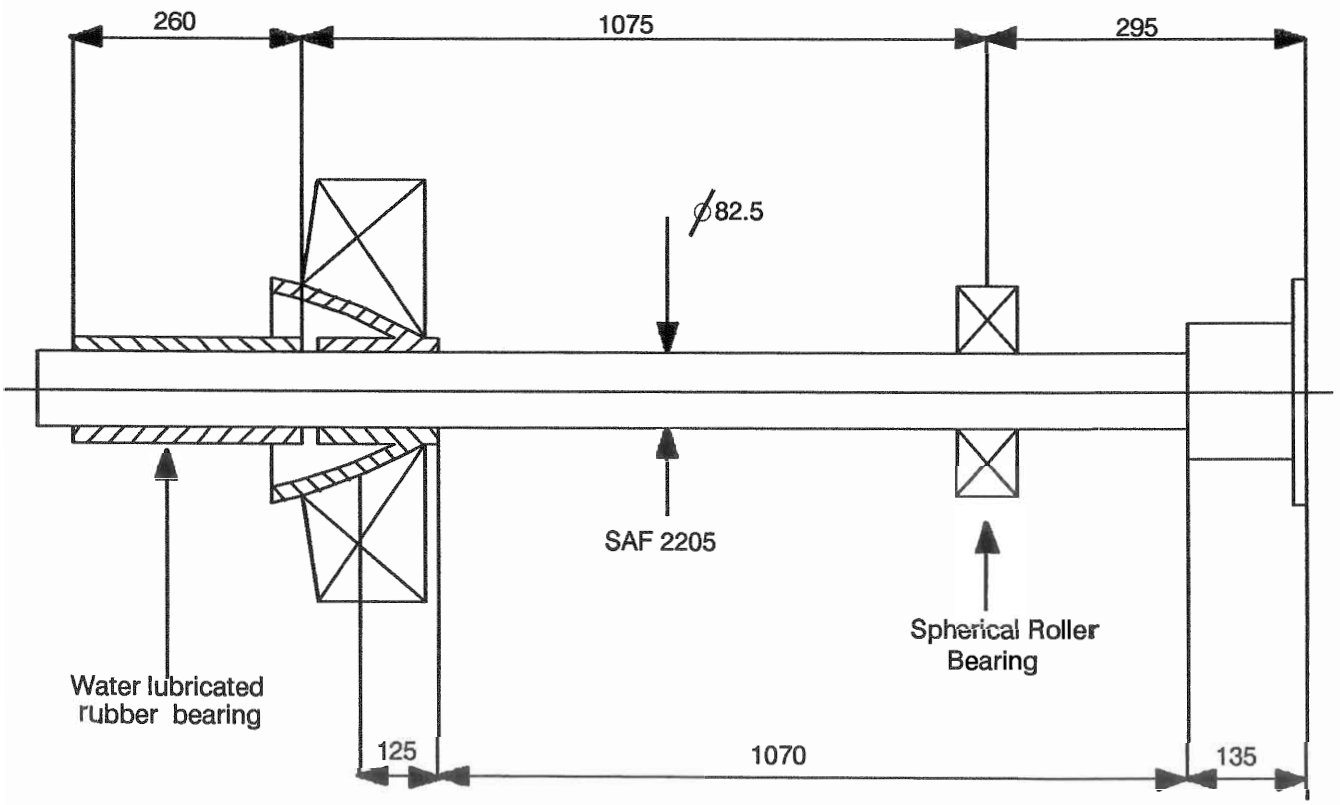


1.5.6 MOMENTS OF INERTIA DATA :

A torsional vibration analysis must be carried out for the complete engine, driveline and jet rotation assembly. this is to be done by the engine or flexible coupling manufacturer.

The following information is provided to enable a torsional vibration analysis to be carried out. This is usually done by the engine maker or flexible coupling maker once the details of the whole drive train are known..

Item	Type	Mass (Kg)	Polar moment of inertia (Kgm^2)
Mainshaft	82.5 dia	70	.06
Coupling	225 dia	9.4	.05
Impeller	38-49	35	0.49 (dry)
Impeller	53-66	38.5	0.54 (dry)

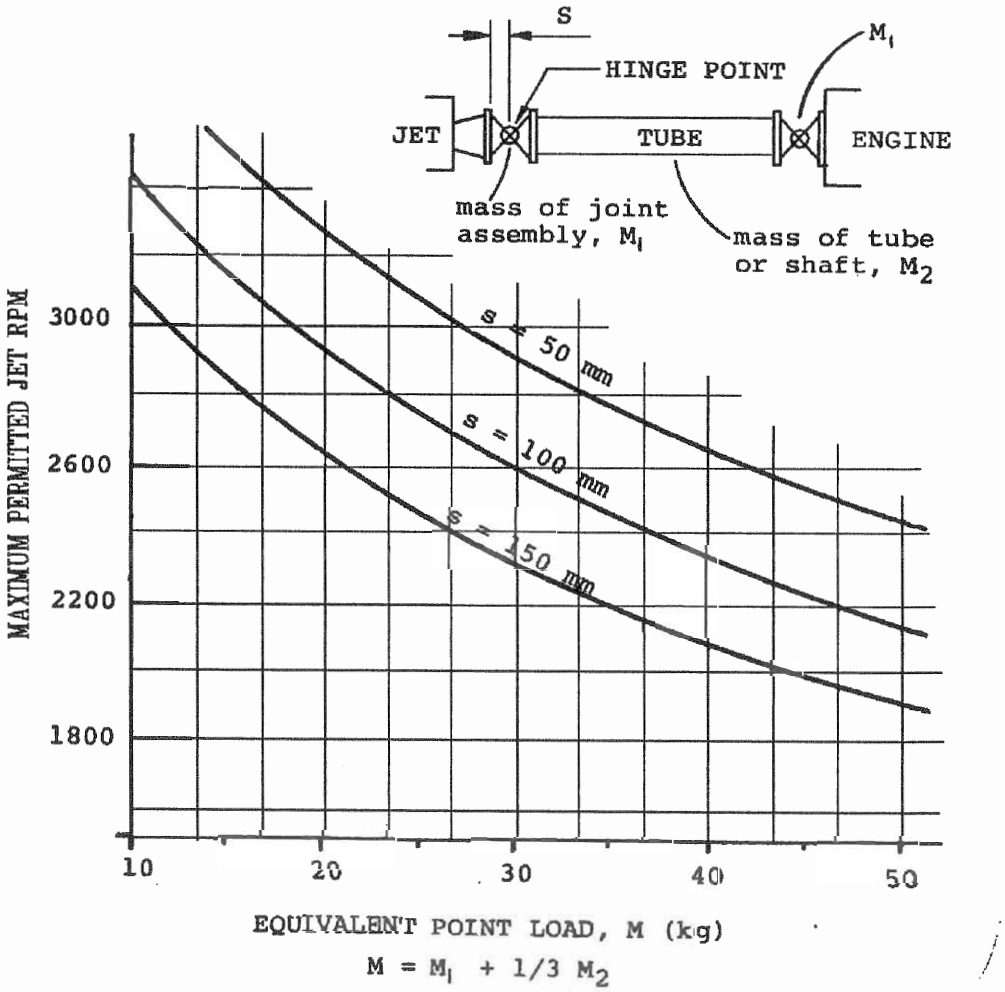


1.5.7 Critical speed of mainshaft

If a heavy driveline is used then a transverse vibrational analysis of the jet Mainshaft should be done.

To use the following figure;

1. Calculate the equivalent point load M.
2. Determine the distance S, the distance from the jet coupling to the hinge point on the joint assembly.
3. Draw a vertical line on the graph (horizontal position determined by M)
4. Take the intersection of this line and the appropriate curve for your S, and make a horizontal line.
5. This will give the maximum permitted rpm for the jet using the driveline you have chosen.
6. If the high idle or no load maximum engine speed is above or near this value then consult Hamilton Jet for a more detailed analysis of the situation.



1.6 Autopilots with Jets

Most jet propelled craft do not have the benefit of keels and rudders to maintain tight directional stability. With care, keels can be applied to jet hulls, but the following alternative arrangement of the autopilot is usually effective:-

a) Reduce the sensitivity so the craft is able to deviate further off course (than would be the case with a propeller and rudder equipped craft), before the autopilot makes a correction

b) Use a higher hydraulic pump flow than normal for propellers so that when a correction is made it is done quickly.

If the above advice is not followed, the system may not stabilise, i.e. it will be continuously correcting, first one way and immediately back the other.

1.7 Loads imposed on hull by the jet unit

All loads produced by the jet unit are a result of the change in momentum of the incoming and outgoing water except for the torque load which is produced by the stator vanes removing the angular momentum put in by the impeller.

Three cases are considered which produce the maximum loads, full ahead, full steering and full reverse (crash stop)

The following information is required for the calculations. Actual values for the 402 jet are included.

	Variable	Units	402 max value
Maximum power	P	(Kw)	750
Boat velocity	V_b	(m/sec)	20.5
Jet velocity	V_j	(m/sec)	35.5
Flow	Q	(m3/sec)	1.29
Density	p	(kg/m3)	1024
Centre line height	H	(m)	.366
Ave inlet depth	h	(m)	.08
Dist- transom to steering	D_s	(m)	.56
Dist- transom to web	D_w	(m)	.91
Dist- transom to reverse	D_r	(m)	1.15
Jetstream angle	a	(^{o})	5^o

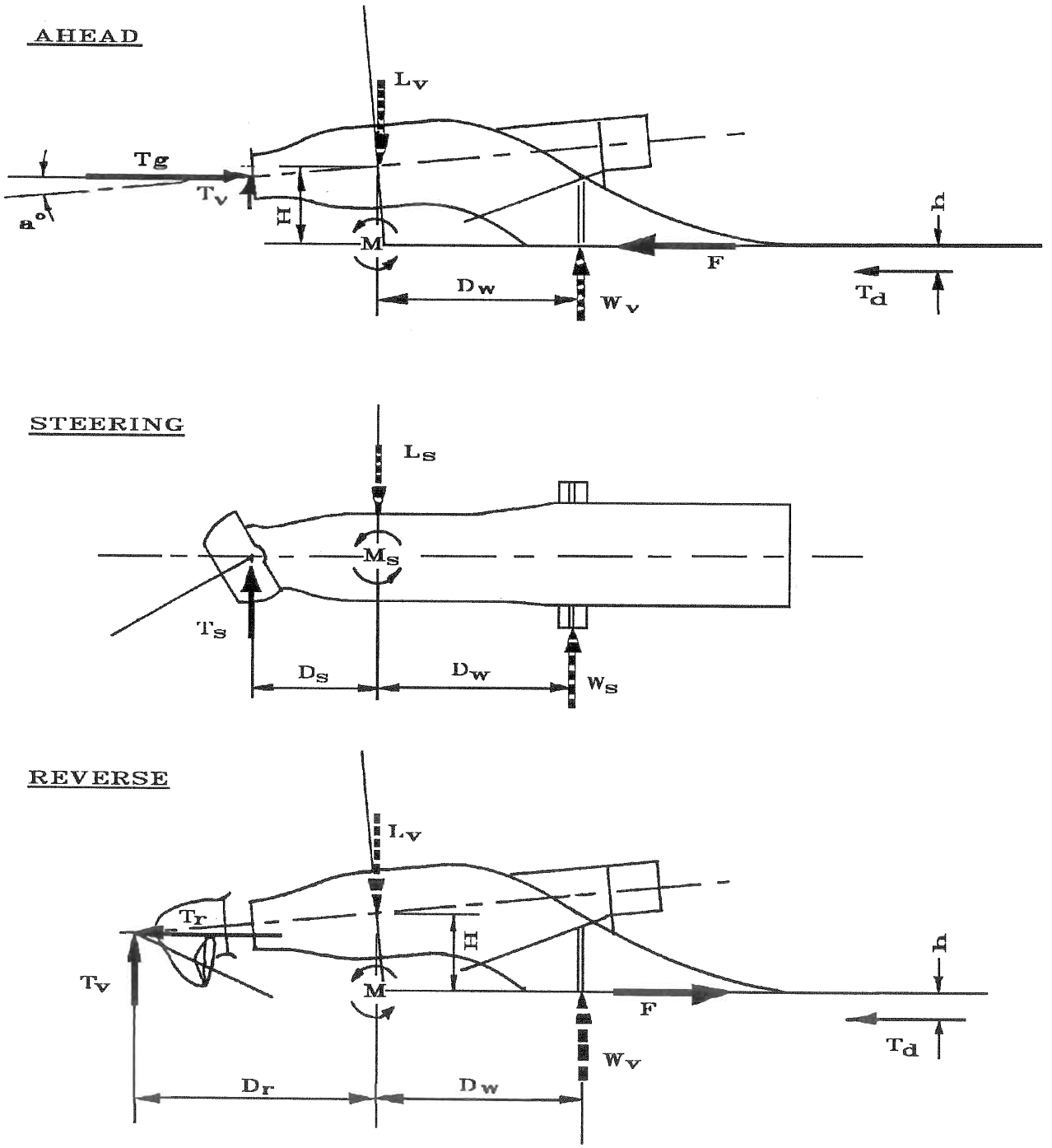
The interaction forces of the jet are as follows

Gross thrust	T_g	($KN = QpV_j cosa^o$)	47	
Vertical component	T_v	($KN = QpV_j Sina^o$)		4
Max Static Thrust	T_{gs}	($KN = QpV_j Sina^o$)		28
Inlet momentum drag	T_d	($KN = QpV_b$)	27	
Net thrust	T_n	($KN = T_g - T_d$)	20	
Steering Side thrust	T_s	($KN = T_g sin30^o$)	23	
Reverse thrust	T_r	($KN = 0.6T_g$)	28	
Lift component	T_v	($KN = T_r tan25^o$)	13	
Torque load	T	(Nm)	3050	

The reaction forces in the hull are as follows

			Ahead/Steering	Reverse
Axial load in hull bottom	F	($KN = T_g - T_d$)	+28	-55 kN
Vertical load in transom	L_v	($KN = T_v + W_v$)	25.4	24
Side load in transom	L_s	($KN = T_s + W_s$)	37.2	-
Vertical load in web	W_v	($KN = M/D_w$)	21.3	10.6
Side load in web	W_s	($KN = M_s/D_w$)	14.2	-
Vertical moment	M	($KNm = T_g xH + T_d xh$)	19.4	9.7
Steering moment	Ms	($KNm = Ts\ xDs$)	13	-

Transom loads L and web loads W are statically indeterminate but are calculated for a worst case scenario which assumes the transom carries only vertical and side loads while the base takes only fore and aft loads.
Loads L_v and W_v balance the moment M which is due to the offset of the thrust and drag lines.
Loads L_s and W_s balance the moment M_s which is due to offset of the steering side thrust.



CHAPTER 2
INSTALLATION

2.0 Drawing References:

The transition duct is supplied ready to weld into a prepared opening in the hull bottom Refer to the following installation drawings at the rear of the manual:

For GRP(or wooden) hulls	105807SY
For Aluminium hulls	105808SY
For Steel hulls	106577

2.1 General

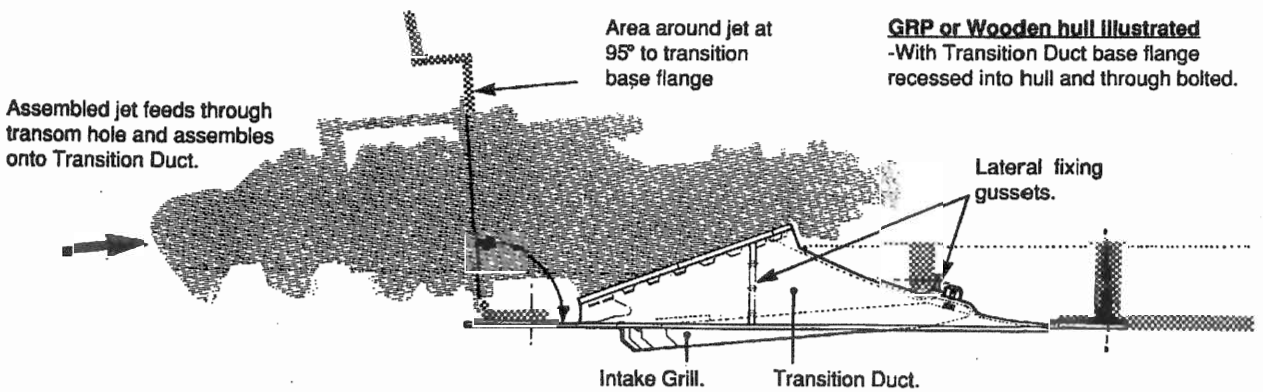
2.1.1 TRANSITION DUCT

The transition duct fits into an opening made in the hull bottom creating a transition for the water to pass from under the hull up into the jet which is mounted on the transition duct.

For wooden and GRP hulls the base flange of the transition is supplied trimmed to size and drilled. It is bolted up into a recess moulded in the hull skin through suitably placed stringers. Special narrowed GRP Transitions can be supplied on request.

For Metal hulls the base flange of the transition is supplied oversize for the boat builder to trim to the desired size and weld flush to the hull skin. (Welding interfaces are of marine grade aluminium plate for aluminium hulls and steel for steel hulls). **For steel hulls the jet must be totally electrically insulated from the steel Transition Duct and hull.** The insulating hardware to achieve this is supplied with the jet.

To transmit propulsive thrust loads from the jet to the hull, lateral gussets on the transition are bolted (for GRP or wooden hulls) or welded (for metal hulls) to the hull stringers (refer section 2.2)
Once fitted, the transition duct becomes part of the hull and is not removed when servicing the jet.



2.1.2 AT THE TRANSOM

A transom area (large enough for the jet transom seal plate to bolt against) has to be carefully prepared at 95° to the transition duct base flange. A hole large enough for the body of the jet to pass through is cut in this prepared transom area. The assembled jet is offered through this transom hole forward onto the transition duct to which it bolts. A solid rubber type transom seal assembly then fits around the jet body and bolts to the transom. The transom does not carry propulsive thrust loads but must resist a vertical force generated when the Reverse duct is in the astern position- refer section 1.7 for loads on the Hull.

2.2 Hull Preparation/Fixing Transition Duct.

2.2.1 GRP (or Wooden) Hulls - refer drawing 105807SY.

The preferred installation for the Transition Duct is to recess the 12mm thick transition duct base flange into the hull which results in the undersides of the hull and transition being flush.

Before the hull is moulded

either -(i) The transtion duct can be placed in the hull mould and the GRP laid over the base flange

or -(ii) A 12.5 (.5") thick mould insert is placed in the mould. When GRP is laid over this the recess is formed in the hull for the transition base flange. The mould insert should also include the required shape to mould the 1705 long hull opening at the same time.

If the hull is already moulded:

(i) The 1705 long opening can be cut and the transtion fitted from underneath the hull with its base flange proud of the hull.

Note carefully that the leading edge of the transition base flange must be faired smoothly forward into the hull with fibre glass - refer to installation drawing.

For the Transom opening:-

A flat area at 95° to the tranition base flange is required, to bolt the jet transom seal assembly to, combined with a hole through which the jet body pases. Details are shown on the installation drawing

The transom preparation can be formed :-

(i) During hull moulding by placing suitably shaped insert into the mould. The insert forms the flat area required at 95° and may also form the required hole (The latter could be cut out after moulding if preferred).

or (ii) After the hull is moulded by cutting out of the transom a piece matching the flat area size required. The 'cutout' is then positioned at 95° to the transition base flange and fibre glassed back to the transom again.

The following Points Should be Noted:

1) The transition ducts for multiple jets will be marked:- "Port" or "Starboard" (and "Centre with" with triple jets). DO NOT INTERCHANGE as each jet has been customised to fit its own transition duct.

2) The transition duct centre line is marked fore and aft as is the position of the aft face of the transom.

3) If the original transom angle is less than 95° the area formed at 95° for the jet may have to be increased to allow sufficient room for the jet steering controls inside the transom.

4) The transom thickness should be a minimum of 20mm in the area prepared for the jet at 95°.

5) If the hull bottom is warped consult CWF Hamilton & Co with details.

6) For centrally mounted jets only, the triangular shaped area fairing the transition to the hull keel should slope down at no more than 5° to the transition base.

7) The joint area should be prepared with wet GRP for the transition duct to bed into and the fixing bolts fitted to secure it in place.

8) It is especially important there is no step at the forward end of the transition. Contours from hull to transition should be smooth with no steps greater than +- 1mm.

9) The webs A (x2) should be bolted to gussets attached to the nearest longitudinal frame. These transfer jet loads to the hull.

10) The web B should be bolted to a transverse member attached to the nearest longitudinal frame on each side. This also transfers the jet loads to the hull.

11) Do not drill any holes for the transom seal plate until the jet unit assembly is finally fitted to the transition. The transom seal assembly should then be correctly located to use as a jig for the bolt hole centres.

12) The fixing of the transition duct to the hull and the strength of the transom must be sufficient to carry the loads imposed by the jet unit on the hull - refer section 1.7.

2.2.2 Aluminimum hulls - refer drawing 105808SY at rear.

The transition duct is supplied to weld into a prepared opening in the hull bottom.It consists of a flange and cutwater cast in LM6 aluminium which is welded to the fabricated part of the duct. The plate used is type 5086 of 12mm thickness. All welds by the boat builder are plate to plate except for the two cast webs A to which gusset plates from the adjacent longitudinal bearer are either welded or bolted.

The transom preparation can be formed either:

- by constructing the whole transom at the required angle. (For multiple jets, curving the transom in plan view can provide greater accuracy with the transom angle noting that the jet is mounted at the hull deadrise angle).

or - by cutting the required area out of the transom, repositioning at the required 95 +- 1° and then rewelding, with suitably shaped packing plates, back to the transom.

The following Points should be noted.

1) The transition duct centrelines are marked fore and aft as well as the position of the aft face of the transom.

2) The transom plate thickness between frames adjacent to the jet should be a least 10mm and in addition this plate must be at 95 +- 1° to the transition duct base. Caution - if the original transom is less than 95° the area formed at 95° may have to be increased to ensure sufficient room for the jet steering controls inside the transom.

3) The base flange of the duct may be reduced in width if desired (see drawing) and the forward corners rounded. In any case the hole cut out in the bottom plating must match the base flange shape with minimal clearance.

4) The 12mm duct base is then butt welded flush with the underside of the hull bottom using a double vee weld preparation. The protruding weld bead on the underside must be as small as possible especially at the forward end. Use ER5356 welding rods or equivalent.

5) Where the hull bottom is warped the bottom plating may be bent up to meet the base or fillet plates may be welded in to fill the gap at the sides.

6) It is especially important that there is no step at the forward end of the duct. Plates must be flush at the bottom and weld beads should not protrude more than 1mm.

7) If the unit is centrally mounted the area ahead of the transition duct must be faired in gently back to the hull. Normally a triangular shaped plate is used running forward at a slope of no more than 5° to the base.

8) The web A on each side is cast and is to be bolted welded to gussets attached to the nearest longitudinal frame.

9) An addition transverse frame is to be welded across the top of the forward part of the duct, to bolt or weld to gusset B (plate), and tied in to the longitudinal frames.

10) The transom hole may now be cut out. Also a 25mm backing ring should be made as shown and welded to the inside of the transom for the studs to tap into. **Do not drill any holes until after the jet is fitted .**

11) The bracing of the transition duct and strength of the transom must be sufficient to carry the loads imposed by the jet unit on the hull. Refer to section 1.7 for the load diagram. In general the spacing of transverse frames is not to be less than that required for adjacent hull plating.

2.2.3 Steel Hulls - refer drawing 106577 at rear

The transition duct is supplied to weld into a prepared opening in the hull bottom. The duct is completely fabricated in steel to AS 1594 Grade 250. all interface welds are to 8mm thick plate.

The transom preparation can be formed either:

- by constructing the whole transom at the required angle. (For multiple jets, curving the transom in plan view can provide greater accuracy with the transom angle noting that the jet is mounted at the hull deadrise angle).

or - by cutting the required area out of the transom, repositioning at the required 95 +- 1° and then rewelding, with suitably shaped packing plates, back to the transom.

The following Points should be noted.

1) The transition duct centrelines are marked fore and aft as well as the position of the aft face of the transom.

2) The transom plate thickness between frames adjacent to the jet should be a least 8mm and in addition this plate must be at 95 +- 1° to the transition duct base. Caution - if the original transom is less than 95° the area formed at 95° may have to be increased to ensure sufficient room for the jet steering controls inside the transom.

3) The base flange of the duct may be reduced in width if desired (see drawing) and the forward corners rounded. In any case the hole cut out in the bottom plating must match the base flange shape with minimal clearance.

4) The 8mm duct base is then butt welded flush with the underside of the hull bottom using a double vee weld preparation. The protruding weld bead on the underside must be

as small as possible especially at the forward end. It is especially important that there is no step here. Plates must be flush at the bottom and weld beads should not protrude more than 1mm.

5) Where the hull bottom is warped the bottom plating may be bent up to meet the base or fillet plates may be welded in to fill the gap at the sides.

6) If the unit is centrally mounted the area ahead of the transition duct must be faired in gently back to the hull. Normally a triangular shaped plate is used running forward at a slope of no more than 5° to the base.

7) The web A on each side is cast and is to be bolted welded to gussets attached to the nearest longitudinal frame.

8) An addition transverse frame is to be welded across the top of the forward part of the duct, to bolt or weld to gusset B (plate), and tied in to the longitudinal frames.

9) The transom hole may now be cut out. Also a 25mm backing ring should be made as shown and welded to the inside of the transom for the studs to tap into. **Do not drill any holes until after the jet is fitted .**

10) The bracing of the transition duct and strength of the transom must be sufficient to carry the loads imposed by the jet unit on the hull. Refer to section 1.7 for the load diagram. In general the spacing of transverse frames is not to be less than that required for adjacent hull plating.

2.3 Mounting the jet

2.3.1 Positioning Units

- 400 series Jet units and Transition Ducts are a matched pair - do not interchange
- 400 Jets are specifically assembled for Port, Starboard or Centre mounting - do not interchange.
- The dipstick & Filler cap should always appear on - the Port side of the Port Jet.
  - the Starboard side of the Starboard Jet.
- For steel hulls insulating hardware is supplied with the jet.

The insulation should be checked before finally bolting the jet and transom seal assembly in place and again afterwards.

2.3.2 Preparing for installation of jet unit

Before installing the jet unit the following parts should be removed to make handling easier and to avoid damage to the controls

1) Reverse Cylinders - See section 2.7.1 for instructions
2) Reverse Duct, remove 8 bolts, washers and the two large Pins
3) Steering Cylinder Remove eyebolt and 4 mounting bolts
4) Steering Tiller and Mounting Bracket. Remove the sender link(S62) from the tiller. Undo the 4 nuts securing the bracket to the intake.
5) Steering Sender Unit(S58). Remove the 2 securing nuts and bracket without disturbing the sender unit.
6) Overflow preventer - Remove from the inspection hatch (if fitted).
7) Fit 12 studs to each flange using Loctite 262
8) The 2 dowels should be loctited into the intake duct flange.
9) Loosen the 2 x M12 nuts clamping the steering shaft seal box to the transom plate.
10) Loosen but do not remove the nuts holding the header ring in place against the transom seal. Slide the transom plate rearwards as far as it will go.

2.3.3 Mounting the jet unit.

Note that for steel hulls the jet must be totally electrically insulated from the hull - ensure insulating disc (18) & bush (19) are in place refer detail 3 on drawing 106577 at rear.

1) Using slings around the tailpipe and the bearing housing lift the jet unit and feed through the transom hole as far as possible.

2) Apply RTV silicone sealant over top face of transition duct flange (to jet).

3) **For Steel hull only** - fit the insulating gasket onto the transition duct and then **apply Marine grease to top face of the gasket**.

4) From inside the boat remove the sling from the bearing housing. If lifting gear is not available within the boat several people should be able to lift the forward end of the unit while this is done.

5) Move the unit forward until the intake flange lines up with the flange on the transition duct.

6) Carefully lower the intake over the studs and engage the two dowels. Keep the two flanges parallel while lowering fully.

7) **For GRP, Wooden or aluminium hulls only** -Place the heavy washers, spring washers and nuts over the up facing studs and tighten. Repeat for the underneath studs. Torque all nuts evenly all round refer M16 Section 6.1.4.

8) **For Steel hulls only** - Place insulating washers, heavy stainless washers, spring washers and nuts on just two of the forward upward facing studs and tighten to hold the jet in place. Remove all lifting tackle and check that the jet body is totally electrically insulated from the hull. If not lift the jet off the transition to find out why the insulation has been broken. Key points are the insulation of the dowels and that the studs must not touch the holes in each flange through which they pass (refer Details 2 and 3 on drawing 106577 at rear)..

When total insulation is achieved with the first two studs then proceed to fit insulated washers etc to the rest of the studs and torque M16 nuts fully - refer 6.1.4. **Recheck the electrical insulation between jet and transition again - it is most important that this is maintained.**

2.4 Transom seal assembly

1) Slide the transom seal assembly up to the transom face and ensure that the steering shaft seal assembly is centred on the steering shaft.

2) Use the transom plate as a template to locate holes:-
   - **For GRP & Wooden hulls**, drill 22 holes 13 dia through.
   - **For Aluminium and Steel** hulls, drill 22 holes 10.2 dia and tap M12 x 1.75 - 6h x 20 deep minimum.

3) Slide the transom plate rearwards again and **for Aluminium and steel hulls only** fit the 22 studs to the transom using loctite 262.

4) Apply RTV silicone sealant to the transom where the transom plate will mount.

5) **For Steel hulls only** - fit insulating gasket up to transom and **apply Marine grease to the exposed face of the gasket.**

6) Slide the transom seal plate into position against the transom.

7) **For GRP or Wooden hulls only** - fit 22 M12 bolts through the transom and transom seal plate **(bolt head outside the hull).**

8) **For Steel hulls only** - fit the flanged insulating bushes to the 22 studs.

9) Fit flat washers, spring washers and nuts to the studs/bolts as shown on appropriate installation drawing and torque for M12 nut - refer Section 6.1.4.

10) **For Steel hulls only - ensure that the transom plate is electrically insulated from the hull.**

11) Tighten the compression seal nuts(11) incrementally working progressively around the header ring(12) until all nuts reach torque for M10 nut - refer Section 6.1.4.

12) Centre the seal box on the steering shaft and torque the 2 X M12 nuts.

2.5 Final assembly

The parts previously removed may now be refitted.

1) Reverse Duct. Grease the two large pivot pins(138) and refit with a washer(62) on each side of each arm. Torque up the 8(202) bolts to 150 Nm with a spring washer(202) under each.

2) Reverse cylinders. See section 2.7.2 for instructions

3) Overflow preventer(if used) - Use RTV sealant and secure with 4 setscrews

4) Steering Tiller and mounting bracket assy(S41) 4 x M12 Nuts and spring washers.

Caution: Refer to section 2.9.5 for correct Cotter (Taper) Pin assembly. Torque Cotter nut as for M12 nut - refer section 6.1.4.

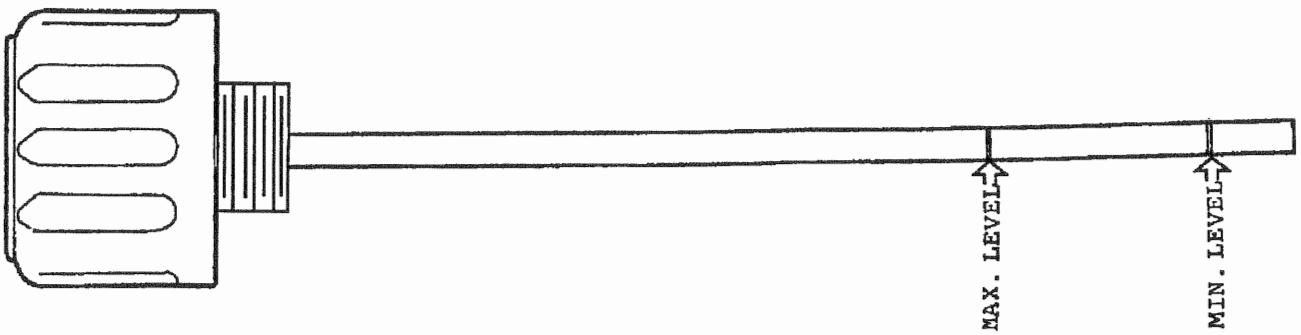
5) Refit Steering Cylinder(151) - 4 mounting bolts(13,14) and one rod end bolt. -

6) The steering sender unit(S58) can now be refitted and the link(S62) reconnected.

2.6 Dipstick & Thrust Bearing Oil :

The dipstick must always be fitted on the Starboard side of the unit when mounted on a deadrise.

PART NUMBER	HULL DEADRISE RANGE
106988SY	5° Port 5° Starboard
106989SY	6° to 15° Port
106990SY	6° to 15° Starboard
106991SY	16° to 25° Port
106992SY	16° to 25° Starboard



Fill the reservoir to the dipstick max level with oil as per specification 6.1.6 - Recommended Lubricants.

2.7 Reverse Cylinder

2.7.1 Removal (refer section 7.4)

The reverse cylinder(141) should be removed from its mounts before installing the jet unit

i) Remove the split pin(C21), cylinder pin(C20) and washer(C22) from the clevis(C11) and lower the reverse duct(75).

ii) Mark the clevis position on the shaft before unscrewing and remove the anode(C15).

iii) Remove the 4 bolts and washers from the two pillow blocks(C16).

iv) Loosen the hoseclips(155) at the transom and pull the cylinder forward until the hose(154) is free from the hose tail(164).

v) Withdraw the cylinder assembly from the jet unit taking care not to damage HSRC controls.

2.7.2 Mounting

The cylinders should not be refitted until the intake and transom plate are securely fastened in place.

i) Slide the cylinder shaft through the transom hole .

ii) Move the cylinder rearwards guiding the hose(154) over the hosetail(164) as far as it will go. With the pillow blocks (C16) refitted to the cylinder(141), note how much further movement is required for the mounting holes to line up. This length must be trimmed off the hose.

iii) Refit the pillow blocks(C16), washers(C24) and bolts(C23) Torque up to 40 Nm (30 lbft)

iv) Tighten the hose clips(155) at each end of the hose(154).

v) Screw the anode(C15) and clevis(C11) back onto the shaft(C1) tightening in the same original position.

vi) With the reverse duct(1) refitted to the tailpipe(75), raise the duct and fit the pin(C20) through the clevis(C11) not forgetting the washer(C22). Secure with split pin(C21).

2.7.3. Adjustment.

Should the marked clevis position be lost readjustment will be necessary. Lower the reverse duct fully until the cylinder is at the end of its stroke. Place a straight edge square to the deflector face from the bottom of the opening across to the reverse duct. The reverse duct opening should line up with the straight edge to ensure all the jetstream is collected. Adjust by turning the clevis on the reverse shaft. The second clevis must be adjusted also to line up with the hole in the duct arm.

2.8 Engine and Driveline Installation

2.8.1 GENERAL

The engine(s) should be located in a position that will give the craft the most suitable fore and aft trim for the proposed boat speed. For semi-planing and moderate planing speed craft it is likely that the engine should be positioned well forward towards amidships for best trim and thus speed. For very high speed craft it is likely the engine should be positioned aft, close to the jet unit, to obtain best trim and speed. Follow the recommendations of the boat designer in this regard or consult C.W.F. Hamilton & Co Ltd.

2.8.2 MOUNTING

Mount the engine via mounting feet fixed to the engine bearers. The feet and bearers do not have to withstand the propulsion thrust load which is transmitted from the jet directly to the hull. Flexible engine mounts will reduce vibration and noise but these must be used in conjunction with a driveshaft system which does not cause a radial or side load at the jet coupling as the engine moves. Refer to "MULTIPLE JETS, Jet Mainshaft Alignment" (section 1.4) plus "DRIVESHAFTS" (section 1.5) for recommended driveshaft and engine installation angles.
For steel hulls - ensure the driveline electrically insulates the engine and gearbox from the jet.

2.8.3 COOLING

A raw water cooling system separate from the jet must be fitted to the engine maker's specifications. the raw water pick up points must **NOT** be directly ahead of the water jet intakes and should be well to the side of the area forward of and the same width as the intake.

2.8.4 ENGINE SYSTEMS

Engine wiring, instrumentation and throttle systems are all conventional - follow the manufacturers recommendations. The boat builder normally supplies the separate throttle control lever, cable and linkages.

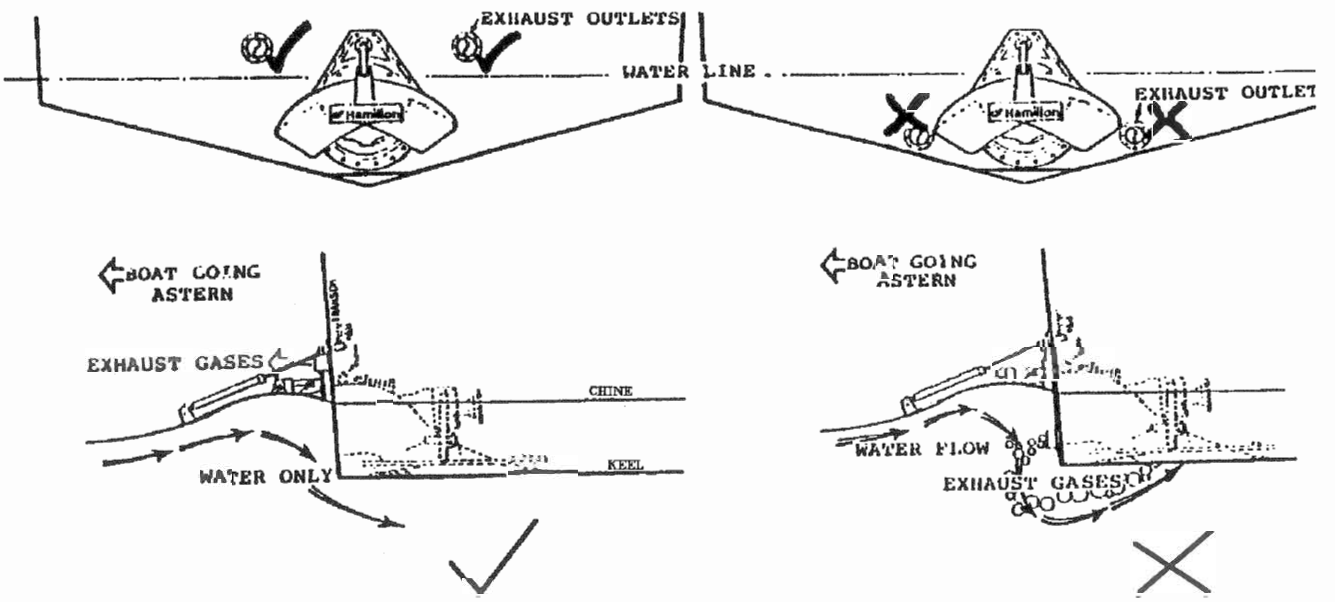
With Steel hulls ensure the controls do not electrically connect the jet to the hull.

2.8.5 GOVERNOR SETTINGS

The "no load" governor setting (or "high idle") on diesel engines should be set well clear of the full throttle R.P.M. achieved when driving the jet unit so that there is no chance of the governor reducing power (and performance) at full throttle. However this must be checked against the critical speed calculation for the jet mainshaft

2.8.6 EXHAUST SYSTEMS

The exhaust system can be any conventional system approved by the engine manufacturer, except that for the efficient operation of the jet in reverse, exhaust outlets are best sited above the waterline.



2.9 Steering system

2.9.1 DESCRIPTION

The steering system is balanced so that power assisted controls are not necessary even for multiple jet units.A minimum of 600mm diameter helm (wheel) is suggested.

SCOPE OF SUPPLY

A Single Station manual hydraulic steering system is included with the jet which gives 1.9 turns of the helm from full lock to full lock. (A greater number of turns will reduce sensitivity of steering during low speed manoeuvring).

For steel hulls the flexible hoses must be replaced with hoses which maintain electrical insulation between the jet and metal tubing (ie the hull).

A steering position indicator system is standard equipment.

Swivel ended tie rods are included with multiple jets.

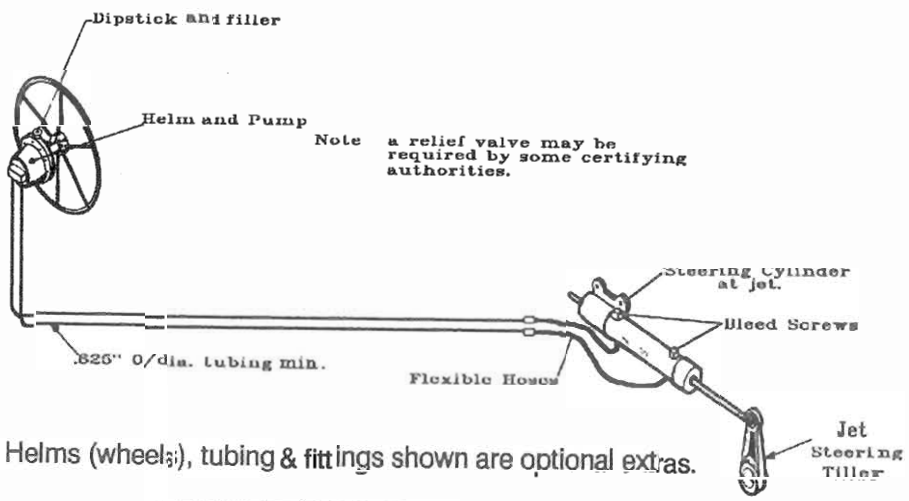
NOT INCLUDED - Steering Wheel (helm)
- tubing and fittings.

OPTIONAL EXTRAS- Fittings for tubing.
- Steering Wheel(s) (Helm(s))
- Cylinder Bypass Valve.
- Dual station system
- Catamaran System.

TUBING & CONNECTION THREADS

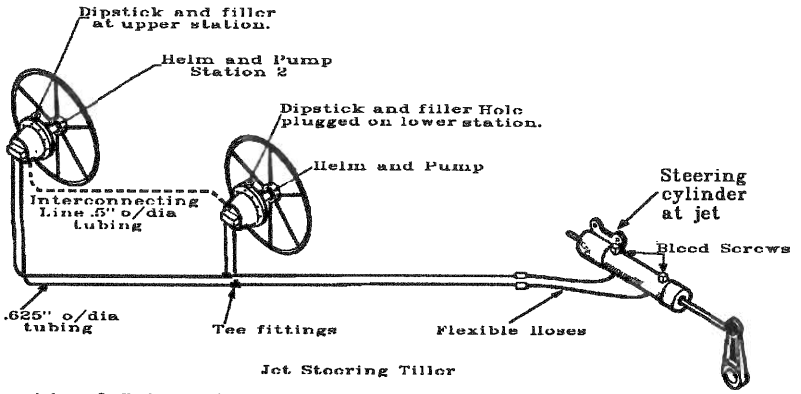
Metal tubing MUST be used suitable for 70 bar (1000 psi) working pressure. **(NOTE - Hydraulic hoses are NOT Satisfactory.)** For thread connections to helm pump and cylinder - refer 2.9.7.3.

SINGLE STATION SYSTEM



Note - Helms (wheels), tubing & fittings shown are optional extras.

DUAL STATION SYSTEM



Notes - Helms (wheels), tubing & fittings shown are optional extras.

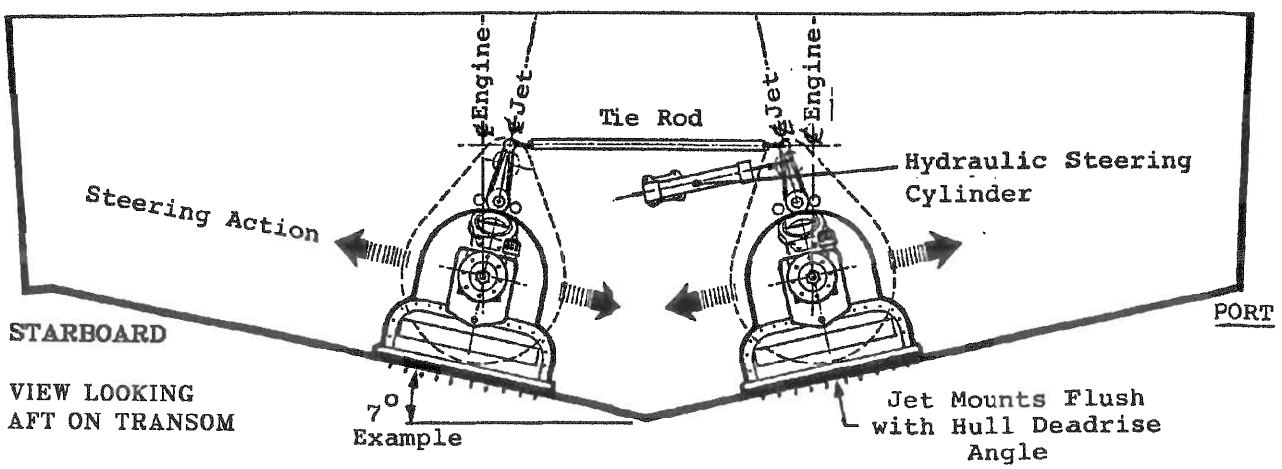
CATAMARAN STEERING

(REFER 2.9.4.)

2.9.2 TWIN JET INSTALLATIONS :

Ganged control of steering in multiple jet installations is achieved by swivel ended tie rod(s) interconnecting the jet tiller arms. An adjustable length tie rod is supplied to facilitate accurate centring of the jets.

For Deadrise Angles up to 16°

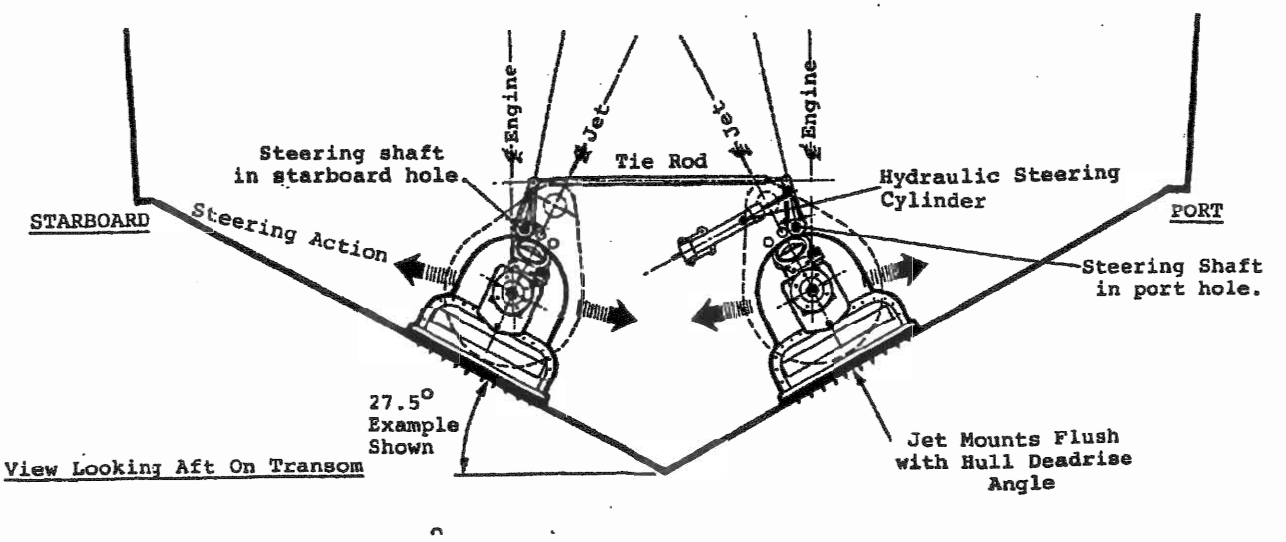


Notes (for deadrise angles up to 16°) :-

- The steering cylinder can mount on either port or starboard jet but always to the starboard side of the jet.
- The steering cylinder and the steering sender bracket both mount by the fixing holes which position them furthest to starboard .
- For each jet fit the cotter (taper) pins for tiller and crank from opposite directions (this places tiller and crank "in-line"). Refer section 2.9.5

For Deadrise Angles of 16° or More

The 402 jet steering assembly (tiller, shaft, nozzle and deflector) can be rotated 16° to port or starboard for maximum effectiveness. The mounting of the jet to the hull and of the reverse cylinders do not change.



Notes (for deadrise angles at 16° or more) :

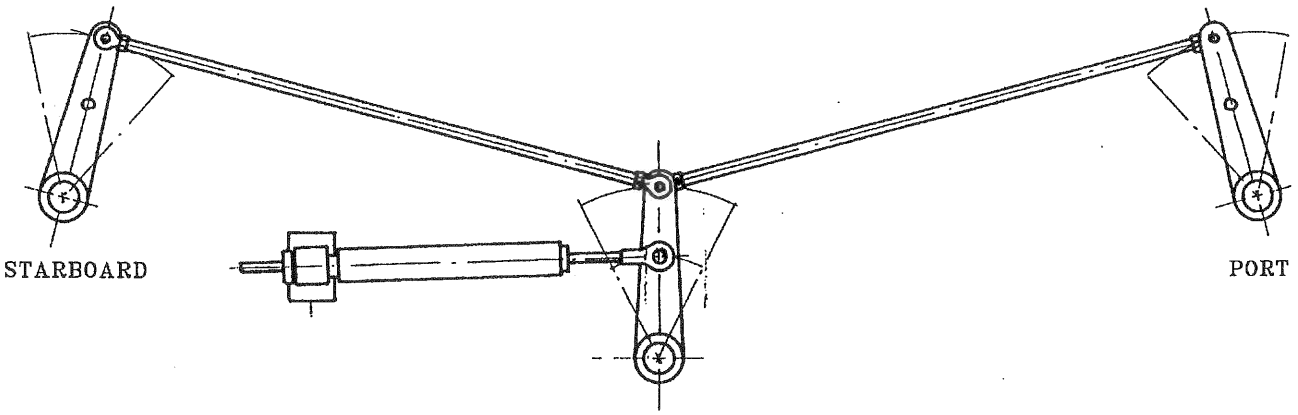
- The steering cylinder can only mount to the starboard side of the port jet unit.
- The steering cylinder and the steering sender bracket both mount by the fixing holes which position them furthest to port - see illustration above .
- Where a deadrise angle over 16° is quoted with the order for multiple jets C.W.F. Hamiltons will deliver the jets with the steering rotated. The steering can however, easily be rotated by the boat builder.
- For both jets - fit the cotter (taper) pins for tiller and crank both from the port side (nuts on starboard side). Refer section 2.9.5.

To Rotate Steering :

- Remove the cotter pin (2) and steering crank (6).
- Remove the 11 nuts and washers (83,84) holding the nozzle (85). Remove the nozzle, with the steering deflector (86) still assembled to it.
- Knock the nylon bung (150) out of the transom hole the steering shaft (55) now has to pass through. Clean off old thread locking fluid from the bung and the hole it was removed from.
- Carefully remove the shaft seal box assy from the centre steering shaft hole and refit in the hole the steering shaft will now pass through.
- Apply N Primer first then Apply Loctite 601, or equivalent thread locking fluid, to the bung (4) and refit in centre steering shaft hole.
- Remove 11 X M12 studs and refit to intermediate holes in tailpipe.
- Rotate the nozzle in the required direction until the 11 nozzle fixing holes line up. Reassemble nozzle to tailpipe and torque up the 11 M12 nuts and washers (83 and 84). (Refer torque table section 6.1.4).
- Refit steering tiller (19) and crank (6). Note the cotter pin in the crank is normally fitted from port to starboard side (i.e. not on starboard side) and the cotter pin in the crank is fitted according to instructions.
- The steering cylinder and the steering sender bracket must be remounted by the fixing holes which position them further to port .

2.9.3 TRIPLE JETS :

- One steering cylinder only is required which must mount on the centre jet.
- Two swivel ended tie rods are used to interconnect the jet tillers : from starboard to centre jet and from centre to port jet. Bolt one tie rod aft and one ahead of centre jet tiller.
- The starboard and port jets can have steering rotated 16° for deadrise angles of 16° or more, but the steering on the centre jet is not rotated.
- A sketch for triple steering arrangement can be supplied on request quoting the hull deadrise angle.
- For all three jets - always fit the cotter (taper) pins for tiller and crank from opposite directions (this places tiller and crank "in-line"), whether steering is rotated or not rotated. Refer illustration A) Section 2.9.5.



VIEW LOOKING AFT

2.9.4 CATAMARAN STEERING

Hamiltons power assited electronic steering system should be used which automatically ensures the jets in each catamaran hull steer in phase. Follow the instructions in the seperate Controls Manual at rear of this manual.

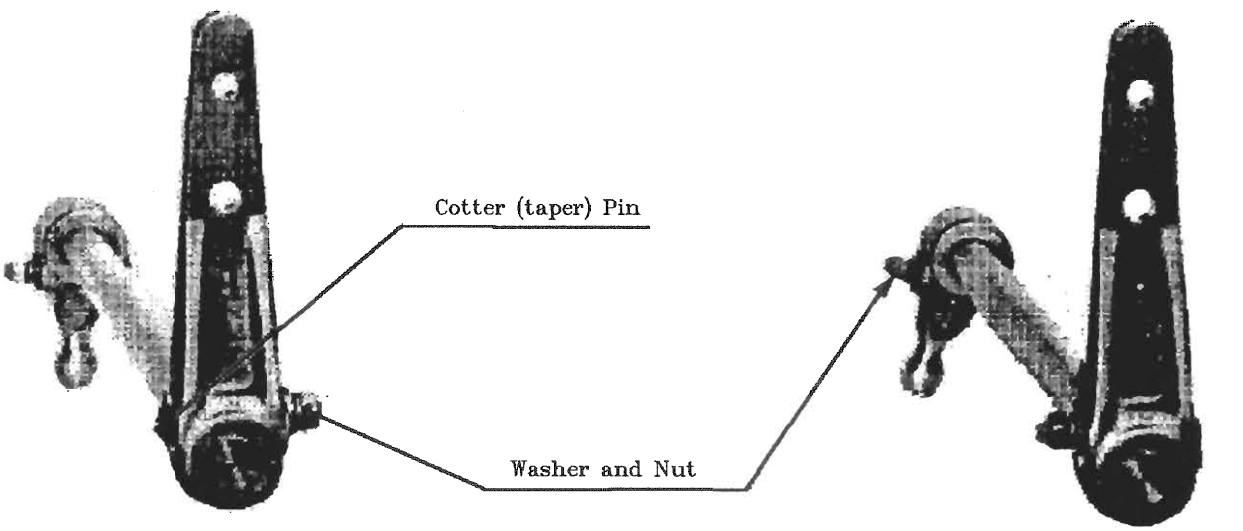
2.9.5 JET TILLER (101):

The Cotter (taper) Pin in the steering crank (100) is normally fitted from port to starboard (i.e. washer and nut on the starboard side). For all single and triple jet installations the cotter on the steering tiller must be fitted from the opposite direction to the cotter in the steering crank, i.e. normally from starboard to port, nut on the port side. For twin jets the cotter (taper) pin arrangement varies with steering rotation, refer section 2.9.2 and sketches below.

Ensure both cotters are fitting correctly and torque up M12 nuts - refer torque table section 6.1.4.

A) ALL SINGLE AND TRIPLE JETS (WHETHER PORT & STARBOARD ROTATED OR NOT).
– TWIN JETS WHEN STEERING NOT ROTATED

B) ONLY FOR TWIN JETS WITH STEERING ROTATION (for both Port and Starboard jets)



Caution. These arrangements may not apply to catamarans. -refer to C.W.F. Hamilton & Co. Ltd.

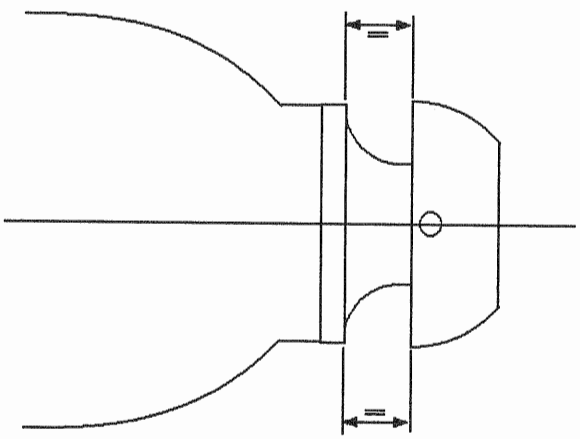
2.9.6 Steering Tie Rod Assembly: (Multiple jets only)

A tie rod kit is supplied with one end NOT welded so the rod tube can be cut to length required and welded.

Having arranged each jets steering shaft assembly and torqued up cotter (taper) pin nuts locate and clamp each jet in central steering position (dead ahead).

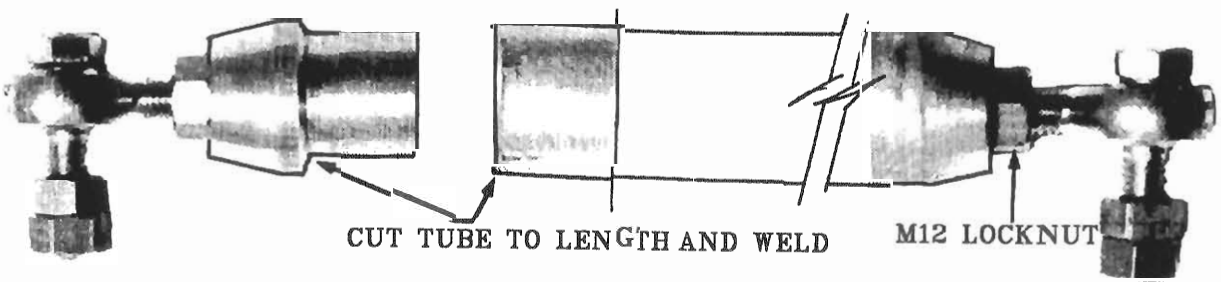
Tie rod - alignment

The best way to ensure each jet is steering dead ahead is to measure the gap between the nozzle flange and the forward opening of the deflector on each side. Adjust until both gaps are the same and temporarily clamp the deflectors so the tillers will not move from dead ahead position. Caution. - Switch off the reverse control system during steering adjustment so the reverse duct is not accidentally lowered on a clamp.



Offer the tie rod up to the upper holes of the steering tillers and mark the length to cut the rod tube. Cut tube and weld to rod end. Bolt one end of tie rod onto forward side of tiller. Adjust thread lengths at ends until the hole at the unbolted end exactly lines up with the hole in the tiller (make sure the jet deflectors have not moved) and bolt up. Check the locknut on the length adjustment are tight and unclamp the deflectors.

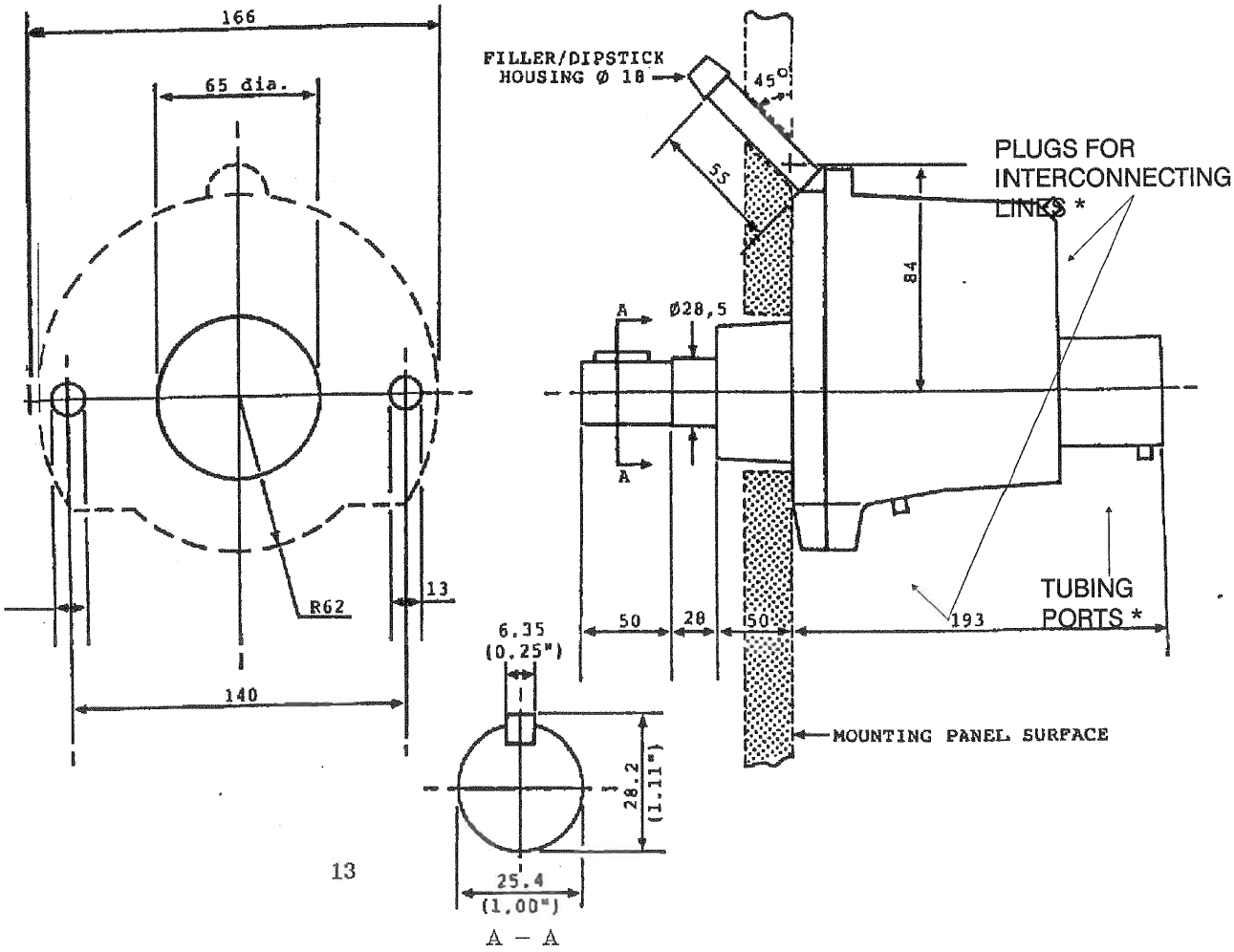
Note : Some steering "lock" (or motion) is lost through the imperfect geometry of the tie rod system. However, this can be ignored as the loss for steering thrust is small.



2.9.7 HYDRAULICS

2.9.7.1 Mounting the Helm Pump

The helm pump may be mounted with the shaft at any angle between horizontal and vertical. The pump has a lockvalve mounted on the rear with NPT outlet ports for tubing connections.



* See 2.9.7.3 for thread sizes.

2.9.7.2 Steering Cylinder (S56) and Sender Bracket

(refer illustrations sections 7.1, 7.5, 2.9.2 and 2.9.3)

- Using 4 bolts and washers, fix the steering cylinder mounting bracket to the Jet unit intake. Fix to port unit of twin jets.

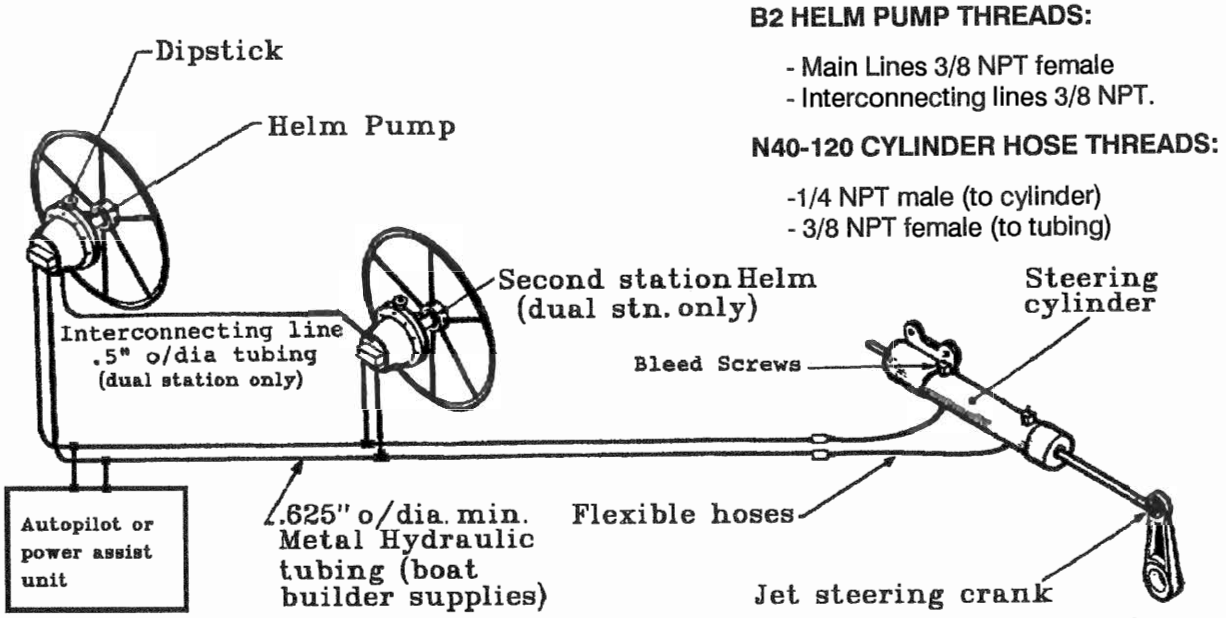
- Mount the steering cylinder to the mounting bracket with 4 M10 studs, nuts and washers provided.

NOTE: with the steering not rotated (steering shaft in centre intake hole) the cylinder and sender bracket are mounted by the fixing holes which position them farthest to Starboard and a 12mm packing piece is fitted under the bracket.

- With the steering rotated 16^{o} the cylinder is mounted to the Port Jet and the mounting bracket is fitted to the holes which position it farthest to Port. There is no packer under the bracket.

- Fit the cylinder shaft end bolt from the Transom side through the cylinder shaft eye and then through the steering Tiller. Place the washer(S13) on first then tighten the first nut up firmly before tightening the second nut firmly to lock.

2.9.7.3 Piping the System:



Keep working conditions as clean as possible. Contamination of any form must be prevented from entering the system. It is essential that all hydraulic tubing is clean inside before starting the installation.

Teflon tape or pipe fitting compounds, commonly used to seal threaded joints, must be used sparingly and applied to the male threads only. The first two threads of the fitting should not be covered. If it is necessary to remove a fitting for any reason, the female thread must be cleaned before reinstalling the fitting.

Steel or soft refrigeration-type tubing rated at a minimum working pressure of 69 bar (1000 psi) is recommended. Flexible hose must not be used in place of the recommended tubing (other than the two short lengths supplied) as it will adversely affect the performance of the system.

The tubing should be installed with lengths as straight as possible. Bends should be as gradual as possible. All lines should have a gradual rise toward the helm pump(s) to provide self- venting. Goosenecks (a vertical bend resembling an inverted letter "U") must be avoided if possible otherwise vent plugs must be installed at the high point of the bend to provide a means for removing entrapped air.

The tubing must be held rigidly where it connects to the cylinder flex hose. **Note for steel hulls** - the standard cylinder hoses must be replaced with non wire wound type to maintain electrical insulation between jet and hull.

Flare type fittings are recommended for problem free connections rather than compression type fittings

A complete kit of adaptors and sleeves etc is available as an optional extra to suit 5/8" o/dia. tubing for helm to cylinder lines and for dual station controls the kit includes tee fittings and the adaptors and sleeves required for 1/2" o/dia. on the interconnecting line.

In a multiple station system, all helm pumps are connected in an identical manner to the hydraulic lines leading to the steering cylinder. (Refer to the Piping drawings above). The pump reservoirs must be interconnected to create a continuous flow path. That is, connect the bottom of the highest pump to the top of the next highest, etc. This interconnection is required to fill and vent the system.

The dipstick tube supplied must be installed in the top of the highest helm pump. The design of this dipstick fitting also allows the system to vent. DO NOT PLUG this hole at the highest station but plug all dipstick holes at any lower level stations.

When connection the steering lines to the cylinder, be certain that the tiller will move in the correct direction. (When standing in front of the wheel, turning a helm pump clockwise pumps oil out of the starboard side of the pump and should give starboard tiller).

If the vessel requires an "inspection approval", a bypass valve to allow emergency mechanical steering may have to be connected between the cylinder ports.

Tubing sizes must be at least as big as shown in the table below. The use of tubing larger than specified will not adversely affect steering performance.

2.9.7.4 Filling and Bleeding the System:

(For Steel hulls only - before filling the system check electrical insulation between the cylinder and tubing has been maintained (see note re hoses for steel hulls on previous page)).

Disconnect the Steering cylinder from the jet tiller. Support the cylinder so it can stroke fully without hinderance.

Ensure that all fittings and plugs are tight as this filling procedure must develop a vacuum in the steering lines. Ensure Bypass valve is closed (optional equipment).

Connect the two identical lengths of clear plastic tubing to the bleed fittings on the steering cylinder. Place the free ends into a container (about one litre capacity) to catch any oil carried with the expelled air. Determine which steering line and bleed screw fitting will be pressurised when turning a steering wheel CLOCKWISE. Open the bleed screw at this fitting 2 turns. The other must remain tight. If a cylinder bypass valve is installed, it must be closed.

Next, fill all helm pump housings starting at the lowest and progressing to the highest. Plug each pump tightly after it is filled except the highest (or only) which is also the filler/vent for the system and it must be fitted with the dipstick tube.

Screw the plastic tubing assembled with a black plastic fitting into the end of the dipstick tube (where the dipstick is normally inserted) until it seats tightly against the O Ring on the fitting. This fitting will self-thread into the tube.

Place the free end of this (filling) tube into a container of oil and hold the container at, or above, the pump level. The end of the tube must continally remain below the oil level. THIS IS VERY IMPORTANT!

Turn the steering wheel CLOCKWISE on this pump only at about one revolution per second. Oil will be drawn into the pump after about 20 revolutions. A mixture of air and oil will be expelled from the bleed fitting on the cylinder. After most of the air is expelled, the system will begin to feel steady and solid. Close the bleed screw tightly and open the opposite bleed screw 2 turns. If iftted, open the Cylinder Bypass Valve and turn steering wheel CLOCKWISE 4 to 5 turns. Close the Bypass Valve.

Now turn the steering wheel COUNTER CLOCKWISE until most of the air is expelled. Close the bleed screw and apply light pressure at both hardover positions.

Remove the black plastic fitting and filling tube assembly. Ensure that the oil level in this pump just shows on the dipstick. Wrap a wiping rag around the dipstick tube. (It is advisable to keep this rag in place for the first week as any air remaining in the system may foam the oil as it naturally vents).

Starting at the lowest helm pump and progressing to the highest, apply first light, then heavier wheel pressure alternately at both hardover positions. The bleed screw at the alternately pressurised ends of the cylinder should be opened several times as each pump is pressurised. KEEP THE SYSTEM FULL OF OIL!

The system is now useable but it will not be smoothly responsive until the air is expelled. Air may continue to work out of the oil for some time so keep a regular check on the oil level for the first few days of operation.

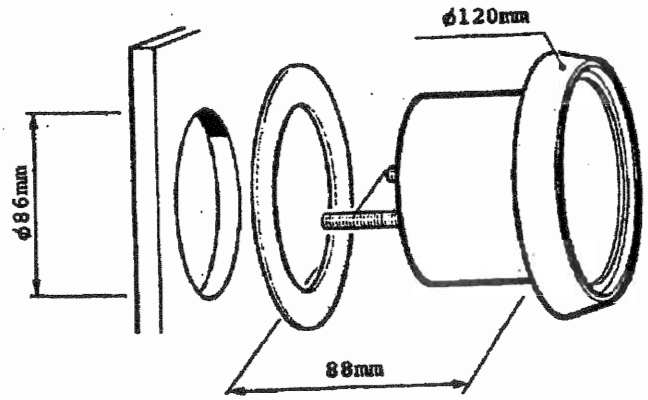
If the plastic tubing assembled with a black plastic fitting is not available, the oil must be poured slowly into the dipstick tube. The rest of the procedure is the same, but the oil level in the highest (or only) helm pump must be maintained to prevent pumping air into the system.

2.9.7.5 Recommended Oils:

Refer recommended lubricants section 6.1.6. DO NOT USE BRAKE FLUID or a heavier viscosity oil.

2.9.8 INDICATOR

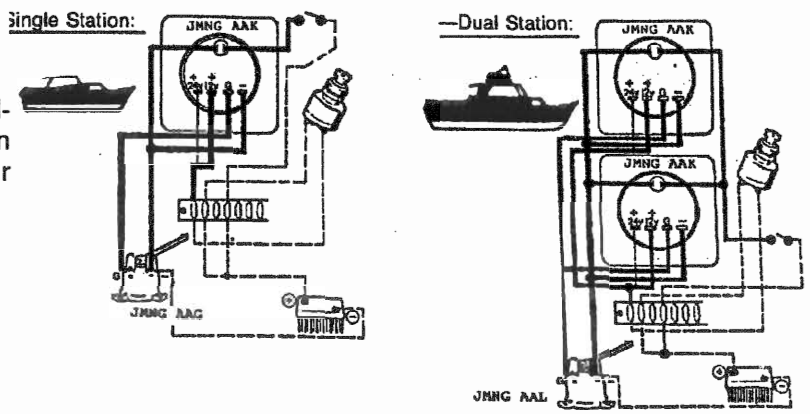
Mounting



Wiring Diagram

Dual Station

The sender must be changed to Hamilton part no. JMNGAAL "Dual Station Sender" and an additional Indicator JMNGAAK purchased.



Sender Adjustment:

- Loosen the 3 M4 sender mounting screws and rotate the sender until the screws are central in the slotted holes in the sender. Temporarily retighten screws.
- Adjust length of sender link and sender arm so sender arm travels from stop to stop (or nearly so). Lock 2 nuts and screw .
- Centralise steering deflector so that the pointer is at 0^{o}. Loosen 3 M4 sender mounting screws and rotate the sender so the indicator gauge (at the helm position) registers zero helm deflection. Lock the 3 M4 screws .

2.9.9 Autopilots

Most jet propelled craft do not have the benefit of keels and rudders to maintain tight directional stability. With care, keels can be applied to jet hulls, but the following alternative arrangement of the autopilot is usually effective:-

a) Reduce the sensitivity so that the craft is able to deviate further off course (than would be the case with a propeller and rudder equipped craft), before the autopilot makes a correction.

b) Use a higher hydraulic pump flow than normal for propellers so that when a correction is made it is done quickly.

If the above advice is not followed, the system may not stabalise, ie: it will be continuously correcting, first one way and immediately back the other.

2.10 Reverse System

Several reverse control systems are offered. For each system a seperate manual is provided (normally included at the rear of this jet manual).

Caution with Steel hulls - hoses making the connection to the jet must be of a type which will maintain electrical insulation between the hull and jet (normally reverse Hydraulic Power Units (HPU) are in electrical contact with the hull).

CHAPTER 3
PRECAUTIONS AGAINST CORROSION

3.0 General

WARNING

C.W.F. Hamilton & Co Ltd have taken precautions during manufacture and assembly of the jet unit, by using materials that are resistant to salt water corrosion and by placing anodes in the most effective places on the jet. **The unit however, is still vulnerable to the actions of the person who fits the propulsion system into the hull and to the actions of his electrician.**

THIS IS THUS A CONDITION OF WARRANTY THAT CRAFT FITTED WITH HAMILTON JETS MUST HAVE A NEGATIVE EARTH BONDING SYSTEM FITTED - as outlined in this section.

Why is it necessary ?

One of the major causes of corrosion of metal parts in salt water, particularly the impeller, is stray currents emanating from the vessel's electrical system. These currents can be very small, often defying detection, but acting over a considerable period can cause heavy corrosion because the jet is in contact with the water and the aluminium in the jet can become an anode to a metal hull or any other metal object in the hull to which it may be electrically connected.

Basic Earth Bonding System

By bonding the jet, * hull and casings or body of **all** metal objects together to the hull anodes with a low resistance bonding system (**separate from "working" 2 wire electric system**) we ensure that the hull anodes corrode and not the jet, hull or metal object in the hull - **because we eliminate any voltage difference between the different metals.**

* **Exception is for steel hulls** when the jet must be totally insulated from the hull and machinery thus relying totally on its own anodes for protection.

Connection of Earth Bonding system to Battery Negative:

As a final move we can connect our Earth Bonding System to the negative battery terminal which then ensures all metal objects in the hull (and the hull if metal) are held at negative battery voltage. This imparts a common "impressed" voltage to all metal objects connected to the bonding system farther ensuring they don't corrode but the anodes do. (No current leaks from battery can occur assuming an isolation switch is fitted on the positive battery terminal - assumed to be normal practice).

NOTE - Systems such as "**Impressed Cathodic Corrosion Protection**" use a similar principle to the Negative Earth Bonding System.

Section 3.1 - for Aluminium, GRP, wood hulls.
Section 3.2 - for Steel hulls
Refer to Manual on control system used for special instructions percular to the control option used.

3.1 Aluminium, GRP and wood hulls (other than steel) :

3.1.1. Bonding system

The bond strip and connecting wires should be aluminium or copper of at least 14.5 sq.mm. cross section area (e.g. 5mm dia.) to give very low (e.g. 0.01ohm) electrical resistance. All junctions should preferably be welded, but if bolted, should be clean, have a good contact, and be regularly inspected. The bond wire or strip which runs fore and aft down the hull, should be kept clear of bilge water where possible, and connected to :-

(a) The engine frame (the engine must have a negative earth).

(b) The jet unit casing.

(c) All anodes attached to the hull.

(d) The fuel tanks and any other major items.

(e) Casings of all major items of electrical equipment.

(f) In the case of a wood or fibreglass hull, to an external earth plate in an area of the hull bottom that is always in contact with the water.

(g) In the case of an aluminium hull, to a connection welded to the hull in an area where the hull is always in contact with the water.

(h) To the NEGATIVE pole of the battery directly.

* This connection is not necessary if:

1. There is a two wire electrical system which is isolated from the hul, jet and engine and-

2. There is an effective leakage monitoring system which is used regularaly and the results are recorde

Note that it is important to check for leakage:

- for every item of electrical equipment in operation
- when there is any alteration to the electrical system of the boat.
- when any electrical connection is made to shore.

3.1.2. Electrical wiring system

Every part of the electrical system should use **TWO** wires, positive and negative, i.e. the negative must not run through the frame of any major unit, through the hull of the boat, or through the bonding system.

DO NOT USE AN EARTH RETURN SYSTEM.

Starter motors should be the 2 wire type with a negative battery terminal rather than the casing of starter connected to the battery negative.

Any item such as HERC pump motor which uses its casing as part of the circuit must be fully insulated from the hull and the casing must not be connected to the bonding strip.

3.1.3. Radio, transceivers, depth sounders and other electrical auxiliaries

Batteries, radio transmitter or other electrical equipment should NOT be earthed to the jet unit.

Be guided by your radio technician, but in general these systems should either be entirely insulated, i.e. separate insulated alternator, separate batteries etc., or the system should be incorporated in the bonding system but with a separate earth plate well removed from the bonding earth strip and from the jet. The metal used for the separate earth plate must be compatible with the bonded earth strip metal and the hull material (stainless is likely to be the best option). Install earth plate as far away from jet as possible.

3.1.4. Zinc anodes

The casing of the jet unit is electrically connected to the jet unit anodes. The anodes, which are zinc blocks, are fixed to various parts of the jet unit below the water line. If the anodes are being eaten away they are providing protection. **They should be inspected and replaced when half consumed**. Further anodes should be fitted on the hull, sufficient for hull protection (see diagram page).

3.1.5. In-service checks

In service, two items should be inspected regularly :-

(a) The bonding system for loose or corroded connections. The bonding system should also be tested to ensure that electrical resistance is still low.

(b) All anodes. If any are more than half-eaten away, replace them with a new anode.

3.1.6. Anti-fouling paint / anti-seize compound

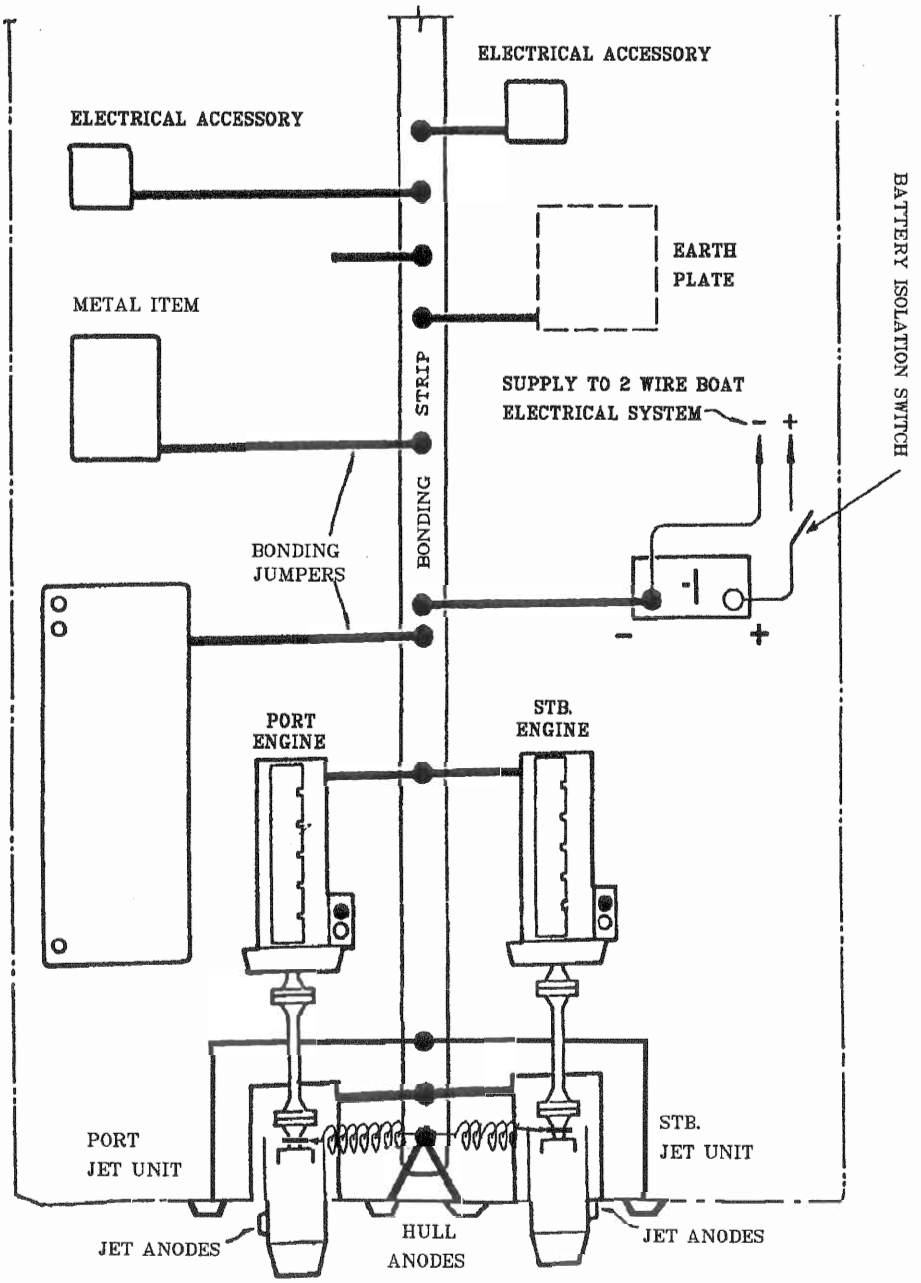
The aluminium parts of the jet should be painted with antifouling paint. Use only tin-based anti-fouling or any anitfouling paint which is suitable for an aluminium hull. Keep stainless steel clean. Anti-foul the interior of the jet aluminium casings if desired but note that if the jet is run at least approximately every two weeks barnacle growth does not normally occur in the jet interior.

Do not use either paint containing copper or graphite based anti-seize compounds as these could cause corrosion of the jet unit

3.1.7 Impressed current protection

Impressed current protection may be used if desired. Follow the supplier's instructions.

3.1.8 EXAMPLE OF A BONDING LAYOUT (NOT FOR STEEL HULLS)



3.2 Steel hulls:

The complete jet unit must be electrically isolated from the hull, engine etc. For the insulation instructions see the steel hull installation section for your jet unit, but specifically, insulation of the jet unit must be accomplished. The remainder of the boat should, in all respects, employ the Bonding System described in section 3.1.

Key areas for insulation of the jet unit are :-

(a)Transition duct to hull.

(b)Transom plate to transom (sometimes by means of the rubber seal ring or gasket).

(c)Control connections such as steering and reverse cables, hydraulic hoses, etc. - (standard reverse hose are non wire wound - i.e. insulating) but the standard steering hoses must be replaced with non wire wound type if not already supplied).

(d)Driveshaft. A coupling shaft using resilient rubber elements can provide the insulation most simply, or a flywheel plate insulated from engine flywheel by means of reinforced insulating sheet, bushes and washes (e.g. Tufnol).

The following additional details apply :-

1.If a negative earth system is used on the boat it must not be connected to the jet unit casing or its anodes.

2.Every part of the boat electrical system should have TWO wires to it, a positive and a negative wire.

3.With electrical auxilliary equipment installation, be guided by your electrician. Do not earth electrical equipment to the jet unit, but to a separate earth installed as far away from the jet as possible.

4.Separate zinc anodes are provided on the jet to protect the jet unit against corrosion.

5.Regularly inspect all anodes and replace any that are more than half-eaten away.

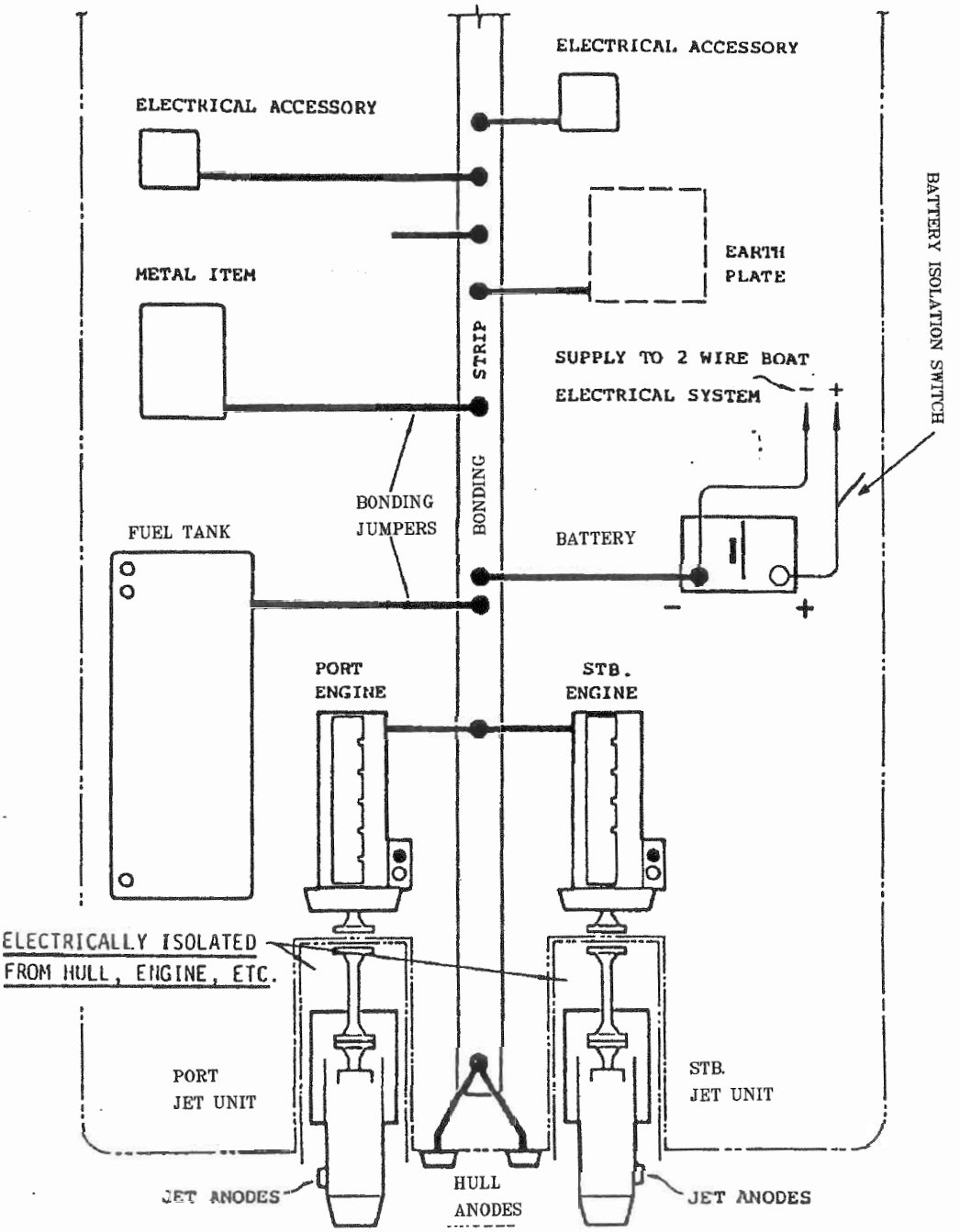
6.Keep stainless steel clean.

7.The aluminium parts of the jet should be fully antifoul painted. The steering deflectors should be removed to fully cover the nozzle and interior surface of the steering deflector.
The antifouling paint should be suitable for an aluminium hull eg:- International Paints "Interspeed 2000" - one of the new paints which does not affect marine life.

CAUTION:- It is common to use a **copper based antifouling paint** on steel hulls - these types definately **cannot be used near the aluminium jet as they will cause the jet to corrode.**
Our advice from the International Paints representative is that Interspeed 2000 can be used on a steel hull but that the copper based antifouling would have cost & life advantages. They therefore recommend using Interspeed 2000 on the steel hull only in the areas within 500mm of the jets.

8.A separate impressed current protection for the jet unit is also recommended if desired.

EXAMPLE OF A BONDING LAYOUT (STEEL HULLS ONLY)



CHAPTER 4
COMMISSIONING & FAULT FINDING

4.1 Pre launch Check list.

4.1.1 HULL/INSTALLATION

- Transition Duct to hull faired fore and aft ☐
- Clear smooth hull aft of intake ☐
- No flow obstruction forward ☐
- Gasket/Sealing/Bolting down ☐
- Exhaust outlets correctly positioned ☐
- No flaps/obstructions to interfere with reverse flow ☐

4.1.2 JET UNIT

- Correct impeller/nozzle fitted ☐
- Transom seal/position/watertightness (do not overtighten) ☐
- Anodes in place/clean/unpainted ☐
- Inspection hatch secure ☐
- Dipsticks correctly located (refer 2.6) ☐
- Front bearing lubrication (check oil level) ☐
- Jet rotor turns ☐

4.1.3 STEERING GEAR

- Deflector matches nozzle ☐
- Deflector pivot pins/secure locking bolts ☐
- Cotter pins installed correctly and secured ☐
- Inboard tiller (clear arm movement) ☐
- Tie rod adjusted (twins), both deflectors dead ahead in unison. ☐
- Hydraulic steering,bled,ample pipe size ☐
- Turns freely,lock to lock (all jets) ☐
- Actuator limits travel,not linkage ☐
- Correct ratio (1.9 turns lock to lock) ☐
- Steering sense (port wheel = port deflector movement) ☐

4.1.4 ELECTRICAL

☐

- Two wire negative earth wiring system and fully connected bonding strip installed as shown in Section 3.

4.1.5 REVERSE SYSTEM

- See separate reverse system manual. ☐

4.1.6 DRIVE SHAFTS

- Driveline details approved by C.W.F.Hamilton & Co Ltd. ☐
- Universal shafts:
  - Yoke disposition ☐
  - Spline engagement ☐
  - Joint angles ☐
- 2 Piece shafts
  - Centre bearing mount ☐
  - Universal angels as recommended ☐

- Line shafts

Square and aligned at engine flywheel	☐
Aligned plummer blocks	☐
Outer bearings close to end couplings	☐
fore and aft positioning	☐

- Torsional coupling

Square at flywheel	☐
All bolting secure	☐
Flywheel bolting secure	☐

4.2 AFTER LAUNCHING THE BOAT

4.2.1 Prior to engine startup

1) Check for water leaks ;
   - at the transom seal,
   - intake base and
   - from under the thrust bearing housing (water seal leak).
2) Check the waterline is at least up to the jet mainshaft centre line at the impeller so the jet will prime (pump water properly) when the engine is started.
3) Ensure the boat is securely moored fore and aft and located in deep clean water
4) For "HERC", set the reverse lever(s) to the zero speed position (or close to this if exact neutral not yet determined).
   For "HSRC"or HYRC, be ready to begin moving lever(s) to zero speed as soon as engines started.

4.2.2 Engine Startup

1) For "HSRC"or HYRC, move the lever(s) to zero speed as soon as the engines have started.
2) At this point the engine supplier's representatives can run their checks.
3) Check for water leaks around the jet while the engine is running, particularly under the thrust bearing housing (water seal).
4) If not already done, proceed to carry out/check reverse control system adjustments while the boat is still securely moored in deep water. (refer to separate reverse control manual)
5) At idle, position steering straight ahead and reverse levers to "zero speed" position (where the boat hovers in the same position). Raise the throttles to verify controls at exact zero speed (boat should not move fore or aft). Adjust the "zero speed" detent position to correspond with true lever position.
6) Before commencing speed trials and proceeding away from dock, recheck all systems are secure and functioning correctly.

7) Operator should be experienced in Hamilton Jet handling techniques and familiar with position/feel of controls.

4.2.3 BOAT SPEED/ HANDLING TRIAL

1) Engine systems should be adjusted and ready for trial.

2) Ensure jet intake screens and insides are clear of any debris which could bave been disturbed during trial - manoeuvre alongside mooring.

3) When proceeding away to open water for trials, check that the steering is working correctly at speed, zero speed and going astern. Observe the jet stream(s) when boat is going dead ahead at speed to ensure it/they are a relatively clean and even shape. If back splash from deflector is evident - steering deflectors may require re-alignment.

4) Periodically check the surface temperature of the thrust bearing housing with the palm of your hand. Due to friction caused by the seals the housing is likely to he hot (it is O.K. if you can hold your hand on the surface for about 2 seconds)- about 55°C is normal at 25°C ambient
A faulty bearing will be heard and felt as a vibration through the housing and likely to cause excessive heat which will be quite noticeable- could even darken paint.

5) The builder/customer can now proceed with trials. It is preferable for a Hamilton distributor to be present to observe, record and verify results.

6) Record accurate maximum speed and engine revolutions timed over a measured course. Note the actual readings given on boat's instrumentation for future calibration of figures.
At Maximum speed, jet revolutions should be verified by use of a hand held tachometer at the jet coupling.

7) Record boat speed at varying engine revolutions if possible.

8) Make observations on boat trim loading etc. and record.

4.2.4 AFTER INITIAL TRIALS

1) Check all oil levels and replenish if required

4.3 FAULT FINDING

4.3.1 Ahead / Astern

1.Refer to Reverse Hydraulics Manual .

2.Refer to Reverse Cylinder Maintenance section 6.2.4.

3.Poor reverse thrust :
-Reverse duct not travelling fully down so whole jetstream enters it.
-Reversed jetstream hitting hull or hull extension such as a trim plate.
-Boat has insufficient immersion at transom and air being sucked from rear into jet intake.
-Effect of engine exhaust on jet reverse (section 2.8.6.)

4.3.2 Jet

Note - assuming the correct impeller and nozzle combination are fitted then:-
High RPM - means jet is at fault
Low RPM - means engine is at fault.

1.Water leaking from under front bearing
-Faulty water seal or counter face.

2.Excessive high pitched rattling whine.
-Faulty thrust bearing.

3.Bad vibrations.
Gradually increasing;
-Worn cutless bearing or cutlass bearing water drain hole blocked.
-Worn driveshaft universal joints.
Sudden increase in vibration
-Debris stuck on impeller

4.Engine revolutions gradually increasing over a period of time. Take off performance poor
-Worn or blunt impellers.
-Excessive impeller tip clearance.

5.Sudden indicated increase in engine revolutions, no noticeable decrease in jet thrust.
-Faulty tachometer.

6.Excessive engine revolutions,noisy jet unit with aerated water from nozzle
-Screen blocked with wood or debris or rope through screen and wrapped around shaft
-object jammed in stators and/or impeller.

NOTE: All the symptoms described in items 2, 3 and 4 may be caused by the same fault as in item 6.

4.3.3 Steering

Air continues to work its way out of manual hydraulic systems for some time. Regularly check the oil reservoir level for some weeks with a new boat and top up if necessary. With air in the system the steering will be soft - and not accurate. Ensure all air is bled from the system following the instructions in section 2.9.7.4. Ensure number of turns of the wheel is not more than 1.9 full lock to full lock otherwise steering will be insensitive. Ensure tubing lines rise steadily from cylinder to helm or air will not work its way back to the helm pump.

With multiple jets ensure the steering tie rod length is adjusted so that all jets steer straight ahead at the same time (Section 2.9.6)

1. If the steering wheel is still difficult to turn, check the following:

   (a) The jet tiller moves easily. Remove the cylinder rod end bolt and operate the wheel. If the cylinder operates easily, the jet tiller and steering assembly very likely has too much friction. Check the steering deflector and steering shaft rotate freely. If the cylinder does not move, and the wheel is still hard to turn, check:

   (b) The system is free of entrapped air. (Refer "Bleeding" Section 2.9.7.4)).

   (c) The system is piped using only the two short lengths of flex hose supplied for the cylinder connection.

   (d) The hydraulic oil is one of the types recommended, that is, not more viscous (thicker) than automatic transmission fluid. (Refer recommended oils Section 2.9.7.5).

   (e) The tubing used is at least the size recommended. (Section 2.9.1)

2. If the steering wheel continues to turn easily and the cylinder does not feel like it reaches hardover, check the following:

   (a) The cylinder bypass valve (if installed) is in the closed (normal) position.

   (b) All system fittings are tight.

   (c) The system is free of entrapped air. If air is in the system, the wheel will spring back when turned and released. (refer "Bleeding" Section 2.9.7.4).

   (d) A lockvalve on another helm pump is not contaminated. Contamination is indicated by the wheel turning at that station. That lockvalve must be disassembled and cleaned. When removing the slotted lockvalve inserts, take care not to lose the retained spring and steel ball or to damage the seals.

   (e) The cylinder piston seals are not damaged. All of the above should be checked and determined to be satisfactory first. Remove the cylinder rod end bolt and attempt to stroke the cylinder rod fully back and forth by hand. If the rod moves, the piston seals must be replaced. Oil leaking along the cylinder rod from either end of the cylinder indicates the rod seals are defective and must be replaced. (Refer Maintenance Section 6).

3. If the number of wheel turns is different when turning hardover to port and hardover to starboard, check the following:

   (a) The system is free of entrapped air. (refer "Bleeding" Section 2.9.7.4).

   (b) The system is piped using only the two short lengths of flex hose supplied for the connection of the cylinder.

CHAPTER 5
OPERATION

WARNING:- DO NOT RUN THE UNIT OUT OF WATER.

5.1 Starting up

1. Before starting engine(s) check:

   - The craft is securely tied up or well clear of other objects.
   - The helm is centred and the reverse controls are at Zero Speed. (note that with jet or engine driven hydraulic pumps it is not possible to move the reverse duct until the pump is running).
   - Clutches or gearboxes, if fitted, are in neutral position.

2. After starting engine(s):

   - Move the helm and reverse levers, if necessary, to stop boat movement.

5.2 Steering:

The steering deflector deflects the jet of water to port or starboard causing the boat to steer to port or starboard respectively.

The following points should be remembered when operating a jet craft :-

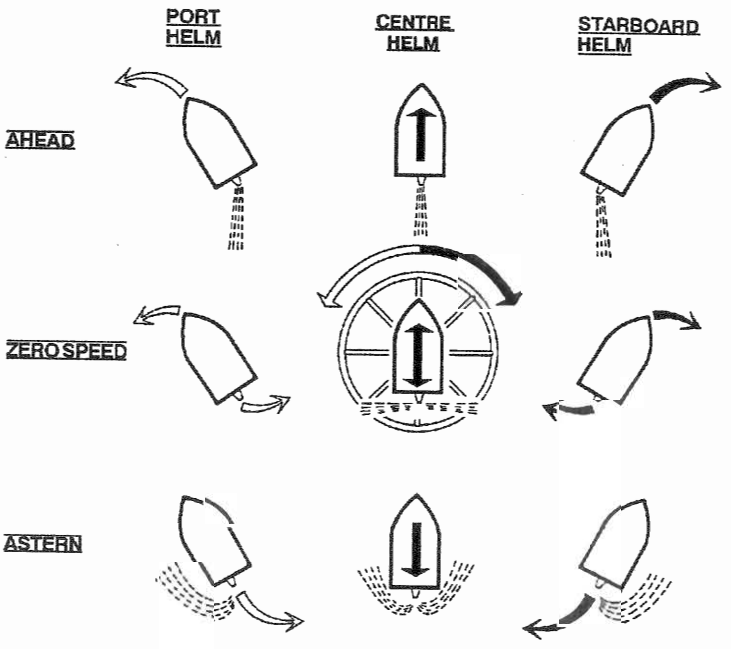
(a) If the engine is stopped there is no jet of water to deflect and thus the craft cannot be steered or stopped. **Never stop the engine or disengage the drive to the jet when approaching a mooring or at any time when steering will be required.**

(b) The wider the throttle is opened the greater the steering effect - i.e. the sharper the turn.

(c) Steering is available at "zero speed" as well as all ahead and astern speeds - a feature which gives the Hamilton Jet unrivalled manoeuvrability.

Remember though that whether going ahead, at "**zero speed**", or astern, **the bow of the boat will always turn the way the steering wheel is turned** , i.e. move steering to port, bow of boat will move to port and vice versa.

This means that **going astern** the boat has **the opposite steering to a motor car**, a feature which can be used to advantage when manoeuvring.



Emergency steering

In the case of a complete hydraulic failure the jets may be steered by manually moving the jet tiller(s). Open the by-pass valve (or disconnect the hydraulic hoses at the cylinders if there is no valve). The deflector position is indicated by the gauge at the helm. Steering may only be possible at low rpm unless an emergency tiller extension (not included in Hamiltons standard supply) is used.

5.3 Ahead/zero speed/astern control:

Astern and "zero speed" are achieved by redirecting the jetstream. If the reverse duct is lowered fully, all of the jetstream is redirected back under the boat giving full astern thrust. If the reverse duct is lowered partially, the jetstream is split giving some ahead and some astern thrust. At one reverse duct position the ahead and astern thrusts will be equal so the boat will not move ahead or astern regardless of the throttle opening.

This position is referred to by Hamiltons as "**zero speed**". (It should not be confused with the neutral position of a gearbox when the driveline stops rotating).

When operating the Hamilton reverse control, **the jet unit is always rotating** regardless of the position of the reverse duct. Any intermediate position between ahead and astern can be selected to give infinitely variable speeds when manoeuvring.

CAUTION

If proceeding at high speed and "Astern" or "ZERO SPEED" control position is selected with the throttle left open, the resultant "braking effect" is very severe - even more so than full braking with a motor car.

The above procedure should therefore NOT be used.

EMERGENCY BRAKING:

For normal operation to "brake" the boat's forward motion :-

(i)Close the throttle.

(ii)Select zero speed or astern.

(iii)Open the throttle, gently at first until the desired braking is achieved.

(iv)Close the throttle as soon as the vessel has slowed.

(v)Do not use full steering until the vessel has slowed.

EMERGENCY MANUAL REVERSE DUCT CONTROL ON TOTAL HYDRAULIC FAILURE.

This is the manual raising and lowering of reverse duct by hand and is only necessary if the following have failed.

a) The hydraulic pumps are non operational
b) The main and any emergency control systems are non operational.

Only operate at engine idle_revs. To Raise the Reverse duct.

1) Attach a rope to the reverse duct lifting eye.
2) Take the weight of the duct.
3) Open the manual bypass valve on the reverse cylinder manifold block underneath the reverse cylinder pivot point (or disconnect hoses from reverse cylinder if no by pass valve fitted).
4) Move the duct to new position and close manual bypass valve (Observe the cylinder stroke for position)(or tie rope off to hold duct if no bypass valve fitted).

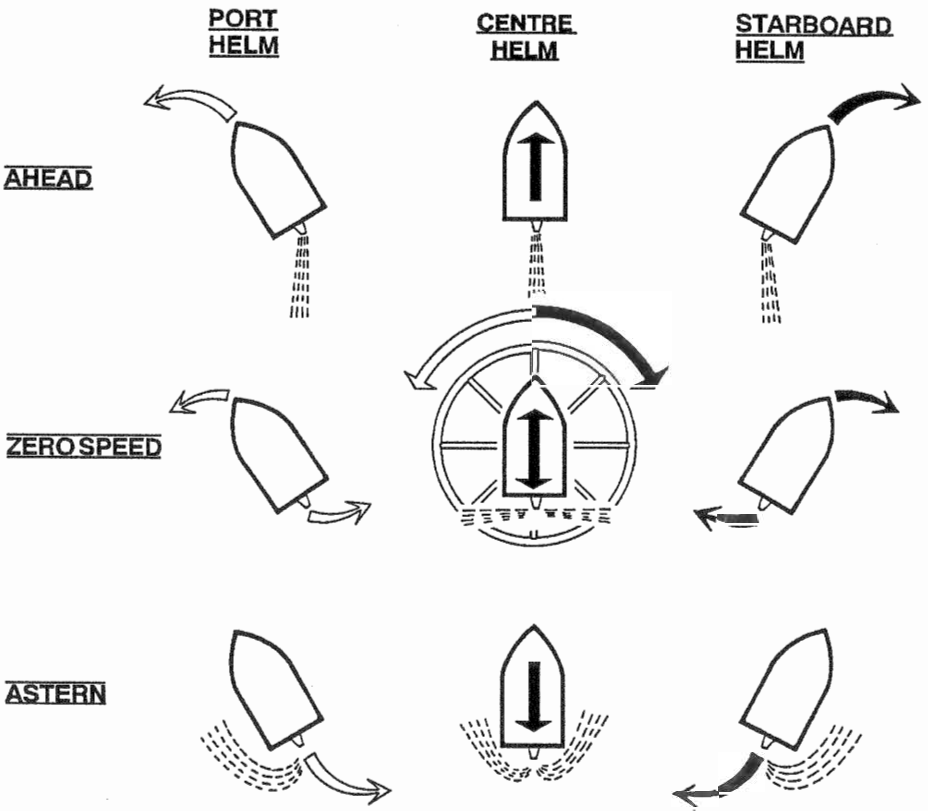
To Lower the Reverse duct

1) Crack open the manual bypass valve slightly until the duct moves under its own weight.
2) Close the manual bypass valve when in position (Observe the cylinder stroke for position.)

(If no bypass valve fitted, slacken and retighten rope in new duct position).

5.4 Low speed Manoeuvring

1. Set THROTTLES to FAST IDLE to suit wind and current conditions. FURTHER USE OF THE THROTTLE SHOULD NOT BE NECESSARY. **Remember the higher the throttle rpm the faster the craft will respond.**
2. Manoeuvre with one hand on the helm and one hand on the Reverse Lever(s).
   a) ROTATE the craft using the helm - **remember the bow will always move the way the helm is turned.**
   b) Move ahead or astern by using the Reverse Lever(s) slightly either side of ZERO SPEED position.



Notes:-

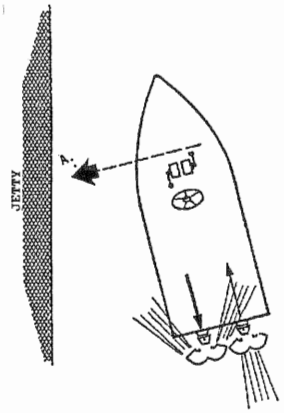
- **DO NOT WORK THE THROTTLES** - leave as set. With **TWIN JETS** best manoeuvring is using the helm with one hand and both Reverse Levers with the other. ONE AHEAD and ONE ASTERN is **NOT** AS EFFECTIVE.
- **USE ONLY LOW ENGINE RPM** - high rpm will give faster response but makes control more difficult.
- If the bow is rotating to starboard, the port lock must be used to stop the rotation (or vice versa) then the helm centered to hold the heading.
- If the boat is moving ahead then the reverse lever(s) must be moved astern to bring the boat to rest (or vice versa) and then zero speed selected to hold position.

5.5 Moving sideways.

5.5.1 WITH TWIN JETS:

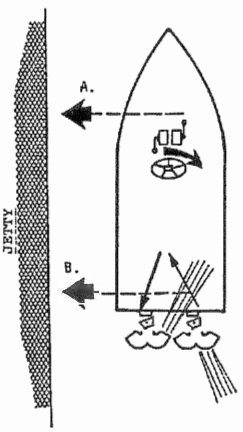
Use the following procedure to move the vessel sideways away from the jetty. Initially both controls are at "ZERO SPEED" and the vessel is stationary.

Moving to Port



A

1. Set both engine speeds to just above idle with slightly higher rpm on the port side.
2. Set steering to ahead.
3. Move the port reverse lever to full astern and the starboard lever to full ahead.



B

4. As the bow begins to swing to Port, turn the helm to starboard to keep the vessel parallel to the jetty. The vessel will now move sideways to Port.
5. Adjust the Port engine rpm to prevent fore and aft movement. (Higher rpm moves vessel aft). This may also be done by bringing the starboard reverse control back towards the Zero Speed position.

Moving to starboard

Instructions 1 to 4 are the same but for Port read Starboard and vice versa. When the Vessel is safely clear move both controls back to zero speed and centre the helm. Then move off in the required direction.

Docking.

Use the above procedure when approaching or moving away from a jetty or another vessel. Note however that if the vessel is moving sideways too fast the controls should be set back to zero speed an the Helm returned to centre. Alternatively set the controls for sideways movement in the opposite direction until the craft stops moving sideways.

5.5.2 WITH TRIPLE JETS:

Using all three jets to move sideways gives best results.

A:

1: Set steering to dead ahead, all three reverse ducts to the "zero speed" position and rpm on all engines to the same value. (The rpm required for manoeuvring will depend on the prevailing se conditions, higher rpm's will improve response.)

B:

2: For sideways motion to port, set the port jet full astern and the starboard jet full ahead (this is reversed for sideways motion to starboard).

3: Use the centre jet reverse duct to control fore and aft movement (duct approximately 80% reversed).

4: Use the helm to control turning (rotation) moments, i.e. for sideways motion to port turn the helm to starboard to balance the turning moment of the port and starboard jets.

This method of sideways manoeuvring should result in 33% more side thrust than if only two jets were used. Once set up, only the centre jet reversed control and the hlem need to be used for controlling the sideways movement.

Moving to Starboard

Instructions 1 to 4 are the same but for "Port" read "Starboard" and vica versa.

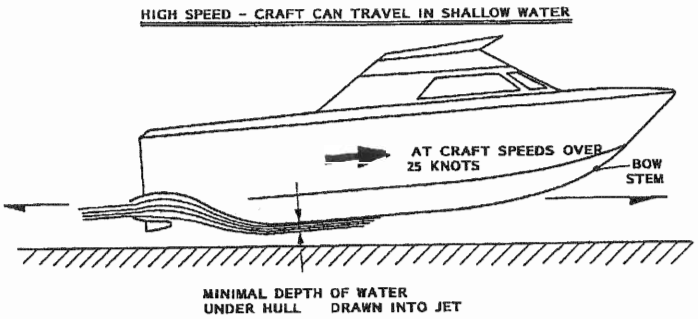
To stop Sideways Movement

Set helm to dead ahead, throttle rpm to idle and reverse to zero speed before the craft reaches the required position. Alternatively set controls to start sideways movement in the opposite direction until craft stops sideways movement then set controls to : - dead ahead steering; idle throttle and zero speed reverse.

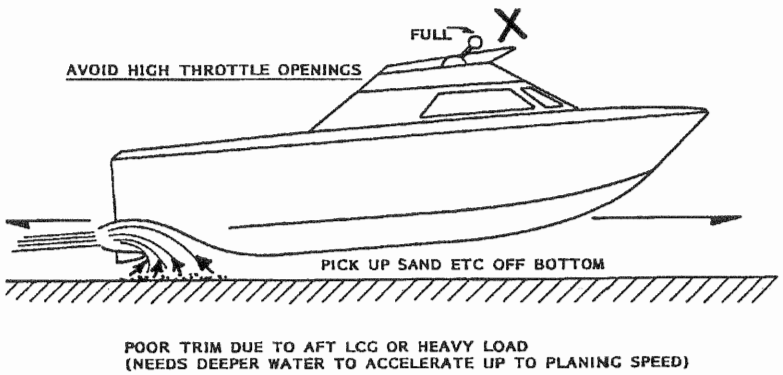
5.6 Shallow water operation:

Avoid pumping stones, sand etc through the jet unit - this will blunt and wear the impeller.

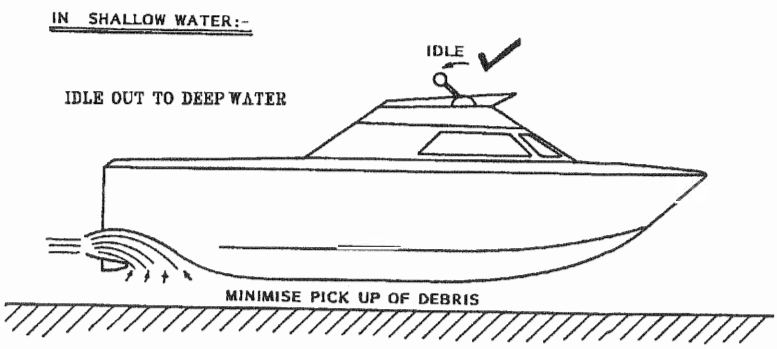
(a)At high planing speeds this is not a problem until the boat is nearly aground.



(b)At slow displacement speeds avoid using high rpm in shallow water.



(c)If it is not possible to pick a deep water area to start off and stop in, idle over the shallow are into deep water before accelerating up to speed. If any debris has been picked up in the intake screen, momentarily stopping the engine should allow the debris to drop away from the screen.



5.7 Blockages, debris, etc in the unit:

Pieces of debris, water weed or sticks, etc will not normally block or harm the unit. However, it is good practice to steer around such debris where possible as any debris caught in the intake screen, impeller or tailpipe stator vanes can affect the jet unit's performance.

Blockages of the unit are usually noticed by :-

(a)The engine unloading (rpm increases).

(b)Lack of jet thrust (boat speed drops).

(c)Excessive noise and vibration from the unit.

If a blockage is indicated, close the throttle of the blocked unit, or stop the engine. Most times, especially if the boat is moving forwards, the obstruction will fall away.

If unsuccessful :-

(i)If a gearbox is fitted, momentarily reversing the jet unit rotation (referred to as "BACK FLUSHING") very effectively clears debris from the intake screen,

or, **with the engine stopped** :-

either -

(ii) Multiple jets only - undertake "Simulated Backflushing". Ensure the reverse duct of the blocked jet is in the Ahead position before stopping its engine. Then go Astern on the other jet(s). The resultant reversed flow through a jet is often sufficient to carry debris forward and out of the jet. Operating the screen rake (if fitted) at this time is more effective than if the craft is stationary or moving ahead.

(iii)Operate the raking screen if fitted, or

(iv)Remove the inspection cover on the intake housing and clear the obstruction.

(v) Send a diver overboard to clear the screen.

CAUTION : Before removing the Inspection Cover (24) :-

(i)Stop all engines.

(ii)Check that the static water level will be below the intake inspection cover lip.

If the static water level is too high, weight can be placed on the bow end to raise the stern end enough to allow the cover to be removed.

Alternatively, an optional extra overflow preventer can be fitted to the inspection point to allow higher water levels.

In debris laden waters it may be necessary to clear the intake screens and impellers before each run. In many cases the debris is picked up while the jet is moored so it is best to clear the screen in open or clear waters.

5.8 Acceleration to high speed

If leaving an area of shallows, or with debris in the water, ensure jets are clear of debris before accelerating to high speed - refer 5.7.

If there is any debris in the jet, the engine will run higher than normal rpm and the craft accelerate only slowly, perhaps not reaching full (planing) speed.

Every day, prior to commencing operations, the Inspection Cover should be removed and any debris removed from around the impeller or intake screen, refer 6.1.1.

CAUTION - ensure the water lever is below the Inspection Cover level before removing it.

WARNING

Running at speed with a partially blocked inlet grill or debris on the impeller will result in cavitation damage to the unit, refer 5.7 (a),(b), & (c) for symptons of blockage.

CHAPTER 6
MAINTENANCE

This unit has been designed to require the absolute minimum of maintenance. However, it is recommended that the unit be dismantled and inspected for the wear on bearings, seals, etc, and corrosion annually as a minimum requirement.

Day to day maintenance should be negligible, but the following points and checks should be noted :-

Refer to the control manual for maintenance of the control system used.

Refer to the HPU manual for maintenance of the Hydraulic Power Pack used.

6.1 Servicing

6.1.1 SERVICING SCHEDULE :-

1.Daily - Pre-Start Up

(a) Check via intake inspection hatch that interior of jet is clear of debris - intake screen, impeller and stator blades.

CHECK WATER LEVEL IS SAFELY BELOW HATCH OR OVERFLOW PREVENTER BEFORE OPENING JET INSPECTION HATCHES.

(b) Check oil level and condition for steering helm pump and reverse HPU. Top up if necessary. Drain and replace oil if it is discoloured or contaminated. (See reverse system Manual and for steering see 2.9.7.4 for bleeding instructions). (See recommended lubricants page 6.1.6).

(c) Check hydraulic oil lines of steering and reverse for oil leaks - particularly if oil has had to be added to a reservoir.

(d) **HERC reverse only:**
- Check for loose electrical connections at the electric HPU.
- Check for loose electrical connections or linkages at jet unit and controller senders (transmitter).

HSRC & HYRC reverse:
- Check for loose linkages.
- Check the tension on the vee belt (if HPU vee belt driven).

(e) Check for loose electrical connections or linkages at position indicator senders (transmitters). (Standard on steering, optional on reverse).

(f) Check for signs of water leaking from under thrust bearing housing = leaking water seal. If water seal is leaking it should be replaced as soon as possible otherwise water may mix with thrust bearing oil causing corrosion and failure of the thrust bearings.

(g) Check thrust bearing oil level and condition.
- A small loss of oil is not critical, seals and sleeves should be changed the next time the craft is docked for maintenance.
- If the oil is a milky (white) colour this confirms water has mixed with the oil caused by a faulty water seal. (See notes under (f) above). Drain oil, flush housing and refill with fresh oil. (See recommended lubricants page 6.1.6).

(h) Check mounting linkages of steering cylinder to tiller are tight. Check Tiller cotter (taper) pin nuts are tight.

2) After initial 5 hours only.
Drain reverse hydraulic oil, change the filter, re-fill system with new oil and bleed (for HERC system bleeding refer HERC Manual). (See recommended lubricants page 6.1.6).

3) Every 30 Hours Running
(Or monthly if not run for 30 hours).
- Lightly grease the following :- (DO NOT OVERGREASE)
  - Drive shaft universals.
  - Pivot point of steering cylinder.
  - Raking screen bearings (if fitted).
- Lightly oil
  - HSRC or HYRC valve linkages (if fitted).
  - Steering shaft bush

4) Every month;
- Check the condition of all anodes (refer to notes under "Sacrifical Anodes" 6.1.3).
- Check Steering Crank Cotter (Taper) pin nut (5) is tight (outboard and inboard).

5) Every 500 hours
(or 6 months if not run for 500 hours).
- Change the hydraulic oil filter on the reverse HPU. (Not required on DC electric HPU - no filter fitted).

6).Every 6 Months:
- Replace all sacrificial anodes.

7).Every Year:
- Dismantle and inspect the jet for wear as per sections 6.2 of the Manual.
- Replace all anodes.
- For reverse system with DC electric HPU only : check condition of electric motor starter switch. Service or replace as required.
- For reverse DC or AC electric motors : check motor bushes. Service or replace as required.
- Replace reverse hydraulic oil and filter (if fitted). (See recommended lubricants 6.1.6).

8). Every 2 Years
- For HERC reverse systems with DC electric motors : replace all motor starter switches and control valve solenoids. "Bench test" DC electric HPU checking relief valve setting (83 bar-1200 psi max.) and battery current draw at relief valve pressure (this should be approximately).

- For HERC reverse control either replace the complete control box or return to New Zealand for checking an servicing by the manufactureres who have a special test rig to do this testing. (A circuit diagram is however included at the rear of the HERC Manual with basic test data to enable an electronics engineer to check the circuit).

6.1.2 When Not in Use

6.1.2.1 Laying Up

When the vessel is out of use the following precautions must be taken to help avoid marine growth and corrosion problems.

At least once per week

1) Turn the mainshaft 180°
2) Lower and raise the reverse duct fully six times.
   Leave in the raised position.
3) Turn the steering deflector fully from lock to lock six times.

If the engine is to be started periodically the jet should also be run. (BOAT MUST BE IN WATER AS JET CANNOT BE RUN DRY).

Prevention of marine growth.

1) Both the inside and outside of the unit should be painted with antifouling (Do not use Copper Based products as these cause corrosion of the aluminium).
   Black is the best colour.

2) Keep the unit out of the light as much as possible.Moor in deep rather than shallow water! An opaque cloth bag is available to place over the steering deflector to prevent light entering. In shallow water a similar cover should be tied over the intake opening.

3) If mooring for longer periods the unit may be pumped dry using compressed air. A sealing plug is fitted into the nozzle and air is introduce via a valve in the inspection cover hatch.

Before restarting after a long period, check for and remove and marine growth on the moving parts and in the water passages.

6.1.2.2 New Jet Preservation

These notes are intended for the extended storage of new waterjets prior to their installation

Preservation

1. Jets may be stored between 10° and 40° C provided the temperature is above the 'dew point' (i.e.. no condensation to be allowed to form).
2. The mainshaft should be fully supported by the shaft support tool to prevent deformation of the cutless bearing.
3. It is desirable to release the shaft support tool and turn the mainshaft by hand several times, say once a month, to ensure that the bearing housing components remain coated in oil.

   Alternatively the Bearing Housing could be fully filled with the recommended lubricating oil to the filler neck to keep the bearings submerged. (This is more important in cold climates where rusting due to condensation could occur)
4. Exposed Steel parts should be coated in shell ensis oil or other rust preventative.
   (i.e. plated components such as; Bearing Retaining Nut, Coupling Flange, Hydraulic hose fittings etc, plus painted steel components such as; valve blocks, Hydraulic Power Units etc).
5. Check the electric terminals of the AC motors every three months to ensure there has been no corrosion.

Depreservation

1. If the Bearing Housing has been completely filled with oil, drain out to restore correct operating level.
2. Remove shaft support tool and refit Inspection cover.
3. Clean Preservation oil off all threads and HSRC/HYRC valve plunger
4. By applying hand to Hynautic slave arm ensure the slave and HSRC/HYRC valve plunger are free to move (the plunger should move in and out approximately 5mm).

6.1.3 SERVICING NOTES

ANTI-SEIZE COMPOUNDS:

Do **not** use **graphite based** anti-seize compounds - these will cause a corrosion problem.

THRUST BEARING:

Change bearing oil after first 5 hours operation. Check oil level every 30 hours operation. Do not overfill. (See Recommended Lubricants section 6.1.6). Ensure correct dipstick is fitted - refer section 2.6. Operating temperature for the bearing housing is normally 50-60°C - it is possible to hold your hand on the housing for 2- 3 seconds only.

REAR BEARING

This is a water lubricated, cutless bearing and requires no attention unless significant wear is apparent.

DO NOT RUN THE UNIT OUT OF WATER as this will damage the bearing and counterface.

To check the bearing for wear (this can be done with the craft afloat) refer to section 6.2.2 i) If operating in debris laden or heavily silted water check the water "Drain Hole" (refer parts illustration) is clear any time the craft is slipped.

WATER SEAL:

This is a carbon face seal type with a hardened counterface and should require no attention. Any failure is detected by water leaking from a hole under the bearing housing.

To inspect seals see dismantling procedure section. Inspect at least every 2000 hours and replace if necessary.

DRIVESHAFT UNIVERSALS:

Grease as recommended by the driveshaft manufacturer. Do not over grease.

SACRIFICIAL ANODES:

The unit is fitted with anodes on the tailpipe (74), steering deflector,nozzle and reverse bucket (120) which will waste away in sea or contaminated water. Regularly inspect these anodes and **replace if half eroded away or more.** If allowed to disappear, corrosion will start on the aluminium parts which could eventually damage the unit. (Anode also fitted to reverse cylinder rod and steering deflector rod).

NOTES

1. The rate at which anodes erode away will vary considerably depending on the nature of the water. Check anodes monthly initially until a safe longer check interval can be established from experience
2. Ensure that mating surfaces are scraped clean for good electrical contact.
3. Ensure that the anodes are not painted over (expecially when applying Antifouling).

4. Scrub down with a wire brush if a coating builds up on the anode.

Check oil levels and inspect all system components to ensure no oil leaks have developed. Top up reservoirs if necessary. Note that the steering system must use a "lighter" oil than the reverse system. See Recommended Lubricants Section 6.1.6

REVERSE AND STEERING JOINTS:

Initially all reverse bucket and steering joints outside the hull should be oiled and checked to see they are operating freely. Once in the water these joints will be water lubricated and will not normally require attention.

CARE OF JET UNIT PAINTWORK:

The main body of the unit is constructed from Silicon-Aluminium alloy (LM6) which best resists corrosion from salt water. These castings are finished in a Poly-urethane paint. Periodic cleaning down, wire-brushing, and repainting with a Suitable antifouling paint (refer 3.1.6) may be necessary depending on water conditions prevailing, and extent of use.

When the craft is on the slip, or at least annually, the complete unit should be removed from the boat, and inspected internally and externally for faults, corrosions, or breakages (follow the maintenance instructions in Section N). Clean down and repaint the castings. **DO NOT use copper- based antifouling paints.** Tin base antifouling paints are suitable. Leave all stainless steel parts polished and unpainted. Leave all anodes Unpainted.

Screen Rake Bearings: (if fitted)

These should be checked regularly for free operation. Stiffness or binding may be caused by debris caught in the screen or seized bearings. Grease bearings periodically. Use water repellent grease.

6.1.4 TIGHTENING TORQUES (for lubricated threads - see above):

(clean all threads thoroughly before reassembly)

. Studs	Thread Size	Description (Item No.)	Torque . Nm	lbs ft.
	M6	Nut	5	3.7
	M8	Nut	12	9
	M10	Nut	24	18
	M12	Nut	40	30
	M16	Nut	60	45
	M20	Nut	120	90
	Special Threads:	- Impeller Nut	1100	800
		- Bearing Retaining nut	840	620
		- Coupling nut	600	450
		-4 x M20 Nuts on long tailpipe studs	260	190
	-Serial #106 & later	-4 x M16 bolts on Rev.Duct pivot pins	150	110
	-Serial# 105 &earlier	Rev.Duct Pivot Pins	1100	810

6.1.5 STANDARD TOOLS RECOMMENDED (not part of jet supply scope)

1. 1" drive torque wrench(s) with capacity to 1100 Nm - impeller nut and coupling nut .
2. 1/2" drive rachet, torque bar and short extension with minimum of 13mm, 17mm, 19mm,24mm,30mm, 38mm, 70mm.
3. 1 x 9mm, 1x10mm , 2 x 17mm and 1 x 24mm A/F spanners.
4. 6mm, Allen key.
5. Long nose pliers.
6. Rubber mallet.
7. 150 and 300 mm Adjustable Wrench.
8. Small, large Straight Screwdrivers.
9. Grease Gun.
10. 38 and 70 mm sockets 1" drive.
11. 1/2" Offset drive (for torquing up the recessed Transition bolts).

6.1.5 cont. SPECIAL TOOLS

ITEM	DESCRIPTION	
	Complete kit of Special Tools - Part Number 106935 *	
Each kit contains :		
1	Impeller Puller	103982
2	Coupling Puller	105854
3	Reaction Arm	105855
4	Retainer nut Spanner	106638Y
5	M16 Bolts (x4)	HYIXYEB
6	M16 Nuts (x4)	JDPVYAL
7	Seal fitting sleeve	103983
8	Shaft support tool	105851

* Serials # 105 and earlier where fitted with bearing locknut 103434 and tab washer 103873 and these require Tool kit 104015 containing Retainer Nut Spanner 103456.

6.1.6 RECOMMENDED LUBRICANTS:

Purpose	Lubricant
Reverse System	Refer to Reverse System manual.
Steering system	I.S.O. viscosity grade 32 *.
Oil filled bearing housing	I.S.O. viscosity grade 46 such as Shell Tellus 46 or equivalent
All other applications eg. bearings, tapers, threads, mating joints and corrosion protection	BP ENERGREASE MM - EP2 (marine multi-purpose extreme pressure grease) or equivalent

***Steering oil notes:**

1. The following oils are preferred due to their superior qualities.

Chevron	: AW Machine 32,
Esso	: Nuto H32
Mobil	: DTE 24,DTE 13
Gulf	: Harmony AW32
Shell	: Tellus 32,
Texaco	: Rando HD32,

2. DO NOT USE BRAKE FLUID or a heavier viscosity oil.

6.2 Disassembly and Assembly Instructions

6.2.1 Thrust bearing assembly and water seal

(Refer to illustrations section 6.1.4 for use of special tools).

Warning: If boat is afloat check that the water level is below the bearing housing before proceeding.

(i) Dismantle thrust bearing

1. Uncouple the driveshaft from the jet unit. Remove plug (111) and drain oil.
2. Prevent coupling (36) from turning with "Reaction Arm" and unscrew nut(37), two turns only, using "Socket Spanner".
3. Fit "Coupling puller" to the coupling flange (36) and tighten the puller bolt firmly. Hit the puller bolt firmly with a hammer to free the coupling flange off its taper.
4. Remove coupling fully.
5. Slacken the 3 bearing nut lockscrews and tap the edges of the nut sharply to release the locking pins. (-for units with KMT Locknuts only).
6. Fit retainer nut spanner sliding coupling back in place behind it. Release bearing retaining nut and remove.
7. If the water seal assembly is NOT to be replaced - remove inspection cover (24) and fit the specials tools "Shaft Support Tool" (so the water seal does not move against its counterface when the bearing housing is removed).
8. Unscrew 6XM20 bearing retaining nuts and remove bearing assembly complete. Remove rearmost oil seal sleeve from shaft after the small round key is taken out.
9. The bearing housing may now be dismantled on the bench.
10. Remove the two small nuts retaining the bearing cap. Watch for the preload springs as this is removed.
11. Remove the distance sleeve, oil seal sleeve and bearings.

(ii) Removing water seal

12. Unscrew seal face retainer nuts (79) and withdraw retainer (116) and thrust collar (96).
13. Screw two M8 bolts into the tapped holes in the seal face holder (92) to remove it along with seal counterface.
14. Remove the seal inspection cover(31) and gasket (32). Release the two grub screws (90) and slide the spring retaining collar (89) aft. Slide the water seal assembly (91) forward off the mainshaft (30).

Note The mainshaft will rest on the lairing inside the intake casting.

(iii) Checking for wear

6.2.1 cont...

Check the following parts for wear and replace where necessary:

15. Oil seals (112) and their sleeves(98) (sleeves may be turned end for end instead of replacing).
16. Bearings (99 and 104).
17. Water seal and counterface assembly (91). Check to see if mating faces are scored or chipped. Always replace both seal and counterface even if one or other appears unworn.
18. "O" ring (106). Check for cuts or deformation.
19. Thoroughly clean all parts.

(iv) Pre-assembly of bearing housing.

1. This can be done on the bench away from the jet unit. Fit aft oil seal (112) with lip inwards, to aft position in housing (35).
2. Take bearing spacer (100) and fit spherical roller bearing (99), and inner portion of thrust bearing (104) on to their respective landings. Warm bearings in oil to not more than 120°C to aid fitting.
3. Slide above assembly into bearing housing (35), leading with the journal bearing, taking care to keep its outer race square until it correctly engages inside the housing. Continue to push home as far as possible (approx 22mm), the outer race being a slide fit in the housing.
4. Fit the outer race of the thrust bearing (104) in place.
5. Fit retaining cover plate (113) without springs or shims, and tighten two M8 nuts on studs (117) lightly to hold assembly together.
6. With feeler gauge take an average reading of the gap between the front face of the housing (35) and the retaining cover plate (113). Check on four sides and average results.
7. Select enough shims from the available shim thickness of .005", .002",.010" (120,121,122) to achieve the measured gap plus an additional clearance of .005" -.007".
8. Remove retaining plate (113), fit front oil seal (112) with lip inwards, into the recess in the retaining plate and refit with eight preload springs (107), o-ring seal (106) and the selected shims set in place. Fit two M8 lock-washers and nuts onto studs (117) and torque up finally.

(v)Reassembly of water seal

(Refer to recommended lubricants (section 6.1.5) and Tightening Torques sections 6.1.4)

1. With the seal inspection cover (31) removed, wet the mainshaft (with a 20 to 1 water to household detergent mix). and carefully replace in the following order using the seal fitting sleeve no 103983 :- seal retaining collar (89), spring, rubber drive ring and rotating parts of seal assembly (91).

Notes - if a replacement seal has been supplied with a thin stainless steel spring retaining collar this <u>should not</u> befitted but discarded.
- Slide the whole assembly some 25mm aft of its final position.

2. Press seal counterface into seal face holder(92).
3. Coat 'O' ring and seal face holder (92) to intake (29) contact faces with marine grease.

4. Fix seal face holder (92) and 'O' ring then thrust collar (96) and retainer (116). Torque up eight M8 nuts (79) with one spring washer under each. 6.2.1 cont...

Warning - Waterseal faces must remain free of grease.

(vi) Re-assembly of bearing housing

1. Slide seal sleeve (112) up to slinger collar (96).
2. Fit round key (128) to shaft recess and slide bearing housing assembly onto the six studs (38), making sure the round key remains in its recess and engages correctly in the keyway in the bearing spacer bore (100).
3. Slide on distance sleeve (114), followed by the second seal sleeve (112) both fully up to the thrust bearing.
4. Fit six M20 nuts (40) and spring washers (39). Tighten evenly to specified torque (section 6.1.4).
5. Screw on large bearing retaining nut (37). Using special spanner no. 103456 with a torque wrench . Tighten to the specified torque (section 6.1.4). Note that the axis of the torque wrench and the spanners should be at 90° to obtain correct torque figure and that if the flange coupling (36) and its key are temporarily fitted, the shaft can be conveniently prevented from turning at this point.
6. Through water seal inspection hatch (31), slide seal assembly (89,91) forward to meet counterface (172). Lubricate as necessary and ensure that all seal parts move freely and ar not desplaced or distorted. Fix with locating collar (89). Tighten two set screws (90) into recesses provided in the mainshaft.
7. Check that mainshaft axial clearance has been maintained. Using a dial gauge on the mainshaft, lever coupling backwards and forwards to ascertain the .005" - .007" backlash is present. remove coupling (64)
8. Where a KMT locknut is used torque up the 3 lockscrews to 18Nm. Otherwise fit retaining nut lock sleeve so that keys engage in slots in nut. Slide flange coupling into place marking the position of the flange coupling's two tapped holes onto the edge of the sleeve . Remove the coupling and sleeve and drill two 11mm holes in the sleeve 10mm in from the protruding edge. Refit the sleeve.
9. Lightly grease bore and key way of coupling flange (36) taper and keyway on mainshaft (30) plus thread and face of coupling nut (37). Fit key (110), coupling (36) and coupling nut (37). Prevent coupling (36) from turning with special tools "Reaction Arm" and torque coupling nut (37) - refer 6.1.4. Using the reaction arm sockets and wrench as handle, check the mainshaft assembly will rotate.
10. Fill the bearing housing with oil until the dipstick oil level reaches the "full" mark. Do no overfill. Refer to section 6.1.3 for recommended Lubricants.

6.2.2 IMPELLER /WEAR RING / OUTBOARD END OF JET

(i) Checking for Wear

Before dismantling the tailpipe end of the jet, remove the inspection cover (24) (or intake screen (44) if in dry dock) and carry out the following checks:-

1. Using feeler gauges, check clearance between the tips of the impeller blades and wear ring (52) **at each side** of the impeller (i.e. not top and bottom). Maximum recommended worn clearance 402 (1.5mm). New clearance is approximately 0.6mm.
2. Push the mainshaft (30) hard from side to side. Check total sideways movement at blade tips. Maximum recommended worn total movement is 0.6mm (.024"). This indicates the amount of wear in the marine bearing (63) and shaft sleeve (64).

(ii) DISMANTLING

6.2.2 cont...

1. Remove the inspection cover (24) and fit the special tools "Shaft Support Tool" (so that the water seal (91) does not move against its counterface when the tailpipe assembly (75) and impeller (20) are removed.
2. Disconnect reverse cylinders (141) from duct (1) by removing hydraulic cylinder pins (140). Move duct through full arc to check for stiffness or slack bushes.
3. Remove reverse duct pivot pins (138) and reverse duct (1).

For units up to and including serial no 105 :- use a 70mm socket to unscrew the threaded reverse duct pivot pins.

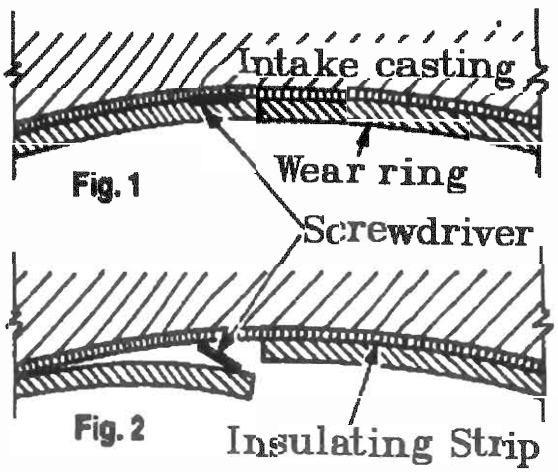
For units including no 106 and on :- unscrew the 4 x M16 bolts (201) before withdrawing the reverse duct pivot pins.

4. Disconnect steering tiller (19) from steering cylinder. Check steering shaft (8) for:-
   (a) Free rotation and axial movement.
   (b) Undue wear in fore and aft bushes (7).
   (c) Undue wear in ball end of crank (6) (check fit in deflector (86) stainless steel bush.
5. Remove cotter (taper pin) (2) from steering crank (6) and ensure that crank rotates freely on shaft.
6. Rotate steering deflector (86) through full arc, to check for stiffness or slack bushes (88). If these seem to be in good condition the deflector can remain on the tailpipe (75) and nozzle (85) assembly.
7. Remove 12 tailpipe nuts (60). Hit tailpipe sideways with a rubber or wooden mallet to free the joint and remove from the remainder of the jet unit, (the steering crank (6) must be taken off the shaft (8) at the same time).
8. Remove grub screw (69), lock coupling (36) with Special Tools "Reaction Arm", so that it cannot rotate and unscrew impeller nut (68) using M70 Socket spanner.
9. Withdraw shaft sleeve (64),
10. Screw Special Tools "Impeller Puller" onto impeller hub and tighten the puller bolt firmly. Free impeller (20) from mainshaft by applying a sharp blow with a hammer to the puller bolt. Withdraw impeller and puller.
11. Remove key (54) being careful not to lose locating dowel (50).
12. Examine wear ring (52). In the unlikely event of this being very badly scored, or if it has swollen inwards, it should be replaced. If possible, request your local agent to carry out the replacement.

(iii) REPLACING THE WEAR RING.

(a) Remove taper sleeve (55) from intake housing bore by applying gentle heat to soften Loctite. If sleeve resists removal it will be necessary to split the sleeve by grinding a 'vee' across the breaking the sleeve at this point.

(b) Locate the joint in the wear ring and insert a wedge between the wear ring and the intake housing until the end of the wear ring is free. (Fig 1 and 2). Pull the end of the wear ring inwards and remove it from intake. Remove insulating strip.



(c) Clean the housing bore thoroughly and degrease. Repaint the bore with a two pot zinc chromate etch primer, allow to dry and then paint with a zinc chromate primer or reaction lacquer metal primer and allow to dry. Apply a second coat of primer and fit the insulator while it is still wet, ensuring the insulating strip is in contact with the paint over the whole surface.

(d) Before the paint dries, smear the whole insulating strip surface with a thin layer of marine grease .

Warning: Because of variations of paint and grease thickness the wear ring may not fit in without some 'dress' filing of mating ends to reduce the circumference slightly.

DO NOT REMOVE TOO MUCH METAL - the wear ring must be a tight fit in the insulating strip to remain in the correct position.

Take a new wear ring and with chamfered end leading, butt the strip at the chamfers by twisting slightly, Fig3 (this reduces the lead diameter) and feed it inside the insulating strip, as it goes in straighten the strip gradually until it butts normally, Fig 4. Slide in as far as possible by hand.

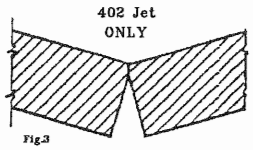


Fig.3

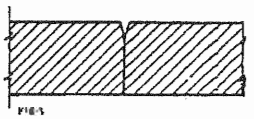


Fig.4

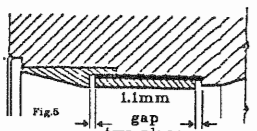


Fig.5

(e) Make a spigotted plate to fit the wear ring. Drive the wear ring in evenly using a heavy hammer until the forward end is just touching a 1mm to 1.2mm thick spacer placed against the front shoulder of the intake bore. Ensure that the gap is even all around.

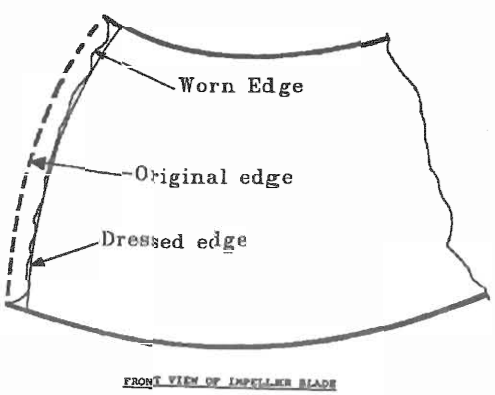
(f) With the last coat of primer still wet press in a new tapered sleeve until the same gap is reached. - refer fig 5. In some cases the sleeve may bottom leaving a slightly larger gap. Check that the resistance between the wear ring and sleeve is over 1000 ohms.

(iv) IMPELLER OVERHAUL

1) Inspect all surfaces of the impeller for any sign of corrosion or erosion damage. Damaged areas should be weld repaired and dressed back to a smooth surface again. Impellers are stainless steel type CF8M conforming to ASTM A 743 or 316 C16 to BS 3100.

Filler metal should have chemical analysis similar to AISI 316L (Carbon content less than 3% eg Philips RS316L) Post weld heat treatment is not required.
CAUTION : - Avoid excessive heating during welding.

2) Check the impeller leading and trailing edges for damage. In particular the outer corners of a blade may be bent if the impeller is dropped or mishandled. Bent or dented blades may be straightened using a large adjustable spanner or other suitable tool. Bring the blade back to its original smooth profile checking against other undamaged blades. Excessively worn or blunt leading edges may be built up by welding. Otherwise sharpen as instructed. Blunt impellers cause loss of performance and sometimes cavitation.

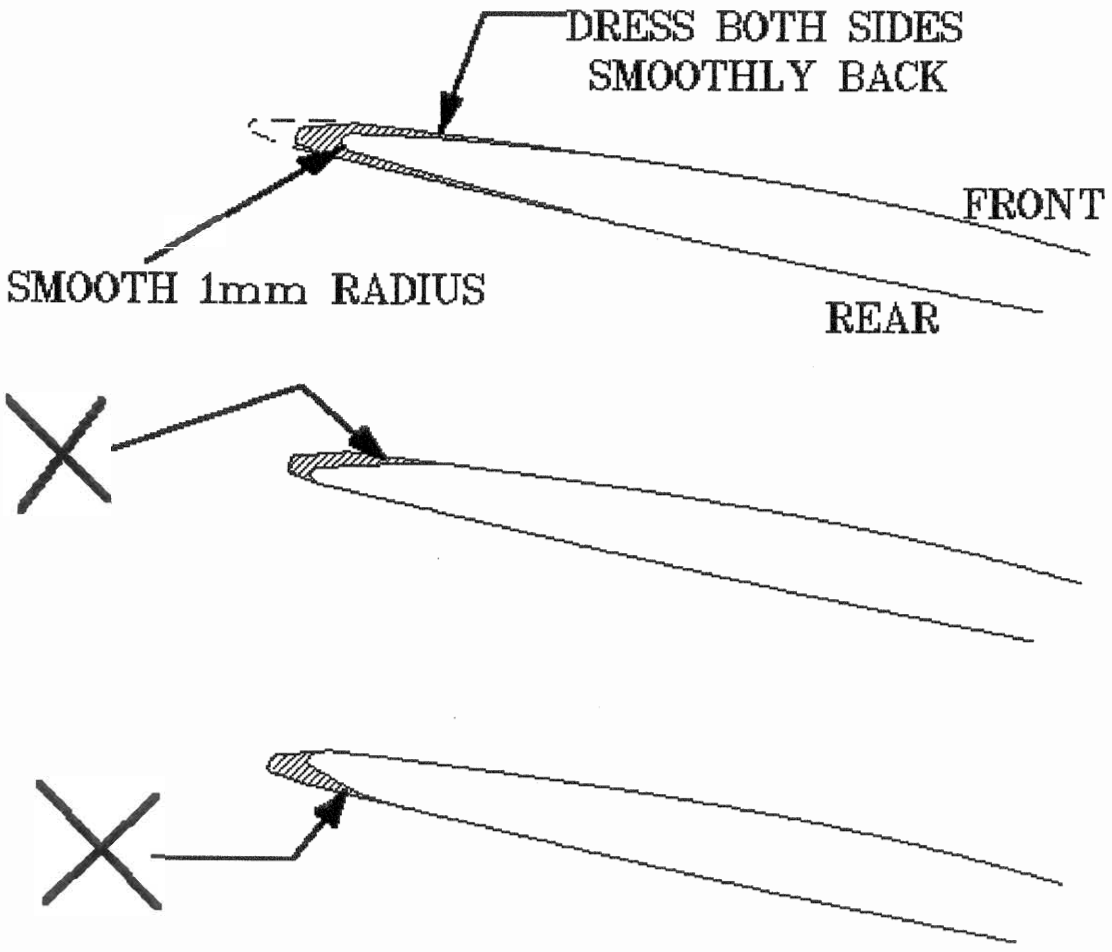


FRONT VIEW OF IMPELLER BLADE

3) Impeller Sharpening. Worn or blunt leading edges should be sharpened as shown below. Dress the edge back to a smooth curve removing the minimum necessary amount of metal.

Then dress both faces of the blade taking slightly more metal off the rear side until the leading edge is 2mm thick all along. Blend well back into the original blade surface. Both front and rear surfaces are to be a smooth uniform curve with no sudden bumps or change in direction. Finally grind or file a smooth 1mm radius along the leading edge. 6.2.2 (iii) cont

The above instructions also apply where the leading edge has to be built up by welding.



4) If the impeller OD is excessively worn (see 6.2.2 (i)) It may be built up by welding. After welding turn on a mandrel **using light cuts to avoid blade distortion.**
Finished OD should be 399.4 to 399.8.
Dress the blade faces back flush with the original surfaces.
The outer diameter must be concentric to the bore within 0.15mm T.I.R.

5) Balance the impeller statically on a suitable mandrel set on horizontal knife edges or bars to within 104 gm cm (ie 5 grams at impeller OD)
Balance weights of 316 SS may be welded to the inside of the hub and grinding material off the weights is permitted.

6) Passivate the impeller in a hot 30% Nitric Acid solution for at least 2 hrs.

(v) OVERHAUL OF TAILPIPE AND NOZZLE

a) Tailpipe

Check the fit of the bearing sleeve(64) in the marine bearing(63). A diametral clearance of .11 to .26 mm is normal and 0.6 mm maximum worn clearance. If the bearing sleeve is badly scored or worn replace. Replace both parts automatically if impeller has just been overhauled and the wear ring (52) replaced.To replace the cutless bearing press out the fairing first followed by the bearing. In case the bearing is tight ensure that the tailpipe is supported at the hub rather than the outer shell to avoid overloading the stator vanes. Clean out the bore and repaint with two pot zinc chromate etch primer. Grease the tailpipe bore before pressing in the new bearing.

Refit the fairing(70) using loctite 262 - do **NOT** paint the mating surfaces but ensure the Locktite is spread evenly over the whole of the mating surfaces to keep water out.

Check the wear in the steering bushes (7). It is important that the steering shaft (8) cannot move sideways in the bushes as this will cause backlash (or lost motion) in the steering. If worn press the bushes out and replace with new bushes. The bores should be thoroughly cleaned and NOT painted. The bushes are a sliding fit and must be fitted with Loctite 262 evenly spread around the bush. Rotate the bush as it is fed into the bore to ensure the Loctite covers the whole mating surface thus insulating and keeping water out.

b) Nozzle(85)

The nozzle is fitted with two Bronze bushes (88). If the bushes are worn press out and replace with a new bushes. The bores should be cleaned and Not painted. The bushes are a sliding fit and must be fitted using Loctite 262. Rotate the bush as it is fed into the bore to ensure the Loctite covers the whole mating surface - it thus insulates and keeps water out.

(vi) RE-ASSEMBLY

1. Clean all parts thoroughly.
2. Smear a light coating of grease over complete mainshaft from in front of impeller seal position including impeller taper and right aft including impeller nut thread.
3. Check impeller seal (53) for damage - replace if necessary, fit into shaft just ahead of impeller taper.
4. Insert impeller key (54) locating it with dowel (50).
5. Slide impeller onto shaft followed by the bearing sleeve (64). When fitting a new impeller into a jet the Impeller Taper must be lapped to the shaft in accordance with British standard MA 74.
6. Prevent shaft rotating by fitting special tools "Reaction Arm", screw on impeller nut (68) and torque as per section 6.1.4.
7. If necessary redrill recess hole for grub screw (69) in mainshaft then fit and tighten grub screw (69) with Loctite 222 (or equivalent) thread locking fluid and tighten.
8. Working through the intake inspection hatch remove surplus grease from the impeller seal recess (at front of impeller). Then slide seal (53) back into the recess while rotating the mainshaft and impeller by hand.
9. Wipe bearing sleeve (64) clean to ensure rubber bearing (63) remains free of grease.
10. Dust rubber bearing (63) with talc or french chalk.

6.2.2 (vi) cont...

11. Clean and grease tailpipe/intake contact faces. Check 'O' Ring (94) for size or damage, replace if required. Refit tailpipe, taking care not to pinch 'O' ring (94) at the same time steering crank (6) onto shaft (8). Screw on 12 x M16 and 4 x M20 nuts with spring washers - threads greased. Torque as per section 6.1.4. noting that special torque applies for the 4 x M20 nuts.

12. Using the special tool "Reaction Arm" fitted to the coupling flange (36), as a handle, turn mainshaft to ensure assembly rotates.

13. Replace and tighten cotter (taper pin) (2) in steering crank (6). With M12 heavy flat and spring washer torque for M12 nut as per section 6.1.4. Ensure cotter fitted the correct way round to tiller cotter - refer Section 2.9.5.

14. The reverse duct (1) may now be refitted. If necessary the bush (137) in the duct arms should be replaced. It is normally a loose fit over the pins and should be round (not oval) with approx .5mm. If replacing, the bore in the arms must be cleaned and painted; first with zinc chromate etch primer and then with zinc chromate primer. Press bushes in when paint is dry. Grease the pins (138) before fitting and ensure there is a washer (62) each side of each arm.
From serial # 106 on:- torque 4 x M16 bolts to secure each pin - note special torque applies, ref 6.1.4.
From serial # 105 and earlier:- check threads on reverse bucket pivot pins (138) are free from burrs, clean threads and taper seats then grease including bore of bushes (137) and washer (62). Torque to special torque for Rev Duct Pivot Pin, refer 6.1.4.

15. Reconnect the reverse cylinder pins (C20). If the clevis pin bush (139) is worn oval it should be replaced. The bore must be cleaned, etch primed and primed with zinc chromate paint and the new bushes pressed in when the paint is dry..

16. Check that steering control from helm to tiller(19) is free and then reconnect cylinder to tiller (19). Refer to steering system installation and adjustment - Section 2.9.

6.2.3 STEERING SYSTEM:

The Steering Cylinder and helm pump parts lists and illustrations are shown in Sections 7.1, 7.2 & 7.3. For fault finding with Steering System refer to Fault Finding section 5.3.

The system oil should be changed annually or immediately if contaminated in any way. If the oil has been contaminated in any way all components, including the helm pumps, must be disassembled, cleaned and the hydraulic lines flushed clean with kerosene, varsol or diesel oil. Check the condition of the cylinder seals carefully before reassembly and replace if necessary. Note - a cylinder seal kit Hamilton part number EXPO RTN is available. Refill system with oil and bleed as per instructions on section 2.9.7.4.

6.2.4 REVERSE CYLINDER:

The Reverse Cylinder assembly is as Parts List and Drawing, section 7.4.

For fault finding with the Reverse System refer to the HSRC,HYRC (or HERC) Manual.

Maintenance:

1.The Reverse Cylinder need only be dismantled if it is suspected that a seal has failed. Typical symptoms of seal failure are:
Piston Seal (C4): Reverse bucket creeping down from up position. (Can also be caused by a faulty solenoid valve on the EHPU - refer HERC Manual).
Shaft Seals (C7): Oil leaking from the Fronthead (C5) or backhead (C6).

Removing from waterjet

2. Disconnect hydraulic hoses and H.S.R.C. linkages from reverse cylinders.
3. Remove split pin(C21) and pivot pins (C20) at reverse cylinder.
4. Remove 8 bolts(C23), flat washers(C24) and 4 pillow blocks(C16).
5. Loosen 2 hose clamps(155) from hosetail(154) at transom.
6. Unscrew clevis(C11) from shaft end and remove anode(C15)
7. Withdraw cylinder shaft through transom holes and remove cylinders for further dismantling.

Dismantling

8. Unscrew lockring(C10) and remove backhead(C6) from cylinder(C9)
9. Withdraw the shaft assembly from the cylinder(C9).
10. Remove all seals from piston (C3), back head (C6) and front head (C5)
11. Unscrew fronthead (C5) from cylinder (C9). Apply minimal heat if necessary to break thread lock fluid on joint.
12. Ensure thread lock fluid is removed from engaging threads and thoroughly clean all parts.
13. Check cylinder (C9) bore and shaft (C1) outside diameter for wear or scores. Replace only as a pair if obviously worn.

Re-assembly

14. Fit new seals to piston (C3), backhead (C6) and fronthead (C5). Note - a cylinder overhaul kit, is available which includes all seals and a bottle of "Loctite 262".
15. Apply "Loctite 262" or equivalent threadlock fluid to cylinder thread engaging fronthead (C5) and tighten fronthead using a strap wrench.
16. Oil shaft/piston assembly and insert into cylinder. Care should be taken so as not to damage seals.

17. Replace new "O" ring (C14) in backhead and re-fit to cylinder . Fit and tighten lockring (C10).
18. If possible, workshop test the reverse cylinder to 138 bar (2000 psi) before reinstalling in the boat.
19. Replace hose (154) and hose clamps to cylinder.
20. Slide shaft through transom hole and connect hose (154) to hose tails (164). Tighten hose clamps(155).
21. Screw clevis (C11) and anode (C15) onto shaft end and tighten locknut(C12).
22. Fit pin(C20) through clevis (C11) and reverse duct arm. Note on older units with a sinlge 105763 spacer (C22) these are fitted between deflector lug and clevis to the insides - refer reverse cylinder drawing. Fit split pins (C21) and splay.
23. Refit 4 pillow blocks (C16), fit bolts (C23) and spring washers(C24). Tighten M12 bolts as per section 6.1.4.
24. Connect up hydraulic hoses and control linkages. (refer to HERC, HSRC or HYRC manual as appropriate).

CHAPTER 7
DRAWINGS

7.0 CONTENTS

NOTE: "C" indicates drawings may be found in Controls Drawings Section
"J" indicates drawings may be found in Jet Drawings Section
"F" indicates drawings may be found in retainer at front of folder.

Other drawings are in body of text.

7.1 Steering Position Indicator

(Refer to Controls Drawings Section)

7.2 Steering Position Sender

(Refer to Controls Drawings Section)

7.3 Steering Helm Pump

(Refer to Controls Drawings Section)

7.4 Steering Cylinder

(Refer to Controls Drawings Section)

7.5 Steering Bracket Rotated

(Refer to Controls Drawings Section)

7.6 Reverse cylinder assembly

(two (2) cylinder assemblies per jet).

Item	Part No.	Reqd.	Description
C1	105602	1	Shaft
C2	105603	1	Compensator shaft
C3	105604	1	Piston
C4	61435	1	Piston seal
C5	HM57071	1	Front head - (replaces 105605, includes extra seal item C7)
C6	105606	1	Back head
C7	61436	4	Shaft seal
C8	61437	2	Shaft wiper
C9	105607	1	Cylinder
C10	105608	1	Lock ring (END CAP)
C11	105609	1	Clevis
C12	JDQKXAL	1	Hex Nut M20 thin 316 s.s.
C13	61438	3	Bearing ring
C14	HMHRABD	1	"O" ring
C15	105764	1	Anode
C16	105610	2	Pillow block
C17	KHITXCO	2	Bush
C18	JENXAAO	2	Dowty washer
C19	NZAAJBD	2	Nipple for Dowty washer (C18)(3/8" BSPP).
C20	105761	1	Cylinder Pin
C21	HUILAAY	1	Split pin 316 S.S.
C22	63689	2	Washer (replaces 105763)
C23	HYQHXFT	4	M12 x 50 Bolt 316 s.s.
C24	JEQKXAH	4	M12 lockwasher

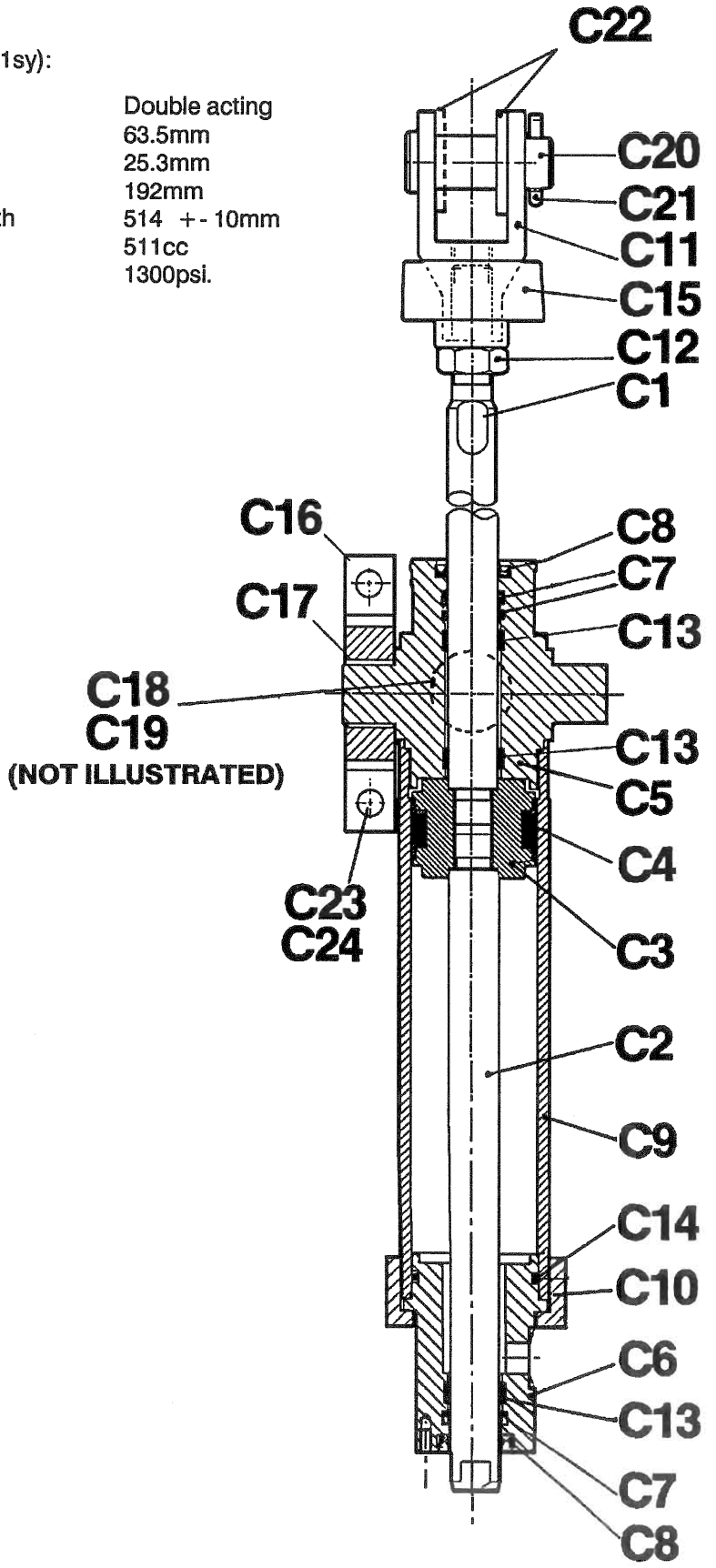
Spare parts - Cylinder Seal Kit 105926 includes items to overhaul two (2) cylinders

Item	QTY
C4,	2
C7,	8
C8,	4
C13	6
C14	2

Plus 10ml "Loctite 262" - part no MRINAAI

Specifications (105601sy):

Type	Double acting
Bore	63.5mm
Shaft Dia.	25.3mm
Stroke	192mm
Extended length	514 +- 10mm
Displacement	511cc
Max pressure	1300psi.



7.7 General Parts List

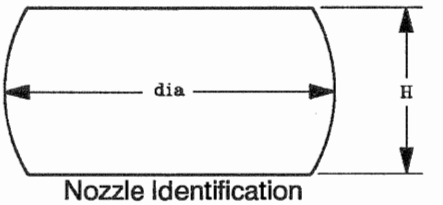
(From Serial Numbers 171,172)

Item	Part No.	Reqd.	Description
1	106598	1	Reverse Duct (replaces 1056323 but items 61,62,137,138,139,201, & 202 must also be changed)
2	105657	2	Cotter (taper) pin
3	104908	2	Washer (for item (2))
4	JEQKXAH	2	Spring washer M12, 316 S.S.
5	JDQHXAH	2	Hex nut M12, 316 S.S.
6	105620	1	Steering crank
7	104837	2	Bush, steering shaft
8	105655	1	Steering shaft
9	103914	16	Stud M10x95 (transom seal)
10	JEQKXAE	20,2	Spring washer M10 316 S.S.
11	JDQHXAE	16,2	Hex nut M10 316 S.S.
12	103904	2	Rear header ring half
13	103906	1	Transom seal
14	105656	1	Steering Shaft seal housing
15	103905	2	Front header ring half
16	105645	2	Steering bracket spacer
18	105644	1	Steering bracket
19	104840	1	Tiller
20	105970Y		Impeller type 38
	105969		Impeller type 42
	105968		Impeller type 45
	105967		Impeller type 49
	105966		Impeller type 53
	105965		Impeller type 57
	105964		Impeller type 61
	105963		Impeller type 66
	106753		Impeller type 70
24	105793	1	Inspection Cover
25	JDQHXAP	4,4,6	Hex nut M20 316 S.S.
26	103452	4,4	Washer M20
27	103421	4	Stud Inspection cover M20 x 90
28	103433	1	Seal inspection cover
29	105652	1	Intake
30	104051	1	Mainshaft
31	103858	1	Inspection cover - rotary seal

32	103859	1	Gasket - rotary seal inspection cover
35	103870	1	Bearing housing
36	107635	1	Coupling flange Assy to suit G.W.B. 587-48 Drive shaft for HM402 Jet.
37	103878	1	Coupling nut
38	103880	6	Stud - Bearing housing M20 x 322
39	JEQKXAL	6	Spring washer M20, 316 S.S.
40	JEQHXAP	6	Hex nut M20, 316 S.S.
41			Transition duct
42			Bolt -screen
43	103448	2	Dowel - (standard)
44	105667	1	Screen
45	102178		Stud, screen M16 x 60
46	HIHKAAA	1	1/8" BSPT Galv. Plug.
48	103423	20	Stud, transition joint M16 x 98
49	JEQKXAJ	22	Spring washer M16, 316 S.S.
50	104004	1	Dowel
51	105887	1	Insulating ring
52	105886	1	Wear ring
53	103934	1	Impeller seal
54	103929	1	Impeller Key
55	104507	1	Taper sleeve
58	102177	12	Stud tailpipe (short) M16 x 85
59	103451	20,12	Washer M16
60	JEQHXAL	22,12	Hex nut M16, 316 S.S.
61	HM57028	2	Reverse mount insert (Serial # 105 & earlier use 105650)
62	106705	4	Thrust washer
63	106267	1	Marine bearing
64	103930	1	Bearing sleeve
65	30688	4	Stud - tailpipe (long) M20 x 220
68	103879	1	Impeller nut
69	JAJYXDB	1	Socket head set screw M12 x 30, 316 S.S.
70	105599	1	Stator hub fairing
71	103927	4	Stud, tailpipe anode M12 x 90
72	JEQKXAH	15,4	Spring washer M12, 316 S.S.
74	103862	2	Anode
75	105759SY	1	Tailpipe kit
76	105659	2	Pivot pin
77	HYQHXCJ	2	Hex head bolt M8 x 80, 316 S.S.
78	JEQKXAC	2,10,2	Spring washer M8, 316 S.S.
79	JDQHXAC	2,2,10,4	Hex nut M8, 316 S.S.
80	105790SY	1	Steering indicator Assy
81	103359	2	Anode
82	30669	11,4	Stud - nozzle M12 x 59
83	JEOZXAK	4,11,8	Flat washer M12, 316 S.S.

Spares Kit includes :-
- Tailpipe housing (105649)
(63) Marine bearing
(70) Hub fairing
(61) Reverse pivot insert (105650) x2
(74) Anode x2
(82) Stud x11
(71) Stud x4
(84) Nut M12 x 4
(72) Spring Washer M12 x 4

84	JDQHXAH	4,11	Hex nut M12, 316 S.S.
85	105957	1	Nozzle 210 (dia = 218,H=182 1)
86	105755SY	1	Deflector Assy. (Includes pivot (105658) and crank (104832) bushes)
87	105645	1	Packer (optional)
88	105660	2	Nozzle Bushes (Bronze)
89	103953	1	Seal Retaining collar
90	JAJYXCY	2	Skt set screw M12 x 16, 316 S.S.
91	61419SY	1	Shaft Seal
92	104027	1	Seal face holder
93	103947		Stud M8 x 75
94	106994	1	'O' Ring (Tailpipe/Intake)
96	103872	1	Slinger
98	103432	2	Seal sleeve
99	JNODADP	1	Bearing
100	103430	1	Bearing spacer
103	104951SY 106989SY 106990SY 106991SY 106992SY	1	Dipstick & Filler cap assy.
104	JNODAEA	1	Bearing
106	HMHRADO	1	'O' Ring 7.25" x 7.5" x .125"
107	60226	12	Spring - bearing preload.
109	JNODAFZ	1	Bearing retaining nut SKF KMT14 (Replaces items (108)), Tab Washer 103873, and (109) , Nut 103434 , - used on serials #105 and earlier).
110	103911	1	Coupling Key
111	HIQUAAE	1	3/4 BSPT Galv. plug
112	JWKZACB	2	Oil seal Stefa 9512012CB
113	103871	1	Bearing retaining plate
114	103887	1	Distance sleeve
116	104028	1	Retainer
117	103687	2	Stud - retaining plate M8 x 78 **(Not Illustrated)**
120	103875	(as reqd)	Shim .005"
121	103876	(as reqd)	Shim .002"
122	103874	(as reqd)	Shim .010"
124			
125	HMHRADL	1	'O' Ring .625" x .75" x .062"
126	HYQHXEH	2	Hex head Bolt M10 x 90, 316 S.S.
127	.		
128	103435	1	Round Key



Nozzle Identification

129	105644	1	Steering bracket
130	105756	1	Overflow preventer (**optional**)
132	63135	1	Patent plate
133	63097	1	Serial No. and Name plate
137	106694	2	Bush - reverse duct pivot (Serials #105 and earlier use 105653)
138	106693	2	Pivot pin (reverse duct) (Serials # 105 and earlier use 105651).
139	106695	2	Reverse duct bush - (reverse cylinder pin)(Serials# 105 and earlier use 105762)
141	105601SY	2	Reverse Cylinder Assy. (refer seperate parts list and drawing)
149	105616	1	Transom plate
150	105619	2	Plug
154	105618	2	Hose
155	HSIJAAY	4	Hose clip
156	61332	1	Scraper (steering shaft)
157	JCQHXAO	2,4	Stud M10 x 50
158	61422	1	Seal (Steering shaft)
162	105903	1	Gasket (Steering shaft seal housing)
163	103910	2	Keeper
164	105617	2	Hose tail
165	106059	2	Keeper Bracket (used on serial #105 and earlier only)
169	JCQHXAG	2	Stud M8 x 35, 316 S.S.
170	JELLAAH	2	Large flat washer
171	104026	1	Gasket
172	103948	1	Pin
173		1	Seal face — Parts of item 91 - Seal Assembly.
174		1	'O' ring - seal face to seal face holder — (not available seperately)
175			
176	102769	4	Stud M12 x 78 long
177	HYQHXCJ	2	Bolt M8 x 80 (anode on rev. duct) (serial #105 and earlier use HYQHXCE - Bolt M8 x 60)
198	103900	1	Blank plate
200	102185-4	2	Anode - (reverse duct)
201	HYQHXIV	8	Hex bolt M16 x 90, 316 S.S. — Use only on serials # 106 and
202	JEQKXAJ	8	Spring washer M16, 316 S.S. — later with Pivot Pin 106693 (138)
203	63895	1	Brush Holder
204	107659	1	Stud for Slipring Assembly

- NOT ILLUSTRATED

OVERFLOW PREVENTER

105756	Overflow preventer kit (Optional extra)

INTAKE COOLER

107566	Cover - Intake Oil Cooler
107568	O-Ring 3.53mm sect. x 1240 long Joined (Cover/Oil Cooler)
NZAAJBF	Nipple 1/2" BSP to 1/2" BSP Dowty Seal
JENXAAR	Dowty Bonded seal 1/2" BSP
30671	Stud M10 x 51 long, 316 SS
JDQHXAE	Spring Washer Dia. 10, 316 SS
JEQKXAE	Nut, M10, 316 SS

TOOL KIT

106935	Toolkit, 402 Jet

WARRANTY

The Company warrants each new Hamilton product to be free from defects in materials and workmanship under normal use and service, its obligations under this Warranty being limited to make good at its factory or at the factory of any subsidiary or branch of the Company the product or any part or parts thereof which shall be returned to it with transportation charges prepaid and which its examination shall disclose to its satisfaction to have been defective provided that the product or such part or parts thereof shall be so returned to it not later than 24 months from the date of the original purchase from the Company or its authorised distributor, or 12 months from commissioning date, whichever occurs first. No allowance shall be granted for any repairs or alterations made by the purchaser or its agent without the written consent of the Company. This Warranty is expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, including any liability under the Sale of Goods Act, 1908, and no other person or agent or dealer is authorised to give any other condition or warranty to assume for the Company any other liability in connection with the sale of its products whether new or second hand. Any obligation on the part of the Company under this Warranty does not apply to any Hamilton product which may have been repaired or altered in any way outside the factory of the Company or to damages caused in the opinion of the Company by overloading, misuse, mis-application, improper storage, abnormal wear and tear due to exposure to the elements, negligence, accident,or whilst being operated in any other way other than in accordance with the operating and maintenance instructions of the Company nor does it apply to repairs made necessary by the use of parts or accessories not recommended by the Company. There is no liability on the part of the Company with respect to any items incorporated in any Hamilton product when such items have been manufactured by others and are warranted by their respective manufacturers in favour of the purchaser or when they are supplied by the Company on special order. The Company shall not be liable for any consequential loss or damage resulting directly or indirectly from any defect in the product the subject of this agreement. No liability on the part of the Company with respect to this Warranty shall extend to second - hand and reconditioned goods and the Warranty does not cover the cost of labour involved in the replacement of defective parts. No liability on the part of the Company with respect to this Warranty shall exist if the Hamilton product is not, in the opinion of the Company, installed as per the "Installation and Service Manual", "Designer's Manual" and / or "Owner's Manual" supplied with each product. For some models of Hamilton product, as specified in the respective model manual, warranty conditions will not apply unless a negative earth bonding system has been installed in the vessel and a mainshaft critical speed check has been carried out to the Company's satisfaction.

C.W.F. HAMILTON & Co Ltd.

This portion must be completed **in every detail** and returned immediately to:
C.W.F. HAMILTON & CO LTD, PO BOX 709, CHRISTCHURCH, NEW ZEALAND.

Purchaser.....

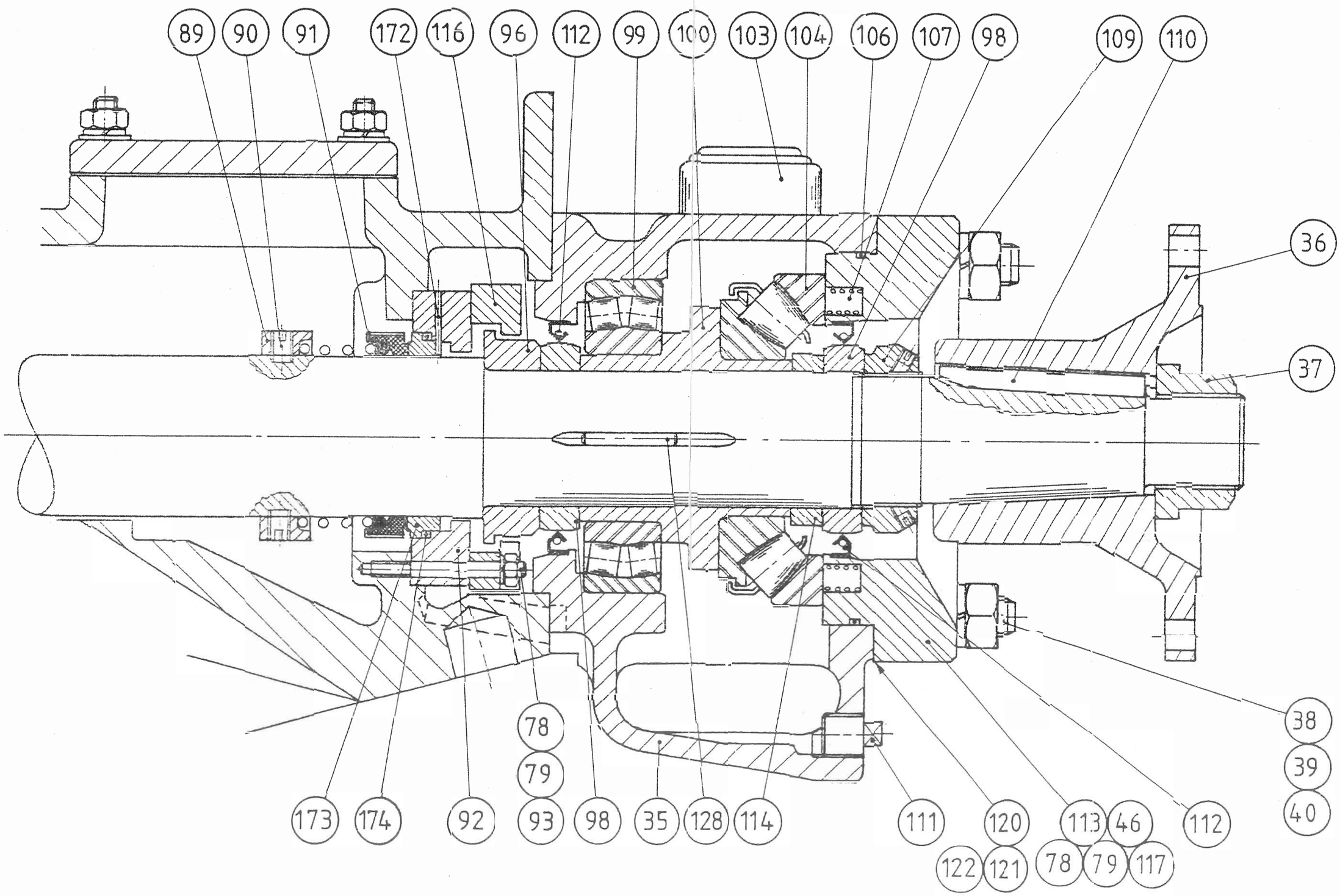
Address .....

HamiltonJet model ..... Serial number.....

Signed..... Date .....

Dealer.....

Delivery date..... Dealer's signature.....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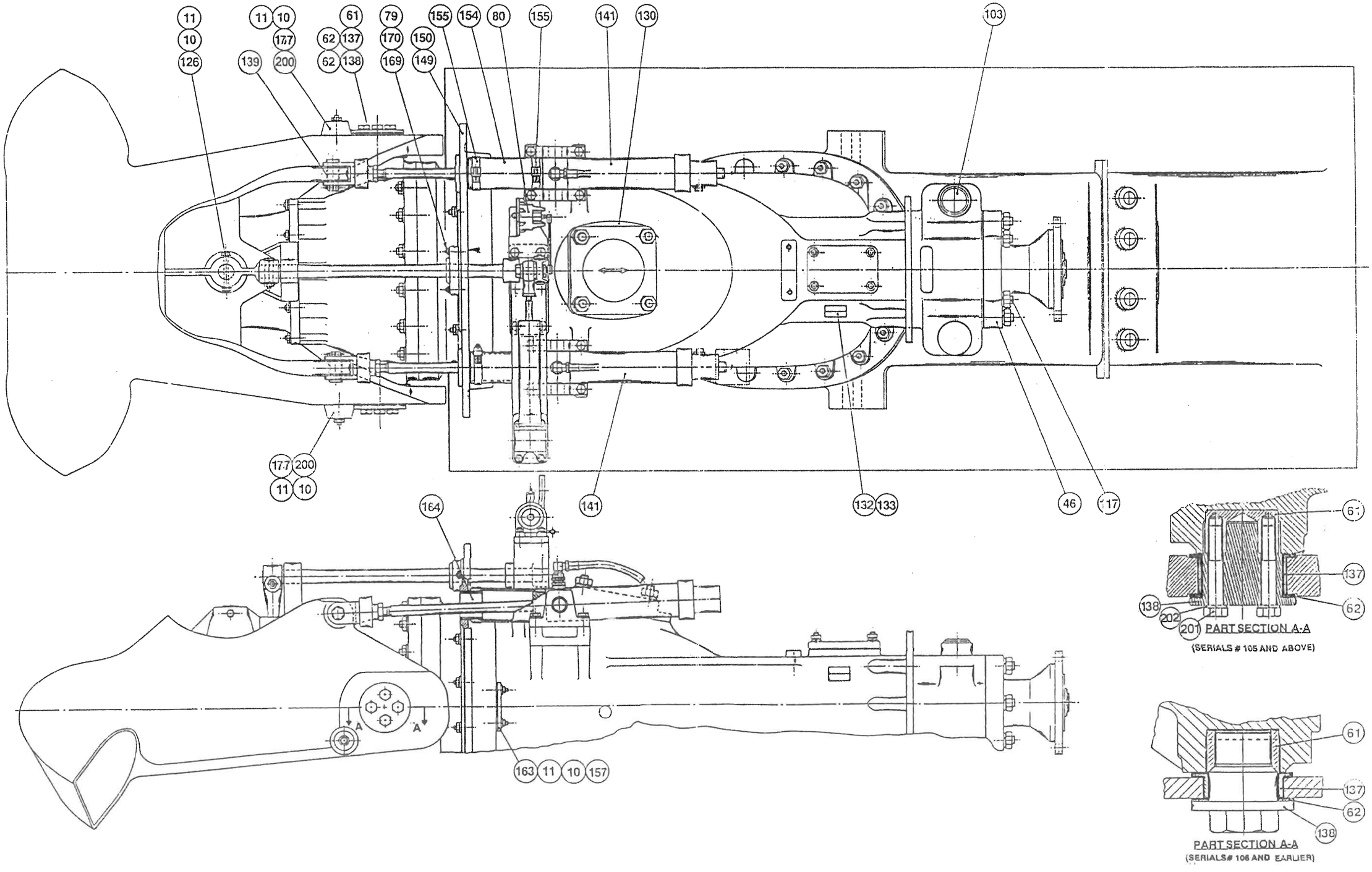
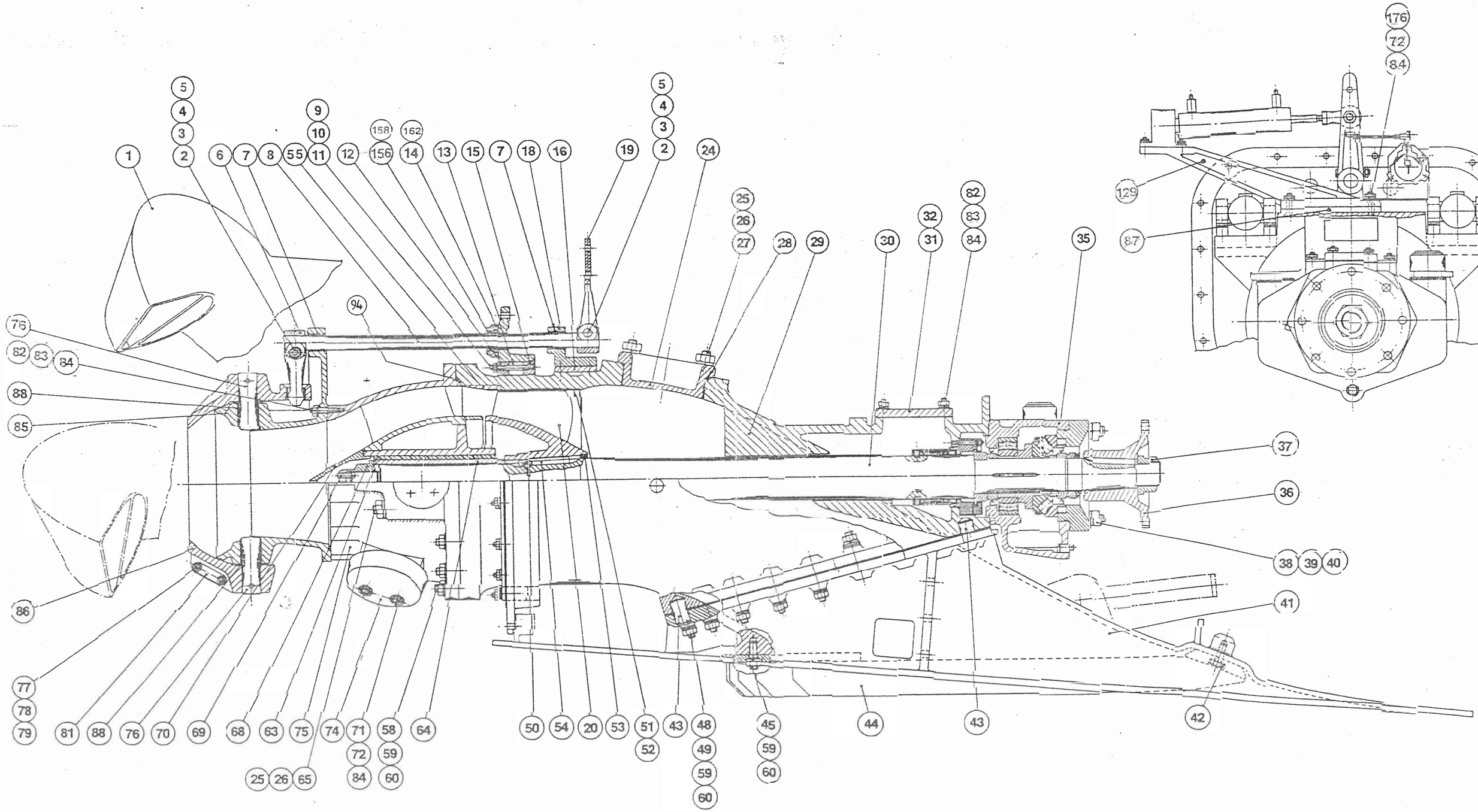


PART SECTION A-A
(SERIALS # 105 AND ABOVE)

PART SECTION A-A
(SERIALS# 106 AND EARLIER)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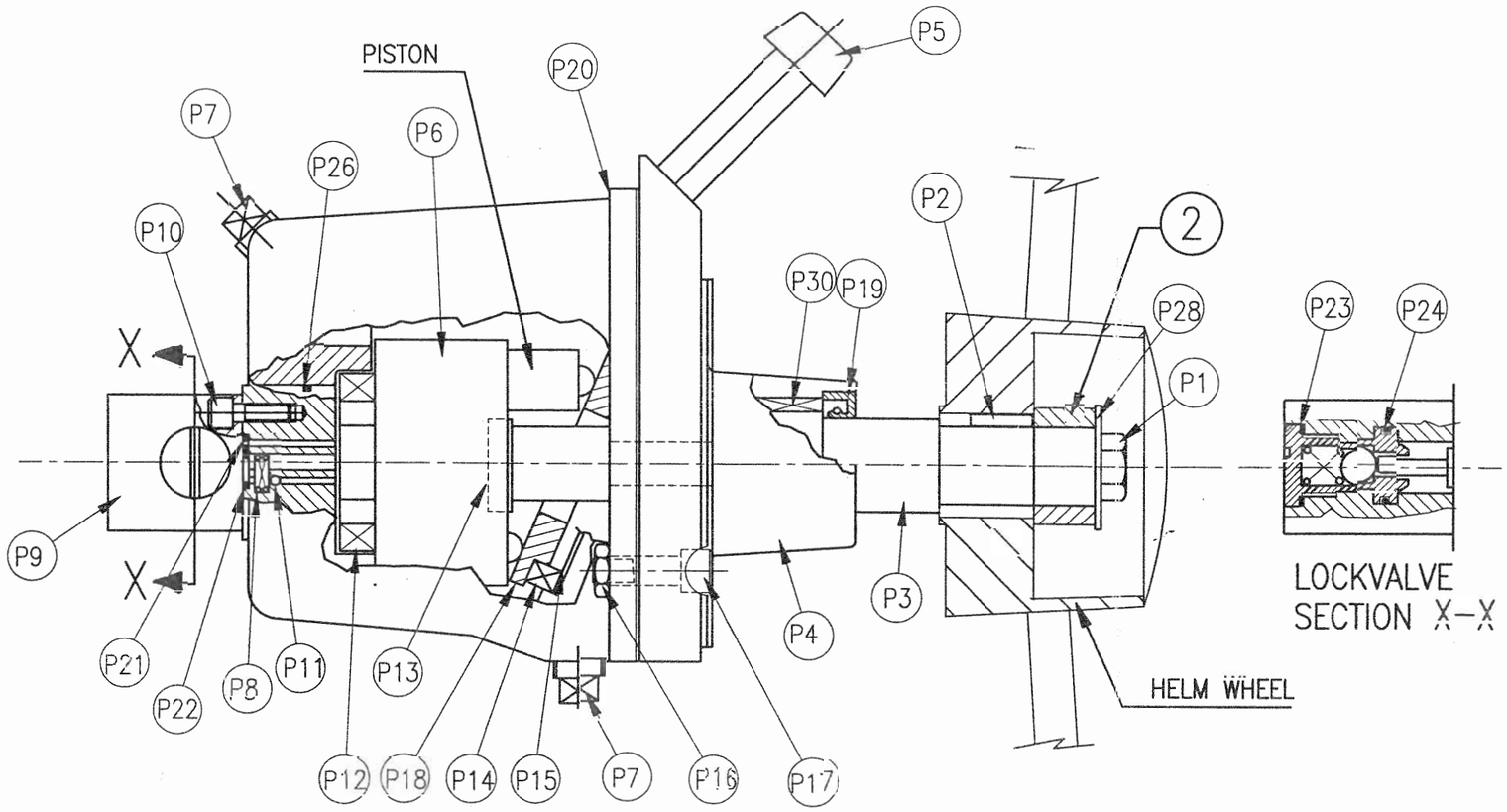
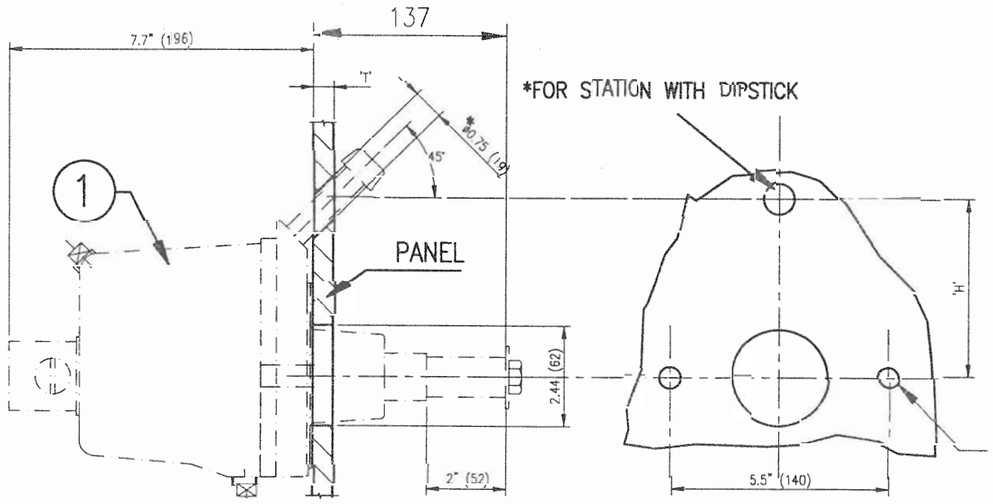
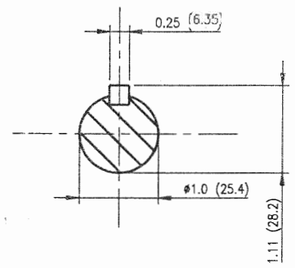


PROJECTION

SPARES ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO CWF H. USE ONLY
3	1	63929	1	HELM PUMP WAGNER B2	63929
4	2	106129	1	BUSH	106129
3	3	EXPORT L	REF	HELM PUMP SEAL KIT	61461





SHAFT DETAILS

ITEM	PART No	QTY.	DESCRIPTION
P1	51–211011	1	BOLT
P2	51–102007	1	KEY
P3	320–0136	1	SHAFT
P4	320–0065	1	FRONT PLATE
P5	111–0004	1	DIPSTICK ASSEMBLY
P6	310–0021	1	HOUSING, PINTLE ROTOR ASSY.
P7	41–132002	2	PLUG
P8	91–990006	2	WIRE BALL STOP
P9	400–0002	1	LOCKVALVE
P10	51–209002	2	CAPSCREW
P11	21–300002	2	BALL
P12	21–100006	1	BEARING
P13	320–0135	1	KEY (ROTOR)
P14	21–100002	1	BEARING
P15	91–990003	1	BEARING CAGE
P16	51–509009	4	NUT
P17	51–209003	4	CAPSCREW
* P19	10–500009	1	SHAFT SEAL
* P20	10–300014	1	GASKET
* P21	11–106006	1	O–RING
* P22	11–106016	2	O–RING
* P23	11–106020	2	O–RING
* P24	11–106016	2	O–RING
P28	51–401005	1	WASHER
P30	320–0210	1	BEARING

3

PANEL CUTOUT
FOR B2 HELM
PUMP

REF	NO.	BY	DATE	AMENDMENTS
CL3704	D	C.W.R.	17–5–95	391, 402 & 422 ADDED.
CL.3681	C	C.W.R.	13–10–95	REDRAWN,PARTS LIST RENUMBERED,NOW A3 MASTER

JET 571 521 391 422 (402)

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

MATERIAL

√ = N9 EXCEPT AS STATED

UNLIMITED DIMENSIONS TO BE ± 0.5

MAT'L CERT

DESIGNED DATE

DRAWN C.W.R. 5–10–94

CHECKED K.V.E. 11–10–94

APPROVED

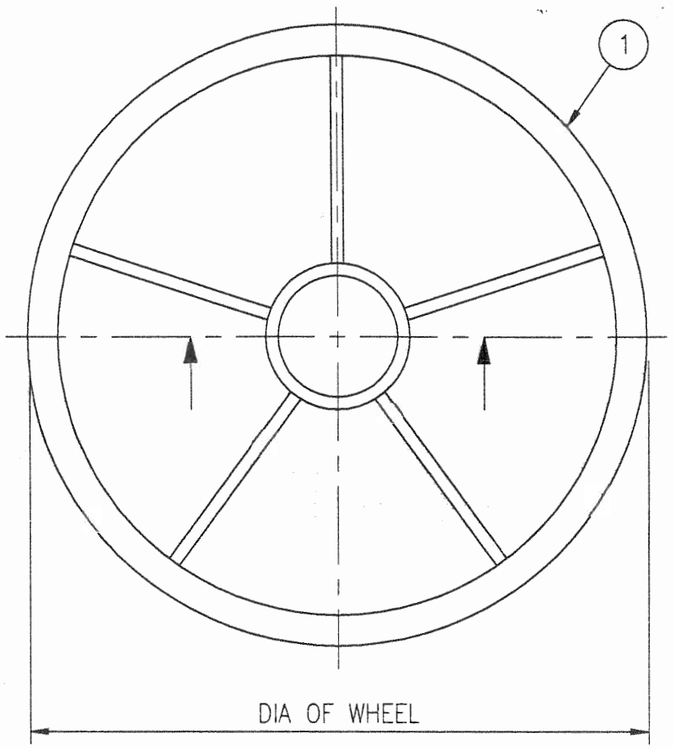
NAME
HELM PUMP
WAGNER B2

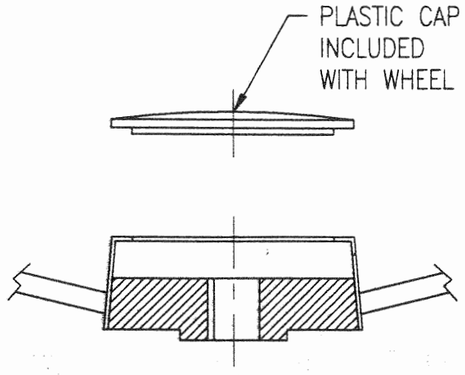
SCALE NONE

No: A3–CTHLM02001 D

D

CTHLM02001



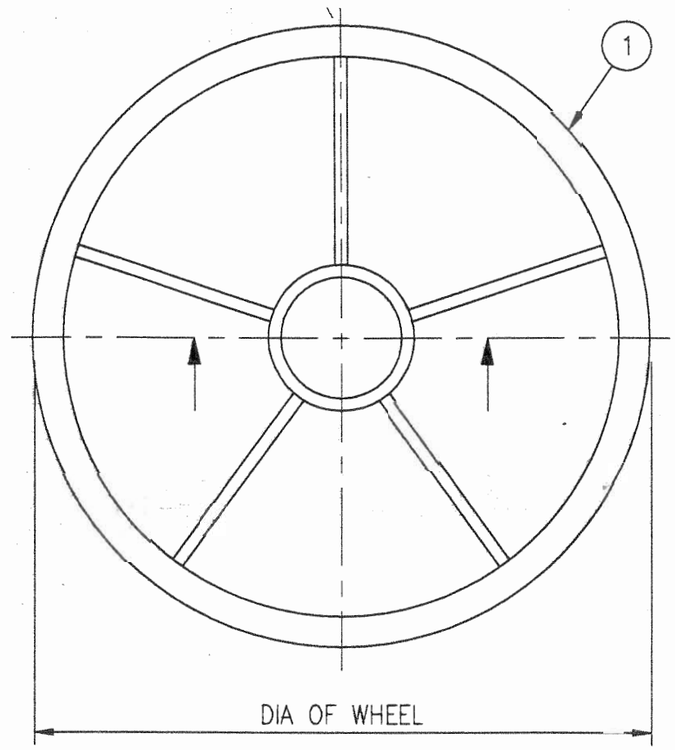


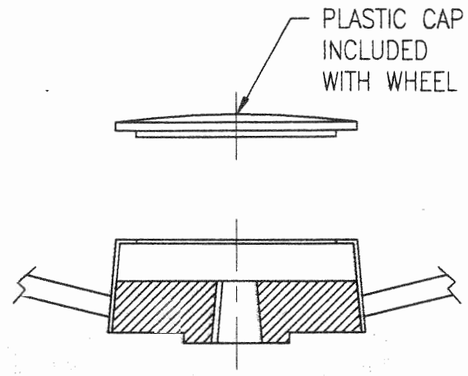
1" PARALLEL BORE

USED ON:- WAGNER B2 AND B4 HELM PUMPS

SPARES ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO CWF H USE ONLY
4	1	64526	1	30" WHEEL 1" PARALLEL BORE	THS
4	1	EXPORT D	1	24" WHEEL 1" PARALLEL BORE	THS
4	1	EXPORT Z	1	20" WHEEL 1" PARALLEL BORE	THIS
4	1	64563	1	18" WHEEL 1" PARALLEL BORE	THIS
4	1	64562	1	16" WHEEL 1" PARALLEL BORE	THIS

SUB ASSEMBLY No: CT HLM 04 001 PARALLEL BORE





3/4" TAPER BORE

USED ON:- WAGNER 700 AND SEASTAR HELM PUMPS

SPARES ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO CWF H USE ONLY
4	1	64501	1	22" WHEEL 3/4" TAPERED BORE	THIS
4	1	EXPORT C	1	20" WHEEL 3/4" TAPERED BORE	THIS
4	1	EXPORT B	1	16" WHEEL 3/4" TAPERED BORE	THIS

SUB ASSEMBLY No: CT HLM 04 002 TAPER BORE

REF	NO.	BY	DATE	AMENDMENTS
CL3754	E	F.K.	5.7.96	PART No'S 64562, 64563 16 & 18" WHEELS ADDED
CL3750	D	F.K.	14.5.96	PART No 64526 30" WHEEL ADDED
CL3743	C	F.K.	11.3.96	22" WHEEL ADDED
CL3732	B	L.C.	20.11.95	REDRAWN ON CAD , 241 ADDED
3648	A	C.W.R.	3.2.94	UPDATED
JET	212	241		

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

PROJECTION

DESIGNED K.V.A	DATE 10.95
DRAWN L COOPER	20.11.95
CHECKED K.V.A.	
APPROVED K.V.E.	16.5.96

NAME
HELM
WHEEL. KITS

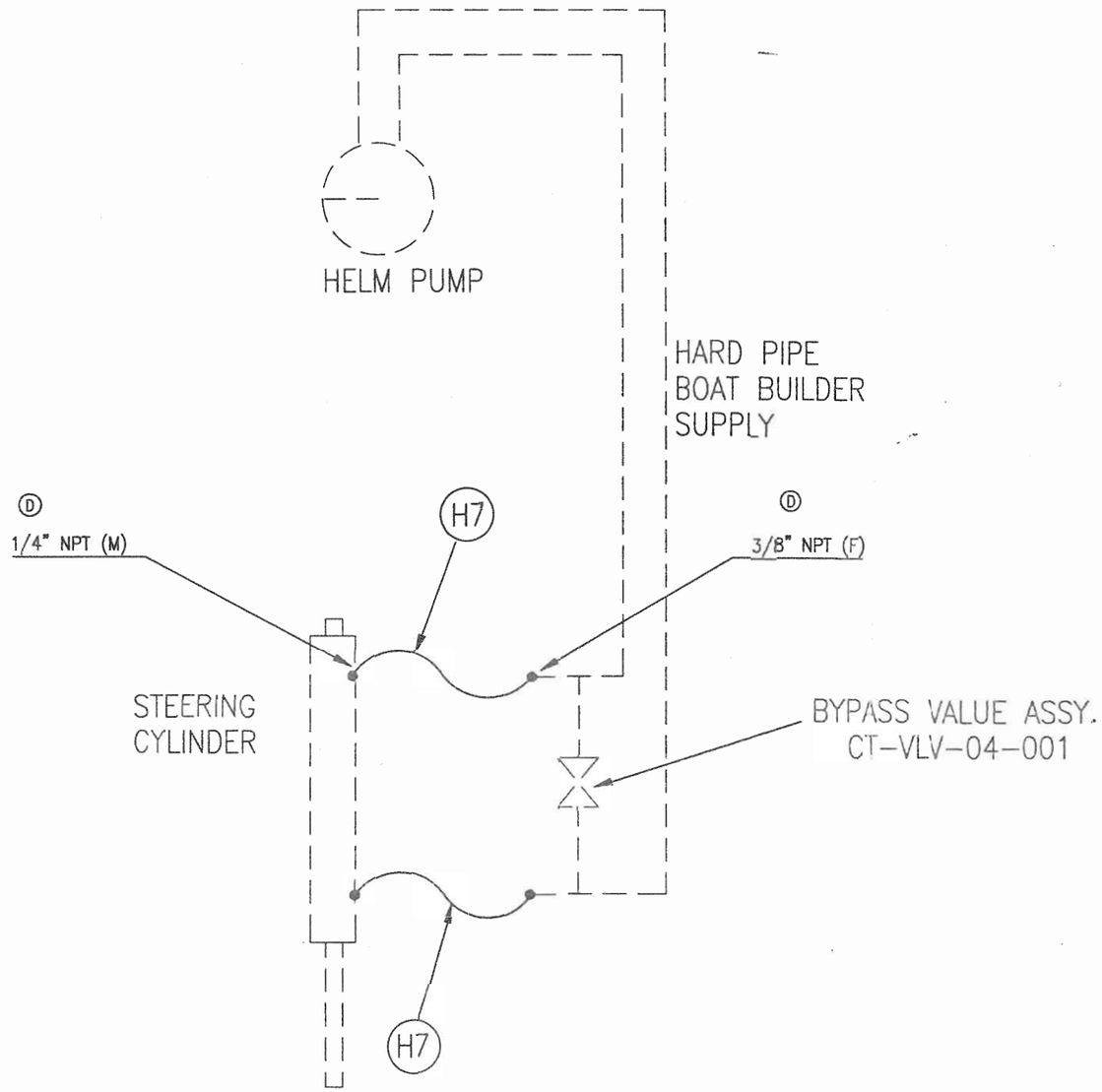
SCALE -

No: ASSY-CT HLM 04 000 E

PROJECTION

SPARES ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO CWF H. USE ONLY
1	H7	*66090	2	WAGNER	THIS

*NOTE:-HOSES ARE ALSO SUPPLIED WITH CYLINDER PART No 63635



E

CTHSE01002

REF	NO.	BY	DATE	AMENDMENTS
CL3749	E	PMW	10-5-96	461 ADDED TO LIST OF JETS
CL.3719	D	C.W.R.	15-8-95	PIPE THREAD SIZES ADDED
CL.3704	C	C.W.R.	17-5-95	391,422 & 402 ADDED
CL.3682	B	CWR	20-10-94	REDRAWN ON CAD
CL3654	A	CWR	21-3-94	UPDATED
CL3639	0	CWR	3-11-93	ISSUED FOR MANUFACTURE

JET 571 521 391 422 (402) 461

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

MATERIAL

√ = N9 EXCEPT AS STATED

UNLIMITED DIMENSIONS TO BE ± 0.5

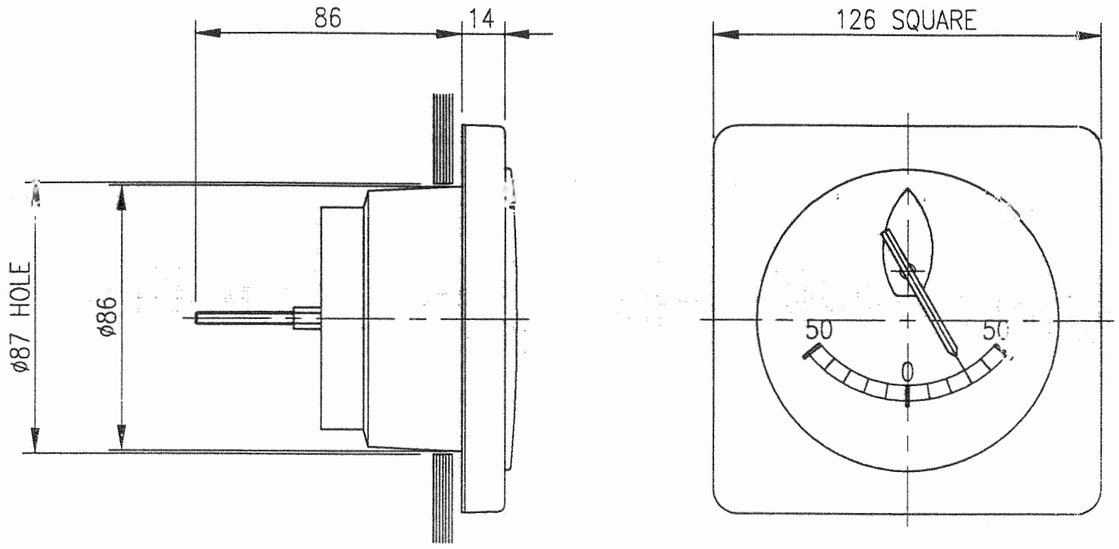
MAT'L CERT	
DESIGNED	DATE
DRAWN C.W.R.	3-11-93
CHECKED M.C.M.	3-11-93
APPROVED K.V.A.	20-10-94

NAME

MANUAL HELM
STEERING
HOSE KIT

SCALE NONE

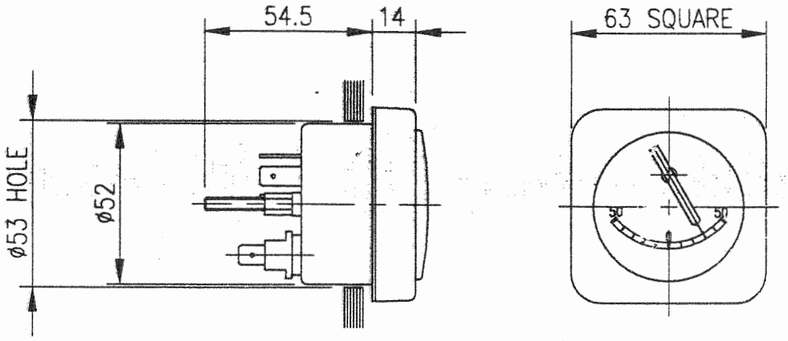
No: A3-CTHSE01002 E



ITEM No1

PART No: 63613
VDO GAUGE PART No: 402732
BEZEL PART No: 240729
VOLTAGE: 12–24V
RANGE: 50° – 0 – 50°

NOTE: REFER TO VDO INSTRUCTION SHEET
FOR FURTHER INFORMATION.



ITEM No2

PART No: 63612
VDO GAUGE PART No: 402731
VOLTAGE: 12V
FOR 24V OPERATION USE DROP IN RESISTOR
PART No: 240701 SUPPLIED
RANGE: 50° – 0 – 50°

SPARES ASSY	ITEM	PART No	QTY	DESCRIPTION	DWG No
3	1	63613	1	GAUGE (VDO) WITH SQUARE BEZEL (LARGE)	THIS
3	2	63612	1	GAUGE (VDO) WITH DROP IN RESISTOR (SMALL)	THIS

REF	NO.	BY	DATE	AMENDMENTS
CL3781	C	P.M.W	12.5.97	REDRAWN ON CAD. REFERENCES TO JETS 273 TO 571 ADDED
CL3654	B	P.M.W	20.3.94	UPDATED
CL3648	A	R.L.	3.2.94	UPDATED
CL3641	0	P.S.	17.11.93	ISSUED FOR PRODUCTION

JET 273 291 321 362 363 391 422 461 521 571

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

PROJECTION

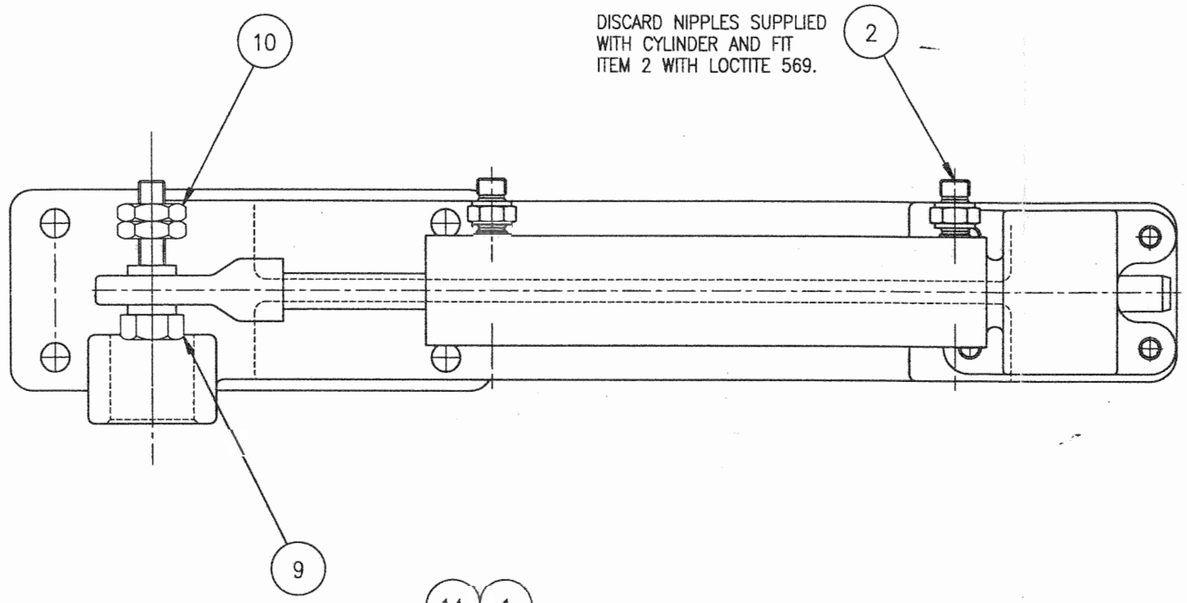
NAME: STEERING INDICATOR GAUGES (VDO)

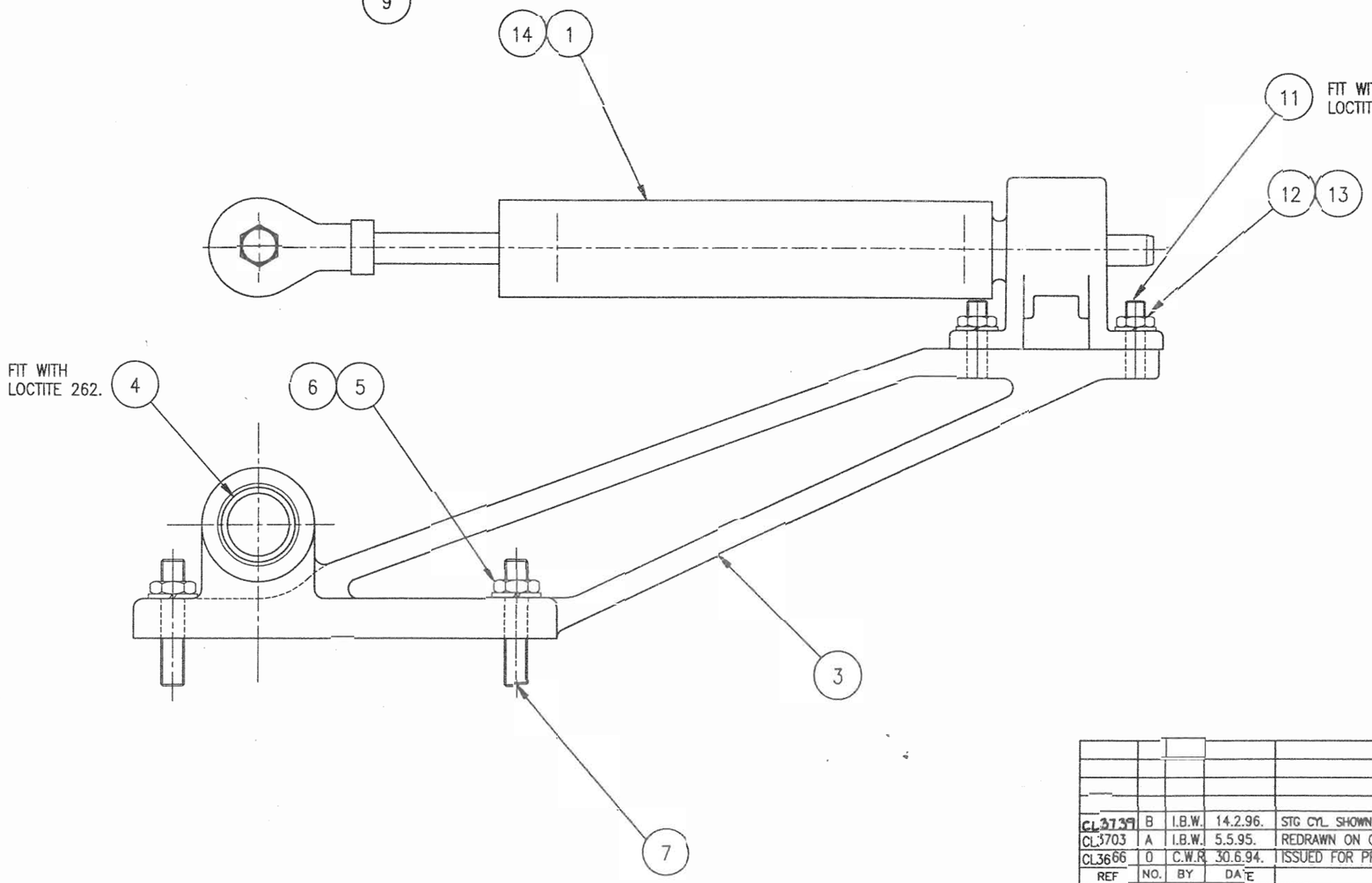
	DESIGNED	DATE
DRAWN	P.M.W.	17.11.93
CHECKED	P.S.	17.11.93
APPROVED	K.V.A.	10.2.94

SCALE 1:2 | No: ASSY–CT IND 01 000 | C

CT-SJK-01-008 | B

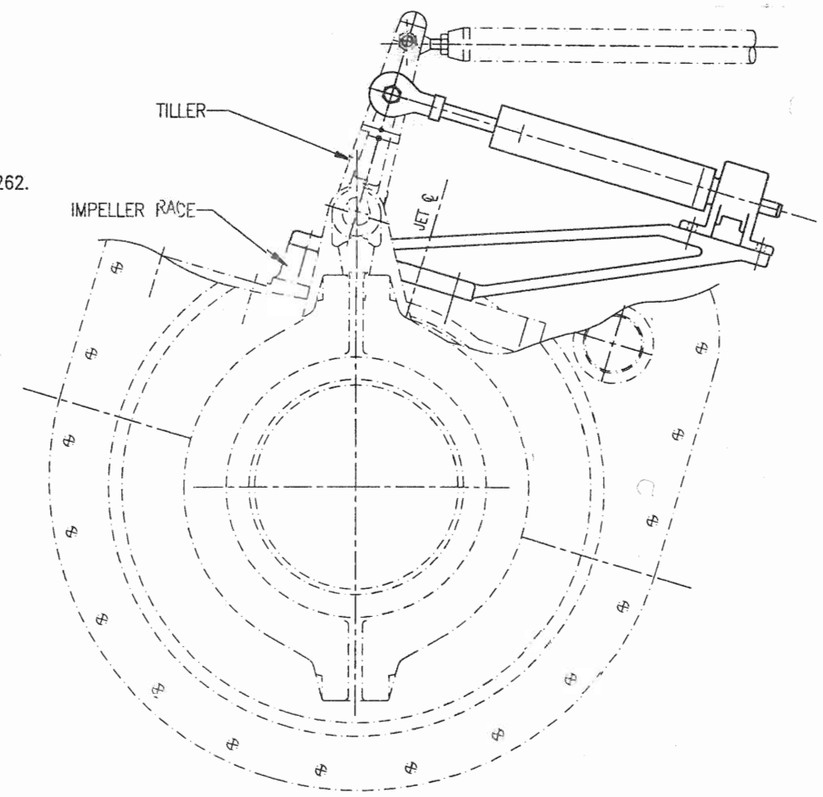
PROJECTION





SPARES ASSY			ITEM	PART NO	QTY	DESCRIPTION	DRG NO (OFF H USE ONLY)
A			3 1	63571	1	STEERING CYLINDER, WAGNER N40-120	–
A			3 2	WAQUBFC	2	NIPPLE, 1/4" N.P.T. x 1/4" B.S.P.P., 316 S.S.	–
	B		4 3	105644	1	BRACKET	105644
	B		3 4	104837	1	STEERING BUSH	104837
	B		4 5	JDQHXAH	4	NUT, M12, 316 S.S.	–
	B		4 6	JEQKXAH	4	SPRING WASHER, ø12, 316 S.S.	–
	B		4 7	103916	4	STUD, M12 x 78 LONG, 316 S.S.	–
	B		4 9	HYQHX10	1	HEX BOLT, M16 x 60, 316 S.S.	–
	B		4 10	JDQKXAJ	2	THIN NUT, M16, 316 S.S.	–
	B		4 11	JCQHXAN	4	STUD, M10 x 40, 316 S.S.	–
	B		4 12	JDQHXAE	4	NUT, M10, 316 S.S.	–
	B		4 13	JEQKXAE	4	SPRING WASHER, M10, 316 S.S.	–
			3 14	EXPORT N	REF	SEAL KIT, STEERING CYLINDER	–

ITEM	SPARES ASSY No.	DESCRIPTION
A	107719	CYLINDER & NIPPLE
B	107718	MOUNT KIT, STEERING CYLINDER



FORWARD VIEW
STEERING CYLINDER POSITION

REF	NO.	BY	DATE	AMENDMENTS
	CL3739	B	I.B.W.	14.2.96.	STG CYL. SHOWN ROTATED, PART No 103916 WAS 102769, WAQUBFC WAS 63948
	CL3703	A	I.B.W.	5.5.95.	REDRAWN ON CAD, VIEW NOW LOOKING FORWARD, NOT AFT.
	CL3666	0	C.W.R.	30.6.94.	ISSUED FOR PRODUCTION
JET	4x32	422	391		

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

MATERIAL: SEE ABOVE

√ = N9 EXCEPT AS STATED

UNLIMITED DIMENSIONS TO BE ± –

MATL CERT		
DESIGNED W.C.M.	DATE 20.6.94.	
DRAWN C.W.R.	21.6.94.	
CHECKED W.C.M.	23.6.94.	
APPROVED K.V.E.	27.6.94.	

NAME: STEERING CYLINDER POWER HELM KIT (ROTATED)

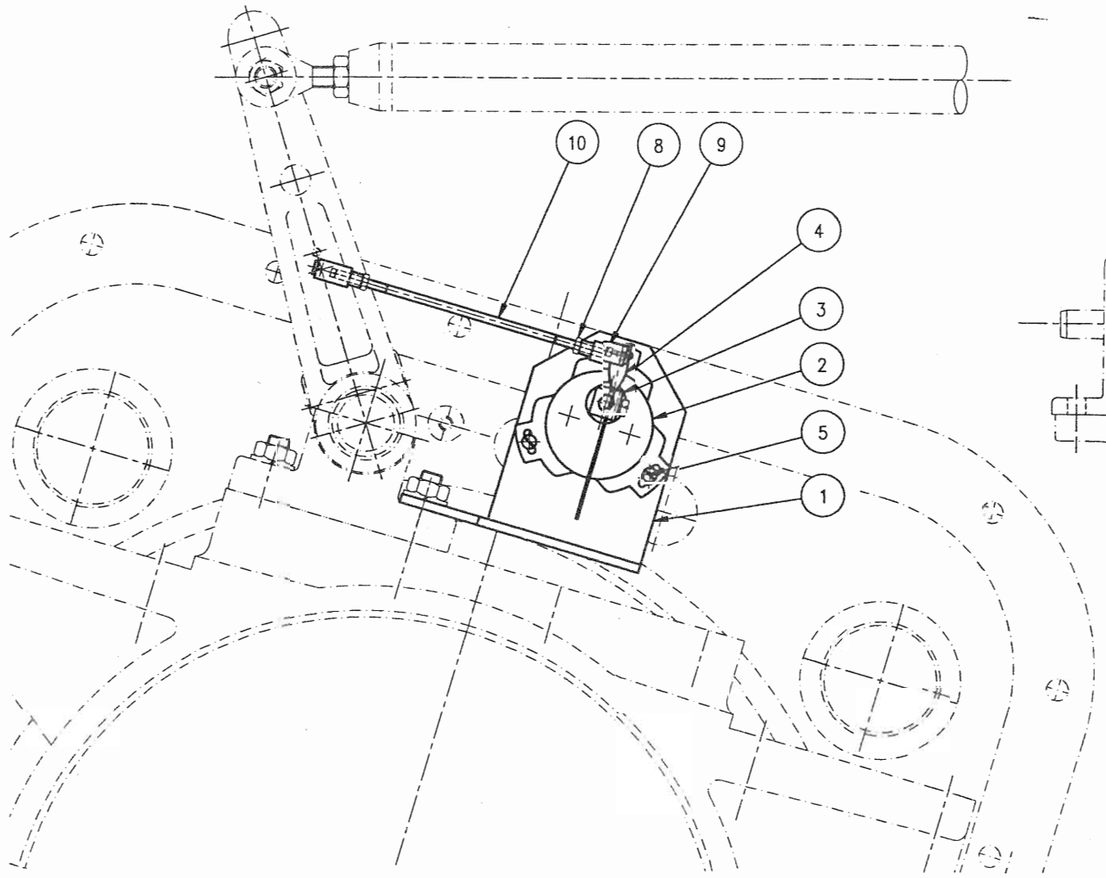
SCALE: – | No: A2-CTSJK-01-008 | B

CT-SDR-02-014 | A

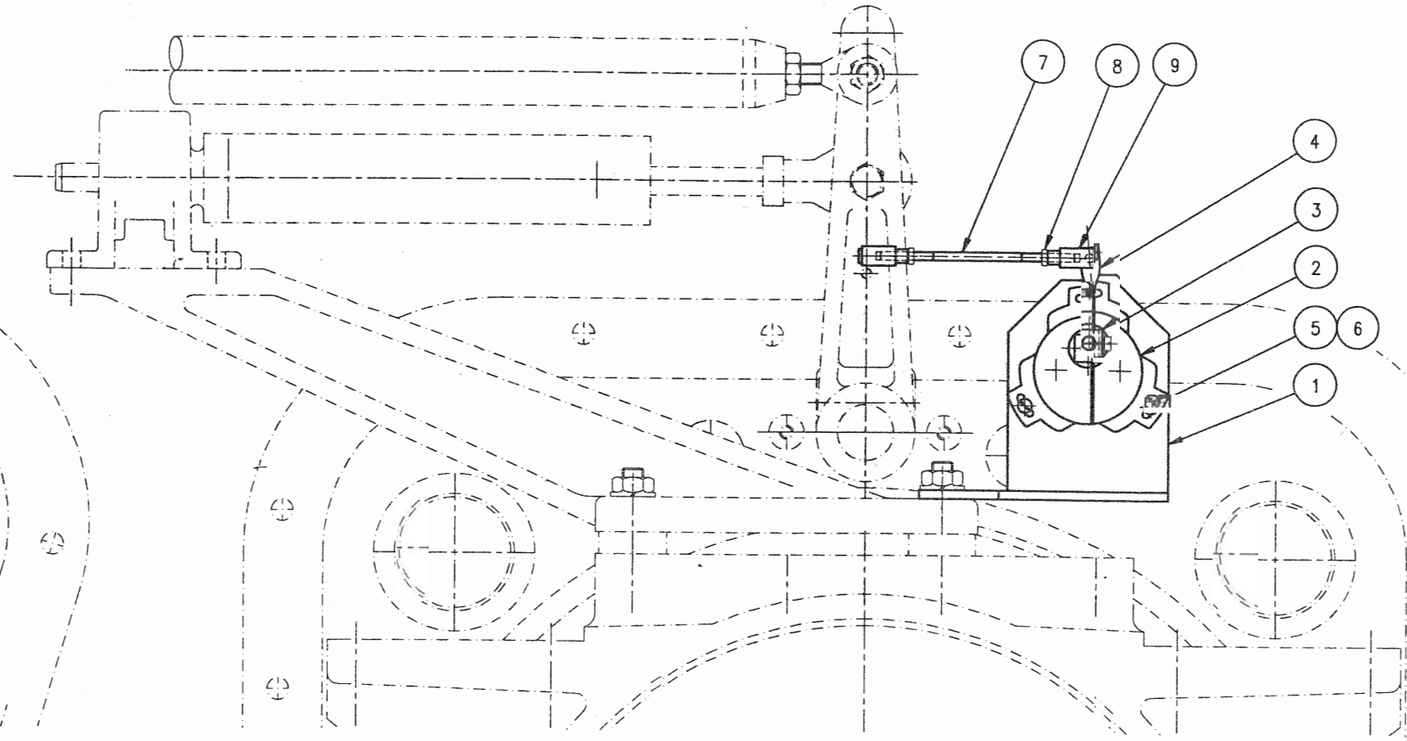
DO NOT SCALE THIS DRAWING.

PROJECTION

ALL DIMENSIONS IN mm. UNLESS OTHERWISE SHOWN.



AFT VIEW
FOR ROTATED STEERING
(TO SUIT HJ391 06 001)



AFT VIEW
FOR NON-ROTATED STEERING
(TO SUIT HJ391 06 006)

SPARES	ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO (OFFICE USE ONLY)
B	A	4 1	105789	1	STEERING SENDER PLATE	105789
B	A	2 2	63618	1	V.D.O. SENDER (SINGLE)	–
B	A	2 3	JMNGAAM	REF	V.D.O. CLAMP	–
B	A	2 4	104552-7	REF	V.D.O. TWISTED LEVER	104552-7
B	A	4 5	JEPRAAN	3	WASHER, 5/32", BRASS	–
B	A	4 6	HZMTXAO	3	M4 x 12 PAN HEAD SCREW, BRASS	–
	A	2 7	104672	1	LINK	104552-2
B	A	1 8	JDKYABQ	2	10 x 32 U.N.F. NUT, BRASS	–
B	A	2 9	KYINAAF	2	BALL JOINT – MORSE	–
B		2 10	108222	1	LINK (LONG)	104552-2

ASSY. KIT

ITEM	SPARES ASSY No	DESCRIPTION
A	108223	SENDER KIT, NON-ROTATED STEERING
B	108224	SEDER KIT, ROTATED STEERING

REF	NO.	BY	DATE	AMENDMENTS
3703 (CL36785)	A	I.B.W.	9.5.95.	DRAWN ON CAD, TILLER ROTATED & LINK LENGTHENED (ROTATED ST'G)
	0	C.W.R.	21.9.94.	ISSUED FOR PRODUCTION
JET	402	422	391	

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

MATERIAL: REFER DWG.

√ = N9 EXCEPT AS STATED

UNLIMITED DIMENSIONS TO BE ± –

MATL CERT

	NAME	DATE
DESIGNED		
DRAWN	C.W.R.	15.9.94.
CHECKED		
APPROVED	K.V.E.	20.9.94.

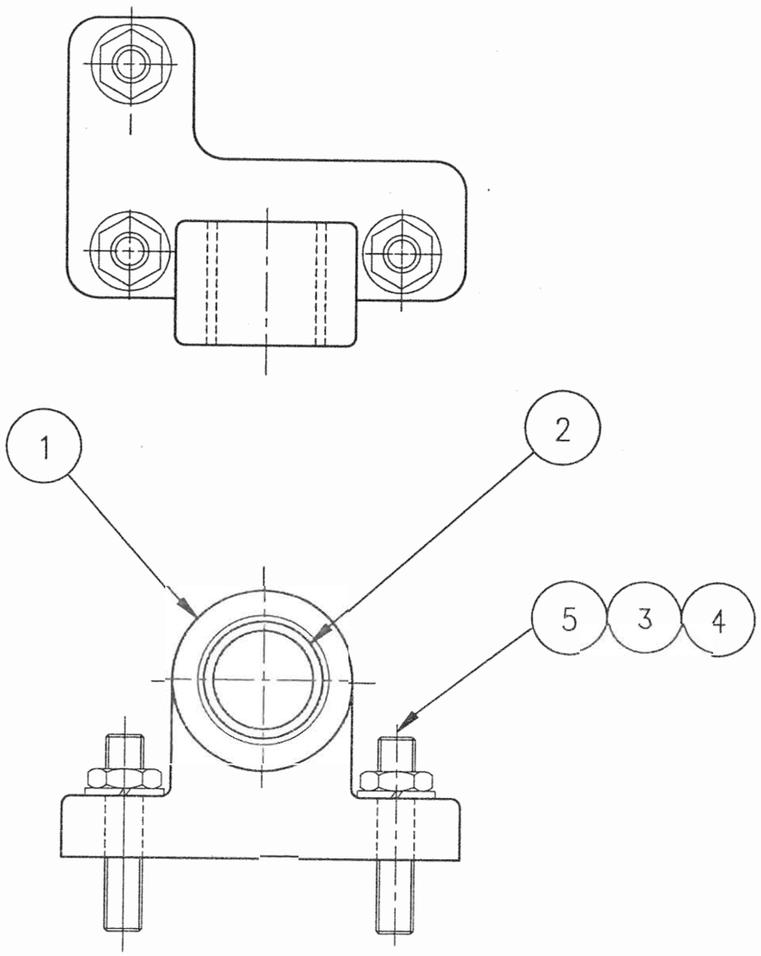
NAME: V.D.O. STEERING SENDER KIT SINGLE STATION

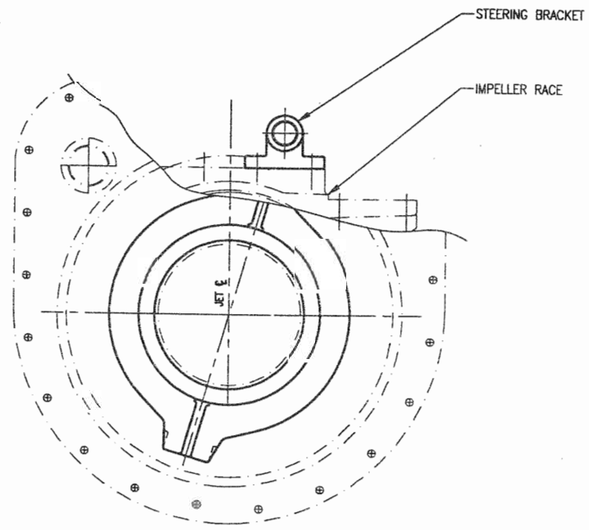
SCALE: –

No: A2-CT-SDR-02-014 | A

PROJECTION

SPARES	ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO CWF H USE ONLY
	4	1	105646	1	BRACKET	105646
	3	2	104837	1	STEERING BUSH	104837
	4	3	JDQHXAH	3	NUT, M12, 316 S.S.	–
	4	4	JDQKXAH	3	SPRING WASHER, M12, 316 S.S.	–
	4	5	103916	3	STUD, M12 x 64, 316 S.S.	–





FORWARD VIEW
STEERING BRACKET POSITION

CT-SJK-01-009 A

REF	NO.	BY	DATE	AMENDMENTS
3703	A	I.B.W.	5.5.95.	DR ON CAD, VIEW NOW FORWARD, WAS AFT. JEQKXAH WAS JDQKXAH
CL3678	0	C.W.R.	21.9.94.	ISSUED FOR PRODUCTION
JET	402	422	391	

C.W.F.HAMILTON & CO. LTD. CHCH. NZ.

MATERIAL: SEE ABOVE

√ = N9 EXCEPT AS STATED

UNLIMITED DIMENSIONS TO BE ± 0.5

MAT'L CERT	
DESIGNED	DATE
DRAWN C.W.R.	31.8.94.
CHECKED	
APPROVED K.V.E.	13.9.94.

NAME: STEERING BRACKET (ROTATED POSITION)

SCALE: –

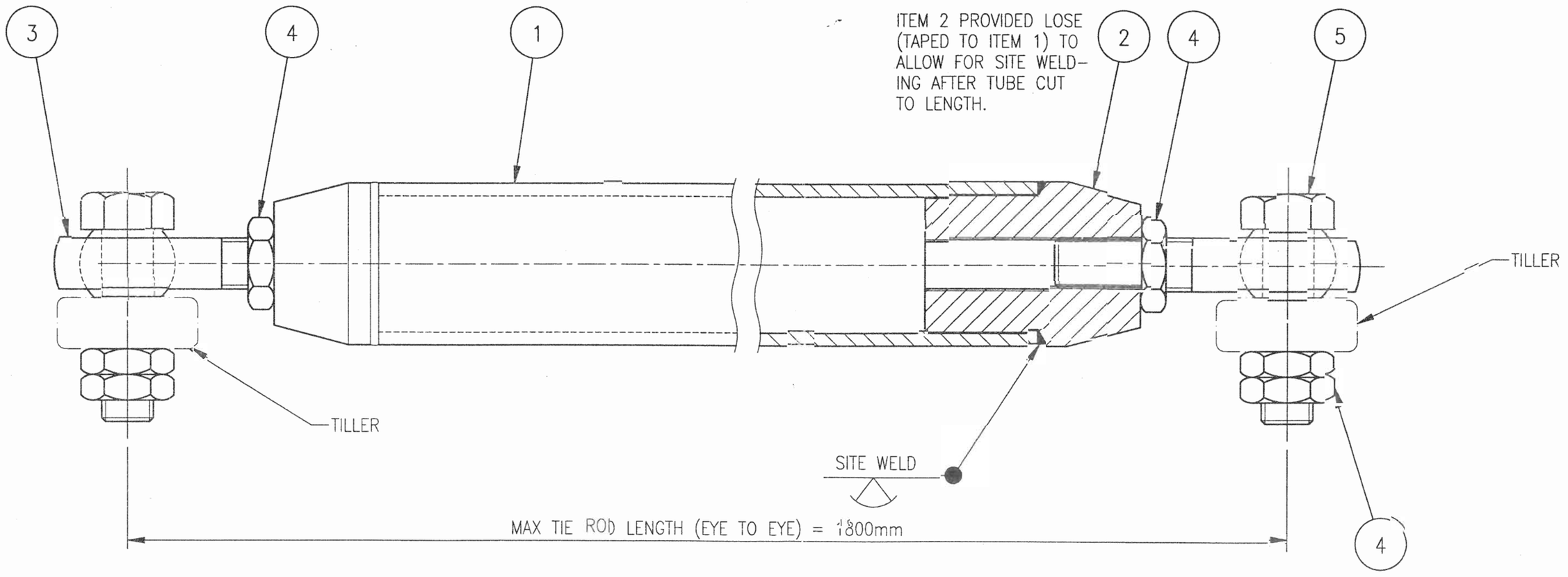
No: A3-CT-SJK-01-009 A

DO NOT SCALE THIS DRAWING.

ALL DIMENSIONS IN mm. UNLESS OTHERWISE SHOWN.

PROJECTION

SPARES			ASSY	ITEM	PART NO	QTY	DESCRIPTION	DRG NO CWF H USE ONLY
			4	1	105005	1	TIE ROD W/A	105005
			4	2	105005-2	1	ROD END	105005
			2	3	JNODAFD	2	ROD END, S.K.F. SAKB 12F	-
			4	4	JDQKXAH	6	M12 THIN HEX NUT, 316 S.S.	-
			4	5	HYQHXFS	2	M12 x 45 HEX HD. BOLT, 316 S.S.	-



CT-SJK-04-003 | A

REF	NO.	BY	DATE	AMENDMENTS
3703	A	I.B.W.	8.5.95.	REDRAWN ON CAD, DWG. 105005Y NOW 105005
CL3678	0	C.W.R.	21.9.94.	ISSUED FOR PRODUCTION, DWG. No. WAS 104941SY

JET 402 422 362 391

C.W.F.HAMILTON & CO. LTD. CHCH. NZ

MATERIAL: SEE ABOVE

√ = N9 EXCEPT AS STATED

UNLIMITED DIMENSIONS TO BE ± 0.5

MAT'L CERT		
DESIGNED	DATE	
DRAWN C.W.R.	14.9.94.	
CHECKED		
APPROVED K.V.E.	20.9.94.	

NAME: TIE ROD KIT (TWIN JETS)

SCALE 1:1

No: A3-CT-SJK-04-003 A