WEIR WARMAN LIMITED

OPERATION AND MAINTENANCE MANUAL

CYCLONE

660 - CS

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NOTE:

This manual has been compiled to suit a particular range of pumps. Additional copies are readily available, however, regrettably a nominal charge is made for the extra copies to cover printing and administrative costs. The policy of continuous improvement may mean that replacement parts may differ from original parts fitted. All information in this manual is based on the latest information available, but the right is reserved to introduce modifications which may affect this information.
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# USER DATA SHEET

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**CONSULTANT:**

**CLIENT:**

**SITE:**

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<td>V.F. Ø</td>
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<td>CYCLOPAC MODEL</td>
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INTRODUCTION

Warman hydrocyclones are unique in several ways. This manual is designed as a reference for users of Warman hydrocyclones.

The purpose of this manual is to -

1. Outline the construction of the Warman “C” series hydrocyclone,
2. Outline the principles and methods of operation of a hydrocyclone; and
3. Describe how to maintain a Warman hydrocyclone and hydrocyclone cluster.

The following optional supplementary sheets are included as relevant additional information.

   1. Dewatering using an underflow density control device (UDC)
   2. The Hydraulic Spigot Assembly (HSA)
   3. Typical applications

Further advice can be obtained by contacting your local Warman representative.
TERMINOLOGY

Cyclones

A cyclone is a simple cono-cylindrically shaped vessel with a tangential inlet and two outlets at either end of its axis. A Cyclone is used to separate two phases from a fluid mixture.

Hydrocyclones

A hydrocyclone is a sub-class or specialised application of a cyclone whereby the process stream is a liquid, generally with suspended solid particles, (i.e. a slurry). The common purpose of the hydrocyclone is to separate or classify sub-sieve size solid particles according to their size.

For brevity, this manual will use the term cyclone to mean hydrocyclone

Spigots

Also referred to as an apex, the spigot is the outlet at the apex end of the cyclone. Commonly it is a simple short cylindrical part, the internal diameter of which is varied to suit the performance required.

Underflow

The underflow is the fluid stream which discharges from the spigot. Cyclones are most commonly operated in a vertical orientation so that the spigot discharges vertically downward and hence the term, “underflow”.

Overflow

Correspondingly, the fluid stream which discharges from the cylindrical end of the body of the cyclone is referred to as the "overflow".
GENERAL DESCRIPTION

A cyclone comprises a number of simple elements as shown on Figure 1, below.

3.1 Cyclone Construction

Warman hydrocyclones are unique in their design and materials of construction. The WARMAN hydrocyclone is a heavy duty design comprising several rigid casing components with corresponding internal, replaceable wear liners (see figure 2, page 7).

The Warman liner system is designed so that no adhesives are required to fasten the liners to the casing. Each liner is moulded to fit precisely into its respective casing component.

These features enable unskilled personnel to readily replace worn components without the delays commonly associated with glued liners.
3.2 **Materials**

A unique feature of the Warman hydrocyclone is the extensive use of Dough Moulding Component (DMC) to construct the casing component.

DMC is a high-tech pressure moulded, fibre-reinforced polymer with the properties of strength, relative lightness, inherent corrosion resistance, exact replication and lower cost.

Most Warman hydrocyclone casing components are made of DMC, although a few large or low usage parts may still be fabricated in mild steel.

The Warman material code can be identified as the last three characters of the part number. DMC is coded P09 and mild steel is coded E02. The part numbers and hence the material codes are listed on the components diagram included with this manual.

The liners are moulded from specially formulated gum rubber, polyurethane or a range of special purpose synthetic elastomers. Different wear resistant materials suit different wear environments, although gum rubber has proven to be the most universally cost effective material.

Typically, wear is greatest in the lowest section of the hydrocyclone, particularly the spigot (or apex). In some applications, ceramic lower cones and spigot liners have proven a cost effective substitute for elastomer, although ceramics vary greatly in composition and wear resistance. Your Warman representative can advise on the suitable choice of special wear resistant materials.

3.3 **Cyclone Size Range**

The “size” of a hydrocyclone is usually defined by the internal diameter of the cylindrical section of the body of the cyclone. Historically, this has been in inches e.g. 15”. The diameter can be augmented by nominating the included cone angle, (particularly if the angle is different from the normal), the particular size range of spigots required and whether the cylindrical section is a standard length or extended.

Warman hydrocyclone models are defined in the manner described above e.g. 15CEL-10°: -

1. the cyclone diameter in inches e.g. 15
2. the cyclone series e.g. C
3. the spigot size range e.g. E
4. extension barrel e.g. L
5. included cone angle e.g. 10°

Details of the various models available are included on the following page, “Product Range”.

## LINER MATERIAL AVAILABILITY

<table>
<thead>
<tr>
<th>Cyclone Model</th>
<th>Cyclone Diameter (mm)</th>
<th>Cone Angle (°)</th>
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<th>COMBINATION</th>
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### Note:
1. A range of inlet, Vortex Finders and Spigots are available for each cyclone model.
2. Rubber liners can be substituted by synthetic elastomers for special applications.
3. Ceramic spigot liners and lower cone liners are available on request.
3. **GENERAL DESCRIPTION**

3.4 **Spigot (Apex) AND Spigot Accessories**

The internal diameter of the spigot is an important determinant of the performance of a cyclone. A wide range of spigot sizes are able to be fitted to each cyclone model by simply unfastening the spigot holder and replacing the spigot liner. These spigots are referred to as Fixed Spigot Assembly (FSA) and the hydrocyclone model is often suffixed (FSA) to denote this feature.

The spigot sizes are divided into a number of size groups to which each group has a common sized spigot holder, e.g.

- **“E”** Spigots range from 38 to 87mm diameter
- **“S”** Spigots range from 60 to 152mm diameter

Although the Fixed Spigot Assembly (FSA) is the most common, a spigot accessory can also be fitted if special spigot control is required, e.g.

1. The Hydraulic Spigot Assembly (HSA) replaces the Fixed Spigot Assembly to provide a nominally reduced spigot internal diameter by hydraulic actuation. This device is particularly useful if constant “fine tuning” of the cyclone is required. Details are contained on a supplementary sheet.

2. The Underflow Density Control device (UDC) is an accessory which clamps to the spigot to provide a constant high-density underflow product, particularly when the feed solids density is highly variable. This device requires additional installation requirements which are detailed on a supplementary sheet.
4. PRINCIPLES OF OPERATION

4.1 General

The hydrocyclone is a simple device, most commonly used for separating or classifying subsieve size (<200 micron) particles in a liquid medium or slurry.

Unlike a screen which employs a fixed dimensional limit on the particle size allowed to pass, the hydrocyclone separates the solid particles according to their relative settling rate. However, rather than using gravity as the accelerating or settling force as in a settling tank, the separation action in a hydrocyclone is induced by the centrifugal force created within the cyclone body.

The inherent settling rate of a slurry is dependent on particle size grading, shape, viscosity of the liquid and most importantly, the relative density and concentration of the solid particles in the slurry.

4.2 Fluid Flow & Particle Motion in a Hydrocyclone

Except for the region in and just around the inlet duct, the motion of the fluid within the cyclone body has circular symmetry as is shown schematically in Fig.3. Most of the incoming fluid moves in an outer helical flow to the outer portion of the inverted cone where it begins to feed across towards the centre. Some of the downward flow leaves through the underflow orifice (spigot) while the rest reverses its vertical direction component via an inner helical flow and discharges out through the overflow orifice (vortex finder).

A comparatively minor flow pattern short-circuits along the top of the cylindrical section and around the outside of the vortex finder to join the rest of the fluid in the overflow.

Solid particles within the slurry are accelerated outward towards the walls of the cyclone body by centrifugal force. This force is greatest on the particles of greatest mass (i.e. greatest size or relative density). As a result, the coarser, heavier solids migrate towards and along the inner wall of the cyclone to leave with some liquid as the underflow. The finer, lighter solids are largely entrained by the drag force of the liquid and leave the cyclone with most of the liquid via the overflow.

Some fine, lighter solids will also be entrained by the liquid in the underflow and is referred to as "unclassified fines".
4. PRINCIPALS OF OPERATION

4.2 Fluid Flow and Particle Motion in a Hydrocyclone

Perspective view of a hydrocyclone showing the vortex flow schematically.

FIGURE 3.
4. PRINCIPALS OF OPERATION

4.3 Cyclone Separation Performance

The common measure of the separation between the fine and coarse solids is the d50, commonly referred to as the cutpoint.

The d50 is the particle size diameter for which 50% by mass reports to the underflow. Solids progressively larger than d50 size have a probability greater than 50% of reporting to the underflow.

Another measure of separation in a cyclone is the proportion of liquid reporting to the underflow compared to that in the feed. This is referred to as the "water split" and is commonly denoted ‘Rf’.

The efficiency of separation is most usefully expressed as a graph of the percentage of solids reporting to underflow versus the particle size and is referred to as a Tromp Curve or Recovery Curve (Refer Figure 4).

The Recovery Curve is S-shaped, passing through the cutpoint and intersecting the Y axis (% reporting to underflow) at a value equal to the water split. This can be understood by considering that all very fine particles are insufficiently distinct from the liquid molecules and thus will be separated in the same ratio as the liquid separates; i.e. as defined by the water split (Rf).

The water split can vary considerably according to the operating conditions and cyclone geometry and can be manipulated accordingly. As such, it is common to remove the effect of the water split from the efficiency definition by correcting the recovery curve so that it passes through the origin.

The corrected efficiency curve is defined by the equation -

\[
Rc = \frac{Ra - Rf}{100 - Rf}
\]

where

- \(Rc\) = Corrected recovery
- \(Rf\) = Water split
- \(Ra\) = % Actual recovery

Figure 4 illustrates both the Actual Recovery Curve and the Corrected Recovery Curve.

Note that the Corrected Recovery Curve also defines a Corrected D50 value, denoted D50c. The D50c is a useful value when comparing the performance of different Cyclones for a particular application.
FIGURE 4: A TYPICAL CYCLONE EFFICIENCY CURVE
PRINCIPALS OF OPERATION

4.4 Operational Variables

Operational variables are the factors external to the cyclone which affect the performance of the cyclone.

• **Feed Solids Concentration**

Usually expressed as percent solids by weight (abbreviated Cw), the proportion of solids in the feed slurry has a substantial effect on the classification performance of the cyclone. In principle, the higher the percentage of solids, the coarser the cutpoint (higher d50). For example, an increase in solids from 5% to 20% by volume will approximately double the cutpoint of the cyclone.

• **Pressure**

The pressure required for the correct operation of a cyclone varies according to the size of the cyclone and the application. It is important that an accurate pressure gauge be located on feed distributor or the feed pipe adjacent to the cyclone inlet, to provide a constant indication of the operating pressure.

The pressure reading should be -

- steady, indicating a constant feed.
- within the designed operating range, usually 60 to 200kPa depending on the application

A change in feed pressure will affect the classification performance and the water split of the cyclone.

Generally, the higher the pressure, the finer the separation and the lower the water split (proportion of liquid reporting to the underflow).
4. PRINCIPALS OF OPERATION

4.5 Cyclone Variables

Cyclone variables are the various dimensional options available for each cyclone model and include -

- **Inlet Diameter**
  - The inlet section is rectangular in shape and is an integral part of the feed chamber liner.
  - The area of the rectangular section is equivalent to the area of a circle, the diameter of which is referred to as the "equivalent inlet diameter".
  - many Warman models have a range of inlet diameters from which to select, according to the performance and capacity required.

- **Vortex Finder Diameter**
  - A wide range of vortex finder sizes are available for each cyclone model. The vortex finder size has the greatest effect on cyclone performance for any given cyclone size (or model), viz. the smaller the vortex finder, the finer the classification and the lesser the capacity of the cyclone.

- **Spigot Diameter**
  - The spigot diameter is generally the most convenient variable to adjust or change and can be considered the "tuning" variable once a cyclone is installed.
  - The spigot diameter has greatest effect on the underflow density of the cyclone. In general, a decrease in spigot diameter will increase the underflow density and improve the efficiency of the classification. However, take care that the spigot diameter is not reduced to the extent that a "rope" condition prevails. Roping indicates that the spigot is overloaded for the volume of solids reporting to the underflow and a larger spigot is required.
5. INSTALLATION REQUIREMENTS

5.1 General

The cyclone should be structurally supported by the mounting plate or mounting feet provided. No external loads should be applied to the cyclone.

The cyclone should be installed in a manner to ensure ready maintenance access, particularly to the spigot.

**Important Note:** Most of the cyclone body components are made of DMC and are therefore unsuitable for oxy-acetylene cutting or any form of welding.

Cyclones are generally installed in a vertical attitude. However, they can be laid over to horizontal without major performance effect. A minimum angle of 10° between the cyclone axis and horizontal is advised to ensure the cyclone will self drain on shutdown.

5.2 Feed Pump

Except for gravity fed cyclones, most cyclones are fed by a centrifugal pump connected to a hopper or tank.

The pump and the hopper must be designed to deliver a constant flow of slurry to the cyclone at the required pressure. Fluctuations in the cyclone feed will affect the cyclone performance.

5.3 Cyclone Feed Pipe

The cyclone feed pipe must be the same diameter as the cyclone inlet flange (or feed matching piece) for a distance at least 10 pipe diameters ahead of the cyclone. It is not recommended to have any bends closer than 5 pipe diameters ahead of the cyclone.

For example: A Warman 10CE cyclone requires a 100mm (4") diameter feed pipe connection. The feed pipe should be 100mm diameter for at least 1.0 metre without bends closer than 0.5 metre.

5.4 Isolation Valve

Cyclone isolation valves should be a full-bore-flow-through type, such as a knife gate valve (e.g. Warman AK valve), or pinch type valve, or a standard knife gate valve with polyurethane or ni-hard flow deflector cones. Valves should not be used to throttle the flow to the cyclone as the resulting turbulence will affect the efficient performance of the cyclone and rapidly wear the valves.
5. INSTALLATION REQUIREMENTS

5.5 Pressure Gauge

It is recommended to install a pressure gauge on the feed distributor or cyclone feed pipe, adjacent to the inlet (refer Section 4.4).

The type most commonly selected is a 100mm diameter, stainless steel body, with a full deflection of 0-250kPa. A large diameter (50mm) diaphragm type gauge protector assembly is essential for the effective utilisation of the gauge.

5.6 Overflow Pipework

Overflow pipework must maintain the diameter of the cyclone overflow connection and contain only large radius bends to direct the flow downward.

Usually, the overflow pipe is short, discharging directly into a collection launder or tank at a level about equal to the cyclone inlet. If a longer overflow leg is required for the installation, a siphon breaker must be installed as shown in figure 5.

If an underflow density control device is fitted to the cyclone, refer to supplementary sheet.

NOTE: The overflow pipes should not be reduced in diameter or directed upward as this will create back pressure and thereby significantly effect the performance of the cyclone.

5.7 Underflow

The cyclone underflow must discharge into an open launder or collection box. No restrictive pipework should be attached to the spigot.

Design of the underflow launder should allow easy visual observation of the spigot discharge spray so that the plant operator is not impeded in checking the underflow condition and detecting any blockages.

The point of impact of the underflow spray on the walls of the launder is subject to high abrasive wear and should be protected by suitable material.
RECOMMENDED OVERFLOW PIPEWORK ARRANGEMENTS

FIG. 5

NOTE
OVERFLOW PIPES MUST
NOT 'HANG' FROM
CYCLONE.
PROVIDE SECURE
INDEPENDENT
SUPPORTS

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<tr>
<td>26C</td>
<td>50</td>
<td>300</td>
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5. INSTALLATION REQUIREMENTS

5.8 Cyclone Cluster (Cyclopac)

If more than two cyclones are required in parallel circuit, the cyclones must be installed in a radial configuration around a central feed distributor to ensure an even flow distribution to each cyclone.

Such configurations are referred to as clusters cyclopacs and are usually integrated with common overflow and underflow launders. In-line manifolds can provide uneven distribution and are usually only considered for use on fine, very dilute slurries.

Correct cluster design is an important element in the successful operation of multiple cyclone installations. Warman engineers can tailor the cluster design for particular installation requirements.

Each cluster has its own particular installation requirements. Typically, clusters have four mounting points or feet attached to the overflow tank or underflow tank, upon which the total load of the cluster is distributed.
6. HYDROCYCLONE MAINTENANCE

6.1 General

Warman cyclones are designed for heavy duty industrial applications, particularly where high wear necessitates the regular checking and replacement of internal wear liners. Typically, site experience will determine the frequency with which particular cyclone components will require replacement. For example, it is normal for the spigot liner to wear out faster than the cone liners.

Similarly, in closed circuit grinding circuits, tramp material can prematurely damage the feed chamber liner.

REGULAR INSPECTION OF PROBLEM AREAS IS THE BEST SOLUTION.

Any unusual or excessive wear should be reported to your Warman representative for consultation on possible alternative materials or processing.

6.2 Lifting, Assembly/Disassembly

All the cyclone components for cyclone models up to the 15C can are man handleable due to the extensive use of light-weight DMC. Cyclone models 20C and 660C contain some heavier components, requiring lifting assistance.

For inspection or replacement of particular liners, partial disassembly can be performed with the cyclone installed. A full inspection or liner replacement is more easily performed by removing the cyclone to a convenient work area.

Cyclones can be lifted by a soft-sling placed around the feed chamber and under the inlet duct, or by attaching an eye-bolt nut to an overflow flange bolt.

Assembly/Disassembly is best undertaken with the cyclone balanced upside down, sitting on its head. Each section can then be easily removed in turn, commencing with the spigot housing at the top.

The cyclones are fastened by hexagonal head, metric bolts of varying sizes

CAUTION: Flange bolts must not be over tightened as this will cause the liners to distort and crack the DMC flanges, e.g. do not use non adjustable pneumatic type "rattle guns".

Do not cut corroded or overtightened bolts with a “gas-axe” as this will damage the DMC casing.
6. HYDROCYCLONE MAINTENANCE

6.3 Casing

With the exception of some of the casing components of the larger cyclones, most of the components are moulded in DMC (refer section 3.2).

DMC requires little maintenance. Should minor damage be sustained, such as where a liner has worn through, the worn are can be filled with polyester based putty or filler.

Since DMC components are much less expensive than steel, repair is generally unwarranted. Structurally damaged components should be replaced.

6.4 Liners

Each of the casing segments has a corresponding moulded elastomer liner, commonly natural rubber, which fits snugly into its casing.

Liners can be easily inspected by unbolting and removing the casing segments.

Warman cyclone liners do not require any adhesives or special tools for replacement. All components are part numbered and their position in the cyclone is readily identifiable on the components diagram for the cyclone.

When replacing the liners, a liberal quantity of hand cleaner cream applied to matching face will assist, particularly the angled face of the cover lined and feed chamber liner. **DO NOT USE GREASE OR OIL.**

6.5 Vortex Finder

The vortex finder can be inspected by removing the overflow pipe. Full inspection requires the vortex finder to be pulled out from the cyclone cover. Usually the vortex finder is a tight fit such that it may be easier to also remove the cover which houses the vortex finder.

6.6 Spigot

The spigot liner is prone to the highest wear and this should be checked regularly. A gauge of the correct dimension can be inserted in the spigot liner or the spigot liner can be easily removed by unfastening the spigot holder.

To a large extent, the underflow density is controlled by the spigot liners internal diameter. Excessive wear will cause a lowering of the underflow density (refer to Section 4.5; Spigot Diameter).

6.7 Cyclone Cluster (Cyclopacs)

Maintenance on cyclone clusters is minimal. A six monthly inspection and repair of damaged paint work and any protective lining is recommended. Welding onto the external surface of cluster steelwork will damage any internal linings. Repair to cluster linings will depend on the type of material and should be carried out by experienced lining applicators. Also check the condition of the cyclone isolation valves, particularly if deflector cones are fitted.
ADDENDUM: SPECIFIC MAINTENANCE INFORMATION

1. CYCLONE LINER WEAR

   Cyclone liners wear life is most effected by oversize or tramp material fed to the cyclone. Such material may tear the liner and cause accelerated wear.

   To prevent wear damage to the outer casing, a regular inspection of the wear liners is advisable. Cyclone liner wear life is very variable and depends on the application. In the coal industry where fine coal slurries are relatively dilute, most cyclone liners would not wear out before six (6) months and may last many years before replacement is required. The liners are structurally supported by the casing and therefore are serviceable until holed.

   There are two locations where cyclone wear is generally greatest, viz:

   1. the internal diameter of the spigot liner
   2. the internal diameter of the vortex finder

   Both these areas should be monitored for wear during regular maintenance shutdowns or every three (3) months until the typical wear life for that particular application is established. Wear in these areas will also manifest a change in performance. Refer Section 2.1 & 2.2 of the Operation Manual.

2. CASING COMPONENTS

   Most of the casing components are made of pressure moulded, fibre-reinforced polyester. Minor surface damage can be repaired using polyester resin based putty. Repair of structural damage is generally unsatisfactory and replacement is required. Refer spare parts list.
1. Dewatering using an underflow density control spigot. Installation, operation and maintenance
2. The hydraulic spigot assembly (HSA)
3. Typical applications and operation
   e.g. - Thickening or Dewatering
        - Classifying
        - Closed Circuit Grinding
SUPPLEMENT No. 1

DEWATERING USING AN UNDERFLOW DENSITY CONTROL ASSEMBLY – THE SPIGOT LIPSEAL.

S1.1 Principal of Operation

The spigot lipseal operates by the syphoning action of the overflow pipe which creates a partial vacuum in the cyclone, thereby drawing in and sealing the “lips” of the spigot. Solid particles reporting to the underflow, build up and break the seal and are thus discharged. This action is self regulating once the correct vacuum is established, as described below.

S1.2 Initial Regulation

It is important that the cyclone is installed with an overflow pipe as shown on drawing A3-37755 on the following page.

For initial operation complete the following steps:

1. Fully close the vacuum valve; then open counting the number of turns to open. Finally, close the valve to the mid-closed position.

2. Start the cyclone on water only

3. On start-up and until the system fills, the spigot lipseal will discharge water for a few seconds until the overflow pipe fills and establishes the necessary vacuum. The spigot lipseal will then close and seal almost drip-tight.

4. Adjust the vacuum valve slowly open until the spigot lipseal dribbles with water, then slowly, close the vacuum valve until the dribble just stops.

5. The cyclone is now ready for normal slurry operation.

S1.3 Trouble Shooting

- Is there sufficient hydraulic flow to “plug” the overflow pipe end orifice and prevent air from entering?

- Is a smaller orifice required because of a low flow?

WARNING: Do not reduce orifice area without careful consideration of the flowrate as the overflow pipe may become backfilled to high to establish the necessary vacuum.

SUGGESTIONS: Use optional water seal illustration on drawing A3-37755.
WARNING

OVERFLOW PIPEWORK MUST BE INDEPENDENTLY SUPPORTED.
DO NOT 'HANG' PIPEWORK FROM THE CYCLONE BODY

NOTE

WELD PLATE TO END OF PIPE AS SHOWN

<table>
<thead>
<tr>
<th>D1 (mm)</th>
<th>D2 (mm)</th>
<th>D3 (mm)</th>
<th>V (mm)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>4C</td>
<td>-100</td>
<td>50</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>6C</td>
<td>-150</td>
<td>80</td>
<td>55</td>
<td>80</td>
</tr>
<tr>
<td>10CF</td>
<td>-250</td>
<td>150</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
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<tr>
<td>26CS</td>
<td>-660</td>
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</table>

WARMAN INTERNATIONAL CYCLONES
UNDERFLOW DENSITY CONTROL D.C.A. SPIGOT
INSTALLATION DIAGRAM

WARMAN INTERNATIONAL LTD.

A3 – 112 – 0 – 37755
SUPPLEMENT No. 2

HYDRAULIC SPIGOT ASSEMBLY

The hydraulic spigot assembly (abbreviated HSA) consists of a manually operated hydraulic cylinder coupled to an enclosed neoprene pressure ring which surrounds the outside diameter of a standard rubber cyclone spigot.

When the cylinder screw is adjusted the fluid expands the pressure ring “compressing” the spigot and so varying the spigot internal diameter (by up to 10mm internal diameter).

Hydraulic fluid is a solution of approximately 1 part soluble oil (Shell Dromus or equivalent) to 40 parts of clean water.

Hydraulic Spigots – Adjustment and Repair

- Partial or inoperative spigot adjustment
  i) check fluid level
  ii) spigot internal diameter is excessively worn (eroded) and pressure ring is at maximum adjustment. Replace spigot liner.

- Fluid leakage from hose and joints connecting cylinder to pressure ring.
  Replace hose and joints.

- Fluid leakage from hydraulic cylinder screw.
  Check cylinder bore for scoring and replace “O” rings.

- Fluid leakage from pressure ring at spigot.
  Replace ruptured neoprene pressure ring.

- Fluid leakage from pressure ring flanges.
  Remove pressure ring assembly and run a bead of silastic (or similar) inside the bolt circle on both sides of the neoprene pressure ring flanges and reassemble.

- Air lock in hydraulic system (bleeding).
  Wind cylinder screw fully open and remove filling plug. “Tilt” cylinder so that filling fluid level is uppermost. Remove hydraulic spigot and bottom cone assembly as an assembly. Turn assembly on the side so that the liquid entry point is highest but still well below the hydraulic cylinder level.
  Tap the side of the assembly lightly and rapidly so that any entrained air bubbles will rise up the piping and vent to atmosphere via the cylinder fill plug.
  Periodically check level of cylinder liquid so it does not fall below the level of the cylinder outlet whilst “tapping”. Ensure no entrained air remains, top up cylinder level and replace filling plug. Reinstall spigot assembly on to cyclone.

- Spigot diameter adjustment requires excessive cylinder adjustment (slow to adjust).
  Bleed hydraulic system to remove air lock. Check for fluid leakage at hydraulic cylinder screw and spigot flange joints.