



Test Stand Operation Manual

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Revision History

| Rev | Date | Reason |
|------------|-------------|--------------------------------|
| A | 11/03/14 | Issued for Use |
| B | 5/5/15 | Added Warning during operation |
| C | 4/23/19 | Updated design |
| D | | |
| | | |

Description of Change

| Rev | Change |
|------------|--|
| B | Added #10 and warning to Rig Up section |
| C | Relief valve integral in manifold – changed Figure 9. Control arm has sealed bearings – no grease needed. Added crank handles to control arm. Added backup kit. Updated Table 2 and 6. |
| D | |
| | |

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GENERAL

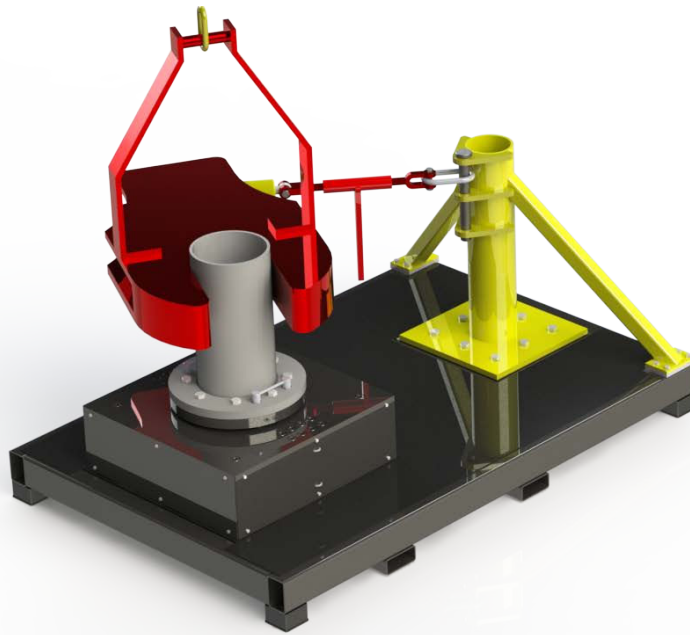


Figure 1

Texas International Oilfield Tools (TIOT) offers a free standing test stand for testing of hydraulic casing and tubing power tongs. The test stand is designed to resist torque applied by a tong through a test mandrel.



Large forces are involved in using this device. Operate this equipment with extreme caution

The test stand utilizes a hydraulic active dual spring disc brake chamber in order to apply friction force (“brake” action) to the rotating (or stationary) test mandrel mechanism. The tong is tested by applying torque to the test stand’s mandrel. The test stand’s brake is activated by pushing and twisting clockwise the red control box button on the control box. The black knob located on the test stand’s control box regulates pressure. A brake foot pedal can be supplied as backup for the mini power unit. The mini power unit attaches to the skid and is removable.



Use the forklift pockets under the skid to properly lift the test stand

CONVENTIONS




| IMPORTANT SYMBOL IDENTIFICATION | |
|---|--|
|  | WARNING to Operators / Users |
|  | CAUTION to Operators / Users |
|  | NOTIFICATION to Operators / Users |

Table 1

SAFETY

Safe installation, operation and service of the Texas International Oilfield Tools Test Stand are the end user's responsibility. It is critical all personnel have knowledge of company specific safety practices. All crew in the vicinity of operations should be trained on rig safety and tool operation.



Modification of the test stand and related equipment is prohibited

SPECIFICATIONS

| Mandrel Size Range | Max. Torque | Max. Mandrel RPM |
|--------------------|----------------------|------------------|
| 1.66" to 20" | up to 80,000 ft/lbs* | 15 |

Table 2

*Number of calipers and skid configuration determine capacity of test stand. See Table 6 for configurations

| Item | Volts | HP | RPM |
|----------------------|-------|----|------|
| Hydraulic Pump Motor | 115 | 1 | 1750 |

| Item | Size |
|---------------------|----------|
| Hydraulic Reservoir | 2 gallon |

| Item | Port | Element |
|----------------------|------|-----------|
| Hydraulic Oil Filter | 3/4" | 10 micron |

| Item | Flashpoint |
|---------------|------------|
| Hydraulic Oil | 250 deg C |

Table 3

Table 4

| Item | Type | CID | kw | Shaft | Inlet | Outlet |
|------|---------------------|-----|------|-------|-------|--------|
| Pump | SAE AA 2 bolt mount | 0.1 | 1/8" | 1/2" | #8 | #6 |

Table 5

| Part Number | # of Calipers* | Max Torque (ft/lbs) | Size Range |
|-------------|----------------|---------------------|---------------|
| T4STAND-20 | 1 | 20,000 | 1.66 – 13-5/8 |
| T4STAND-40 | 2 | 40,000 | |
| T4STAND-60 | 3 | 60,000 | 1.66 - 20 |
| T4STAND-80 | 4 | 80,000 | |

* or using dead head pins

Table 6



Torque ratings should not be exceeded – may cause operator injury and skid failure

Brake Maximum Operating Pressure (at 15.7MPa (157bar)): 2277.1 PSI
 Foot pedal factory set not to exceed 2,200 lb/ft and operates at 90 psi



If the air over hydraulic foot pedal requires replacement, order from TIOT

GENERAL ARRANGEMENT

Dimensions are for reference only and may vary on each unit. Shown without mini power unit attached.

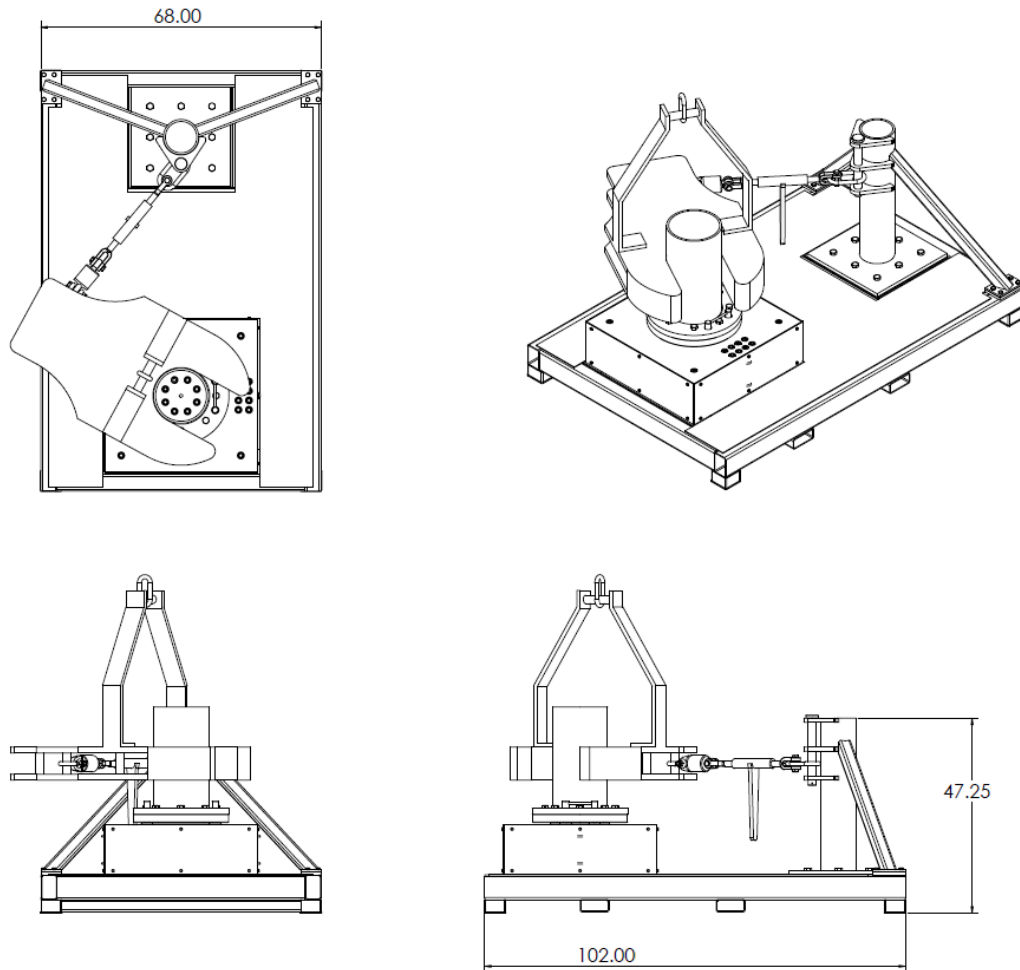


Figure 2

BACKUP KIT

Tongs with backups can be tested with the newest design mandrel part number T4STAND-BUKIT9625. This design handles 9-5/8", but others can be made for 7" to 13-5/8". Custom design is available.



Figure 3

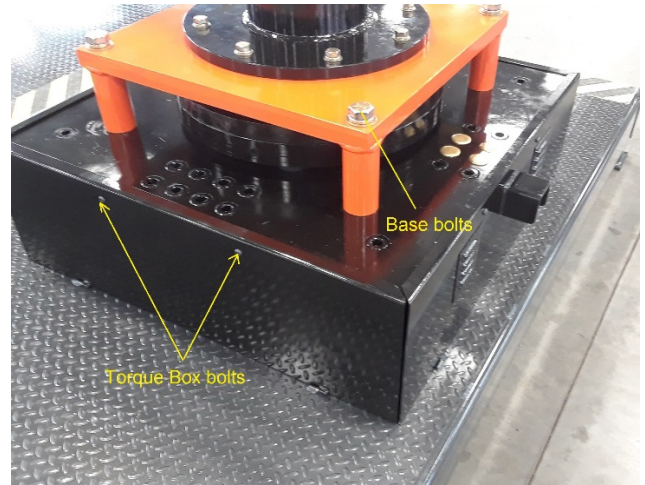


Figure 4

To test a tong without backup, the backup mandrel must be removed. The backup mandrel is designed to handle torsion both in the upper and lower portions together. To remove backup mandrel, remove the lower orange base bolts (see Figure 4) and lift the mandrel using the lug. See Figure 5.



Using the backup mandrel to test a tong without a backup may cause bodily injury.

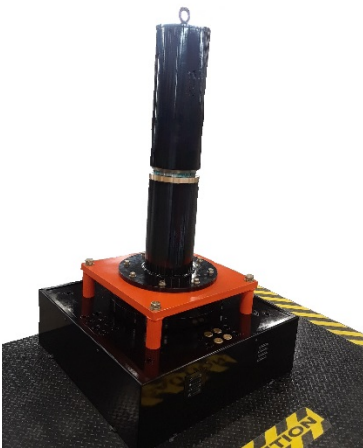


Figure 5



Figure 6

The torque box with the backup mandrel also has hinged sides allowing easier access to the brakes. To view brakes, remove the two (2) 5/16" bolts shown in Figure 4 and side can lay flat. Slide side away from hinge to remove completely.

The control box is mounted on the mini power unit and can telescope out. See Figure 6. The lifting eye allows the mini power unit to be lifted. See Figure 7. The control box can be removed by loosening the two (2) bolts shown in Figure 8 and lifting up.



Figure 7

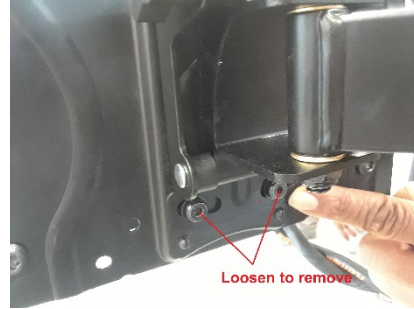


Figure 8

RIG UP/CONFIGURATION PRE-TEST

Use the following steps to prepare the test stand for operation.

1. Test stand should be positioned on firm ground and leveled both horizontally and vertically. Ensure that the test stand is defect free and ready for testing.
2. Suspend power tong using an overhead crane. Ensure tong is leveled both side to side and front to rear. Incorrect tong leveling can compromise operator's safety and cause equipment damage, as well as inaccurate torque readings.

The suspension line must support power tong weight as well as any other forces acting upon it during the test process

3. Attach the load cell to the ratchet turnbuckle, which is connected to the snub line post using a shackle. Turn ratchet to shorten or lengthen the snub line and adjust to 90 degrees (as seen in Figure 2). Use the safety wireline when using the backup mandrel.



Torque gauges and load cells are factory supplied as matched calibrated pairs

4. Place torque gauge in control box's holder. See Figure 9.

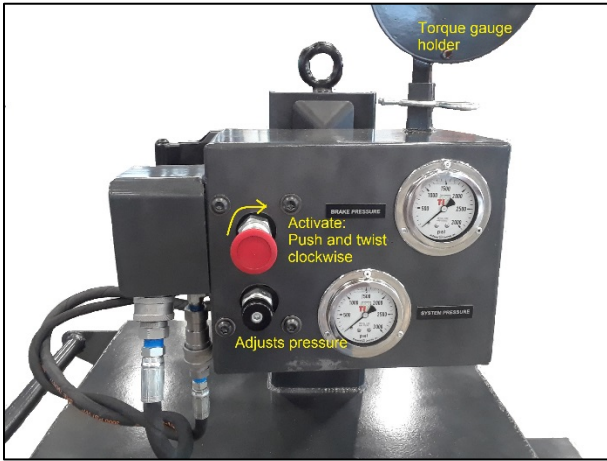


Figure 9



Figure 10

5. Use crank handles/knob to lock control box and arm position for optimal operator access
6. Connect the hoses from the mini power unit (unit seen in Figure 13) to the control box per Figure 11. Backup mini power unit is already connected.



Figure 11

7. Plug in mini power unit using the supplied power cord
8. Turn on mini power unit
9. Ensure tong and snub line are at a 90 degree angle as shown in Figure 2 before testing tong
10. Place the tong jaws below the 20" mark (measured from the base) on the mandrel.



The test stand can be damaged if the tong is set higher

NOTE



Loosen the suspension line once the tong is installed. Any upward pull force on the mandrel can damage the test stand

IF using the brake with air over hydraulic foot pedal:

Attach the torque gauge to the tong and connect a clean dry air supply to foot pedal as shown in Figure 12.



Figure 12

The force (Lbs) on the snub line can be calculated as a function of the maximum power tong's torque output. Divide the maximum torque output of the tong (ft/lb) by the tong's arm length (in feet)



Example: Maximum torque = 40,000 ft/lb; Tong arm length = 36" (3'); Total force = 40,000/3 = 13,333 lbs

The test stand can also be operated using the dead head/stop pins instead of the brake. See Figure 14 of dead head installed.



Figure 13

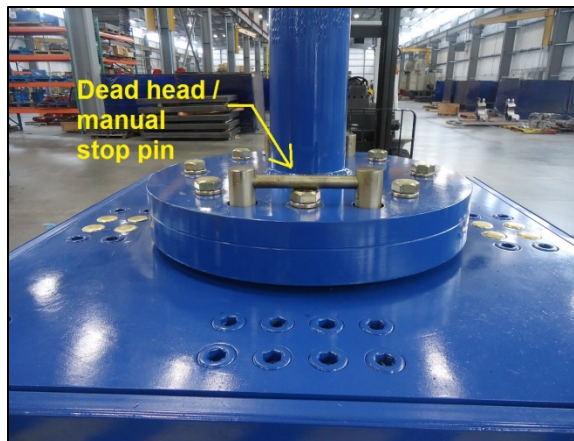


Figure 14

POWER TONG TEST

Open and close tong door manually 5 times verifying the power tong door latch works properly. Open the door and close around the mandrel.



Ensure tong and snub line are at a 90 degree angle as shown in Figure 2 and tong is level (front to back and side to side) so that the tong dies grip the mandrel uniformly

Run tong without pressure on the brake in low torque. Stop tong and shift into high torque. Push the tong's valve activation lever to makeup so tong will grip the mandrel. Verify tong dies grip mandrel uniformly. If not gripping uniformly, release tong and readjust tong's level. Activate brake by pushing and turning the red button clockwise. Slowly apply minimum brake pressure (about 250 to 500 psi on the control box gauge) by turning the black knob clockwise slowly to increase pressure and run tong with 5,000 to 7,000 ft/lbs of torque. Gradually increase the brake pressure until the torque gauge reads the desired makeup torque setpoint. Keep the brake pressure setting and release the tong. Then reapply tong to makeup torque setpoint.



Use the stop pins to dead head the mandrel and test the tong's maximum torque – NOT the brake

For breakout, follow rig up section instructions except tong is located on left side of test stand (viewing with back to the stub post). Load cell needs to be attached to the interior rear of the tong (opposite side as shown in Figure 2). TIOT recommends using the stop pins to simulate breakout. Pull the tong's valve activation lever to breakout and verify tong dies' grip mandrel uniformly. Torque to desired breakout setpoint.

RIG DOWN/CONFIGURATION POST-TEST



If tong operator feels excessive skid movement, thoroughly inspect welds and beams under skid

After a test:

1. Release power tong from mandrel
2. Disengage brake (if used) by pressing and turning red button counterclockwise and reset pressure setting by turning black knob counterclockwise. See Figure 10.
3. Let mandrel spin/rotate

4. Bleed off pressure to brakes by disengaging red button (Figure 10). Verify zero (0) pressure on the pressure gauges before disconnecting hoses.



Before disconnecting or changing hoses on mini power unit, bleed pressure from brakes using the relief valve (Figure 15)

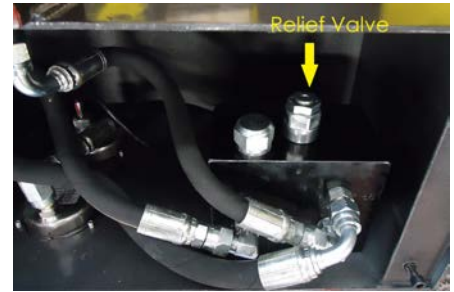


Figure 15

PREVENTIVE MAINTENANCE



This is a suggested PM schedule. The tool owner has the responsibility to adjust the program according to actual tool usage



When there is suspicion that the test stand has been **overloaded**, it should be pulled from operation for an Annual type PM

Normal wear in course of use will eventually reduce the test stand's capability. Inspect the mandrel, snub post, and skid frame regularly for wear. Cracks or the appearance of damage can indicate disrepair, even impending failure, and requires prompt attention. The test stand must be either pulled from operation immediately or repaired. Each use of the tong test stand could be considered a performance test.

Daily (PM1) – While in use

- Apply EP 4 grease to grease port on skid. See Figure 16. Also grease ratchet/turnbuckle
- Visually check for damage and cracks – if found, pull from operation for repair
- In mini power unit, a) check hydraulic oil level gauge seen in Figure 17. If below 50, fill to top of gauge b) ensure no leaks
- Inspect visible welds
- Look for worn, damaged, loose or missing parts – replace or tighten
- Verify skid is leveled per rig up configuration/pretest instructions
- Inspect the screws for back rotation after each test



Figure 16: Grease port



Figure 17 - Gauge at 60



When refilling the hydraulic tank, the added oil must be 1) filtered through a 10 micron purity offline filter and 2) the same type (no mixing of oils)

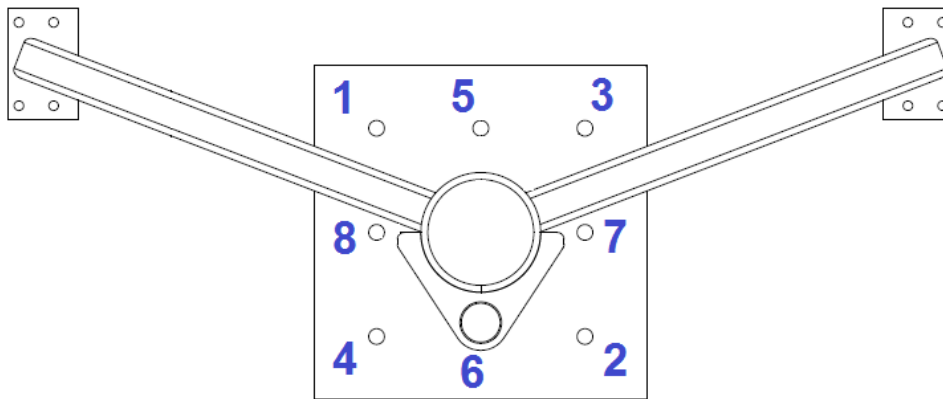


Figure 18 - Recommended torque pattern

When replacing the mandrel or snub post, TIOT recommends the following torque pattern shown in Figure 18:

1. Snug tight screw #1 and then cross to opposite side #2, repeat sequence until #8
2. Start torqueing at #7 (opposite) - reversing order until torqueing #8
3. Skip and do every other (go to #5, #7, #6, etc) - ending at #8

| Recommended Torques | |
|-----------------------------|--------|
| Item | ft/lbs |
| Mandrel screws | 600 |
| Snub Post screws (1") | 600 |
| Snub Post arm screws (5/8") | 160 |

Table 7

Quarterly (PM2)

- Check brake pads. Replace when two (2) mm of the friction material/lining is left
- Remove coating and debris from critical areas before disassembling to perform Magnetic Particle Inspection (MPI) on critical welds as indicated in Structural Welding Code AWS D1.1
- Carry out daily PM

Semi-Annual (PM3)

- Carry out quarterly PM
- Change brake hydraulic oil filter

Annual (PM4)

- Repeat semi-annual PM
- MPI critical areas twenty four (24) hours after use
- Repair skid as needed - recommend repairs be done by TIOT
- Replace brake pressure mineral oil every 8,000 hours or yearly
- To prevent the brake seals from drying out and sticking, the brake must be operated at full stroke at least 20 times



MPI is required after remanufacture or a major weld repair

BRAKE PAD REPLACEMENT

The brake pads on a delivered test stand have been 'bedded in'. When brake pads are replaced, the brakes require 'bedding in'. This can be done by using the test stand with increasing load or speed until sufficient coefficient of friction is achieved.



Always use new pads with a new disc/rotor

To install new brake pads, remove all four (4) sides from the torque box. Remove all 27 mm brake bolts. See Figure 19. Loosen the corner bolts (1" – 8) about half (1/2) an inch and gently pry up the lid to release the torque on the top of the box. Undo and remove all hydraulic lines. Remove the upper half of the caliper and slide it out followed by the lower half. Replace pads per instructions in Appendix A.



Assembly requires a clean and dust free environment. Pads must stay dry and free of oil/grease. Any oil or grease will reduce stopping efficiency by 20%

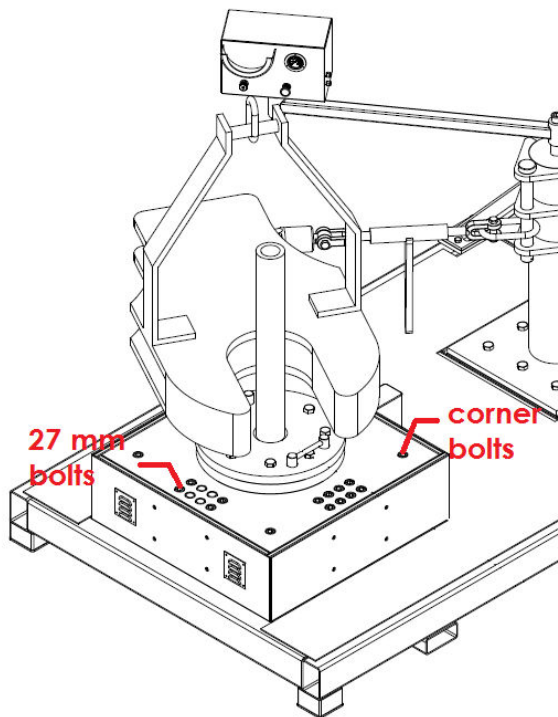


Figure 19

| Brake Caliper Recommended Torques | |
|-----------------------------------|--------|
| Item | ft/lbs |
| Retraction bolts | 10 |
| Cap Screws - mounting | 600 |
| Socket Head - mounting | 600 |

Table 8

While brake is disassembled, check drain plug o-ring. Lubricate with grease if needed. Replace if cracked or smashed. The brake will leak if the o-ring is not placed correctly. Slide the lower half back into place and then reinstall the upper half. Repeat for the remaining brakes. When all the brake pads are changed, reconnect the hydraulic lines. Tighten the corner bolts and then reinstall the brake bolts. Tighten per Table 8. Bleed brakes several times to remove any air in the lines using the following procedure:

Brake Pad Replacement continued

Items required for bleeding of brakes (Figure 20):

- 1/4" male minimess
- 800 mm test hose
- Catch container (not shown)

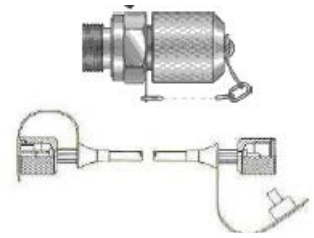


Figure 20

Steps to bleed air from brakes:

- Ensure pressure is removed from system
- Remove the hydraulic plug from a pressure port (upper not shown in Figure 21) on a caliper half with an allen wrench
- Attach 1/4" male minimess and tighten
- Attach test hose to minimess
- Route loose end of test hose into catch container
- Pressurize brakes (which will allow air to be flushed from system)
- Multiple plugs can be bled if more than one (1) minimess and test hose is available



Two (2) minimess and two (2) test hoses are included

- Reinstall plug when bled



Both sides and each half needs to be bled



Figure 21; Hydraulic plug



Ensure no oil gets on the braking disc when bleeding brakes

Pressurize brakes and check for leaks. 'Bed in' new pads by applying 25% of the rated clamping force applied (approximately 580 psi) to the organic pad five (5) to six (6) times in a row. Run until 'bedded in' as per Appendix B.



Keep disc surface temperature below 180 deg C (356 deg F). If above, let it cool down and then repeat

Reinstall the torque box sides.

CRITICAL WELDS

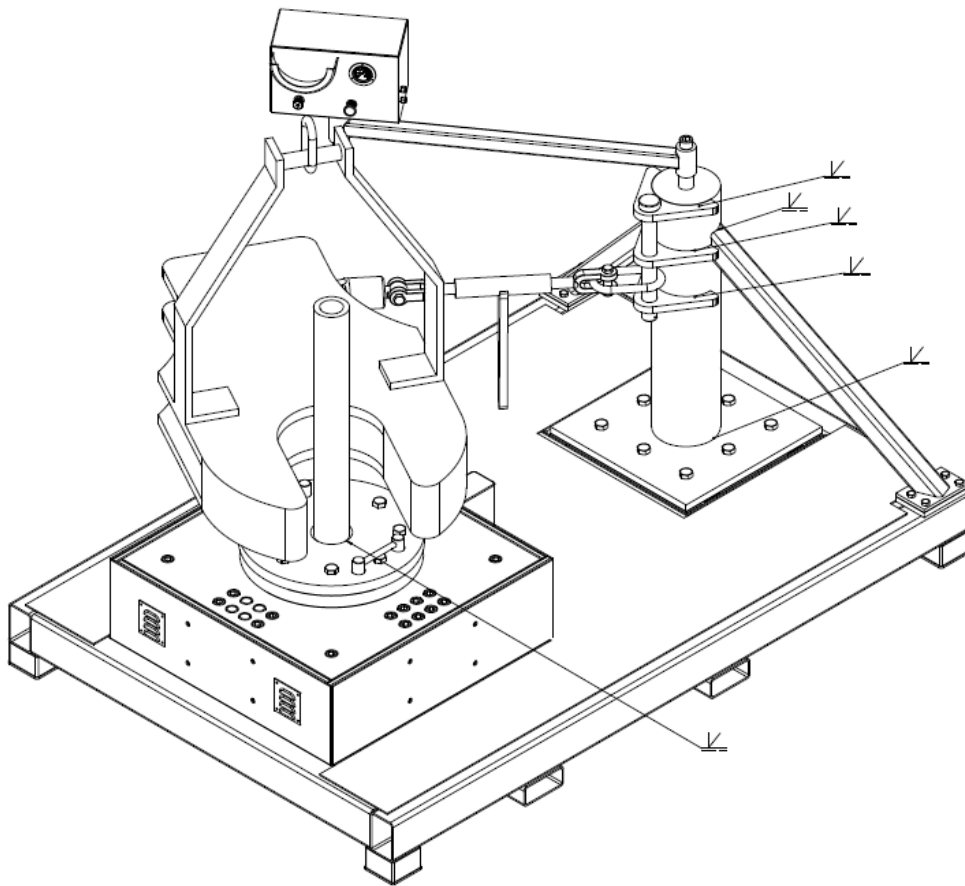


Figure 22

TROUBLESHOOTING

Refer to Appendix A for brake troubleshooting

| Failure Mode | Possible Cause | Possible Solution |
|---|-------------------------------------|------------------------------|
| Long braking time or insufficient brake force | Load too heavy, speed too high | Check tong setting |
| | Oil, paint or grease on disc or pad | Clean disc |
| | | Clean or replace pads |
| | | Check valves for leaks |
| Torque gauge not getting proper readings | Snub line is not at correct angle | Check length of snub line |
| | Incorrect torque gauge used | Check gauge and tong used |
| | Insufficient power supplied to tong | Check connections and valves |
| Bent/deformed pins | Overload | Replace Pins |
| Leakage | Loose seals | Check connections and valves |

Table 9

STORAGE AND TRANSPORTATION

- Unpainted surfaces should be coated with rust preventing agent
- Prevent excessive exposure to water and moisture
- Use the forklift pockets under the skid to lift the test stand

SPARE PARTS LIST

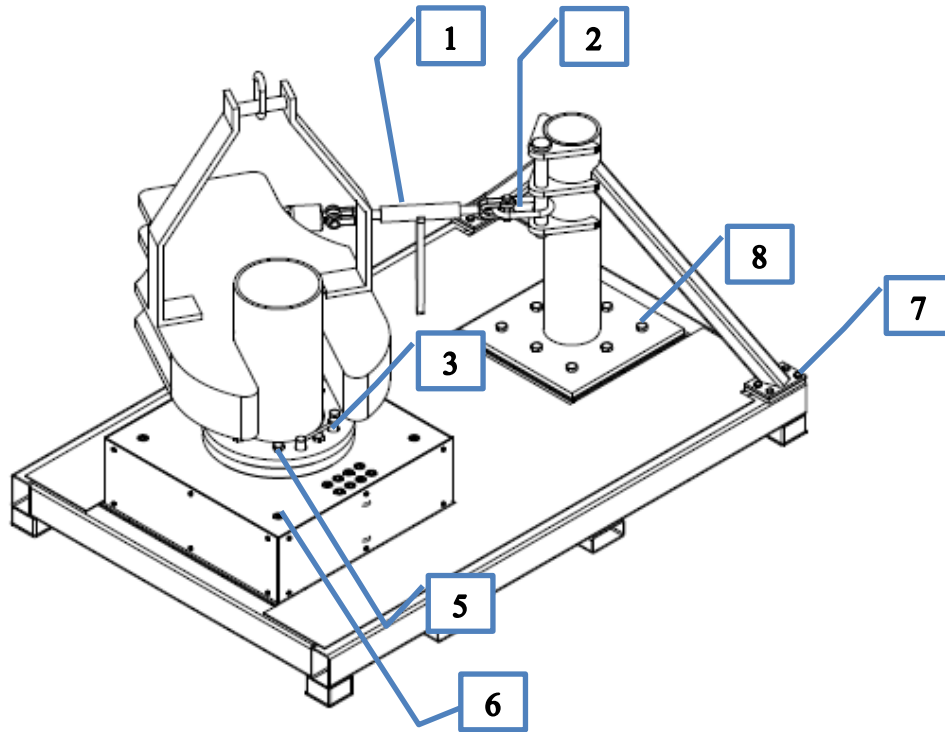


Figure 23

| Item | Component | Qty | P/N |
|------|-------------------------------|-----|--------------|
| 1 | RATCHET/TURNUCKLE | 1 | CDR-2-J-J |
| 2 | D RING/SNUB LINE PIN | 1 | T4STAND-S21 |
| 3 | DEAD HEAD PIN | 2 | T4STAND-B12 |
| 4* | BRAKE (SET OF 2) | 1 | BSAB90-S-417 |
| 5 | SCREW | 8 | 040075 |
| 6 | SCREW, BLACK OXIDE | 4 | 040212 |
| 7 | SCREW | 8 | 040021 |
| 8 | SCREW | 8 | 040205 |
| 9* | FOOT PEDAL - ADJUSTED TO 2200 | 1 | 060067 |
| 10* | RED PUSH BUTTON - CONTROL | 1 | PRH101K30 |
| 11* | BLACK CONTROL KNOB | 1 | MSV11-10 |
| 12* | VALVE BODY (FOR EACH BUTTON) | 2 | B10-3-A8T |
| 13* | HOSE IN MINI POWER UNIT | 2 | 050117 |
| 14* | BRAKE PADS (SET OF 2) | 2 | T4STAND-B16 |
| * | <i>not shown</i> | | |

Table 10

BACKUP PARTS LIST

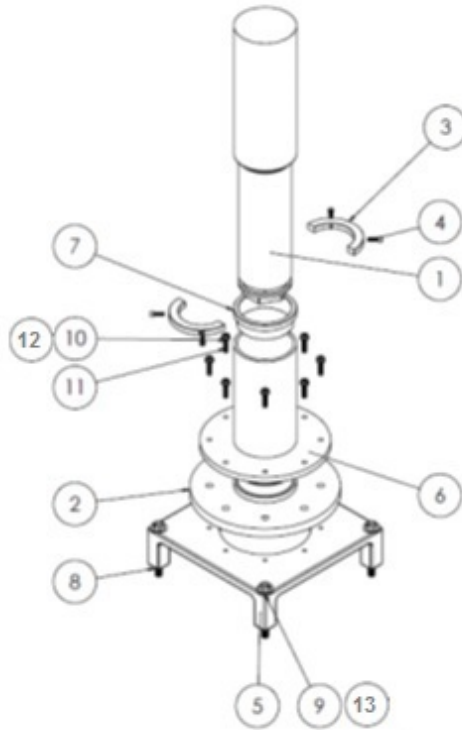


Figure 24

| Item | Component | Qty | P/N |
|------|-------------------------|-----|--------------|
| 1 | 9.625 BACKUP MANDREL | 1 | T4STAND-BU02 |
| 2 | BOTTOM PLATE | 1 | T4STAND-BU01 |
| 3 | LIFT BUSHING | 2 | T4STAND-BU06 |
| 4 | SCREWS FOR LIFT BUSHING | 4 | 040266 |
| 5 | STATIONARY COVER | 1 | T4STAND-BU04 |
| 6 | 9.625 MANDREL | 1 | T4STAND-BU03 |
| 7 | BUSHING | 1 | T4STAND-BU05 |
| 8 | BOLTS FOR COVER | 4 | 09-0288-1 |
| 9 | WASHERS, LOCK 1" | 4 | 040130 |
| 10 | WASHERS, FLAT 5/8" | 8 | 040055 |
| 11 | BOLTS FOR MANDREL | 8 | 040267 |
| 12 | WASHERS, LOCK 5/8" | 8 | 040054 |
| 13 | WASHERS, FLAT 1" | 4 | 02-E0001 |

Table 11

APPENDIX A

SVENDBORG BRAKES

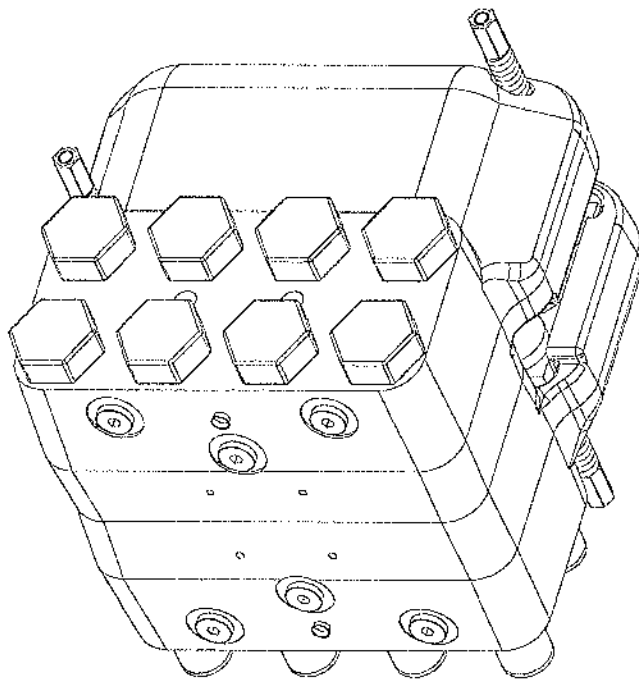
GLOBAL
LEADING
EXPERTS 

**INSTALLATION &
MAINTENANCE
MANUAL**

| | |
|-----------|--------------|
| Name: | MEB-0090-020 |
| Date: | 18.08.2014 |
| Revision: | B |

Installation and Maintenance Manual

**HYDRAULIC ACTIVE
DUAL SPRING
DISC BRAKE
BSAB 90-S/R-407**



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APPENDIX A

Installation and Maintenance Manual for BSAB 90-S/R-407

SVENDBORG BRAKES

1. General

Thank you for buying a Svendborg Brakes product.
Before using the product please read this manual carefully.

1.1 Who to contact

If you have any questions regarding this manual please contact your local representative or nearest Svendborg Brakes Office:

Head office

Svendborg Brakes - Denmark
Phone: +45 63 255 255
Fax: +45 62 281 058
E-mail: sb@svendborg-brakes.com

For local offices / current contact information, please refer to www.svendborg-brakes.com.

1.2 Safety

The Svendborg Brakes brake line of products are designed to be mounted on a rotating brake disc for use in conjunction with parking brake applications, service brake applications or emergency brake applications only.

Note:

- Always make sure that you consult Svendborg Brakes before using tools or any other equipment not recommended/specified in this manual.
- In order to maintain the guarantee always use original spare parts from Svendborg Brakes.
- It is the customer's responsibility that the brake and hydraulic aggregate are always clean, and free from dirt, grease or oil.
- It is the customer's responsibility that the air gap between brake pads and brake disc never exceeds the air gap recommended.
- Always use a torque wrench when refitting mounting bolts or valves in order to ensure the torque obtained is the torque described in this manual.
- There should be one manual available for the service/maintenance crew as a minimum.

Hydraulic power unit:

- Do not operate the hydraulic power unit before correctly filling the reservoir/oil tank with oil.

- Do not adjust valves or pressure switches to higher operating pressure than specified in the manual.
- Do not change the size or type of components.
- Do not use hydraulic fluids not recommended in this manual.

Brakes:

- Do not operate the brake before removing the air from the hydraulic system by bleeding and then re-filling with oil.
- Do not use higher operating pressures than specified on the nameplate of the brake/or in the manual.
- Do not use the brake pads when they are worn to the minimum thickness as shown in the manual.
- Do not operate the brake if there is dirt or corrosion protection on disc or brake pads.

Personal safety:

Do not work on the brake/system before attending all the following matters:

- Make sure the brake disc is locked and not able to rotate before adjusting the brake and/or air gap.
- Be sure to lock/secure the brake piston by using the air gap bolt/air gap nut if working on a spring applied brake.
- Make sure there is no pressure on the hydraulic power unit or circuit.
- Make sure that the oil pressure in the accumulator(s) has been relieved/removed.
- Make sure the control signals has been shut off and blocked before working on the system.
- Make sure the electrical power has been shut off.
- Be sure the manual has been read and understood.
- Avoid prolonged skin contact with hydraulic fluids - read the manufacturer's instructions before using hydraulic fluids.
- If using solvent cleaners you must read the manufacturer's instructions before using a solvent cleaner, and then carefully follow these instructions

Heavy equipment

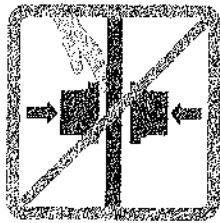
Be careful when lifting the brake or brake components - it is heavy equipment and is not made for manual lifting.



Use proper lifting equipment in order to prevent personal injuries.

Fingers warning

Never place your fingers between the brake pad and the brake disc when the brake is connected to the hydraulic system.



1.3 Safety terms/symbols used in this manual

To ensure that you perform certain tasks properly, please take note on the following symbols used throughout this manual.



WARNING: Information to prevent personal injury when trying to complete a task.



CAUTION: Information to prevent damage to the components when trying to complete a task.



IMPORTANT: Information that you **MUST** follow to complete a task.



NOTE: Tips and additional information to aid in completing a task.

Figures within brackets () relate to position number and appendix number i.e. (15-C) refers to position number 15 in appendix C on both drawing and bill of material (parts list).

1.4 Disclaimer

Svendborg Brakes reserves the right to revise this document without prior notification. These documents have been proofread for errors in translation and accuracy. Despite this, technical and typographical deviations may occur.

This document is updated on a regular basis; changes will be published in future

printings. Improvements or changes to the described products or manual can be implemented at any time without preceding notice.

In no event shall Svendborg Brakes be liable for any special, incidental, consequential or punitive damages. This includes, but is not limited to: damage to other property or person, inconvenience, loss of goodwill, lost profits or revenue, loss of use of this product or any associated equipment, cost of substitutive equipment, downtime costs or claims of any party such damages, resulting from any misspellings or inaccurate information in this users guide.

This document or parts hereof may in no event be copied, reproduced, changed or translated to other languages without explicit written permission from Svendborg Brakes.

1.5 Original language

The original language of this manual/instruction is English.

All other languages are translations of the original.

1.6 Conversion factors

All units in this manual are in metric units.

If you have needs for conversion between metric and imperial units the following figures can be used.

APPENDIX A

Table 1.1

| Conversion factors | | | |
|--------------------|----------------------|------------|-----------------------------|
| Length: | | | |
| 1 | inch | = 25.4 | mm (millimetre) |
| 1 | mm (millimetre) | = 0.0394 | inch |
| Mass: | | | |
| 1 | kg (kilogram) | = 2.2046 | lb (pound) |
| 1 | lb (pound) | = 0.4536 | kg (kilogram) |
| Force: | | | |
| 1 | N (Newton) | = 0.2248 | lbf. (pound force) |
| 1 | kN (kiloNewton) | = 224.8089 | lbf. (pound force) |
| Pressure: | | | |
| 1 | Bar | = 0.1 | MPa (Mega Pascal) |
| 1 | Bar | = 14.5038 | PSI (pound per square inch) |
| 1 | MPa (Mega Pascal) | = 1 | N/mm ² |
| 1 | N/mm ² | = 145.038 | PSI (pound per square inch) |
| Torque: | | | |
| 1 | Nm (Newton meter) | = 0.7376 | lbf.ft. (pound foot) |
| 1 | lbf.ft. (pound foot) | = 1.3557 | Nm (Newton meter) |

Examples:

| | | | | | |
|-----------------------|---|----------|---|----------|--------|
| 115 bar | = | 11.5 MPa | = | 1667.94 | PSI |
| 320 N/mm ² | = | | = | 46412.00 | PSI |
| 305 Nm | = | | = | 224.96 | lbf.ft |

1.7 Nameplate / Serial-numbers

Before contacting Svendborg Brakes or your local reseller please **record** the serial number of the product found on the nameplate.

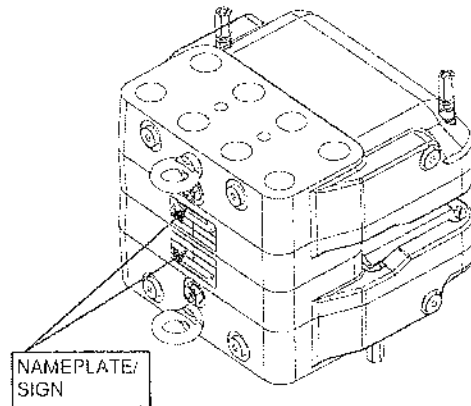
This will ease the process of identifying the actual product supplied and will help in locating eventual problems.

The nameplate looks like shown in figure 1.1 and is positioned on the brake as per figure 1.2.

FIGURE 1.1

| | |
|---------------------------|---------------------------------|
| SVENDBORG BRAKES | |
| BSAB 90-S-407 | |
| 10/2014 | |
| ITEM NO. 490-2326-801 | CLAMPING FORCE 0 - 200 000 N |
| SERIAL NO. 1-200015626 | OPPL PRESSURE 0 - 15.7 MPa |

FIGURE 1.2



Example:

Naming of the brake:

"TYPE"

The type is the description (name) of the brake.

Serial number:

The serial number is located on the nameplate/sign at the label named "SERIAL NO.".

The serial number is a unique number, which identifies the brake.

Other information on the nameplate/sign

"ITEM NO"

This is the item number of the brake.

"CLAMPING FORCE" and "OPERATING PRESSURE"

The performance of the brake is shown by the clamping force provided and the corresponding operating pressure.

Production year

The year and week number of manufacturing is stated in the upper area of the nameplate. A brake manufactured in week 10 in 2014 is marked "10/2014".

1.8 How the brake works

The brake is designed to transfer a clamping force into a braking torque from the brake calliper to a brake disc - either in order to stop the rotation of the brake disc or to prevent rotation when stopped (parking brake).

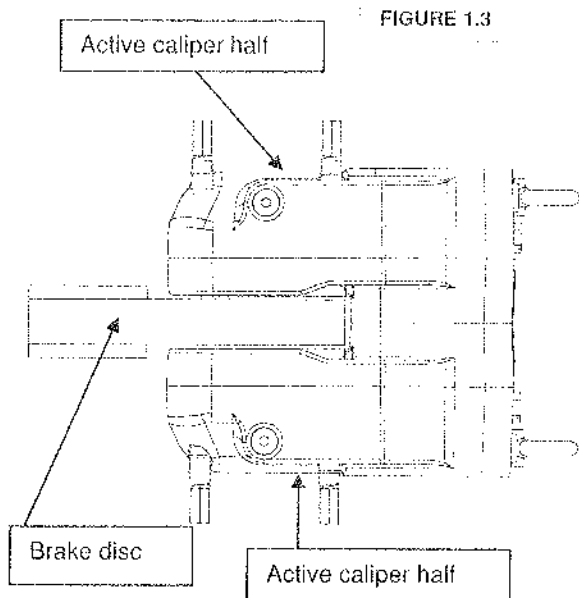


FIGURE 1.3

1.9 Function

The BSAB 90 is designed as a hydraulically applied disc brake.

The clamping force increases when the hydraulic pressure increases.

The Dual Spring brake consists of two active calipers each containing two pistons.

The active calipers are mounted/joined together onto the bracket using bolts and spacers (spacers only where applicable).

The assembled/bolted unit is fixed to the bracket and does not move.

When braking, the pistons inside both active calipers and both the brake pads will move towards the brake disc and generate a braking force on both sides of the brake disc.

Only limited movement of the brake disc is allowed. The movement of the brake disc must be within the total air gap of the brake as specified. The alignment of the brake and the bracket must be adjusted to match this.

Brake disc movements exceeding the air gap as specified for the brake will in worst case result in damage to the brake/brake disc/hub/coupling or mounting structure.

Check the mounting and dimension drawings for exact dimensions, tolerances and allowed movement.

This Manual is valid for the brake option BSAB 90-S/R-407.

The BSAB 90 brake is designed as a hydraulically applied disc brake.

The clamping force is obtained from the hydraulic pressure applying force to the pistons and to the brake pad against the brake disc.

The reaction force is transferred via the yoke.

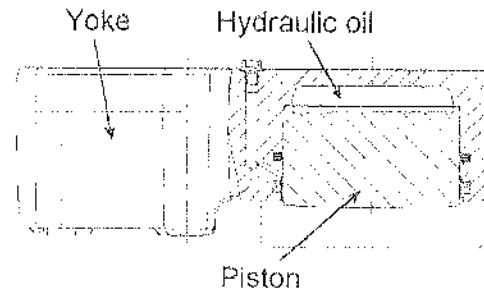


FIGURE 1.4

Applying and relieving hydraulic pressure to the pressure ports operates the brake.

The brake generates the clamping force by the pistons executing movement towards the brake disc. This happens when the hydraulic oil pressure is applied to the hydraulic unit and the chamber behind the piston.

The braking force decreases when hydraulic oil pressure is removed from the hydraulic chamber/unit causing the piston to execute a short stroke towards the yoke - away from the brake disc.

The pad retraction springs (mounted in the brake pads) will then pull the pads away and allow the brake disc to rotate freely.

1.10 Operating conditions

The BSAB 90 brake is designed for operating at a maximum operating pressure at 15.7MPa (157bar).

For applications in wind turbines the operating temperature range is from -40°C to +60°C.

Please ensure that the hydraulic oil is suitable for operation at the actual temperature.

Please be aware that the reaction time / operating time may vary dramatically depending on oil type and temperature.

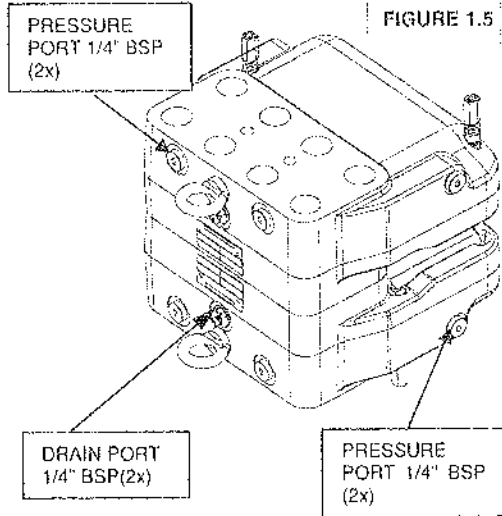
1.11 Ports/Connections

Each caliper half is as standard provided with four pressure connections 1/4" BSP (6-C) and one drain connection 1/4" BSP (7-C) - see figure 1.5.

APPENDIX A

IMPORTANT

Both calipers must be connected in order to make the brake operate correctly.



Pressure ports

The pressure ports are used to operate the brake. The connection at the lowest position must always be used as a pressure connection when connecting the brake to the hydraulic system. The pressure ports not in use must be plugged with a steel plug with an o-ring. The pipe work for the pressure connection should be designed so that the hydraulic system for the brakes can be bled as close to the brake unit as possible.

The brake should always be bled from the highest port when mounted.

The highest pressure connection can be used if flushing is required.

Flushing is depending on the design of the hydraulic system and may not be an option.

Drain ports

The drain connection (7-C) provides access to the chamber between the outer seal (4-C) (and (5-C)) and the wiper (3-C) through a hole in the yoke.

This can be used to detect leakage and prevent leaking oil from reaching the brake disc.

1.12 Connecting the brake(s)

The brake(s) can be connected in several different ways depending on the actual application/needs.

The brake is as standard supplied with a plastic plug in the drain port (7-C). The pressure ports are plugged with steel plugs (6-C).

It is not necessary to use flexible hoses when connecting the brake/calipers. They can be connected with pipes, but for installation and maintenance issues, it may provide some advantages using flexible hydraulic hoses as a final part/section of the connection when connecting the pressure ports on the brake to the hydraulic power unit.

Pressure connection

Connect the pressure to the lowest port and bleed from the highest port.

Bleeding can be done by using a test point male (1/4" BSP) (mini-mess) and hose - see recommended spare parts for item numbers.

IMPORTANT

Bleeding must be done for both brake calipers i.e. both sides of the brake.

Drain connection

CAUTION

Never apply any pressure to the drain port (7-C).

If hydraulic pressure is applied to the drain port, the oil/pressure enters the chamber between the seal and the wiper. The pressure then blows off the wiper and most likely destroys the seals.

It is highly recommended to connect the drain port to a (preferably clear) tube leading to a drain bottle. This prevents damp air from entering the brake and leaking oil from reaching the brake disc. Remember to use the lowest positioned drain port for the drain connection.

IMPORTANT

Beware that oil on the brake disc reduces the braking force remarkably.



The drain port could also be connected directly to the tank of the hydraulic power unit.

Using drain bottles that are clear and one bottle for each brake caliper makes detection of potential leakages easier.

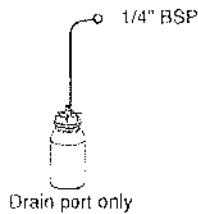


FIGURE 1.7

1.13 Lubrication

Different types of lubrication are used in different situations.

This can either be for lubrication of the seals or when tightening bolts of a diameter above 16mm.

Some symbols are used on the drawings to indicate where lubrication is needed during service.

- △ Grease - Molykote P74
- Grease - Molykote Longterm 2 Plus
- Hydraulic oil
- MoS₂ Molybdenum Disulfide

Molykote is produced by Dow Corning.

The hydraulic oil may be synthetic or mineral oil as per recommended oil types.

Molybdenum Disulfide (MoS₂) is to be found in various forms; either spray, fluid or solid state.

1.14 Transport

When leaving the factory the brake is always packed / wrapped to ensure maximum security for the product during transport.

The weight of one brake caliper is approx. 26kg (excluding brake pads and bracket). The total weight of two caliper halves is about 55kg.

1.15 Storage

General minimum storage requirements are:

- All equipment containing hydraulic parts incl. brakes must be stored indoors and above +5°C to avoid condensation.
- All electrical equipment must be stored indoors, in dry, non-condensing conditions above +5°C
- Equipment/boxes must not be in direct contact with water/rain and must be stored under cover.

Brake(s), steel parts, hydraulic and electrical parts shall be stored indoors within a temperature range of +5°C to +40°C.

Maintenance of the brake is needed for storage longer than 12 months. In order to prevent the seals drying out and sticking to

the piston, the brake piston must be operated at full stroke at least 20 times every 12 months.

The hydraulic unit must be stored indoors within a temperature range of +5°C to +40°C.

Oil should be added to the tank and pumps should be started up for storage longer than 12 months.

Bolts, nuts and washers etc. should not be removed from their original product packaging and must be kept dry indoors. Temperature control is not required.

Brake pads must be stored indoors. Temperature control is not required.

Spare seal kits should be kept away from direct sunlight and should be stored in their original bag, ideally in a box or dark area.

Control panels must be stored indoors in an upright position within a temperature range of +5°C to +40°C. Battery maintenance will be required for storage longer than 12 months.

Brake discs, couplings and hubs are treated with corrosion protection. If stored outdoors, the equipment must be stored in a sealed plastic bag in its wooden box. The box must be placed under cover but does not need controlled temperature.

The brake(s)/bracket(s) are treated at the factory with corrosion protection.

IMPORTANT

Anti-corrosion protection should be reapplied if removed during transporting or handling.

1.16 Disposal

General

The operator and/or user is responsible for the proper disposal of the brake and the associated components.

In case of any doubts about the correct disposal please do not hesitate to contact Svendborg Brakes or your local dealer or regional disposal enterprises for further information.

Brake pads

The brake pads are made from a steel back plate and brake pad material/lining. The brake pad material is either made from an

organic compound or from sintered metal. Each type is asbestos free and free of lead.

The brake pads can be treated as steel waste/scrap.

Hydraulic oil

Hydraulic oil must be treated professionally when disposed in order to prevent pollution. The oil must be removed from the brake and from the hydraulic system/unit and stored in proper containers until delivery to local disposal enterprises.

Brake

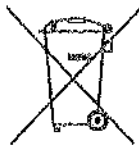
The brake is in general made of cast iron or machined steel. Once the hydraulic oil has been removed from the brake, and the seals have been removed the brake can be treated as steel waste/scrap.

Seals

The seals and o-rings used in the brake are made of either Polyurethane (PUR), PTFE (Teflon) or rubber (NBR). They can all be treated as normal waste.

Electronics

If equipped with any electronic equipment as sensors, indicators or similar - this equipment should be treated as electronic waste.



1.17 How to order spare parts

When ordering spare parts for your brake please refer to the specific item number in the parts list/bill of material - see appendices or the recommended spare parts list.

For full identification of the brake please note the serial number and preferably the item number and type, stated on the name plate/sign - see Section 1.7 - *Nameplate / Serial-numbers*.

2. Installation

2.1 Lifting and handling

The BSAB 90 Dual spring brake is equipped with eyebolts on the calipers and should only be lifted by means of placing a hook through them.

In order not to damage any parts on the brake do not fit any hook or tie any rope, chain or strap around indicators, hoses etc. When lifting please note that the weight one caliper half is approx. 26kg (excl. brake pads). The total weight of two caliper halves incl. brake pads is about 55kg.

2.2 Cleaning the brake disc


Before installing the brake calipers the brake disc must be cleaned from any dirt or anti corrosive protection.

The anti-corrosive protection can normally easily be removed in two steps:

- 1) By using kerosene or similar for the initial cleaning.
- 2) Using solvent cleaners to remove the remaining dirt completely.

Use a cleaning solvent for the final cleaning. Solvent cleaners could be clear methylated or white spirits or isopropyl alcohol.

Any residual oil or anti-corrosion preparation will reduce the coefficient of friction greatly.

 **WARNING**

Solvent cleaners are flammable and poisonous and can cause burns.

To avoid serious personal injury when you use solvent cleaners, please read the manufacturer's instructions before using a solvent cleaner and then carefully follow those instructions.

Also follow these procedures:

- Wear eye protection
- Wear clothing that protects your skin
- Work in a well-ventilated area

Always follow local rules and regulations for/when working with solvents.

2.3 Cleaning the mounting surfaces

The mounting surface of the bracket must comply with the relevant arrangement drawings and mounting data drawings.

It is critical that the brake is bolted to the mounting surface in compliance with the

tolerance specified on the caliper dimension drawing.

 **IMPORTANT**

The joint between the mounting surfaces of the yoke and the customer post/gearbox is classified as a friction joint.

Therefore NO lubricant or other compound shall be applied between the caliper and mounting surfaces.

The mounting of the caliper does NOT rely on the shear capacity of the mounting bolts but of the friction joint. This friction joint is created by the clean, dry, lubricant free surface machined to the correct surface finish and of the tension created by the mounting bolts.

The mounting surfaces for the yoke and bracket (if applicable) should be cleaned in the same way as the brake disc - see section 2.2 - *Cleaning the brake disc*.


 **WARNING**

Solvent cleaners are flammable and poisonous and can cause burns.

2.4 Handling/mounting the brake pads

Friction material is a very essential part of the brake system and the brake pads should be handled carefully to avoid damages to the brake pads/friction material.

The brake pads should be kept as clean as possible - be careful to protect the pads from grease and oil. Even a small amount of oil can reduce the friction coefficient considerably.

 **NOTE**

All brake pads supplied by Svendborg Brakes are asbestos free and free of lead. Certificate is available on request.

Svendborg Brakes supplies several types of brake pads with different brake pad materials depending on the actual needs in the application.

In general there are two types of brake pads:

- Brake pads with organic/composite linings
- Brake pads with sintered metal pucks/material

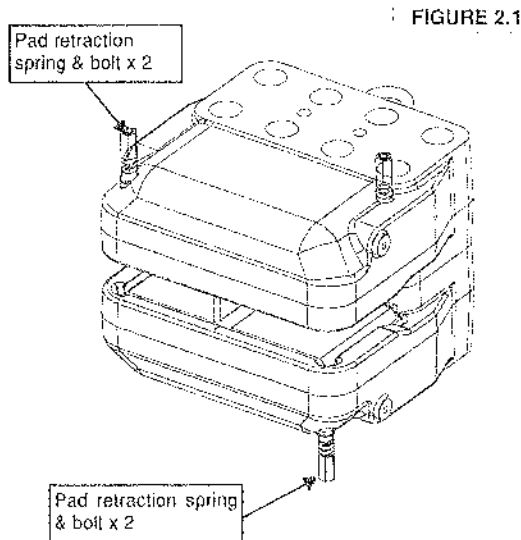
- 2.4.1 Organic brake pad material is very sensitive to grease and oil and cannot be cleaned. If exposed to this the brake pad must in most cases be discarded and replaced.
- 2.4.2 Brake pads with sintered metal brake pad material are less sensitive to dirt, grease and oil and can in some cases - where not fully soaked up with oil - be cleaned with solvent and re-used.



WARNING

Solvent cleaners are flammable and poisonous and can cause burns. Please follow the manufacturer's instructions and see section 2.2 - *Cleaning the brake disc*.

- 2.4.3 After mounting the brake pads the pad retraction springs should be mounted onto the brake pads.



2.5 Mounting the brake

Mounting can in general be done in several ways:

- 1) Mount and align the bracket, mount the brake(s) to the bracket and check the alignment (and adjust accordingly).
- 2) Mount the brakes to the bracket, mount and align the bracket to the brake disc and foundation.
- 3) If the brake is bought with a bracket it may already be mounted from the factory - the brake and bracket are to be mounted and aligned.

The following instruction is based on that the brake is to be mounted on the bracket on site.

If the brake is already mounted onto the bracket please skip the corresponding sections.

Short summary of what to do:

- Prepare the brake
- Check/clean mounting surfaces
- Mount the bracket (if applicable)
- Mount the brake pads and pad retraction springs on the caliper half.
- Mount the brake
- Check alignment/adjust accordingly
- Tighten the brake/bracket

Prepare the brake

- 2.5.1 Move eyebolts to the position needed.

Check the mounting surfaces

- 2.5.2 Check that the mounting surface of the bracket complies with the relevant arrangement drawings and mounting data drawings i.e. is flat and positioned with the right angles to the brake disc, before mounting the brake.

- 2.5.3 Ensure that the mounting surfaces are clean from dirt and oil - otherwise clean as per section 2.3 - *Cleaning of the mounting surfaces*.

Mount the bracket (if applicable)

- 2.5.4 Mount the bracket and align it to the brake disc.
Do not tighten the mounting bolts to the full torque as adjustment may be needed.

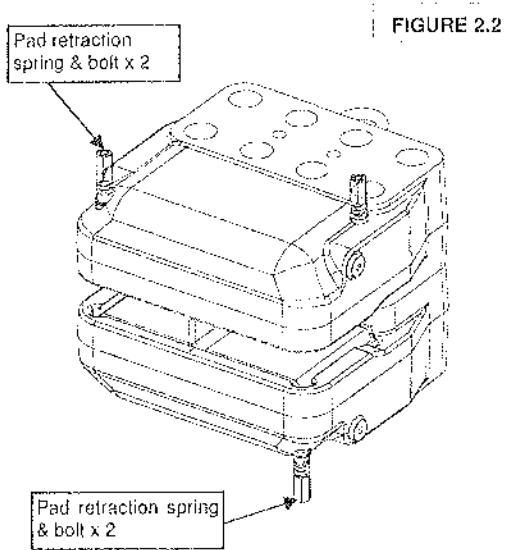
Mount the brake

- 2.5.5 Fit the brake pads in the caliper halves. - Be careful to protect the pads from grease and oil. Even a small amount of oil can reduce the friction coefficient considerably.
- 2.5.6 Lift one caliper half, including the brake pad, to the bracket and align the holes for the mounting bolts.
- 2.5.7 Mount the mounting bolts through the caliper and bracket and let the caliper rest on the bolts.
- 2.5.8 Lift the other caliper half into place and align it to the mounting bolts - Remember to fit the O-ring (2-A), between the calipers.
- 2.5.9 Fit and tighten the washers and nuts slightly. Before fully tightening the nuts and bolts please make a visual check to see if any interference between brake, bracket and brake disc is present. Make sure that the brake disc rotates freely without touching the

brake halves and fit the brake so that the pads are aligned correctly with the disc. To allow expansion, caused by temperature increase in the brake disc, a clearance of minimum 1mm. per 1000mm. of the brake disc diameter is recommended between the caliper halves and the brake disc.

NOTE

The brake calipers may need to be lifted before final tightening of the bolts/nuts as gravity makes the calipers tend to move down. In general this should not be a problem - but if the bracket has large mounting holes this could cause problems.



2.5.10 Fit the pad retraction springs and bolts and mount these - tighten firmly according to table 2.2 - *Bolts for pad retraction springs*.

| Table 2.2 | | |
|--|--------|-------|
| Bolts for pad retraction springs | | |
| Bolt size | Torque | |
| | | Dry |
| M8 8.8 | | 19 Nm |
| "Lubricated" is based on Molykote - MoS2 | | |

Check alignment

2.5.11 Check the alignment of the brake/bracket and brake disc.

Adjust the position of the bracket by moving it or adding shims until the brake is perfectly aligned to the brake disc.

2.5.12 Check that the brake disc is able to rotate freely, without touching the brake.

Tighten the bracket/brake

2.5.13 When aligned, tighten the mounting bolts for the brake (8 x M27) grade 10.9 or 12.9 to the correct torque. Use the tightening torques from the spare-parts drawing or Table 2.3 - *Mounting bolts for caliper half*.

| Table 2.3 | | |
|--|-----------------|-----|
| Mounting bolts for caliper half | | |
| Bolt size | Torque | |
| | Lubricated MoS2 | Dry |
| Standard bolts (DIN 912/DIN 931/ISO 4014 style) | | |
| M27 10.9 | 1080 Nm | |
| M27 12.9 | 1290 Nm | |
| "Lubricated" is based on Molykote - MoS2 | | |

2.6 Inspecting the alignment of the brake

2.6.1 Check the tolerances with app. B. The disc's angularity and run out in relation to the base plate must not exceed the permissible values. The distance between brake pad holder and the brake disc should be equal on both sides.

IMPORTANT

The axial movement of the brake disc must not exceed 0.3mm - see mounting drawing appendix B.

2.7 Bleeding and flushing the caliper

Each brake caliper and all hydraulic power units supplied from Svendborg Brakes have been individually flushed before leaving the factory. Despite that fact the hydraulic system must be flushed and bled before taking the system into operation. The flushing of the system will remove dust particles and potential dirt from the system. Even a tiny amount of dust can cause damages to the system.

After the flushing, the individual brake calipers should be bled in order to remove any air in the system. If the calipers are not properly bled, damages to the seals may occur.

2.7.1 The calipers hydraulic system must always be bled in conjunction with assembly, repairs or when making changes in the system.

Failure to bleed the brakes will allow air to remain in the brake system. This may prevent the hydraulic system from generating sufficient braking force. Furthermore, air in the system can create "diesel effect" and destroy/blow the seals.

The caliper must be bled at the highest point on the brake through the pressure port (6-C). A special bleeding plug (Mini mess/test point) 1/4" BSP and a hose can be supplied from Svendborg Brakes.

2.8 Bedding in

To obtain the rated coefficient of friction between the brake pad and the brake disc, and to ensure the pad surface is aligned to the disc, it is essential that the pads are bedded to the disc surface.

The coefficient of friction may drop by approx. 20% when not bedded in.

This can be done by making a series of load-tests with increasing load or speed until sufficient coefficient of friction is achieved.

If the brake disc is new, the time of bedding in will be longer because the disc also has to be bedded in. Always use new pads with a new disc. Never use used pads with a new disc.

During the process of "bedding in", the disc temperature should be monitored to ensure that the disc does not overheat.

Organic pads:

Organic pads can normally be bedded in by driving the disc through the pads with a minimum of 25% of the rated clamping force applied or, if that is not possible by making a series of activations with increased load or increased speed.

Maximum temperature of the disk during bedding in, is approx. 200 ° C for organic brake pads

Sinter-metal pads:

The bedding in process for sinter-metal pads is the same as for organic pads, but with a slightly higher clamping force when bedding in - approx. 40% of the rated clamping force applied.

Maximum temperature of the disk during bedding in, is approx. 350°C for sinter metal brake pads.

This instruction for the bedding in process is also to be found delivered with new brake pads.

2.8.1 Connect a hand pump and a pressure gauge into one of the pressure ports (6-C).

2.8.2 Start the application/rotating of the brake disc.

2.8.3 Apply the hydraulic pressure to the correct pressure level. Run until bedded in.

Example:

25% of clamping force needed
25% of the operating pressure of 15.7MPa is approximately 4.0MPa (40 bar)
The hydraulic pressure of 40 bar should be applied during bedding in.

2.9 Removing the brake

2.9.1 Make sure that there is no pressure applied to the caliper and then disconnect the hydraulic system.

2.9.2 Remove the pad retractions springs (and bolts) from the calipers.

2.9.3 Secure the worn brake pads in its positions by means of strips or similar when lifting/handling the brake.

2.9.4 The brake can now be removed safely by unscrewing the mounting bolts (8xM27-12.9) going through the caliper.

3. Maintenance

3.1 Replacing the brake pads

The brake pads must be replaced at the latest when 2mm of the friction material / lining is left on the brake pad.


The brake pad thickness can always be checked with a gauge. Measure the total thickness of the individual pad and measure the thickness of the steel back plate – subtracting these gives the lining thickness.

The brake pads should be kept as clean as possible - be careful to protect the pads from grease and oil. Even a small amount of oil can reduce the friction coefficient considerably.


- 3.1.1 Ensure there is no pressure on the caliper.
- 3.1.2 Remove the 4 pad retraction springs (and bolts).
- 3.1.3 Remove the 8 mounting bolts (M27).
- 3.1.4 Replace the worn pads with the new pads and press the pistons back into the caliper.
- 3.1.5 Re-assemble the brake and tighten the mounting bolts. Use the tightening torque specified in table 2.3.
- 3.1.6 Remount the pad retraction springs & bolts. Use the tightening torque specified in table 2.2.
- 3.1.7 Connect the pressure and drain lines.
- 3.1.8 Apply the oil pressure. Allow the pads to engage the brake disc.
- 3.1.9 Activate the brake a couple of times.
- 3.1.10 Remember to bed in the brake pads before taking the brake into full load situations - see section 2.8 - *Bedding in of the brake pads.*

3.2 Replacing other components

Some minor components may be replaced with the brake mounted on site, but it is highly recommended to take the brake to a workshop for repairs.

 CAUTION

When lifting please note that the total weight of the complete brake is approx. 55kg. The caliper half itself weighs approx. 26kg.

 WARNING

Always ensure there is no hydraulic pressure applied on the brake before starting work on the brake.

3.3 Dismantling the active caliper

General

The greatest possible cleanliness must be observed when working on a hydraulic system of any type.

Each part must be cleaned thoroughly with solvent cleaners.

Solvent cleaners could be clear methylated or white spirits or isopropyl alcohol.

 WARNING

Solvent cleaners are flammable and poisonous and can cause burns. See section 2.2 - *Cleaning the brake disc* for additional information.

Parts must be stored in a clean and dust free environment. All assembly work must also be carried out in clean and dust free environment.

Contamination with dirt shortens the lifetime of the seals considerably and may also damage the caliper.

The surface of the internal components i.e. piston (2-C) and the yoke (1-C) that are in contact with the seals are all ground or polished.

Please check that these surfaces are not damaged or scratched in any way and handle them with care to avoid damaging the surfaces.

A damaged/scratched piston will immediately ruin the seals resulting in leakage.

3.4 Replacing the seals

Our sealing solution has changed over time. However they are chosen with 'form, fit and function' which means that they are fully interchangeable.

In order to improve retraction performance for rotor brakes the current seal kit with stepseals use a PTFE main seal and wiper, both with back up o-ring.

When replacing the seal kit the PTFE seal & wiper is preferred for rotor brakes.

If the brake is leaking it is recommended to replace all seals at one time.

APPENDIX A

IMPORTANT

Make sure there is no pressure on the caliper.

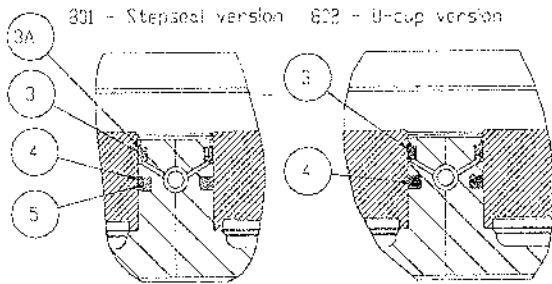
- 3.4.1 Remove the piston (2-C) by hand. If it is not possible to get a good grip of the pistons, then try to move the pistons out of the yoke by applying compressed air to the pressure port. Be very careful to avoid the pistons being shot out of the caliper, when you apply the compressed air.

IMPORTANT

Handle the pistons carefully. A scratched piston can immediately destroy the new seals.

- 3.4.2 Store the pistons in a safe location while replacing the seals.
- 3.4.3 Remove the wiper (3-C) (or 3-C/3A-C) and the U-cup (4-C) (or the step seal: rod seal (4-C) and the O-ring (5-C)).

FIGURE 3.1



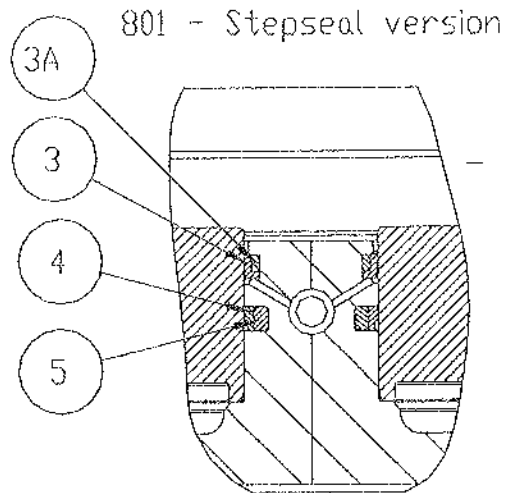
Use a screwdriver to lever the seal and the wiper out of the grooves.

Be careful not to damage the edges of the grooves.

- 3.4.4 Clean and dry the involved parts, see section 2.2 - *Cleaning the brake disc* for details.
- 3.4.5 Open the seal kit and place the seals on the table in correct order.
- 3.4.6 **Mounting the new seals - Stepseal version:**

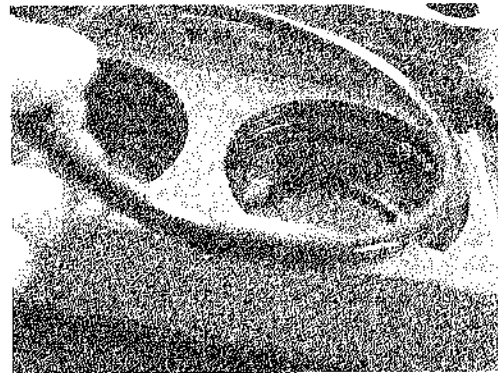
For the 801 seal kit refer to figure 3.2 for orientation of seals.

FIGURE 3.2



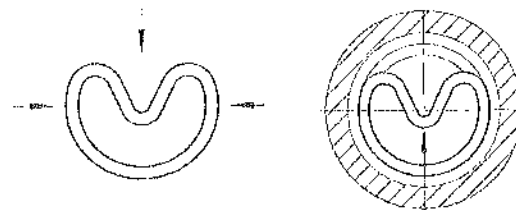
- 3.4.6.1 Mount the O-ring (5-C) in the groove before mounting the seal (4-C).
- 3.4.6.2 Mount the O-ring (3A-C) on the wiper (3-C) before mounting the wiper

FIGURE 3.3



- 3.4.6.2 Ensure the orientation is correct and that the O-ring is fully in place.
- 3.4.6.3 It may be easier to mount the wiper if it is squeezed into a soft U-bend / kidney shape.

FIGURE 3.4



APPENDIX A



CAUTION

Only use your fingers to squeeze out any kinks. Be very careful with the edges on the piston rod seals as they are quite sensitive.

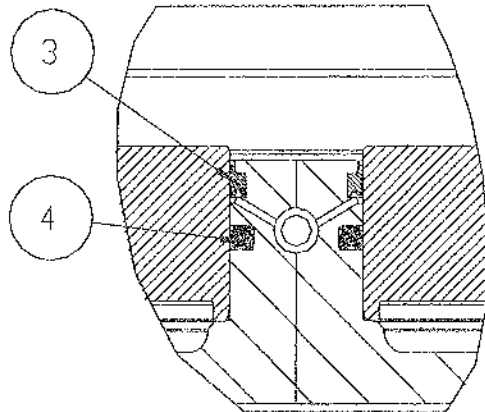
Lubrication is only necessary after dismantling the active caliper for internal maintenance. Please see appendix C.

3.4.7 Mounting the new seals – U-cup version:

For the 801 seal kit refer to figure 3.5 for orientation of seals.

FIGURE 3.5

802 - U-cup version



3.4.7.1 Mount the U-cup (4-C) in the groove, ensuring the orientation is correct.

3.4.7.1 Mount the wiper (3-C) with the dust lip of the wiper must be facing outwards.

3.4.8 Lubricate the seals and yoke according to the lubrication note in the Appendix C - *Spare parts drawing*. If the indicated lubricant is not available hydraulic oil may be used.

3.4.9 Place the pistons (2-C) in the yoke (1-C).

3.4.10 Push the pistons down as far as possible and fit the brake pads.

3.4.11 Use new bolts when mounting the calipers again. Apply the tightening torques from the spare-parts drawing or from Table 2.3 - *Mounting bolts for caliper half*.



NOTE

Mounting must in general ALWAYS be carried out using new bolts, nuts and washers; otherwise the required pre-tension force of the bolt connection may not be present.

4. Maintenance schedule

The maintenance intervals on a brake system depend on the usage of the specific brake system and also the design of the application in which the brake system is used.

Frequent usage will result in an increased need for maintenance / inspection.

The checks listed are those that should be performed on a regular basis and are recommended as part of normal planned maintenance tasks.

For a new installation / design where the exact conditions are unknown it is recommended to start with quarterly maintenance / inspection of the brake system.

Once the system has proven to work perfectly the interval can be increased to twice a year, yearly or even longer.

If it turns out that the operating conditions are very good i.e. almost no brake dust, disc is perfectly clean etc. consider increasing the maintenance intervals.

For detailed information on your specific application please contact Svendborg Brakes.

In order to prevent unplanned stops we recommend annual maintenance as a minimum.

Visual checks

- Check for damaged brake lines / pipes / hoses and the hydraulic connections for leaking oil
- Check the calliper(s) for leaks
- Check the drain connection(s) for leaking oil (ideally drain bottles on every calliper)
- Check the callipers and brake disc for oil or grease contamination
- Check the brake pads for excessive wear
- Use the amount of brake dust near the brake as indication of correct maintenance intervals

Check the brake pads for wear

- Check for total pad wear (when to replace the pads) by measuring the remaining thickness of the brake pad lining or if the brake is provided with pad worn indicator(s) and the signal is still on during braking no replacement is needed
- Check the pads for excessive and uneven brake pad wear

Brake disc

- Corrosion on the disc – especially the area covered by the brake pads – must be removed as this can have a negative impact on the brake pads and brake performance
- Check for oil and grease contamination and/or water (e.g. from condensation)

Yaw / slewing brake systems

- Removal of all brake dust from the brake disc by manual cleaning – use protective measures and vacuum cleaner or similar
- Materials that stick harder to the surface should be grinded away / off
- Check hydraulic pressure during yawing and during holding and adjust if necessary
- Color changes of the metallic blank disc surface to yellowish or brownish color should be removed (by grinding)
- In order to remove debris occurring on the brake pads the yaw disc can be turned three revolutions (either direction) preferably running at 0bar hydraulic pressure (typical unwinding pressure) or running at 15bar hydraulic pressure (if 0bar is not possible) on the brakes as this will ease the removal – clean the dust away as previously listed
- A leakage in the drain connection of maximum 0,2litre per brake (2 halves) per year is acceptable

Function test

- Apply the brake in order to ensure the piston and pads can operate
- For yaw / slewing systems (very low speed) check pressure during yawing and during holding and adjust if necessary

Hydraulic oil

- If the brake is not connected to a hydraulic power unit with flushing capability or with a separate return line, it is highly recommended to replace the oil in the brake on a regular basis.
If the oil inside the brake is not replaced the performance of the oil will be degraded over time.
Replacement can be done by bleeding the brake.
- If the oil is dirty, replacement is recommended. Alternatively take an oil sample to check oil condition prior to replacing.

APPENDIX A

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5. Trouble shooting

| Fault | Cause | Action |
|---|---|---|
| The brake applies slowly. | Air in the hydraulic system | Bleed system at highest point and at brake |
| | Abnormal throttling in the hydraulic system or valve in wrong position | Check that all valves are in the correct position. |
| | Abnormal throttling in the hydraulic system caused by dirt | Clean and check pipes, hoses and valves. |
| | The hydraulic oil in pressure lines between brake and tank has too high viscosity (too thick) | Check that the oil is of the recommended grade and the temperature is not too low. |
| Long braking time or long braking distance or insufficient braking force. | Load too heavy or speed too high | Check the load and speed values. |
| | Oil, paint or grease on brake disc or brake pad. | Clean the brake disc - see section Replace or clean the brake pad Check the hydraulic system does not leak. |
| | Not all brakes are braking/connected. | Check valves where applicable - check that the individual brake is working. |
| Leakage | Worn seals | Replace seals - check sealing surfaces |
| Uneven wear on pad. | The brake/bracket is incorrectly aligned | Check the alignment |
| | Excessive disc run out or shaft deflection | Replace the brake disc and check the shaft run out. |
| Abnormally heavy wear on pad. | Increased brake utilisation | Check that the load speed and frequency do match specified values |
| | The brake does not lift the brake pad/piston properly. | Check for remaining hydraulic pressure in the brake. |

Appendix A - Parts list for complete brake

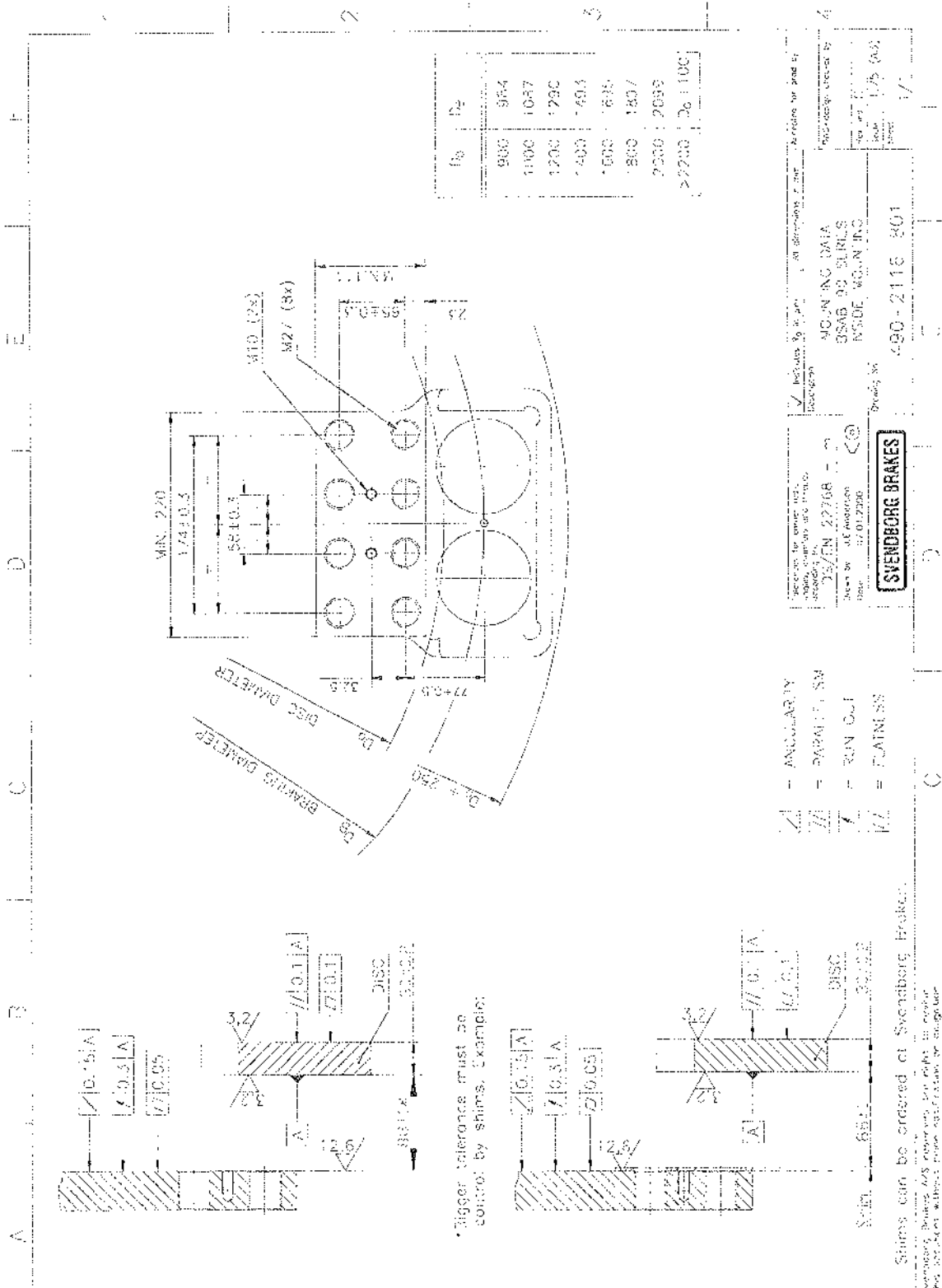
- ① 490-2326-801 BSAB 90-S-407 COMPL. D30 F/M27 F/2X RETR./U-CUP
- ② 490-2326-802 BSAB 90-S-407 COMPL. D30 F/M27 F/2X RETR./STEPSEAL
- ③ 490-2691-801 BSAB 90-R-407 COMPL. D30 F/M27 F/2X RETR./U-CUP
- ④ 490-2691-802 BSAB 90-R-407 COMPL. D30 F/M27 F/2X RETR./STEPSEAL

| Pos no. | Qty/pcs | | | | Item no. | Description |
|---------|---------|---|---|---|---------------|---|
| | ① | ② | ③ | ④ | | |
| 1 | 2 | - | - | - | 490-2325-801 | BSAB 90-S-407 ½ F/M27 D30 F/2X RETR./U-CUP |
| 1 | - | 2 | - | - | 490-2325-802 | BSAB 90-S-407 ½ F/M27 D30 F/2X RETR./STEPSEAL |
| 1 | - | - | 2 | - | 490-2690-801 | BSAB 90-R-407 ½ F/M27 D30 F/2X RETR./U-CUP |
| 1 | - | - | - | 2 | 490-2690-802 | BSAB 90-R-407 ½ F/M27 D30 F/2X RETR./STEPSEAL |
| 2 | 1 | 1 | 1 | 1 | 6490-0028-006 | O-RING Ø6X5 |

The following parts must be ordered separately, Please see Appendix G

| | |
|----------------------------|--|
| PAD RETRACTION SPRING SET. | Available in three qualities: Standard, strong and short |
| BRAKE PAD SET | Brake pad sets for BSAB 90-X-407 are available in different types and qualities. Please contact Svendborg Brakes for selection/order no |

Appendix B - Mounting data, inside mounting



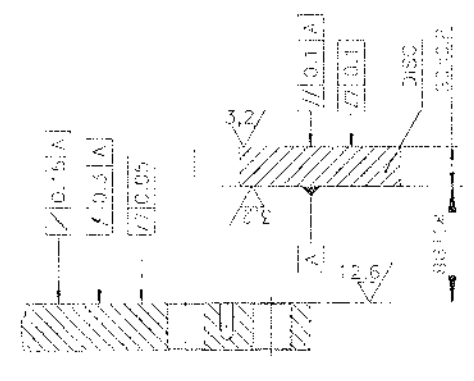
Includes 10 gaskets
 Includes 10 gaskets
 Includes 10 gaskets
 Includes 10 gaskets

MOUNTING DATA
 BSAB 90 SERIES
 INSIDE MOUNTING

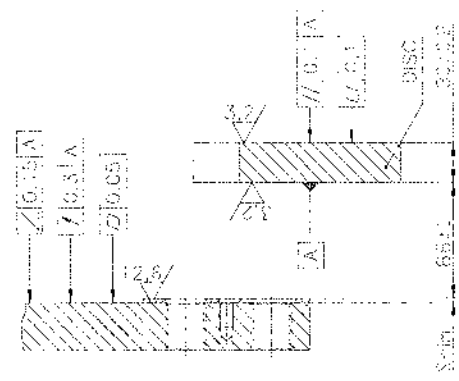
Part No. 490-2116-801
 Rev. 3/87

SVENDBORG BRAKES

- ∠ ANGULARITY
- ∠ PARALLELISM
- ∠ RUN OUT
- ∠ FLATNESS



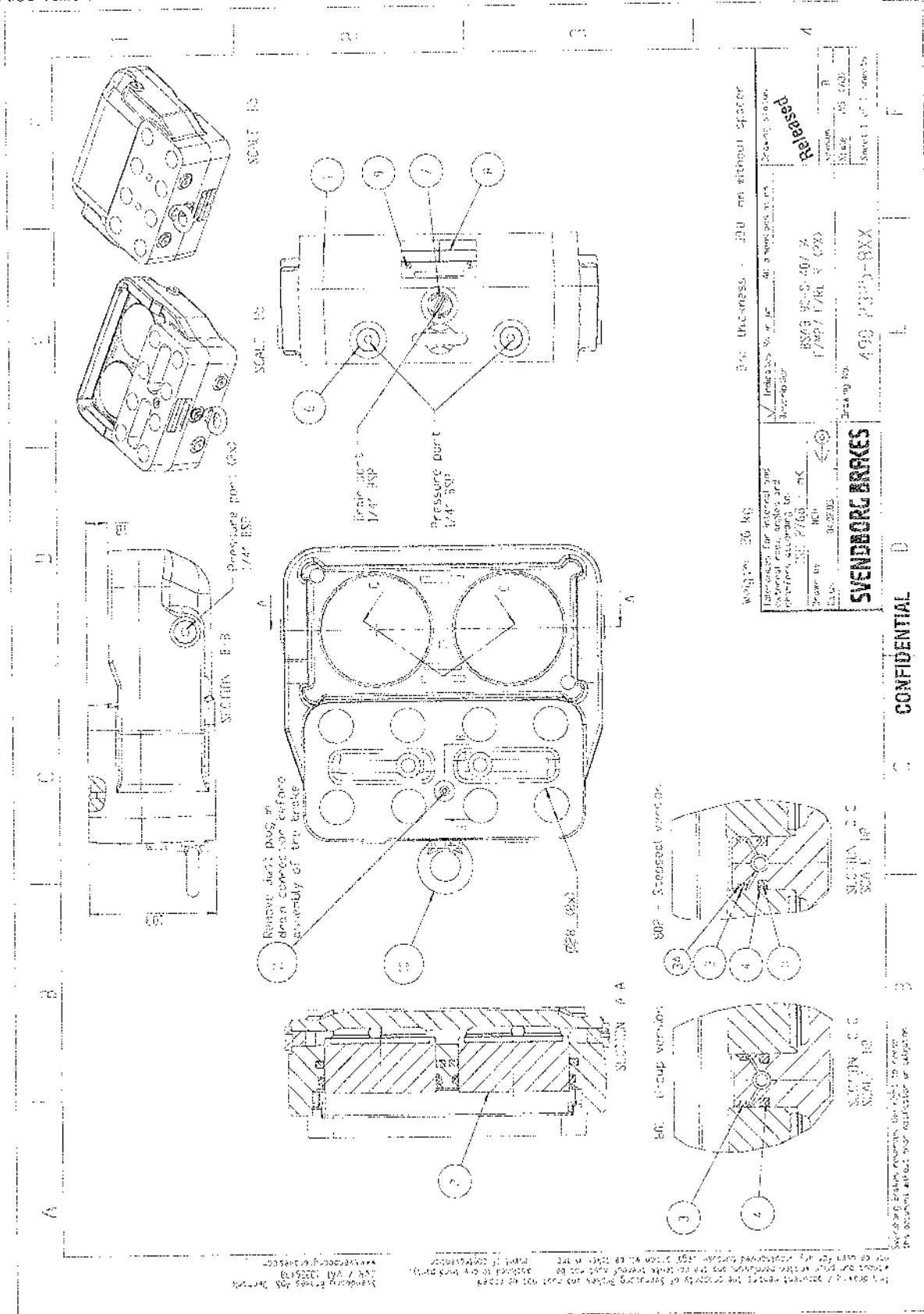
* Bigger tolerance must be control by shims. Example:



Shims can be ordered at Svendborg Products.
 Svendborg Brakes A/S reserves the right to make changes without prior notification.

Appendix C - Spare parts drawing

Also valid for 490-2690-8XX



Appendix C - Spare parts list

- ① 490-2325-801 BSAB 90-S-407 ½ F/M27 D30 F/2X RETR./U-CUP
- ② 490-2325-802 BSAB 90-S-407 ½ F/M27 D30 F/2X RETR./STEPSEAL
- ③ 490-2690-801 BSAB 90-R-407 ½ F/M27 D30 F/2X RETR./U-CUP
- ④ 490-2690-802 BSAB 90-R-407 ½ F/M27 D30 F/2X RETR./STEPSEAL

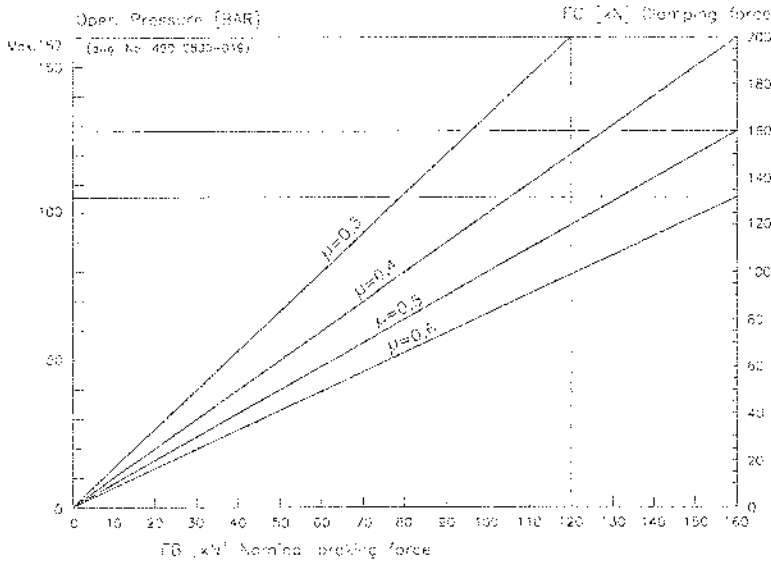
| Pos no. | Qty/pcs | | | | Item no | Description |
|---------|---------|---|---|---|---------------|------------------------------------|
| | ① | ② | ③ | ④ | | |
| 1 | 1 | 1 | 1 | 1 | 490-2324-001 | YOKE BSAB 90-X-407 |
| 2 | 2 | 2 | - | - | 490-2029-001 | PISTON BSAB 90-S-XXX HARD CHROMIUM |
| 2 | - | - | 2 | 2 | 490-2029-004 | PISTON BSAB 90-R-XXX HARD CHROMIUM |
| 3 | 2 | - | 2 | - | 6490-0015-009 | WIPER Ø90x7.3 |
| 3 | - | 2 | - | 2 | 6490-0015-017 | WIPER Ø90 EXCLUTER |
| 3A | - | 2 | - | 2 | | O-RING |
| 4 | - | 2 | - | 2 | 6490-0023-014 | ROD SEAL Ø90X6.3 |
| 5 | - | 2 | - | 2 | 6490-0024-006 | O-RING Ø94.62X5.33 |
| 4 | 2 | - | 2 | - | 6490-0051-001 | ROD SEAL Ø90X6.3 U-CUP |
| 6 | 4 | 4 | 4 | 4 | 2522-2111-110 | HYDR PLUG 1/4"BSP W/SEAL |
| 7 | 1 | 1 | 1 | 1 | 2522-4525-110 | PLUG 1/4"BSP PLASTIC |
| 8 | 1 | 1 | 1 | 1 | 490-1263-001 | NAMEPLATE W/2 HOLES |
| 9 | 2 | 2 | 2 | 2 | 4490-0676-001 | BLIND RIVET Ø2,4X6 RH AL/ST |
| 10 | 1 | 1 | 1 | 1 | 4490-0610-001 | EYEBOLT M10 |
| 11 | 1 | 1 | 1 | 1 | 6490-0004-008 | DBI-DUT no.3 |

Appendix D - Technical Datasheet

DATA SHEET

Name: DEB-0090-001
 Date: 25.09.2013
 Revision: C

TECHNICAL DATA AND CALCULATION FUNDAMENTALS FOR DISC BRAKE BSAB 90-X-4XX WITH M27 MOUNTING BOLTS



BRAKING TORQUE

The braking torque M_B is calculated from following formulas:

$$M_B = a \cdot F_B \cdot \frac{(D_0 - 0,102)}{2} \quad [\text{Nm}]$$

$$F_B = F_C \cdot 2 \cdot \mu \quad [\text{N}]$$

$$F_C = A \cdot P \cdot 10 \quad [\text{N}]$$

Where:

- a is the number of callipers acting on the disc
- F_B is the braking force according to table above [N]
- D_0 is the disc outer diameter [m]
- F_C is the clamping force [N]
- A [cm²], P [bar] and μ see values below

The actual braking torque may vary, depending on friction coefficient.

CALCULATION FUNDAMENTALS

| | |
|--|--------------------------------------|
| Weight of caliper (without brake pads): | Approx. 55kg |
| Overall dimensions: | 220 x 240 x 260mm |
| Pad width: | 102mm |
| Pad area: (organic) | 20.300mm ² (*) |
| Max. wear of pad: (organic) | 10mm / 8mm (with 10mm backplate) (*) |
| Pad area: (sintered) | 16.350mm ² (*) |
| Max. wear of pad: (sintered) | 6mm (*) |
| Nominal coefficient of friction: | $\mu = 0,4$ |
| Total piston area - each caliper half: | $A = 127\text{cm}^2$ |
| Total piston area - each caliper: | 254cm ² |
| Volume for each caliper at 1 mm stroke: | 25cm ³ |
| Volume for each caliper at 3 mm stroke: | 76cm ³ |
| Actuating time (guide value for calculation): | 0,4sec. |
| Pressure connection/port: | 1/4" BSP |
| Drain connection port R: | 1/4" BSP |
| Max. operating pressure: | $P = 157\text{bar}$ |
| Recommended pipe size: | 10/8mm |
| Operating temperature range | |
| General usage: | -20°C to +70°C |
| For brake applications in wind turbines: | -40°C to +60°C |
| (For temperatures outside this range contact Svendborg Brakes) | |
| (*) On each brake pad | |

Appendix F - Recommended fluid

DATA SHEET

| | |
|-----------|--------------|
| Name: | DEB-DIVE-005 |
| Date: | 19.05.2014 |
| Revision: | I |

RECOMMENDED FLUID FOR DISC BRAKES & HYDRAULICS
PRESSURE FLUIDS / OIL TYPES

The following oil types are recommended by Svendborg Brakes -- other types corresponding to these can be used.

The general temperature range for our standard ranges of products using hydraulic oil are -20°C to +60°C (-4°F to +140°F) however the BSAK and BSAB brake series are generally approved for lower temperatures. These are approved for usage at -40°C in wind turbines and for -30°C in other applications.

When quick brake reaction times are critical and operating at temperatures below 0°C (+32°F) it is recommended to use the oil types listed in the Cold section as these types provides the most constant reaction times. Extreme temperature applications may require special options. Please contact Svendborg Brakes.

| | Cold / special option | Standard | | Special option |
|--|---------------------------------|--------------------------------|---------------------------------|---------------------------------|
| Mineral oil | -40°C - +60°C -40°F - +140°F | -20°C - +40°C -4°F - +104°F | +10°C - +60°C +50°F - +140°F | +30°C - +70°C +86°F - +158°F |
| Shell | Tellus S4 VX 32 | Tellus S2 V32 | Tellus S2 V46 | Tellus S2 V68 |
| Mobil / EXXON | - | DTE 10 Excel 32 | DTE 10 Excel 46 | DTE 10 Excel 68 |
| Texaco | Rando Ashless 8401 | Rando HDZ32 | Rando HDZ46 | Rando HDZ68 |
| Valvoline | - | Ultramax HVL P32 | Ultramax HVL P46 | Ultramax HVL P68 |
| Synthetic oil | -40°C - +50°C -40°F - +122°F | -20°C - +40°C -4°F - +104°F | +10°C - +60°C +50°F - +140°F | +30°C - +70°C +86°F - +158°F |
| Mobil | - | SHC 524 | SHC 526 | SHC 526 |
| Bio Oil ⁽¹⁾ (Ester or Colza oil) | -40°C - +50°C -40°F - +122°F | -20°C - +30°C -4°F - +86°F | +10°C - +60°C +50°F - +140°F | +30°C - +70°C +86°F - +158°F |
| Shell | - | Naturelle HF-E15 | Naturelle HF-E32 | Naturelle HF-E46 |

General: Mineral Pressure Fluids according to DIN 51524 Part 3

(1) There must be less than <200PPM water in the oil, due to the seals.

Viscosity

Recommended viscosity range: 20-200 cSt at working temperature. Generally Svendborg Brakes systems are designed to allow higher viscosity in short periods.

Filtration

The oil in a hydraulic system and the oil added to the hydraulic system must always be filtered. The level of cleanliness in a hydraulic system is an important factor to the lifetime of the system. When refilling the hydraulic tank, it is stipulated that the oil added to the system is filtered through a 10-micron purity off-line filter unit to the classes listed below.

The hydraulic system, supplied by Svendborg Brakes, has a build-in oil filter with a standard 10-micron purity filter. To maintain a reliable system it is recommend that only hydraulic oil of the following classes of purity is used: NAS 1638, Class 8, or ISO 4406, Class 19/17/14.

It is recommended that the filter is changed at a minimum, once every six months or more often depending on the level of exposure to contamination.

Service life of pressure fluids

Mineral oil: 8.000 Hours or at least once a year.
Other fluids: 2.000 Hours or at least once a year.

Change of pressure fluid

Note: The mixing or blending of different brands or types of pressure fluid can cause unintended chemical reactions, such as sludging, gumming etc. The complete hydraulic system should be thoroughly flushed prior to changing from one oil type to another.

The respective manufactures should be contacted prior to changing from one pressure fluid to another.

Seal material

Brakes from Svendborg Brakes are normally supplied with PUR-seals (PolyURethane)

PTFE (PolyTetraFlourEthylen) seals can be delivered on request for most of the brake types.

Note: the BSFG 400 brake series are supplied with NBR rubber fabric seals (acrylNitrile Butadiene Rubber).

Appendix G - U-cup information

DATA SHEET

| | |
|-----------|--------------|
| Name: | DEB-DIVE-008 |
| Date: | 22.11.2012 |
| Revision: | C |

U-CUP INFORMATION

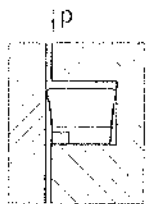
Svendborg Brakes is constantly optimizing the performance of components used in our systems to fit to the applications where our products are used.

For the majority of applications the optimum sealing system is polyurethane seals (PU) and the profile is typically called a U-cup seal as this is softer and is normally more gentle to the piston / moving parts. The polyurethane seal can be either with or without an o-ring in the seal depending on the configuration – see illustration below.

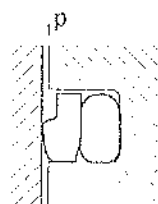
The older seal types are typically based on rubber fabric materials or in some cases a PTFE based seal (Stepseal).

This information is to inform how the U-cup seals shall be mounted when replacing your seals and your documentation does not correspond to the seals.

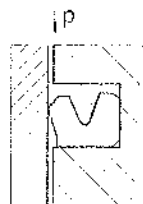
The “lp” refers to the pressure side.



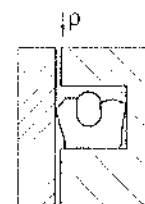
Rubber fabric
Seals



Stepseal
(PTFE & o-ring)

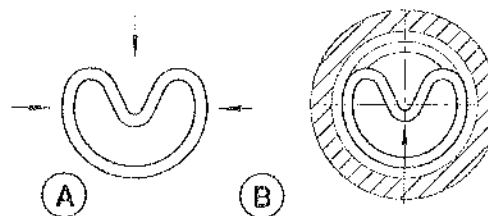


U-cup without
o-ring



U-cup with
o-ring

To mount the seals - gently form it into a U-shape / kidney-shape without any sharp bends and fit it into the groove



NOTE:

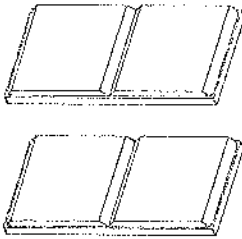


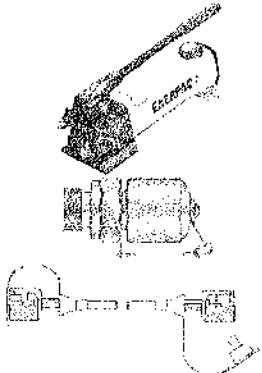


The polyurethane U-cup type is fully interchangeable with the old types with exception of special applications with special temperature ranges and special hydraulic oil types where other types may be recommended.

The standard U-Cup seals are only to be used within an ambient temperature range of -30°C to +80°C. Please make sure that this temperature range corresponds to the ambient temperature range of your brake.

Please do not hesitate to contact Svendborg Brakes if any doubt about the sealing type to be used or if the temperature range is outside the mentioned limits you must specify, that you need step seals.

Appendix G - Recommended spare parts

Recommended spare parts for one brake

| Item | Item number | |
|--|--|---|
| <p>Brake pad set Organic SB1001 (dynamic) Organic D2013 (dynamic/static)</p> <p>Organic BE3521 (dynamic)</p> <p>Order 1pcs PER brake (1 set contains 2 brake pads)</p> | <p>491-0013-801 490-2138-001</p> <p>490-3015-801</p> |  |
| <p>Pad retraction spring set</p> <p>Pad retraction spring set (standard) Pad retraction spring set (strong) Pad retraction spring set (short)</p> | <p>490-1127-801 490-2610-801 590-0735-801</p> |  |
| <p>Seal kit Seal kit (step seal) Seal kit (U-cup)</p> <p>Order 1set of seal kit PER brake (1 set contains seals for 4 pistons)</p> | <p>490-2722-806 490-2722-803</p> |  |
| <p>Tools (Used for pressurizing the brake manually)</p> | | |
| <p>Hand pump with 800mm test point hose</p> <p>Test point connectors (Mini mess) Test point male 1/4" BSP (pressure) Test point male 1/4" BSP(drain)</p> <p>Test point hose 800mm</p> | <p>0350-1019-801</p> <p>9009-1010-040 9009-1010-040</p> <p>9009-3010-008</p> |  |
| <p>Other parts</p> | | |
| <p>Drain kit Drain bottle with tubing and fittings</p> <p>Drain bottle 0,5L plastic Drain bottle 1,0L plastic</p> | <p>9640-0999-001 9640-0999-002</p> |  |
| <p>Adaptor(BSP on brake) Male BSP to male NPT 1/4" BSP to 3/8" NPT (pressure and drain)</p> | <p>9040-1200-802</p> |  |

APPENDIX B

| | | | |
|-------------------------|-------|--|----------------|
| SVENDBORG BRAKES | TITLE | Guidelines for bedding in process – BE3521 pads | NAME: INS -099 |
| | | | DATE: 05/02/08 |
| | | | REV: - |

Purpose: Guide lines for the brake pad bedding in process

Extent: Material type BE3521 / Spring applied brakes

How:

The bedding in process is vital to achieve a good contact area and therefore optimal friction. Pads that are not bedded may only achieve less than 80% of the expected friction coefficient. Each application is different so these guide lines must be reviewed in relation to the actual machine and its capabilities.

The process can be applied to both new and used pad sets. Check the brake or system manuals for details about installation of the brake and pads and adjustment of the brake calliper before proceeding.

Bedding in consists of grinding / rubbing the pads against the disc under controlled conditions until the highest spots in the material are reduced and the contact area is more than 75%

The recommended process is to let the pads trail against the disc at reduced pressure for approx. 500 to 800meters.

Apply hydraulic pressure to the calliper from the main system or with use of a hand pump. The hydraulic pressure should be calculated to reduce the pad pressure that the brake is applying to the disc to approx 25-30% of the rated clamping force.

This brake clamping force value for the calliper is obtained from the brake nameplate or the calliper data sheet.

For small callipers (or low force callipers) this force may need to be increased to achieve sufficient friction and temperature.

Towards the end of this operation the disc temperature should (ideally) reach a temperature of 150-180°C. This temperature should be held for approx 10-20 seconds.

At this temperature friction coal (pad burning) develops and there will be a burning smell.

After the process, check that the pads have achieved the required minimum 75% area contact.

The process may need to be repeated.
Be careful to control the temperature level, especially with multiple tries.



Shell Cleaning Procedures

LEVEL I- ALL UNITS

- A. Sand Blast or high speed rotary brush
- B. Remove any foreign materials such as metal shavings, sand or grit
- C. Clean with high pressure air
- D. Inspect for residual
- E. Repeat if necessary

LEVEL II - CUSTOMER REQUEST (Additional charges will apply)

- A. Bath fully in environmentally safe solution for 5 to 10 minutes
- B. Rinse thoroughly in water
- C. Bathe fully in commercial grade, environmentally safe emulsifiable degreaser (10% solution) for 2 to 5 minutes
- D. Rinse thoroughly with water
- E. High pressure water wash
- F. Inspect for residual
- G. Repeat if necessary

LEVEL III - AccuFlushSM

Certified Accumulator Flushing Services. Cleanliness to NAS 1638, SAE 4059D, ISO 4405, AS 4059, API, Department of Defense or other customer required Standards. Call factory for complete details.

CUSTOMER REQUEST

Customer specified procedures

Corrosion Protection Specifications

| Part | Water Service (WS) | Special Service (SS) | Extreme Service (XS) |
|---------------------|---------------------|----------------------|---------------------------|
| Protective Cap | 303 Stainless Steel | 300 Series Stainless | 300 Series Stainless |
| Hex Jam Nut | 304 Stainless Steel | 300 Series Stainless | 300 Series Stainless |
| Oil Port | Electroless Nickel | 316 Stainless Steel | 316 Stainless Steel |
| Poppet | 304 Stainless Steel | 304 Stainless Steel | 304 Stainless Steel |
| Spring | 302 Stainless Steel | 302 Stainless Steel | 302 Stainless Steel |
| Piston | 303 Stainless Steel | 300 Series Stainless | 300 Series Stainless |
| Nut | 303 Stainless Steel | 300 Series Stainless | 300 Series Stainless |
| Anti-Extrusion Ring | Electroless Nickel | Electroless Nickel | Electroless Nickel |
| Spacer | Electroless Nickel | 316 Stainless Steel | 316 Stainless Steel |
| Locknut | Electroless Nickel | 316 Stainless Steel | 316 Stainless Steel |
| Interior Shell | Phenolic Coating | Electroless Nickel | Phenolic Coating |
| Exterior Shell | White Enamel | Electroless Nickel | 3-Coat White Marine Epoxy |
| Bleed Plug | 316 Stainless Steel | 316 Stainless Steel | 316 Stainless Steel |
| Gas Valve Stem | 12L14 | 316 Stainless Steel | 316 Stainless Steel |
| Metal Backup Ring | 304 Stainless Steel | 300 Series Stainless | 300 Series Stainless |

"WS": Designed with internal protection only. Not recommended for outdoor service.
"SS & XS" Designed with internal and external protection

Also available: CS & PS options:

CS. Combination Service: Same as XS but with no special internal or external coatings.
PS. Prime/Stainless Service: Same as XS but no special external coating.

Other special order materials are also available at additional cost and lead time.



ACCUMULATOR SELECTION, INSTALLATION AND MAINTENANCE

Accumulators manufactured by **Accumulators, Inc.** have proven to be extremely reliable in a multitude of fluid power applications. Proper selection, installation and maintenance practices can lead to a long and trouble-free life, for the accumulator and the system.

ACCUMULATOR SELECTION

TRAINING.

It is highly recommended that a qualified Fluid Power *Design Specialist* review the selection and design of all accumulator systems. The Fluid Power Society's certification program is an excellent training source for industry professionals. Training and technical information is also available from both the Fluid Power Distributor's Association and National Fluid Power Association. The Fluid Power Educational Foundation supports programs in a number of technical schools and universities.

Authorized **Accumulators, Inc.** Distributor/Service Providers have on-staff professionals that can assist you with the design and manufacture of accumulator systems.

Accumulators, Inc's. experienced staff can also help guide you with your selection.

The selection process, while being fairly straight forward, does involve several important factors that must be addressed. System planners often specify familiar components used in previous designs, when they should be taking into consideration changed or additional parameters found in the new system. Each of the following factors should be evaluated on a system-by-system basis to ensure a successful project.

ACCUMULATOR APPLICATION AND SIZING

TYPE of APPLICATION. It is important to determine the Type of application or function. The application type determines sizing and precharge. Additionally the placement of the accumulator, in relation to other components, is dependent on function.

The most common Types are:

1. Energy or Fluid Storage used for auxiliary or emergency power requirements and pressure holding.
2. Shock Cushioning used to reduce pressure waves or "Water Hammer".
3. Suction Stabilization, when pump demands intermittently exceeds the feed line.
4. Pulsation Dampening used to smooth out the flow and pressure of piston pumps.
5. Supplemental Fluid Source for reserve fluid source, leakage and temperature compensation, pressure holding, and energy make-up.
6. Fluid Dispensing used to supply small fluid volumes for lubrication.

More detailed information concerning Application Types is available in *Hydraulics and Pneumatics Magazine's* 2004/2005 Fluid Power Handbook & Directory. Additional information is contained in this catalog.

TYPE of ACCUMULATOR. There are generally six types of accumulators, each with its own inherent advantages and disadvantages.

1. Bladder Accumulators. Excellent for rapid response, complete separation of gas and fluid, contamination tolerant, low maintenance, easy to repair. Precharge must be maintained at all times.
2. AccuMight Diaphragm Accumulators. Excellent for mobile applications, complete separation of gas and fluid, contamination tolerant, low maintenance, easy to repair. Precharge must be maintained at all times
3. Piston Accumulators. Available in many sizes, fair separation of fluids and gas, moderate maintenance, reliable. Requires very clean fluids, difficult to repair.
4. Buoyant Float Accumulators. Accumulators, Inc's. Patented unit. Rapid response, extremely high and low temperature operating ranges contamination tolerant. For low cycling and emergency power applications only.
5. Spring accumulators. Simple design, low maintenance. Limited applications
6. Weight-loaded. Simple design, reliable. Bulky and not commercially available.

SYSTEM REQUIREMENTS. In order to select the correct accumulator unit, the designer must have the following parameters available:

1. Flow rate, and total fluid volume required. This can be determined in a number of ways and requires pump, piping, cylinder and other component specifications.
2. System maximum working pressure. Calculated peak demand, as well as intermittent and momentary



“spikes”, must be taken into consideration. All components that affect pressure, such as pumps, valves, cylinders, and the often-ignored piping, must be taken into account.

3. System minimum working pressure.
4. Ambient, Minimum and Maximum Fluid Temperatures. Actual operating temperatures within the accumulator are often well beyond those calculated. In cases such as these the accumulator becomes a heat sink.
5. Fluid Specifications. Can be obtained from supplier. Often available with the MSDS.
6. Cycle timing. Whether hours or milliseconds, the “work” and “recover” time is important.

With this information in-hand, the following can be determined:

PRESSURE: The accumulator design Maximum Allowable Working Pressure (MAWP) should meet or exceed the system maximum pressure. System spikes must be identified and accounted for. ACC INC accumulators are available in 3000, 6000 and 10,000 psi models. Never use the accumulator’s Proof or Design Burst Pressure in your assessment. (Installation of an accumulator with a MAWP exceeding the system MAWP is safe and acceptable).

DESIGN CODE: Some applications require the accumulator to meet ASME or other design codes. The location of the system installation or the type of system often will require a specific inspection agency or quality standard. Code requirements should be determined prior to specification. **Accumulators, Inc.** can meet most design codes and agency approvals.

SIZING: The selection of the proper size accumulator is important for efficient operation. If too small, there may be insufficient capacity to do the job. Sizing is dependant on the type of application. Calculations are based on variations of Boyle’s law. Sizing formulae are available on the Accumulators, Inc. website, in this catalog, and in a number of industry wide publications. There are also numerous sizing programs available.

FLUID COMPATIBILITY: As with all hydraulic seals, it is important that the system fluid be compatible with the accumulator’s elastomer compound. Several compounds are available. Compatibility charts are available at www.accumulators.com and many rubber manufacturers’ websites, this catalog, and in a number of industry wide publications. Extensive information is also available from the Rubber Division of the American Chemical Society at <http://www.rubber.org/>. For metal surfaces, additional corrosion protection is required, when high water content fluids are used. Stainless steel, phenolic coating or electroless nickel can be specified.

TEMPERATURE: Each type of elastomer compound has associated Minimum and Maximum temperatures. The designer must ensure that the system does not exceed this range. See “Bladder Material Specifications” above.

PRECHARGE: The proper nitrogen gas precharge is crucial to the operation of any accumulator. It is generally a percentage of the Min or Max working pressure of the system, determined by the Type of application. The calculation is part of all sizing formulae.

CONNECTIONS, PLACEMENT AND ORIENTATION: As with all fluid power components, the connection, placement and orientation of the accumulator can affect the efficiency. Since every system is different, it is up to the user to determine the best arrangement.

Once the designer has all the parameters and determines all the requirements, the selection process is almost complete. The final step is to buy the unit. As straightforward as this may seem, it is often a point of major miscommunication. While the designer may have all the data, it is up to the buyer to give the accumulator supplier the correct specifications. Needless to say, care should be taken, at each step, to make sure the correct information is supplied.

With your new accumulator in hand, all that remains for worry-free operation is correct installation, commissioning, and maintenance!

ACCUMULATOR INSTALLATION

Installation may seem, to many, a very simple process, but it is perhaps the most misunderstood procedure in the life of an accumulator! We have heard this said thousands of times: *“I’ve been installing accumulators for years; I know what I’m doing!”* Fact is, many do not or at least don’t follow ALL of the following recommendations.

TRAINING

Again, it is highly recommended that a qualified Fluid Power **Installer** prepare and place any system’s accumulators.

Authorized **Accumulators, Inc.** Distributor/Service Providers have on-staff professionals that can assist you



with installation.

The following guidelines should be considered in the accumulator's installation:

COMMISSIONING

1. Carefully remove the accumulator from the factory packaging. Read and understand all factory labels, stickers, tags and nameplates attached to the accumulator and the packaging. Read and understand any written factory instructions accompanying the accumulator.
2. If the accumulator is part of a third party OEM system, read and understand all OEM labeling and instructions.
3. Inspect the unit for visible damage, and verify correct part number and thread types.
4. Units are generally shipped from the factory with no precharge. User **MUST** precharge the unit prior to operation. Follow all the steps listed in "**Bladder Care Instructions**", below.

PRECHARGING AND START-UP INSTRUCTIONS

PRECHARGE

See BLADDER CARE INSTRUCTIONS section of this catalog.

INSTALLATION

For most systems, the installation process is a matter of placement, connection and operation.

1. **Placement** of the accumulator in the system is generally specified by the system designer. In these cases the installer should take a "reality check" to make sure the selected location is: **Feasible**. Is there enough space for the unit including mounting hardware and some maneuvering area? **Sensible**. Is the unit close to the "work"? Is it secured properly? Is the connection of similar size to the line? **Accessible**. Will maintenance personnel be able to check the unit for leakage and properly maintain precharge?
2. **Connection**. The designer may select from a number of available threaded or flanged fluid connections. It is up to the installer to have the correct mating parts and any necessary seals not supplied with the accumulator. The connection should be in the same scale as the piping. (A quarter inch connection on a six-inch pipe may not be very efficient). Fittings should be of sufficient pressure rating.
3. **Install** the accumulator on the system. Make sure the connection is tightened appropriately for the selected type of connection
4. Pressurize the system. **CHECK FOR LEAKAGE.**
5. Operate. Following initial operation, check the accumulator precharge and also check for fluid and gas leakage. See BLADDER CARE INSTRUCTIONS below.

With your new accumulator installed, all that remains for worry-free operation is proper maintenance!

ACCUMULATOR OPERATION AND MAINTENANCE

Accumulators, Inc. accumulators generally work so well, that their operation and maintenance is virtually ignored by plant personnel. Only after a good deal of abuse or neglect does anything go wrong. At that point system failure can occur and the accumulator may be damaged.

These costly repairs and downtime can be avoided by proper operation and basic maintenance.

TRAINING

Once again, it is highly recommended that a qualified Fluid Power **Mechanic** perform the maintenance on accumulator systems.

Most **Accumulators, Inc.** Authorized Distributor/Service Providers have on-staff professionals that can assist you with operation and maintenance. In addition, only **Accumulators, Inc.** has a nation-wide **Service and Repair Center** program.

The following guidelines should be considered in the accumulator's operation:

INTENDED OPERATION

Initial design and installation of the accumulator system is based on the **SPECIFICATIONS** provided by the user to the system manufacturer, who in turn provided information to ACC INC. Your system was based on the following **DESIGN PARAMETERS**:

1. Flow rate, and total fluid volume required. This was determined by the pump, piping, cylinder and



- other components' specifications.
2. System maximum working pressure. Calculated peak demand, as well as intermittent and momentary "spikes", was taken into account.
 3. System minimum working pressure.
 4. Ambient, Minimum and Maximum Fluid Temperatures
 5. Fluid Specifications.
 6. Cycle timing.

Most system manufactures provide detailed operating instructions, as well as classroom and on-site training. System operators and mechanics should familiarize themselves with these instructions. **Accumulators, Inc.** provides written instructions with all its units as well as labeling, alerting everyone to possible danger:

Always think **Safety!**

- Wear proper eye protection
- Wear steel toed shoes
- Take proper safety precautions

***NOTE:** Most accumulators are shipped from the factory with minimal pressure. It is the responsibility of the user to determine the proper precharge level and to insure that that pressure is maintained at all times. In general, precharge should equal 30% to 80% of the maximum system pressure.*

REAL-WORLD OPERATION

Once a system is in actual operation, it is time for a *reality check*. Have ANY of the DESIGN PARAMETERS changed from the initial intended operation?

Flow rate, and total fluid volume, working pressures, demand, fluid temperatures or cycle timing. Is the intended fluid being used?

Any change in one or more of these conditions may require a different accumulator for peak efficiency.

ON-GOING OPERATION

Over time operating conditions do change. Periodic review of the operating conditions will insure efficient accumulator operation. Once again ask the question Have ANY of the DESIGN PARAMETERS changed?

Particular attention should be given to the system fluid: As other components wear, fluid may become contaminated, or breakdown, operating temperatures can change and leakage can take place. Any change in any system variable WILL affect the accumulator.

MAINTENANCE

Precharge is the most critical accumulator maintenance issue. An improper precharge level will cause a decline in accumulator efficiency. An extremely low precharge will cause bladder damage. Make sure system operating parameters have not changed since installation.

For cycling applications, check the precharge weekly. For non-cycling applications, check monthly.

You will normally lose some gas, over time, due to *permeance* (the slow leakage of gas through the bladder). A more rapid loss may indicate a gas valve problem. **Complete loss of gas can indicate a broken bladder.**

See BLADDER CARE INSTRUCTIONS below.

Other factors to periodically review that can reduce efficiency or damage the accumulator.

- Is the system fluid contaminated? Have fluid properties broken down?
- Is the fluid level reduced? Are there system leaks?
- Has the operating temperature changed?
- Are system components at optimum condition? Wear and tear on the system can change system parameters affecting the system temperature, cycle time and pressure.
- Have the system requirements changed? A change in the system operations can affect the system temperature, cycle time and pressure.

If a new or different accumulator is indicated, or a modification of an existing unit is required, or if repairs are necessary, contact your local **Accumulators, Inc.** Authorized Distributor/Service Provider.



BLADDER CARE INSTRUCTIONS

BLADDER REPLACEMENT ACCUMULATOR PRECHARGING ACCUMULATOR PRECHARGE MAINTENANCE ACCUMULATOR COMMISSIONING

(For 3000, 4000, 5000, 6000 and 10,000-psi Accumulators)
(Does not apply to Gas Bottles, Transfer Barrier and Float Accumulators and AccuMights)

WARNING: NEVER USE OXYGEN OR SHOP AIR!
This can be extremely dangerous and will void your warranty.

- ✓ Precharge with **DRY NITROGEN (N₂) GAS ONLY!**
- ✓ Never operate accumulator without nitrogen gas precharge.
- ✓ Release all system *hydraulic* pressure before attempting any maintenance or service.
- ✓ Use only genuine ACC INC approved charging and gauging equipment for precharging and pressure check.
- ✓ Follow all instructions below.
- ✓ Wear proper eye protection
- ✓ Wear steel toed shoes
- ✓ Take proper safety precautions

NOTE: All bladders are shipped from the factory with no precharge. Most accumulators are shipped with just minimal pressure. It is the responsibility of the user to determine the proper precharge level and to insure that that pressure is maintained at all times. In general precharge should equal 30% to 80% of the maximum system pressure.

BLADDER REPLACEMENT- REMOVAL

1. Turn off your system (equipment), release all pressure.
2. Remove gas protective cap and valve cap from accumulator.
3. Install genuine ACC INC approved charging and gauging assembly on gas valve stem. Attach the air chuck to the accumulator bladder gas valve by hand tightening its swivel hex connection. For Top-Repairable models use a TR Valve Extension (AI-TR-015)
4. **For 3000 psi accumulators.** Turn the air chuck " T " handle clockwise until it stops. This opens the valve core. **For 4000 psi and higher accumulators.** Open the valve by turning its top (small) hex nut, counter-clockwise.
5. Bleed off all nitrogen gas by opening up the bleed valve completely. (For 4000 psi or higher accumulators, the gas valve must also be opened)
6. Remove the gauging device from gas valve stem.
7. Release any remaining gas pressure from accumulator. (For a 3000-psi accumulator, remove the valve core from gas stem using core tool. For 4000-psi or higher accumulators, open the gas valve fully, then remove gas valve)

WARNING. HIGH PRESSURE GAS IS DANGEROUS!
Wear proper eye protection. Take proper safety precautions

8. Remove accumulator from system.
9. Remove hex jam nut and nameplate.
10. Remove lock nut from bottom of unit using spanner wrench.
11. Remove spacer and rings.
12. Push the plug assembly into the accumulator and through the Anti-Extrusion ring, remove AE ring by folding it and pulling it through the hole.
13. Remove plug assembly.
14. Pull the old bladder out of the bottom of the accumulator.



BLADDER REPLACEMENT- INSTALLATION

1. Remove the valve core on a 3000-psi accumulator or the gas valve on a 4000-psi or higher accumulator from the new bladder. Squeeze all the air out. Replace the valve core or gas valve. Unfold bladder completely.
2. Reinstall the valve core or gas valve
3. Lubricate the bladder and shell with system fluid
4. Attach a bladder pull rod to the bladder by carefully threading over the Schrader connection. Stick the rod through the accumulator (bottom to top). Pull bladder through. Do not allow the bladder to bind or kink.
5. Remove the pull rod
6. Attach the nameplate and hex nut to the exposed gas valve stem. Hand tighten
7. Push the plug assembly, then anti-extrusion ring into the accumulator.

Caution: DO NOT BEND OR FOLD THE BLADDER!

This can cause the bladder to burst

8. Pull the plug assembly through the anti-extrusion ring. Seat ring in the hole, metal side down.
9. Install a NEW metal back up washer, NEW O-ring. (Be careful not to pinch the O-ring), NEW rubber back up ring, spacer, and lock nut (hand tighten).
10. Precharge the accumulator (See Instructions below).
11. Tighten hex jam nut making sure the gas valve stem does not rotate
12. Tighten locknut on fluid end.

PRECHARGING INSTRUCTIONS

➤ **If the accumulator is already installed on a system**

1. Pump a small amount of system fluid (10% of accumulator capacity) into the accumulator, at low pressure. (Do not exceed 35 psi)
2. Turn off all power to the system and release all hydraulic pressure from the accumulator.

➤ **If accumulator is not yet installed:**

1. Place a small amount of fluid (10% of accumulator capacity) into the accumulator. Lubricate as much of the bladder surface area as possible.
2. Remove the protective cap (gas valve guard) and the valve cap (if there is one).
3. Attach the gland & nut portion of the charging assembly (CGA-580 for 3000 psi accumulators, CGA-677 for 4000 psi and higher) to a dry nitrogen gas bottle, tighten securely. If the gland & nut do not fit, you are using the wrong gas or wrong pressure!
4. Attach the air chuck to the accumulator bladder gas valve by hand tightening its swivel hex connection. For Top-Repairable models use a TR Valve Extension (AI-TR-015)
5. **For 3000 psi accumulators.** Turn the air chuck " T " handle clockwise until it stops. This opens the valve core. **For 4000 psi and higher accumulators.** Open the valve by turning its top (small) hex nut, counter-clockwise.
6. Set nitrogen bottle gas regulator (if attached) to 35 psig. (The use of a nitrogen gas regulator is strongly recommended!)
7. Open nitrogen bottle gas valve. (If you are not using a nitrogen gas regulator, care should be taken to slowly "crack" the valve open.) With a regulator, valve can be opened fully.
8. Pre-charge slowly (35 psig) using dry nitrogen gas, until bladder is fully inflated.

Caution: INITIAL PRECHARGING AT A FLOW RATE ABOVE 35 PSIG WILL CAUSE THE BLADDER TO BURST

Make sure to precharge to minimum of 30% of operating pressure

9. Continue pre-charging to desired pressure by increasing gas flow slowly.
10. **For 3000 psi accumulators.** Turn the air chuck " T " handle COUNTER-clockwise until it stops. This CLOSSES the valve core. **For 4000 psi and higher accumulators.** CLOSE the valve by turning its top (small) hex nut, clockwise.
11. Remove the charging assembly. Check for gas leakage. (The use of gas leak detection fluid or soapy water is recommended.)
12. Tighten hex jam nut and lock nut fully.
13. Replace the valve cap, protective cap and ACC INC nameplate). Tighten, hand tight.
14. Install accumulator on system. CHECK FOR LEAKAGE.
15. Pressurize system. Operate.



Caution: PRECHARGE MAINTENANCE

For cycling applications check the precharge weekly. For non-cycling applications, monthly.
 You will normally lose some gas, over time, due to Permeance.
 A more rapid loss may indicate a gas valve problem

1. Release system pressure. Not gas pre-charge.
2. Remove gas protective cap (valve guard) and valve cap.
3. Install gauging device on gas valve stem.
4. For 3000-psi accumulators, screw down air chuck " T " handle, check pressure. For 4000 psi and higher, open gas valve hex fitting (do not loosen from bladder). Check pressure
5. Add additional **dry nitrogen gas** if necessary, using the above procedures.
6. To release excess nitrogen gas (if any) open up bleeder valve, located at bottom of gauging device, until desired pressure is achieved.

NEW ACCUMULATOR COMMISSIONING

Prior to operating a new accumulator on any system a few common sense steps should be taken

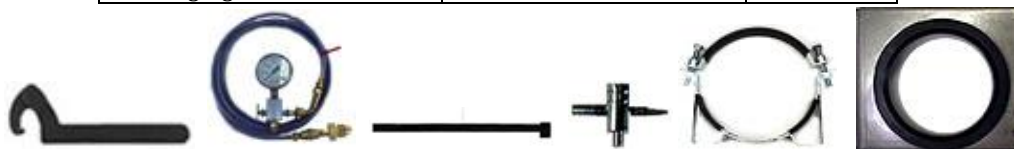
1. A qualified Fluid Power specialist should review the accumulator's application for correct sizing, pressure, cycling, connections, placement and efficiency.
2. Carefully remove the accumulator from the factory packaging, read and understand all factory labels, stickers, tags and nameplates attached to the accumulator and the packaging.
3. Read and understand any written factory instructions accompanying the accumulator
4. If the accumulator is part of a third party OEM system, read and understand all of their labeling and instructions
5. All the steps listed in **Accumulator Precharging** (above) should be followed.
6. The proper training of your accumulator maintenance personnel is recommended
7. Consult the factory or your local Accumulators, Inc. Authorized representative, with any questions.

GAS SAFETY CAP

The ACC INC yellow plastic safety cap, located at the top of the protective cap, is designed to "blow-off" if there is a valve stem gas leak. If cap is missing, check pre-charge immediately!

CHARGING & GAUGING RECOMMENDED ACCESSORIES

| Item Description | ACC INC Part Number | Pressure |
|---|----------------------------|----------------|
| Economy Maintenance Kit | AI-TKITB | 3000 psig |
| Complete Maintenance 3K Kit | AI-TKIT | 3000 psig |
| Complete Maintenance 6K Kit | AI-TKIT-6 | 6000 psig |
| Deluxe Maintenance Kit | AI-TKIT1 | 3000-6500 |
| Charging & Gauging 3kpsi Kit 3000 psig gauge | AI-CG3-KIT-SS | 3000 psig |
| Charging & Gauging 3kpsi Kit 6000 psig gauge | AI-CG3-6KT-SS | 3000 psig |
| Charging & Gauging 6kpsi Kit 6000 psig gauge | AI-CG6-6KT-SS | 3000-6500 psig |
| Bladder Pull Rod | AI-501 (1 Quart, 1 gallon) | all |
| | AI-502 (2.5 gal, 5 gal) | all |
| | AI-503 (10 gal, 11 gal) | all |
| | AI-504 (15 gal) | all |
| Valve Core Tool | AI-506 | 3000 psi |
| Spanner Wrench | AI-505 | all |
| Lifting Hook Assembly | AI-511 | all |
| Charging valve extension | AI-TR-015 | All TR units |



Many of these parts are available in our Accumulator Accessory Kits or individually. See pages 31-34



Bladder Storage

1. Bladders are shipped in sealed UV protective black bags. Store bladders in these bags until needed.
2. The cartons in which the bladders were shipped are designed to prolong the storage life of the bladders. Keep the bladders in these boxes until the bladders are needed in service.
3. Keep the tops of the cartons sealed at all times. After removing some of the bladders, reseal the carton.
 - * By keeping the carton and bag closed, ozone attack from sunlight and artificial lighting will be prevented.
4. Keep the bladder storage area away from sunlight, ultraviolet light, or other ozone producing items, if possible.
5. Optimum storage conditions for bladders are in a dark, cool (72 F) clean room.
6. Rotate your bladder inventory.

Bladder Failure: The Most Common Causes. (non-warranty damage)

1. PROBLEM: STAR BURST (AT BOTTOM OF BLADDER)

Cause 1: Excessively rapid precharging causes bladder to freeze and burst, or extrude through plug orifice before poppet can close.

Solution: Always use an approved nitrogen gas regulator for precharging.

Cause 2: Low Fluid temperature causes bladder to become brittle.

Solution: Use a low temperature bladder.

Cause 3: Lack of lubrication on the bladder causes excessive stretching

Solution 3: Always lubricate bladder prior to use. Use fluids with good lubricity. Use a water service accumulator for water based or low lubricity fluids.

2. PROBLEM: STAR BURST (6" TO 8" FROM BOTTOM OF BLADDER)

Cause 1: Folding of bladder bottom during replacement causes it to be pinned against shell wall. Bladder cannot stretch to close the poppet and it bursts.

Solution 1: Never fold bladder when repairing unit.

3. PROBLEM: POPPET CUT (AT BOTTOM OF BLADDER)

Cause 1: Excessive flow rate causes bladder to extrude down through plug before poppet can close.

Solution: Use a High Flow Accumulator or multiple units of Standard Accumulators

Cause 2: Poppet does not close all the way, which causes the bladder to extrude.

Solution: Inspect plug and poppet assembly for damage, corrosion, or debris. Replace as needed.

Cause 3: Bottom of bladder has hardened due to the reduction of plasticizers from the elastomer, which is caused by excessive heat or chemical degradation.

Solution 3: Use a Viton or other bladder

4. PROBLEM: PICK-OUT (PIN HOLE NEAR TOP OF BLADDER)

Cause: Operation of the Accumulator with little or no precharge allows fluid pressure to force bladder to extrude into gas valve.

Solution: Always operate accumulator with proper nitrogen gas precharge. Check precharge often

5. PROBLEM: BUBBLES, BLISTERS OR RUBBER FLAKING ON BLADDER SURFACE OR BURNT SMELL

Cause: Incompatible fluid, or excessive temperature.

Solution: Refer to rubber compatibility chart and Temperature chart for correct elastomer compounds.

6. PROBLEM: TEARING OF BLADDER AROUND GAS VALVE STEM

Cause: Twisting of gas valve stem during replacement.

Solution: When tightening gas valve hex jam nut, use a second wrench to keep gas valve from twisting. Do not use excessive torque.

7. PROBLEM: GROOVES OR HOLES ON BLADDER SURFACE

Cause: Fluid contamination causes foreign debris entrapment between bladder and shell during cycling.

Solution: Use clean fluid and proper filtration.



8. PROBLEM: RUBBER HAS BECOME BRITTLE CAUSING CRACKS OR FLAKES

Cause: Excessive heat can cause the bladder to re-cure or harden due to the reduction of plasticizers from the elastomer.

Solution: Use a Viton or other bladder and/or install heat exchanger in system. Do not use or store units in hot environment or in direct sunlight.

9. PROBLEM: RUBBER IS BRITTLE IN COLD WEATHER SERVICE

Solution: Use a low temperature bladder.

10. PROBLEM: HAIRLINE CRACKS ON BLADDER SURFACE

Cause: Improper storage. Sunlight, fluorescent light, heat, dust and cold can cause bladder to weather check.

Solution: Store bladder in black bags provided with Accumulators, Inc. bladder kits. Store in 65-75 degree F. dark room.

11. PROBLEM: STRETCHING

Cause: Bottom of bladder has a small poppet mark indicating bladder has stretched due to adherence to wall from insufficient lubrication

Solution: Use a fluid with more lubricity.

Solution: Use a water service accumulator with a coated interior.

12. PROBLEM: SET MARKS ON BLADDER CAUSED ADHERENCE TO SHELL WALL

Cause 1: After precharging, bladder was not cycled for an extended time period

Solution: Do not precharge bladder until just prior to service

Cause 2: Prior to precharging, bladder was not properly lubricated

Solution: Lubricate the bladder and shell prior to precharge

The following causes account for 75% of all bladder warranty claims:

13. PROBLEM: SHARP CUT ON BLADDER SURFACE

Cause: Razor blade or knife used in customer's receiving department.

Solution: Open bladder kits carefully!

14. PROBLEM: BROKEN VALVE CORE

Cause: Excessive torque used to install valve core.

Solution: Order replacement valve core.

15. PROBLEM: BROKEN OR DAMAGED GAS VALVE STEM OR THREADS

Cause: Excessive torque used to install gas charging valve (air chuck).

Solution: Hand tighten gas-charging valve during precharge.

16. PROBLEM: FLUID INSIDE OF BLADDER

Cause: There is a hole somewhere in the bladder.

Solution: Replace bladder.

17. PROBLEM: EXCESSIVE WEAR

Cause: Improper accumulator sizing.

Solution: Contact Accumulators, Inc. technical staff for recommendations.

18. PROBLEM: GAS VALVE STEM CORROSION

Solution: Order special service type bladders.

19. PROBLEM: GAS VALVE IS LEAKING GAS (Valve Stem Repair)

Cause: Dirt may get into the gas valve stem keeping the valve core from sealing.

Solution:

1. Turn off all system pressure, bleed fluid pressure from accumulator.
2. Bleed gas precharge pressure from accumulator
3. Remove valve core and throw it away
4. Using an approved valve core tool, clean the valve stem internal threads. (Do not use the tapered threads).
5. Remove the tool.
6. Using shop air or nitrogen, blow out the cleaned stem.
7. Replace the valve core with a new one.
8. Precharge using Dry nitrogen only. Follow instructions above.
9. Check for leakage using soapy water.
10. If leakage continues replace the gas valve stem.



The above list covers only the most common causes of non-warranty failure. Our in-house QC department, as well as our molders and chemists, have collected a wealth of experience in bladder analysis. There is often additional evidence and factors that can contribute to an evaluation. Most bladder failures are caused by a combination of factors, usually from the list above.

In general, bladder problems can be alleviated by proper sizing, correct compatibility and temperature evaluation, good hydraulic design, proper installation, appropriate precharging, good lubrication, and periodic maintenance. Accumulators Inc. does not warrant systems or fitness for purpose. A qualified fluid power specialist should review any application

IMPORTANT SAFETY WARNING

ALWAYS PRECHARGE ACCUMULATOR WITH DRY NITROGEN GAS (N₂) ONLY

ALWAYS USE GENUINE ACCUMULATORS, INC. REPLACEMENT PARTS AND ACCESSORIES. ACCUMULATORS, INC. FULLY WARRANTS ALL ACCUMULATORS, PARTS, AND ACCESSORIES TO BE FREE OF ANY MATERIAL OR ASSEMBLY DEFECTS. SEE PRODUCT WARRANTY FOR ALL DETAILS.

Caution: OPERATION OF ACCUMULATOR WITHOUT SUFFICIENT PRE-CHARGE (MINIMUM OF 30% OF MAXIMUM WORKING PRESSURE) CAN CAUSE BLADDER "PICK-OUT"

Most units are shipped with only 35 psig precharge. You must add additional precharge before operation

Custom Engineered Products

Accumulators, Inc. can design products to fit your precise requirements. We can help you select special fluid or gas ports, special elastomers, and special coatings. These products can be assigned proprietary part numbers for your exclusive use. Perfect for OEM applications



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e-mail: info@accumulators.com

AccuMight® Operating, Precharge and Commissioning Instructions



(For 3000, 4000, 5000-psi AccuMights)
(Does not apply to Accumulators, Gas Bottles, Transfer Barrier and Float Accumulators)

WARNING: NEVER USE OXYGEN OR SHOP AIR!
This can be extremely dangerous and will void your warranty!

- ✓ Precharge with **DRY NITROGEN (N₂) GAS ONLY!**
- ✓ Never operate AccuMight without nitrogen gas precharge.
- ✓ Release all system *hydraulic* pressure before attempting any maintenance or service.
- ✓ Use only genuine ACC INC approved charging and gauging equipment for precharging and pressure check.
- ✓ Follow all instructions below.
- ✓ Wear proper eye protection
- ✓ Wear steel toed shoes
- ✓ Take proper safety precautions

NOTE: Most AccuMights are shipped with just minimal pressure (35 psig). It is the responsibility of the user to determine the proper precharge level and to insure that that pressure is maintained at all times. In general, precharge should equal 30% to 80% of the maximum system pressure.

WARNING. HIGH PRESSURE GAS IS DANGEROUS!
Wear proper eye protection! Take proper safety precautions!

AccuMight Bladder Removal

1. Turn off your system (equipment), release all hydraulic or fluid pressure.
2. Remove gas protective cap (2) and valve cap (3) from AccuMight.
3. Install genuine ACC INC approved charging and gauging assembly on gas valve stem. Attach the air chuck to the AccuMight bladder gas valve by hand tightening its swivel hex connection.
4. **For 3000 psi AccuMights.** Turn the air chuck " T " handle clockwise until it stops. This opens the valve core. **For 4000 psi and higher AccuMights.** Open the valve by turning its top (small) hex nut, counter-clockwise.
5. Bleed off all nitrogen gas by opening up the bleed valve completely. (For 4000 psi or higher AccuMights, the gas valve must also be opened)
6. Remove the gauging device from gas valve stem.
7. Release any remaining gas pressure from AccuMight. (For a 3000-psi AccuMight, remove the valve core (4) from gas stem (5) using core tool (AI-506). For 4000-psi or higher AccuMight, open the gas valve fully, then remove gas valve
8. Remove AccuMight from system.
9. Unscrew the upper portion of the AccuMight using a band wrench and a vise. (AM60 has a removable screw cap(7))
10. Remove bladder (9or10) carefully making sure o-rings (if any) and back-up rings (if any) are removed. Please note the configuration of the components. (Different models have different configurations)
11. Thoroughly clean the interior of the shell sections paying particular attention to the seat area.



AccuMight Bladder Installation

1. We recommend that a new gas valve(5), new o-ring(6) and/or a new valve core(4) be installed.
2. Lubricate the AccuMight bladder and shell with system fluid.
3. Apply a small amount of compatible grease on the new o-ring, new bladder "lip" and shell seat area.
4. Carefully insert new bladder making sure the "seat" is properly aligned
5. Attach the two shell sections
6. Hand-tighten the sections, making sure the bladder and o-ring are correctly seated and are not "pinched".
7. Tighten fully using a band wrench and vise.
8. Precharge the AccuMight (See Instructions below).
9. Reinstall the unit on the system

AccuMight Precharging Instructions

If the AccuMight is already installed on a system

1. Pump a small amount of system fluid (10% of AccuMight capacity) into the AccuMight, at low pressure. (Do not exceed 35 psi)
2. Turn off all power to the system and release all hydraulic pressure from the AccuMight.

If AccuMight is not yet installed:

3. Turn unit upside down (Fluid-end up). Place a small amount of fluid (10% of AccuMight capacity) into the AccuMight. Lubricate as much of the AccuMight bladder surface area as possible.
4. Remove the protective cap(2) and the valve cap(3) (if there is one).
5. Attach the gland & nut portion (CGA-580 for 3000 psi accumulators, CGA-677 for 4000 psi and higher) of the charging assembly to a dry nitrogen gas bottle, tighten securely. If the gland & nut do not fit, you are using the wrong gas or wrong pressure!
6. Attach the air chuck to the AccuMight bladder gas valve by hand tightening its swivel hex connection.
7. For 3000 psi AccuMight, Turn the air chuck " T " handle clockwise until it stops. This opens the valve core. For 4000 psi and higher AccuMight open the valve by turning its top (small) hex nut, counter-clockwise.
8. Set nitrogen bottle gas regulator (if attached) to 35 psig. (The use of a nitrogen gas regulator is strongly recommended!)
9. Open nitrogen bottle gas valve. (If you are not using a nitrogen gas regulator, care should be taken to slowly "crack" the valve open.) With a regulator, valve can be opened fully.
10. Pre-charge slowly (35 psig) using dry nitrogen gas, until the AccuMight bladder is fully inflated.

**Caution: INITIAL PRECHARGING AT A FLOW RATE ABOVE 35 PSIG
 WILL CAUSE THE BLADDER TO BURST**

Make sure to precharge to minimum of 10% of operating pressure

11. Continue pre-charging to desired pressure by increasing gas flow slowly.
12. For 3000 psi AccuMights, Turn the air chuck " T " handle COUNTER-clockwise until it stops. This CLOSSES the valve core. For 4000 psi and higher AccuMights CLOSE the valve by turning its top (small) hex nut, clockwise.
13. Remove the charging assembly. Check for gas leakage. (The use of gas leak detection fluid or soapy water is recommended.)
14. Replace the valve cap, protective cap). Tighten, hand tight.
15. Install AccuMight on system. CHECK FOR LEAKAGE.
16. Pressurize system. Operate.

**FAILURE TO FOLLOW PROPER SERVICE AND INSTALLATION INSTRUCTIONS
 MAY VOID ACC INC PRODUCT WARRANTY**

AccuMight Commissioning

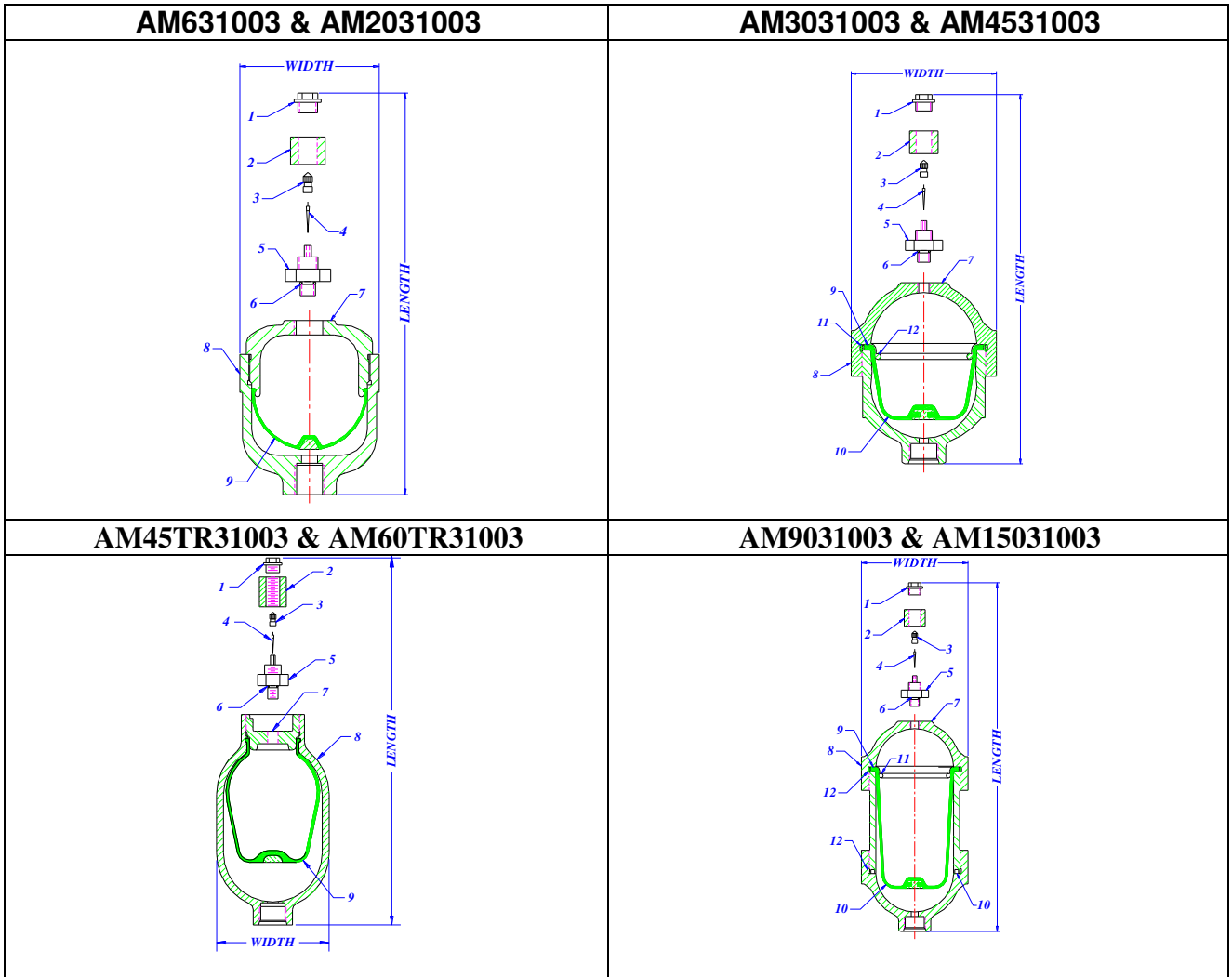
Prior to operating a new AccuMight on any system a few common sense steps should be taken

- A qualified Fluid Power specialist should review the AccuMight's application for correct sizing, pressure, cycling, connections, placement and efficiency.
- Carefully remove the AccuMight from the factory packaging, read and understand all factory labels, stickers, tags and nameplates attached to the AccuMight and the packaging.
- Read and understand any written factory instructions accompanying the AccuMight
- If the AccuMight is part of a third party OEM system, read and understand all of their labeling and instructions
- All the steps listed in **AccuMight Precharging** (above) should be followed.
- The proper training of your AccuMight maintenance personnel is recommended

Consult the factory or your local Accumulators, Inc. Authorized representative, with any questions



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AccuMight Dimensions

| Size | 3000 psi | Length | Width | Fluid Port | Gas Port |
|--------|-------------|--------|-------|----------------|--------------|
| 6 ci | AM631003 | 5.8 | 3.0 | 3/4"-16 UNF | .305-32 UNEF |
| 20 ci | AM2031003 | 6.8 | 3.9 | 3/4"-16 UNF | " |
| 30 ci | AM3031003 | 7.5 | 4.5 | 3/4"-16 UNF | " |
| 45 ci | AM4531003 | 8.2 | 5.4 | 1 1/16"-12 UNF | " |
| 45 ci | AM45TR31003 | 8.3 | 4.6 | 1 1/16"-12 UNF | " |
| 60 ci | AM60TR31003 | 9.0 | 4.6 | 1 1/16"-12 UNF | " |
| 90 ci | AM9031003 | 12.1 | 5.4 | 1 1/16"-12 UNF | " |
| 150 ci | AM15031003 | 18.1 | 5.4 | 1 1/16"-12 UNF | " |

This is just a small representation of the many variations of AccuMights.

Also Available:

- Low Pressure and High Pressure units
- Various elastomers such as Butyl, EPDM, Silicon and Floral-elastomers.
- Several exotic and corrosion resistant materials such as Stainless Steel and Plastics
- Low cost non-repairable designs

Call the factory for more information



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AccuMight Precharge Maintenance

For cycling applications check the precharge weekly. For non-cycling applications, monthly
 You will normally lose some gas over time due to Permeance.
 A more rapid loss may indicate a gas valve problem

1. Release system pressure. Not gas pre-charge.
2. Remove gas protective cap (valve guard) and valve cap.
3. Install gauging device on gas valve stem.
4. For 3000-psi accumulators, screw down air chuck “ T ” handle, check pressure. For 4000 psi and higher, open gas valve hex fitting (do not loosen from bladder). Check pressure
5. Add additional dry nitrogen gas if necessary, using the above procedures.
6. To release excess nitrogen gas (if any) open up bleeder valve, located at bottom of gauging device, until desired pressure is achieved.

AccuMight Charging and Gauging Accessories

| Item Description | ACC INC Part Number | Pressure |
|---|---------------------|--------------------|
| Basic Maintenance Kit | AI-TKITB | 3000 psig |
| Standard Maintenance Kit | AI-TKIT | 3000 psig |
| Deluxe Maintenance Kit | AI-TKIT1 | 3000-6500 |
| Charging & Gauging 3kpsi Kit 3000 psig gauge | AI-CG3-3KT-SS | 3000 psig |
| Charging & Gauging 3kpsi Kit 6000 psig gauge | AI-CG6-3KT-SS | 3000 psig |
| Charging & Gauging 6kpsi Kit 6000 psig gauge | AI-CG6-6KT-SS | 3000- 6500 psig |
| Valve Core Tool | AI-506 | 3000 psi |

AccuMight Replacement Parts

| Part Description | Part Number | Part Description | Part Number |
|--------------------------|-------------|-------------------------|-------------|
| Component List | | | |
| Safety Cap | AI-1QT-308 | Gas Valve O-Ring | AM-310 |
| Protective cap | AI-1QT-306 | Large O-Ring (45,90,15) | AM-410-B |
| Valve cap | AI-1QT-303 | Small O-Ring (90,15) | AM-410-C |
| Valve Core | AI-S-304 | Teflon Ring (45,90,15) | AM-411 |
| Gas Valve | AM-309 | Metal Ring (45,90,15) | AM-412 |
| Mounting Hardware | | | |
| 90-150 U-Bolt | AM-507-KIT | 30-150 Base | AM-512 |
| 30-150 Collar | AM-507-KIT | Rubber Insert | AM-513 |

See Page 39 for AccuMight Mounting Hardware

AccuMight Series Repairable Diaphragm Accumulators *The OEM Solution*

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MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: MOBIL DTE 10 EXCEL 32
Product Description: Base Oil and Additives
Product Code: 201560103630, 622621-00, 97AY99
Intended Use: Hydraulic fluid

COMPANY IDENTIFICATION

Supplier: EXXON MOBIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA. 22037 USA
24 Hour Health Emergency 609-737-4411
Transportation Emergency Phone 800-424-9300
ExxonMobil Transportation No. 281-834-3296
Product Technical Information 800-662-4525, 800-947-9147
MSDS Internet Address <http://www.exxon.com>, <http://www.mobil.com>

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

Reportable Hazardous Substance(s) or Complex Substance(s)

| Name | CAS# | Concentration* |
|--|------------|----------------|
| HYDROTREATED LIGHT PARAFFINIC DISTILLATES, PETROLEUM | 64742-55-8 | 20 - 30% |

* All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

SECTION 3 HAZARDS IDENTIFICATION

This material is not considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

POTENTIAL HEALTH EFFECTS

Excessive exposure may result in eye, skin, or respiratory irritation. High-pressure injection under skin may cause serious damage.

NFPA Hazard ID: Health: 0 Flammability: 1 Reactivity: 0
HMIS Hazard ID: Health: 0 Flammability: 1 Reactivity: 0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

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SECTION 4 FIRST AID MEASURES

INHALATION

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

INGESTION

First aid is normally not required. Seek medical attention if discomfort occurs.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO₂) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Pressurized mists may form a flammable mixture.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulfur oxides, Incomplete combustion products, Oxides of carbon

FLAMMABILITY PROPERTIES

Flash Point [Method]: >175°C (347°F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

SECTION 6 ACCIDENTAL RELEASE MEASURES

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NOTIFICATION PROCEDURES

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

PROTECTIVE MEASURES

Avoid contact with spilled material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for advice on the minimum requirements for personal protective equipment. Additional protective measures may be necessary, depending on the specific circumstances and/or the expert judgment of the emergency responders. For emergency responders: Respiratory protection: respiratory protection will be necessary only in special cases, e.g., formation of mists. Half-face or full-face respirator with filter(s) for dust/organic vapor or Self Contained Breathing Apparatus (SCBA) can be used depending on the size of spill and potential level of exposure. If the exposure cannot be completely characterized or an oxygen deficient atmosphere is possible or anticipated, SCBA is recommended. Work gloves that are resistant to hydrocarbons are recommended. Gloves made of polyvinyl acetate (PVA) are not water-resistant and are not suitable for emergency use. Chemical goggles are recommended if splashes or contact with eyes is possible. Small spills: normal antistatic work clothes are usually adequate. Large spills: full body suit of chemical resistant, antistatic material is recommended.

SPILL MANAGEMENT

Land Spill: Stop leak if you can do it without risk. Recover by pumping or with suitable absorbent.

Water Spill: Stop leak if you can do it without risk. Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

| |
|------------------|
| SECTION 7 |
|------------------|

| |
|-----------------------------|
| HANDLING AND STORAGE |
|-----------------------------|

HANDLING

Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source). When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations). Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static accumulation. Consult local applicable standards for guidance. Additional references include American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents) or National Fire Protection Agency 77 (Recommended Practice on Static Electricity) or CENELEC CLC/TR 50404 (Electrostatics - Code of practice for the avoidance of hazards due to static electricity).

Static Accumulator: This material is a static accumulator.

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STORAGE

The container choice, for example storage vessel, may effect static accumulation and dissipation. Do not store in open or unlabelled containers. Keep away from incompatible materials.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMIT VALUES

Exposure limits/standards (Note: Exposure limits are not additive)

| Source | Form | Limit / Standard | | | NOTE | Source |
|--|---------------------|------------------|---------------------|--|------|---------|
| HYDROTREATED LIGHT PARAFFINIC DISTILLATES, PETROLEUM | Mist. | TWA | 5 mg/m ³ | | N/A | OSHA Z1 |
| HYDROTREATED LIGHT PARAFFINIC DISTILLATES, PETROLEUM | Inhalable fraction. | TWA | 5 mg/m ³ | | N/A | ACGIH |
| HYDROTREATED LIGHT PARAFFINIC DISTILLATES, PETROLEUM | Mist. | TWA | 5 mg/m ³ | | N/A | ACGIH |

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

No special requirements under ordinary conditions of use and with adequate ventilation.

PERSONAL PROTECTION

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

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No protection is ordinarily required under normal conditions of use.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

No skin protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid skin contact.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

Comply with applicable environmental regulations limiting discharge to air, water and soil. Protect the environment by applying appropriate control measures to prevent or limit emissions.

| | |
|------------------|---|
| SECTION 9 | PHYSICAL AND CHEMICAL PROPERTIES |
|------------------|---|

Note: Physical and chemical properties are provided for safety, health and environmental considerations only and may not fully represent product specifications. Contact the Supplier for additional information.

GENERAL INFORMATION

Physical State: Liquid

Color: Amber

Odor: Characteristic

Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION

Relative Density (at 15 °C): 0.84

Flash Point [Method]: >175°C (347°F) [ASTM D-92]

Flammable Limits (Approximate volume % in air): LEL: 0.9 UEL: 7.0

Autoignition Temperature: N/D

Boiling Point / Range: > 316°C (600°F) [Estimated]

Vapor Density (Air = 1): > 2 at 101 kPa [Estimated]

Vapor Pressure: < 0.013 kPa (0.1 mm Hg) at 20 °C [Estimated]

Evaporation Rate (n-butyl acetate = 1): N/D

pH: N/A

Log Pow (n-Octanol/Water Partition Coefficient): > 3.5 [Estimated]

Solubility in Water: Negligible

Viscosity: 32.5 cSt (32.5 mm²/sec) at 40 °C | 6.6 cSt (6.6 mm²/sec) at 100°C

Oxidizing Properties: See Hazards Identification Section.

OTHER INFORMATION

Freezing Point: N/D

Melting Point: N/A

Pour Point: -51°C (-60°F)

DMSO Extract (mineral oil only), IP-346: < 3 %wt

Decomposition Temperature: N/D

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SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Excessive heat. High energy sources of ignition.

MATERIALS TO AVOID: Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

| <u>Route of Exposure</u> | <u>Conclusion / Remarks</u> |
|---|---|
| Inhalation | |
| Toxicity: No end point data for material. | Minimally Toxic. Based on assessment of the components. |
| Irritation: No end point data for material. | Negligible hazard at ambient/normal handling temperatures. Based on assessment of the components. |
| Ingestion | |
| Toxicity: No end point data for material. | Minimally Toxic. Based on assessment of the components. |
| Skin | |
| Toxicity: No end point data for material. | Minimally Toxic. Based on assessment of the components. |
| Irritation: No end point data for material. | Negligible irritation to skin at ambient temperatures. Based on assessment of the components. |
| Eye | |
| Irritation: No end point data for material. | May cause mild, short-lasting discomfort to eyes. Based on assessment of the components. |

CHRONIC/OTHER EFFECTS

Contains:

Base oil severely refined: Not carcinogenic in animal studies. Representative material passes IP-346, Modified Ames test, and/or other screening tests. Dermal and inhalation studies showed minimal effects; lung non-specific infiltration of immune cells, oil deposition and minimal granuloma formation. Not sensitizing in test animals.

Additional information is available by request.

The following ingredients are cited on the lists below: None.

--REGULATORY LISTS SEARCHED--

1 = NTP CARC
2 = NTP SUS

3 = IARC 1
4 = IARC 2A

5 = IARC 2B
6 = OSHA CARC

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SECTION 12

ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Not expected to be harmful to aquatic organisms.

MOBILITY

Base oil component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Base oil component -- Expected to be inherently biodegradable

BIOACCUMULATION POTENTIAL

Base oil component -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

OTHER ECOLOGICAL INFORMATION

VOC: 6.1 G/L [ASTM E1868-10]

SECTION 13

DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products. Protect the environment. Dispose of used oil at designated sites. Minimize skin contact. Do not mix used oils with solvents, brake fluids or coolants.

REGULATORY DISPOSAL INFORMATION

RCRA Information: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed as hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity and is not formulated with contaminants as determined by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. **DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION.**

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THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

| | |
|-------------------|------------------------------|
| SECTION 14 | TRANSPORT INFORMATION |
|-------------------|------------------------------|

LAND (DOT): Not Regulated for Land Transport

LAND (TDG): Not Regulated for Land Transport

SEA (IMDG): Not Regulated for Sea Transport according to IMDG-Code

AIR (IATA): Not Regulated for Air Transport

| | |
|-------------------|-------------------------------|
| SECTION 15 | REGULATORY INFORMATION |
|-------------------|-------------------------------|

OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purposes, this material is not classified as hazardous in accordance with OSHA 29 CFR 1910.1200.

Complies with the following national/regional chemical inventory requirements:: DSL, ENCS, PICCS, TSCA
Special Cases:

| Inventory | Status |
|-----------|--------------------|
| AICS | Restrictions Apply |
| IECSC | Restrictions Apply |
| KECI | Restrictions Apply |

EPCRA SECTION 302: This material contains no extremely hazardous substances.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: None.

SARA (313) TOXIC RELEASE INVENTORY: This material contains no chemicals subject to the supplier notification requirements of the SARA 313 Toxic Release Program.

The following ingredients are cited on the lists below:

| Chemical Name | CAS Number | List Citations |
|--|------------|----------------|
| HYDROTREATED LIGHT PARAFFINIC DISTILLATES, PETROLEUM | 64742-55-8 | 1, 4, 17 |

--REGULATORY LISTS SEARCHED--

- | | | | |
|---------------|--------------|-------------------|-------------|
| 1 = ACGIH ALL | 6 = TSCA 5a2 | 11 = CA P65 REPRO | 16 = MN RTK |
| 2 = ACGIH A1 | 7 = TSCA 5e | 12 = CA RTK | 17 = NJ RTK |
| 3 = ACGIH A2 | 8 = TSCA 6 | 13 = IL RTK | 18 = PA RTK |
| 4 = OSHA Z | 9 = TSCA 12b | 14 = LA RTK | 19 = RI RTK |

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5 = TSCA 4

10 = CA P65 CARC

15 = MI 293

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16

OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:

Revision Changes:

Section 07: Handling and Storage - Storage Phrases was modified.

Hazard Identification: Health Hazards was modified.

Section 11: Dermal Lethality Test Data was modified.

Section 11: Dermal Lethality Test Comment was modified.

Section 11: Oral Lethality Test Data was modified.

Section 11: Inhalation Lethality Test Data was modified.

Section 11: Dermal Irritation Test Data was modified.

Section 11: Eye Irritation Test Data was modified.

Section 11: Oral Lethality Test Comment was modified.

Section 11: Inhalation Irritation Test Data was modified.

Composition: Component table was modified.

Section 15: List Citation Table - Header was modified.

Section 15: National Chemical Inventory Listing was modified.

Section 16: Code to MHCs was modified.

Section 15: Community RTK - Header was modified.

Section 08: Exposure limits/standards was modified.

Section 15: Special Cases Table was modified.

Section 12: Other Ecological Information - Header was added.

Section 15: Chemical Name - Header was added.

Section 15: CAS Number - Header was added.

Section 15: List Citations - Header was added.

Section 15: List Citations Table was added.

Section 08: Exposure Limits Table was added.

Section 08: Exposure Limit Values - Header was added.

Section 08: OEL Table - Form Column - Header was added.

Section 08: OEL Table - Limit Column - Header was added.

Section 08: OEL Table - Notation Column - Header was added.

Section 08: OEL Table - Source Column - Header was added.

Section 08: Exposure Limit Values - Header was added.

Section 12: California VOC was added.

Section 12: California VOC was added.

Section 08: Exposure limits/standards - Header was deleted.

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MHC: 0B, 0B, 0, 0, 0, 0

PPEC: A

DGN: 7087020XUS (1013882)

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