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Installation and Maintenance Manual

HYDRAULIC FAIL-SAFE
DISC BRAKE

BSFI 3090-MS35S-104 AWA

PWE 1570 / 77

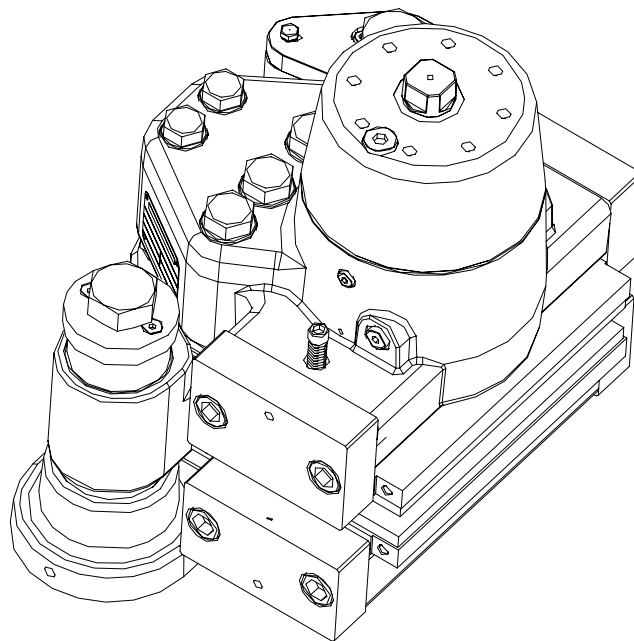


Table of Contents

TABLE OF CONTENTS	1
1. GENERAL	3
1.1 Who to contact	3
1.2 Safety	3
1.3 Conventions used in this manual	4
1.4 Disclaimer	4
1.5 Conversion factors	5
1.6 Nameplate / Serial-numbers	5
1.7 How the brake works	6
1.8 Function	7
1.9 Transport.....	7
1.10 Connections	8
1.11 Lubrication	9
1.12 Storage	9
1.13 Disposal	9
1.14 How to order spare parts	10
2. INSTALLATION	11
2.1 Lifting and handling.....	11
2.2 Cleaning the brake disc	11
2.3 Cleaning the mounting surfaces	11
2.4 Handling / mounting the brake pads	11
2.5 Mounting the brake	13
2.6 Checking the air gap	16
2.7 Inspecting the alignment of the brake	16
2.8 Positioning system.....	16
2.9 Adjusting the positioning system	18
2.10 Bleeding and flushing the caliper	19
2.11 Installing the Indicators	19
2.12 Bedding in	20
2.13 Removing the brake.....	21
3. MAINTENANCE	22
3.1 Indicators	22
3.2 Replacing the brake pads	22
3.3 Replacing other components	24
3.4 Dismantling the active caliper	24
3.5 Replacing the seals.....	24
3.6 Checking the spring pack	30
3.7 Replacing the spring pack	31
3.8 Lubrication of the brake	33
4. TROUBLE SHOOTING	34
APPENDIX A - DIMENSION DRAWING	37
APPENDIX B - ASSEMBLY DRAWING, BRAKE	37
APPENDIX B - ASSEMBLY DRAWING, BRAKE	38
APPENDIX B - ASSEMBLY PARTS LIST, BRAKE	38
APPENDIX B - ASSEMBLY PARTS LIST, BRAKE	39
APPENDIX C - SPARE PARTS DRAWING, CALIPER HALF EXPLODED	41
APPENDIX C - SPARE PARTS DRAWING, CALIPER HALF	42
APPENDIX C - SPARE PARTS LIST, CALIPER HALF	43
APPENDIX D – SPARE PARTS DRAWING, PASSIVE CALIPER	44
APPENDIX D – SPARE PARTS LIST, PASSIVE CALIPER	44
APPENDIX E – MOUNTING DRAWING	45
APPENDIX F - POSITIONING SYSTEM	46

APPENDIX I - TECHNICAL DATA	51
APPENDIX J - RECOMMENDED FLUID	52
APPENDIX K - RECOMMENDED SPARE PARTS.....	53

1. General

Svendborg Brakes' range of high-integrity brakes offers a brake designer a system of braking that meets the highest requirements for safety and reliability for large braking applications and multifunctional service braking.

Svendborg Brakes is able to deliver to you complete solutions including brakes, hydraulic power units and electronic SOBO[®] brake-controls.

1.1 Who to contact

In case you have any questions to this manual please contact your local representative or nearest Svendborg Brakes Office:

Svendborg Brakes offices:

Denmark:

Jernbanevej 9, DK-5882 Vejstrup
Tel +45 63 255 255
e-mail: sb@svendborg-brakes.dk

Germany:

Kirchnerstrasse 42, DE-32257 Bünde
Tel +49 522 368 540-0
e-mail: sb@svendborg-brakes.de

Spain:

C/ San Benito 24, 1ºB, ES-42001 Soria
Tel: +34 975 233 655
e-mail: sb@svendborg-brakes.es

USA:

P.O. Box 1948, Denver, CO 80201-1948
Tel: +1 303 285 1271
e-mail: sb@svendborg-brakes.us

or visit us at:

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 A/S 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 A/S.
- 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 change the size or type of spring pack.
- 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:

- The manual has been read and understood.
- The brake disc is locked and not able to rotate before adjusting the brake and / or air gap.
- Locking / securing the brake piston by using the air gap bolt / air gap nut if working on a spring applied brake.
- Being sure there is no pressure on the hydraulic power unit or circuit.
- Being sure the oil pressure in the accumulator(s) has been relieved / removed
- The control signals has been shut off and blocked before working on the system.

- The electrical power has been shut off.

Heavy equipment

Be careful when lifting the brake or brake components - it is heavy equipment and is not made for manually 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 without having the brake piston properly secured.



Pressure warning

Never apply pressure to the brake before being sure that the end cap is turned sufficiently into the yoke

If the end cap is not fully tightened while pressurized - the thread may be destroyed and the end cap screw may be shot out of the brake



- 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.

1.3 Conventions used in this manual

To make sure 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 A/S 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 can sometimes occur.

This document is updated on a regular basis; changes will be published in future printings. Improvements and/or changes to the described products or manual can be implemented at any time without preceding notice.

In no event shall Svendborg Brakes A/S 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 A/S.

1.5 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.

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/mm² = 46412.00 PSI
 305 Nm = 224.96 lbf.ft

1.6 Nameplate / Serial-numbers

Before contacting Svendborg Brakes A/S or your local reseller please **record the serial number** of the product.

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

Brakes - sign / nameplate

The sign is located on the brake and should look like this:

FIGURE 1.1

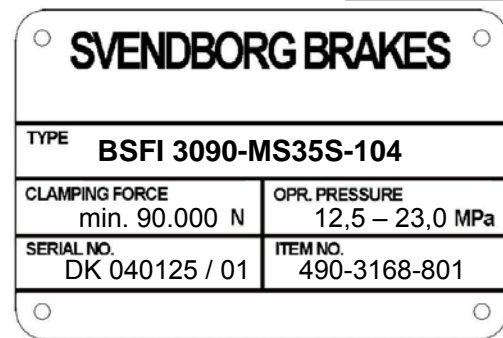
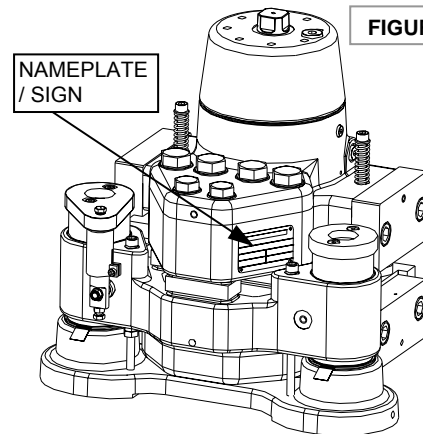


FIGURE 1.2



Naming of the brake:
 "TYPE"

The type is the description (name) of the brake. Our brakes are named after following nomenclature:

BSFI 3000-MSXXX-XXX

- BS = Brake system
- F = Fail-safe – spring applied/hydraulic released
- I = Brake version
- 3000 = Clamping force – last 3 digits in kN i.e. 3090 = 90,000 N
- MS = MonoSpring
- XX = Disc thickness in mm
- X = Finish (S/R) (Standard / Offshore)
- 1XX = Version / option number of the brake

Example:

BSFI 3090-MS35S-104 means that this is a **Mono Spring** brake in the **BSFI 3000** brake series with **90,000N** in clamping force made for a **35mm** brake disc in **Standard** finish and in the option **104** which is equivalent to a brake with AWA.

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 by the origin of the brake, the date produced (year month date) and the number in the series.

Example:

DK 040317 / 02 indicates this is brake number 02 produced in Denmark on March 17th in 2004.

For tracking purposes the serial number is also written on the delivery note / invoice.

Other information on the nameplate / sign "ITEM NO"

This shows the item number of the brake including the version number.

"CLAMPING FORCE" and "OPERATING PRESSURE"

The performance of the brake is shown by the clamping force provided.

The operating pressure has to ensure correct use of the brake.

Brakes with a spring pack

Spring applied fail safe brakes are marked with the minimum clamping force (nominal) provided and the minimum operating pressure (oil pressure) to ensure that the brake is lifted.

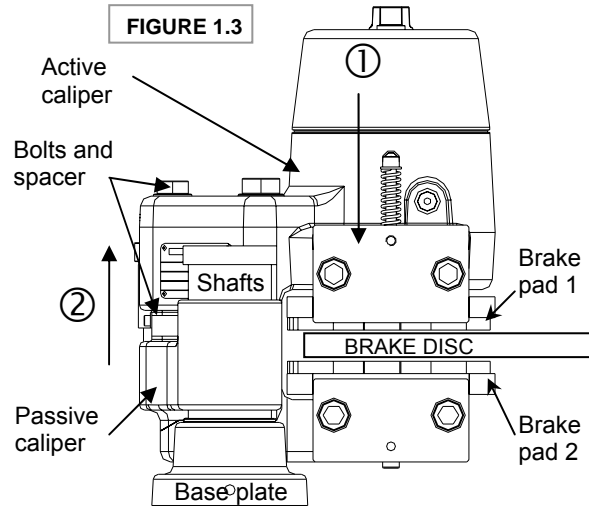
1.7 How the brake works

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

The BSFI 3000 Mono Spring is designed as a fail-safe spring-applied hydraulically released disc brake.

The brake can be supplied with various clamping forces.

The Mono Spring brake contains one spring pack only (Belleville cup springs) – these springs are located inside the active caliper.



The active caliper is mounted / joined together with the passive caliper using bolts and spacers (spacers only where applicable).

The assembled / joined caliper is floating on the two shafts of the base plate and the bearings which are placed inside the passive caliper.

When braking - the piston inside the active caliper (and brake pad no. 1) will move towards the brake disc.

The brake pad no. 2 and the passive caliper will then lift towards the brake disc and provide a braking force on both sides of the disc because the active and passive caliper are assembled / joined and is floating on the shafts.

Please notice that the brake pad (no. 2) in the passive caliper does not move.

Only the brake pad in the active caliper moves – therefore the pad holder in passive caliper is lower than in the active caliper.

Only limited movement of the brake disc and brake is allowed. The sliding capabilities of the brake are limited in both directions of the mounting surface – forward and backwards.

When moving too close towards the mounting surface, the brake will touch the base plate preventing it from sliding freely.

In worst case this may cause damages to the brake / brake disc / hub / coupling and or mounting structure.

When moving backwards from the mounting surface the forces / torque on the shafts and base plate will increase resulting in reduced lifetime.

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

In order to prevent the passive caliper from sliding incorrectly on the shafts it is necessary to use flexible hydraulic hoses as a final part / section of the connection when connecting the pressure ports on the brake to the hydraulic power unit.

This Manual is valid for the brake option BSFI 3090-MS35S-104 AWA.

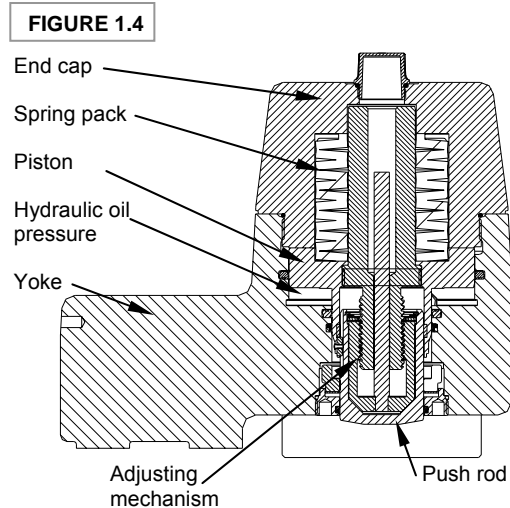
1.8 Function

The BSFI 3090-MS35S-104 AWA is a brake with **Automatic pad Wear Adjustment** called AWA. AWA means that the brake will adjust itself as the brake pads wear.

The brake will therefore always provide the same air gap (distance between brake disc and brake pads) and the same clamping force throughout the lifetime of the brake pads.

The BSFI 3000 Active caliper is designed as a fail-safe spring-applied hydraulically released caliper.

The clamping force is obtained from the spring pack applying the force to the piston and through the adjusting mechanism and push rod through the brake pad against the brake disc.



The reaction force is transferred via the end cap to the yoke.

When hydraulic pressure is applied and released to the pressure ports the brake is in operation.

The brake applies the clamping force when the hydraulic oil pressure is released / removed from the hydraulic chamber / unit causing the piston to execute movement towards the brake disc.

When hydraulic oil pressure is applied to the hydraulic chamber / unit the braking force decreases causing the piston to execute movement away from the brake disc (towards the end cap).

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

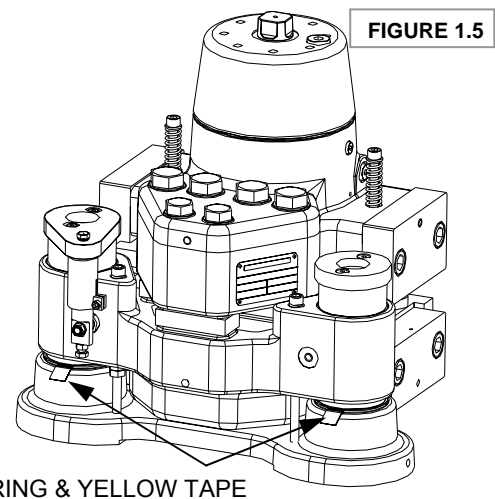
1.9 Transport

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

The weight of the caliper is approx. 220 kilos.

IMPORTANT

The brake has one O-ring (6-B) mounted on each shaft between the base-plate and the passive caliper. The O-rings are split / open and are mounted with a piece of yellow tape and – they are for transportation only and must be removed before usage of the brake.



IMPORTANT

If the brake is supplied with a positioning system (optional) the bolts and springs (pos ① on figure 1.6) may already be mounted from the factory. This will be done to prevent the caliper to slide on the shafts during transport.

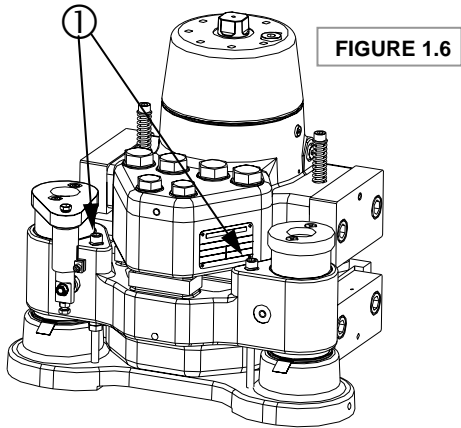


FIGURE 1.6

These bolts (if mounted) will have to be removed during mounting of the brake and refitted during the adjustment process.

1.10 Connections

The brake is provided with two pressure connections 1/4" BSP (15-C and 15A-C) and two drain connections 1/8" BSP (13-C and 14-C).

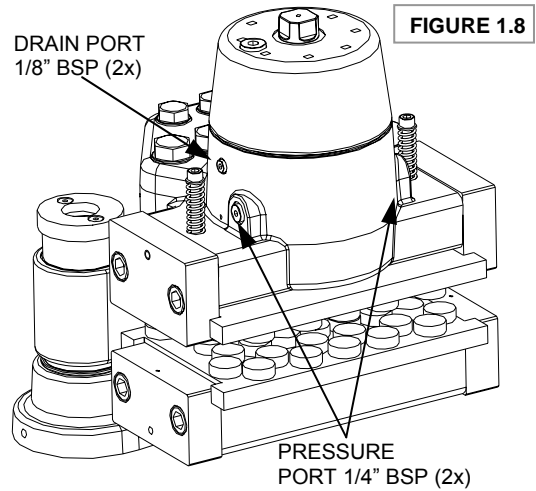


FIGURE 1.8

Pressure ports

The pressure ports are used to release the brake. The connection at the lowest position shall always be used as a pressure connection when connecting the brake to the hydraulic system.

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 connections (13-C or 14-C) provide access to the chamber between the outer seal (6-C) and the wiper (5-C) in the front and in the back (7-C and 9-C) through a series of holes in the yoke.

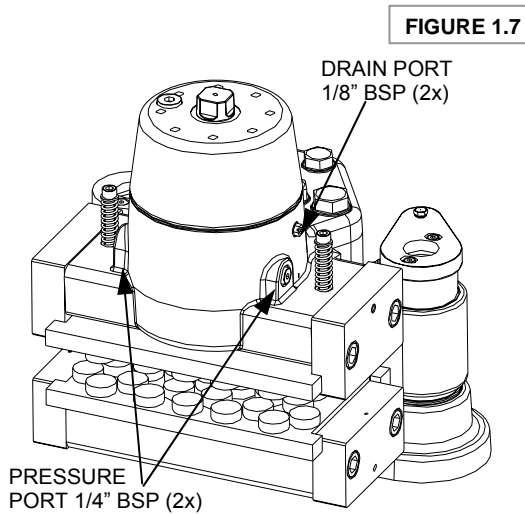


FIGURE 1.7

NOTE

It is recommended to use / connect the drain connection because this can prevent leaking oil from reaching the brake disc resulting in reduced braking force.

A pipe with a length of approximately 10 to 20cm can be connected to the lowest drain port connection (1/8" BSP).

A plastic hose (preferably clear) can be connected to the free end of the pipe (from before) and then connected to a container, bottle or similar.

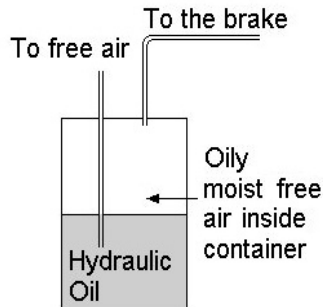
Using a clear hose makes it easy to see if leaking occurs from the seals.

The brake can as an option be supplied with an air-breather in one of the drain ports (13-C or 14-C).

IMPORTANT

To prevent misty air to enter the interior of the brake causing possible damage, fill the container only partly with hydraulic oil and let the free air pass through this oil.

FIGURE 1.9



When using this brake in salty and / or aggressive environments please replace this breather with a drain connection as described previously in order to prevent the aggressive air to enter the interior of the brake.

CAUTION

Never apply any pressure to the drain connections (13-C & 14-C). Applying pressure could damage the seals because the hydraulic oil / pressure then enter the chamber between the seal and the wiper and will blow off the wiper and most likely destroy the seal.

IMPORTANT

In order to prevent the passive caliper from sliding incorrectly on the shafts it is necessary to use flexible hydraulic hoses as a final part / section of the connection when connecting the pressure ports on the brake to the hydraulic power unit.

1.11 Lubrication

Different types of lubrication are used in different situations.

This can be either for lubrication of the seals or disc springs during servicing 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 B20
- Hydraulic oil

MoS₂ Molybdenum Disulfide

Molykote is produced by Dow Corning Hydraulic oil can be synthetic or mineral oil as per recommended oil types. Molybdenum Disulfide (MoS₂) can be in various forms; either spray, fluid or solid state.

1.12 Storage

The brake / caliper is externally treated at the factory with an anti-corrosion film which is sufficient for indoor storage for up to 12 months.

If the brake / caliper is to be stored for periods longer than 12 months the active caliper / piston must be "worked" / operated at full stroke, at least 20 times every 12 months to prevent the seals from sticking to the piston.

IMPORTANT

The anti-corrosion protection should be reapplied if necessary after transporting or handling.

1.13 Disposal

General

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

If 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 of a steel back plate and brake pad material / lining. The brake pad material is either made of an organic compound or of the sinter metal type. 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 treated 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

**1.14 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 1.6 – “Nameplate / Serial-numbers”.

2. Installation

2.1 Lifting and handling

The BSFI 3000 Mono spring brake is equipped with eyebolts on the caliper and should only be lifted by means of placing a hook through them.

The eyebolts mounted on the brake can be moved to the back of the passive caliper half or they can be mounted in the brake pad holders for lifting.

If the eye bolts are mounted in brake pad holders please remove the eyebolts again before use of the brake.

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, positioning system, etc.

When lifting please note that the total weight of the complete brake is approx. 220kg.

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 petroleum or diesel fuel 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 can be flammable, poisonous and can cause burns.

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

Also follow these procedures:

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

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

2.3 Cleaning the mounting surfaces

The mounting surface of the bracket or customer post / gearbox must comply with the relevant arrangement drawings and mounting data drawings.

If the mounting surface is not within the specification this can cause the base plate to permanently distort and prevent the caliper from sliding on the shafts / axles.

It is critical that the base plate is bolted to the mounting surface in compliance with the tolerance specified on the caliper dimension drawing.



IMPORTANT

The joint between the base plate 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 base plate should be cleaned in the same way as the brake disc - see section 2.2 – '*Cleaning the brake disc*'.



WARNING

Solvent cleaners can be flammable, poisonous and can cause burns.

Please follow the manufacturer's instructions and see section 2.2 – '*Cleaning the brake disc*'.

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 Svedborg Brakes are asbestos free and free of lead. Certificate is available on request.

Brake pads can be supplied in several types and 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 Brake pads with organic brake pad material is quite sensitive to dirt, grease and oil and they are normally packed / sealed in plastic to protect them from contamination – please keep the pads in the package for as long as possible.

Organic materials are very sensitive to grease and oil and can not be cleaned. They must in most cases be discarded and must be replaced if exposed to this.

2.4.2 Brake pads with sinter metal brake pad material is 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.

Since they are not that sensitive the brake pads of sintered metal are not necessarily wrapped in plastic.



WARNING

Solvent cleaners can be flammable, poisonous and can cause burns. Please follow the manufacturer's instructions and see section 2.2 – 'Cleaning the brake disc'.

2.4.3 The brake pads can be in different versions – either with or without integrated pad holders / guides and in different brake pad materials.

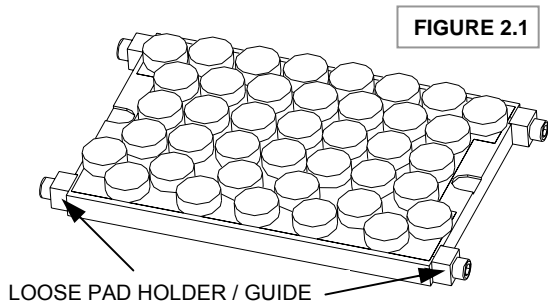


FIGURE 2.1

On the pad versions with loose pad holders mounted on the pad, it is possible, when assuming that the space is available for the hub, to change the pads just by removing the 2 innermost bolts (M10x25) and pad holders on each pad and thereafter by sliding the brake pad towards the centre of the main shaft.

Mounting is done in reverse order.

For information on the tightening torque for the loose pad-holders please refer to Table 2.2 – 'Bolts for brake pad holders / pads'

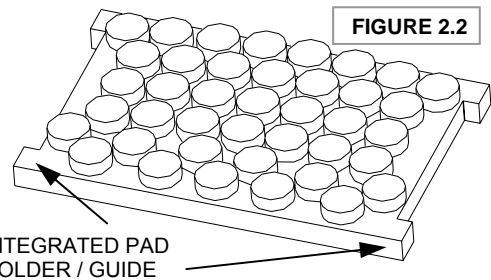
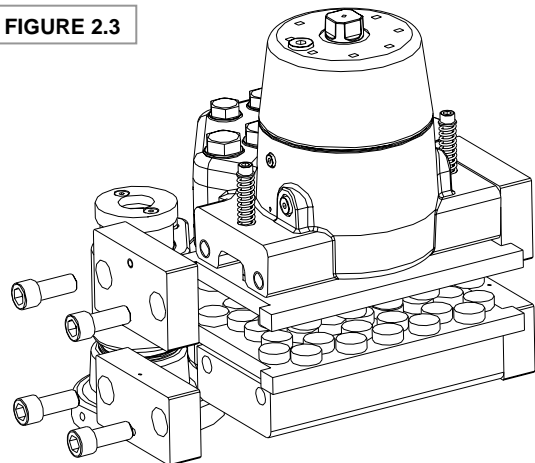


FIGURE 2.2

On the pad versions with integrated pad holders the brake pad can be removed by removing the 2 bolts (M20x50) (5-C) and the pad holder (4-C).

The brake pad can be removed by sliding the brake pads sideways out of the brake. Mounting is done in reverse order.

FIGURE 2.3



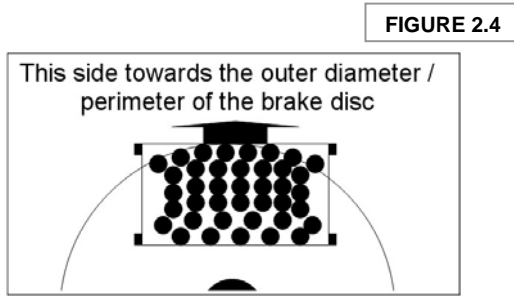
CAUTION

It is essential that sinter metal brake pads are placed correctly before usage.

On some brake pads the sinter metal pucks are placed to absorb the heat as effectively as possible.

If using sinter metal brake pads with pucks (round or rectangular shape) placed in a curved pattern the brake pad should be

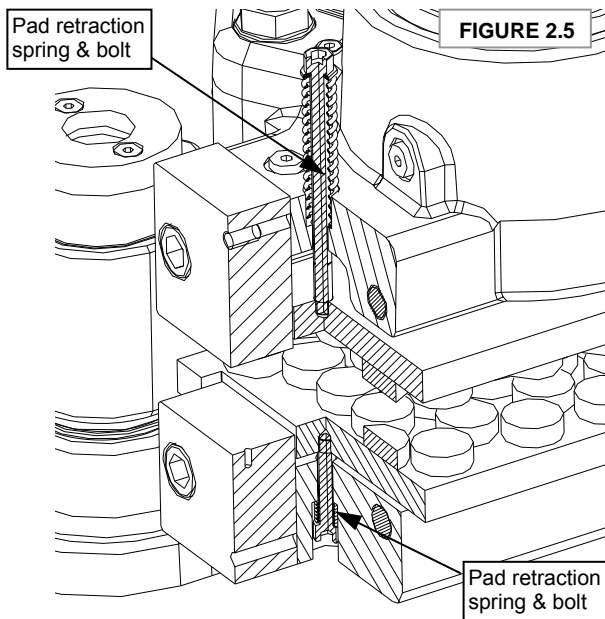
placed with the curve towards the perimeter of the brake disc.



NOTE

The pad holder on the active caliper is higher / larger than the one on the passive caliper. This is because the brake pad on the passive caliper does not move whereas the brake pad in the active caliper moves the full distance.

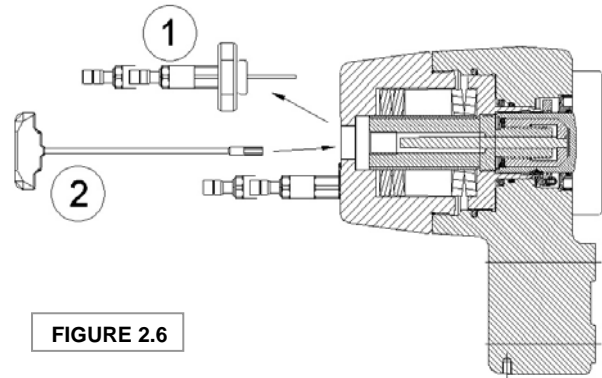
2.4.4 After mounting the pad holders the pad retraction springs should be mounted into the brake pads.



2.5 Mounting the brake

2.5.1 Remove the indicators (if fitted) to prevent them from being damaged.

2.5.2 Use the spanner to rotate the push rod clockwise - the push rod will now be retracted into the housing of the brake.



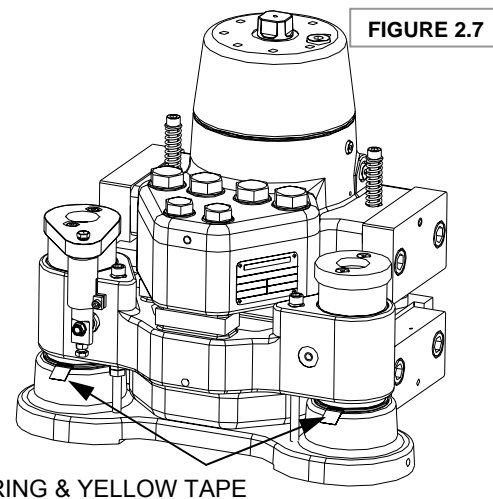
IMPORTANT

The push rod can only rotate, when there is no pressure on it. When forces are reacting on the push rod, the thread inside the AWA mechanism will lock, preventing the push rod from rotating.

This means that it can only rotate when:

- the brake pads are removed
- there is no hydraulic pressure on the brake
- the push rod does not touch the brake disc

2.5.3 The brake has one O-ring (6-B) mounted on each shaft between the base plate and the passive caliper. They are only mounted for avoiding damages during transport and must be removed before usage of the brake. These O-rings are split and are marked with a piece of yellow tape.



2.5.4 Check that the mounting surface of the bracket or customer post / gearbox complies with the relevant arrangement drawings and mounting data drawings i.e. is flat and at right angles to the brake disc, before mounting the base plate.

- 2.5.5 Ensure that the mounting surfaces are clean of dirt and oil – otherwise clean as per section 2.3 – ‘Cleaning of the mounting surfaces’.
- 2.5.6 Position the brake on the mounting flange and mount the lowest bolt – without fully tightening it.
- 2.5.7 If possible tip the brake backwards using the lower bolt (M36) as pivot. Doing this will ease the mounting of the brake pads on initial installation.

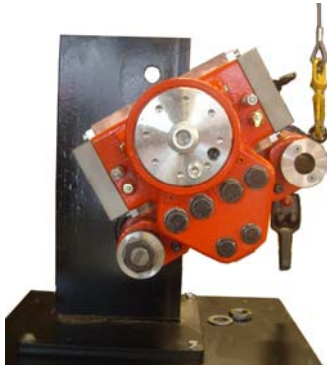


FIGURE 2.8

If this is not possible mount the brake with both M36 bolts and tighten according to section 2.5.17 / Table 2.4



NOTE

The brake may be delivered with lifted piston / compressed spring pack from the factory. In this case please disregard the next section as the nut is already mounted – continue at section 2.5.12.

- 2.5.8 Remove the threaded plug (15-C) in the lowest pressure connection
- 2.5.9 Connect a hand pump or a hydraulic unit to the pressure port (1/4” BSP) (15-C).
- 2.5.10 Apply the minimum release pressure according the nameplate / sign or to Table 2.1 - ‘Minimum release pressure’ to ensure the brake is fully lifted.

Maximum pressure allowed on the brake is 21.0 MPa (210 bar)

Table 2.1	
Minimum release pressure	
Brake size	Min. pressure
BSFI 3090	12.5 MPa
BSFI 3100	13.5 MPa
BSFI 3110	16.0 MPa
BSFI 3120	17.5 MPa

- 2.5.11 Remove the cover (27-C) and mount the air gap bolt (Bolt M24x50) and the washer in the piston (8-C)
This will ensure that the piston is locked in lifted position when working with the brake pads.

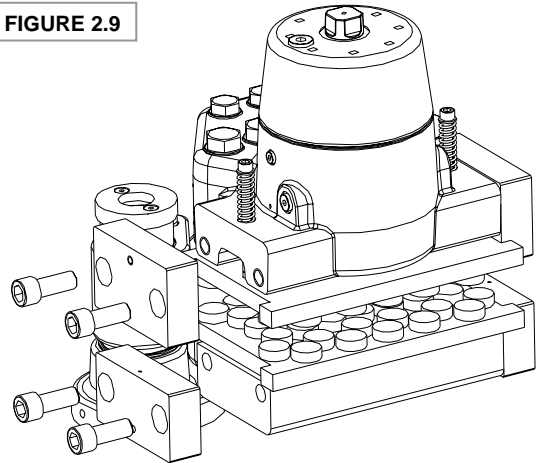


IMPORTANT

Only tighten the air gap bolt (part of tool kit) with the fingers or if using tools – only use very little force. Tightening the bolt too much will make it almost impossible to remove it again.

- 2.5.12 Release / remove the hydraulic pressure again
- 2.5.13 Align the brake on the shafts to the disc (slightly in the middle).
- 2.5.12 Prepare the brake pads for mounting. Be careful and protect the pads from grease and oil, see section 2.4 -‘Handling / mounting the brake pads’.

FIGURE 2.9



NOTE

If the brake has been tipped backwards / pivoted it may be possible to mount the brake pads and pad retraction springs without having to remove the brake pad holders. Please note that the piston has to be fully lifted and the push rod has to be fully retracted in order to mount the brake pads

- 2.5.15 Slide the brake pads into position and mount the brake pad holder (4-C) and the two bolts (M20x50) (5-C) again.

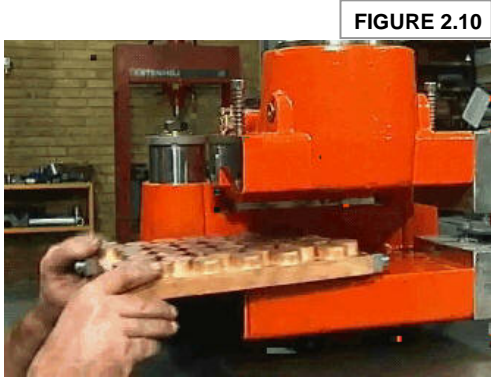


FIGURE 2.10

Use the tightening torque specified on the spare parts drawing or from Table 2.2 – ‘Bolts for brake pad holders / pads’.

Table 2.2		
Bolts for brake pad holders / pads		
Bolt size	Torque	
	Lubricated MoS2	Dry & Oiled
M10 8.8	37 Nm	45 Nm
M20 8.8	305 Nm	365 Nm
“Lubricated” is based on Molykote – MoS2		

2.5.16 Fit the pad retraction springs and bolts and mount these - tighten firmly according to Table 2.3 – ‘Bolts for pad retractions springs’.

Table 2.3		
Bolts for pad retraction springs		
Bolt size	Torque	
	Lubricated MoS2	Dry & Oiled
M10 8.8	20 Nm	27 Nm
“Lubricated” is based on Molykote – MoS2		

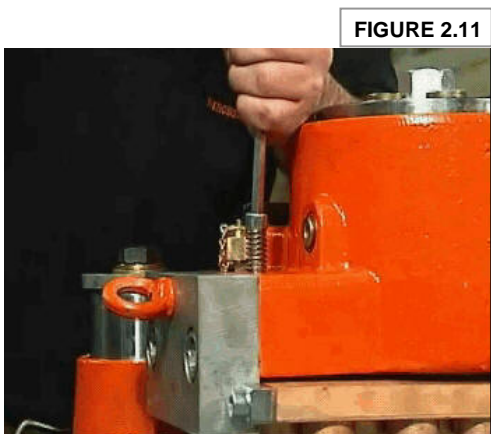


FIGURE 2.11

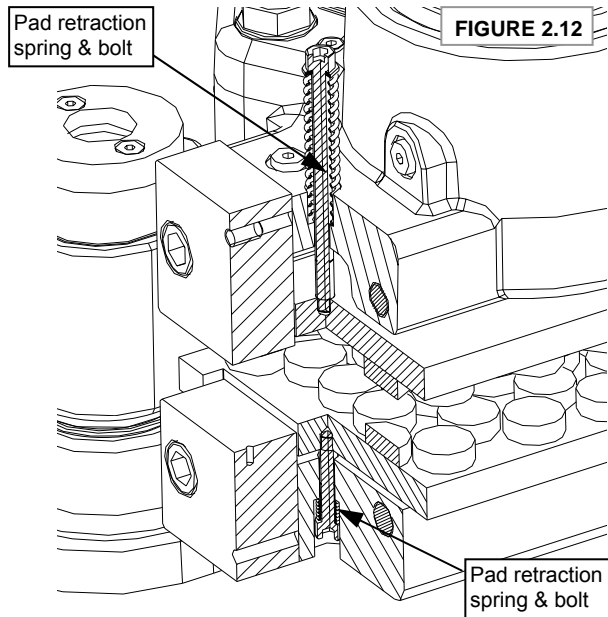


FIGURE 2.12

2.5.17 If the brake was pivoted, please check the mounting surfaces and the brake disc for dirt and grease before rotating into place and mount the brake with 2 x M36 bolts minimum grade 10.9 for BSFI3090 and above.

Use the tightening torques from the spare-parts drawing or Table 2.4 – ‘Mounting bolts for base plate’.

Table 2.4		
Mounting bolts for base plate		
Bolt size	Torque	
	Lubricated MoS2	Dry & Oiled
M36 8.8	1820 Nm	2160 Nm
M36 10.9	2560 Nm	3000 Nm
“Lubricated” is based on Molykote – MoS2		

2.5.18 Check that the brake disc can rotate freely, without touching the brake and that the brake is aligned parallel to the brake disc.

2.5.18 Apply the minimum release pressure according the nameplate / sign or to Table 2.1 - ‘Minimum release pressure’ to ensure the brake is fully lifted.

Maximum pressure allowed on the brake is 21.0MPa (210bar)

2.5.19 Remove the air gap bolt (M24x50) and the washer. Release the pressure from the hand-pump. Unplug and remove the pump afterwards.

2.5.20 The hydraulic power unit can now be connected to the brake by using the lower pressure connection (17-C) and a hose. The pressure line must be minimum $\varnothing 10\text{mm}$.



IMPORTANT

Remember to bleed the brake before use - see section 2.10 – ‘Bleeding the caliper’.

2.5.21 Operate the brake for 5-10 times, until the brake pads are in contact with the brake disc as this will make the automatic wear adjustment adjust the brake.

2.5.22 Connect the drain lines to the brake. The drain line can be of plastic.

2.5.23 Mount the indicator(s) in the end cap if equipped – see section 2.11 – ‘Installing the indicators’.

2.5.24 Check the air gap – see section 2.6 – ‘Checking the air gap’.

2.6 Checking the air gap

The air gap is the space between the brake pads and the brake disc.

This total air gap is set from factory and can not be adjusted. The actual air gap will be between 1.5 and 2.5mm depending on the size of brake (spring force) and the version of the brake.

If another air gap is needed the brake has to be dismantled and changes must be carried out in a workshop prepared for hydraulic work. For further information consult Svendborg Brakes A/S or your local dealer.

Before checking the air gap be sure that the brake has been activated 5-10 times in order to readjust correctly.

2.6.1 Check the actual air gap preferably by using a feeler gauge.

FIGURE 2.13



Check that the air gap between the disc and the pad is between 2.0 and 3.3mm.

If the brake is equipped with a positioning system the air gap must be adjusted to the same distance on both sides of the brake disc - see section 2.8 - ‘Positioning system’ for details.

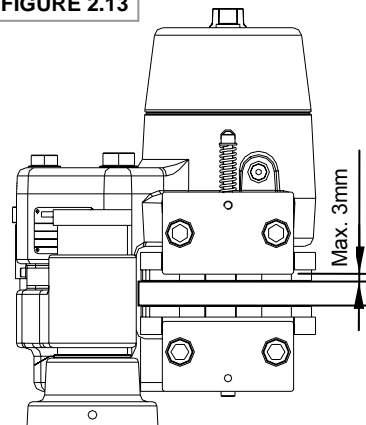
2.7 Inspecting the alignment of the brake

2.7.1 Apply hydraulic pressure to the brake and make sure that the piston is completely lifted and the brake pads are not in contact with the brake disc.

2.7.2. Check that the brake pads can move freely within the brake pad holders. The pad retraction springs will reduce the movement somewhat, but the brake pad must not be stuck to the brake.

Check the distance to the brake disc from the brake pad holders on the active caliper. The distance must not be larger than 3mm and not less the 1mm.

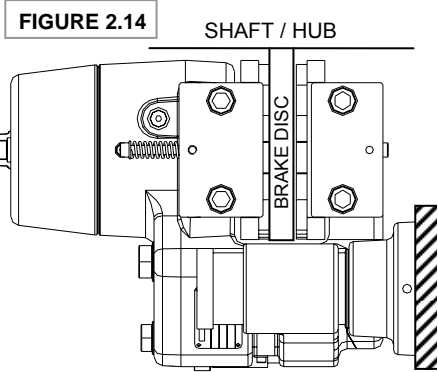
FIGURE 2.13



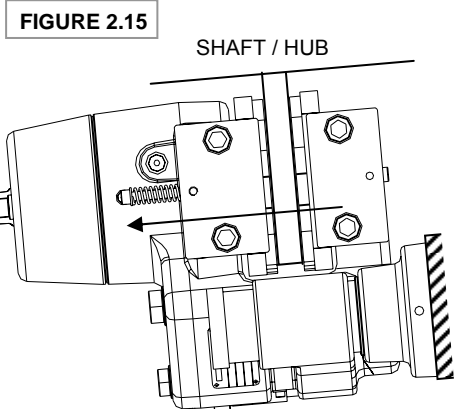
This check only needed at initial installation.

2.8 Positioning system

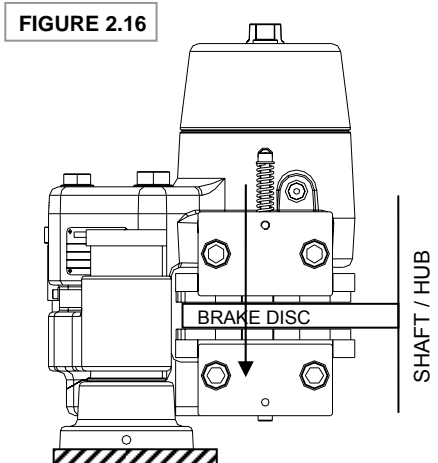
If the mono spring brake is mounted in perfect vertical position the brake pads on the passive side of the brake will slightly touch the brake disc (figure 2.14).



If the brake is not mounted at level i.e. it is mounted downwards like in a typical wind turbine (figure 2.15), the gravity will provide a force on the brake, making the brake pads on the passive side touch the disc – this will result in wear on the pads and a positioning system is highly recommended.



If the brake is mounted in horizontal position (figure 2.16) even higher gravitational forces will occur. In this situation a special positioning system is recommended / needed.



Please note that in this situation wear will be on the active side.

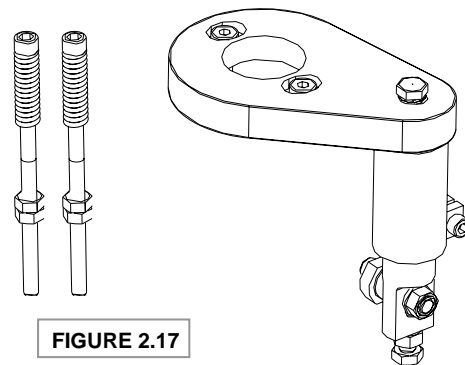
If axial movement of the brake disc occurs and wear on the brakes pads becomes a problem - the mono spring can be equipped with a positioning system.

In general the positioning system has two functions:

- 1) adding forces to absorb/minimize the gravitational forces – using springs in either direction
- 2) to align the brake within the air gap i.e. to position the brake with equal amount of space between the brake disc and the brake pads on both sides

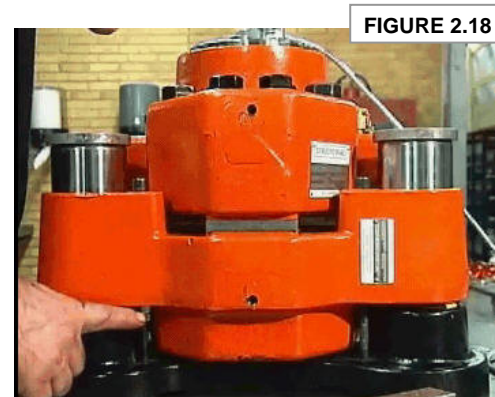
The positioning system for the AWA brakes is special because it has to compensate for the fact that the brake readjusts when the brake pad wears.

For the AWA brakes the positioning system consists of the special sliding system and 2 bolts, 2 springs, 2 washers and 4 nuts.



The two bolts from the positioning system are inserted through the springs and the passive caliper and into the threads in the base-plate.

The springs should always push / move the passive caliper away from the brake disc.



Remember to mount / fit the nuts before entering the thread into the base-plate.

2.9 Adjusting the positioning system

This section is only relevant if the brake is equipped with a positioning system.

After initial installation / replacement of the brake pads the positioning system shall be adjusted accordingly, i.e. the distance between the brake pad and the brake disc should be adjusted to the same distance on both sides.

All position numbers refer to the spare parts list in Appendix F – ‘Positioning system’.

2.9.1 Check that the 2pcs. bolts M10 x 180 / 200mm and springs are mounted in the passive caliper.



FIGURE 2.19

2.9.2 Close the brake (remove the hydraulic pressure).

2.9.3 Loosen the bolt (10-F).

2.9.4 Remove the nut and washer (12-F & 6-F).

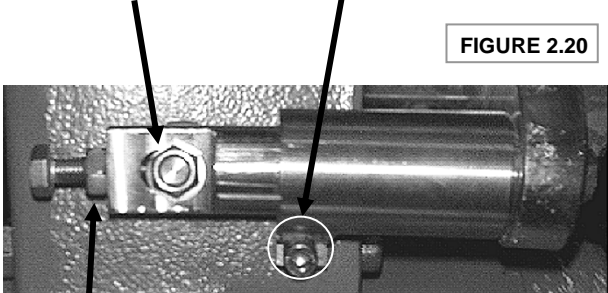


FIGURE 2.20

2.9.5 Loosen the nut (13-F).

2.9.6 Loosen the bolt (9-F) approx. 10mm.

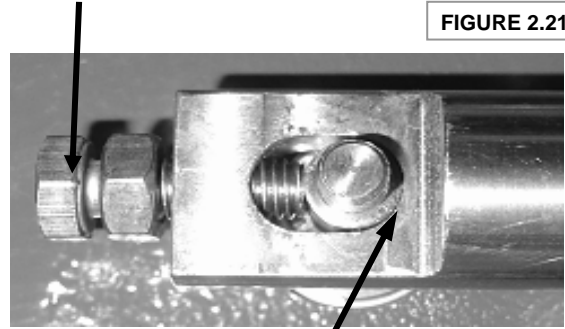


FIGURE 2.21

Distance (y) = 0

2.9.7 Tighten bolt (9-F) to zero distance (y=0).

2.9.8 Activate the brake 5–10 times until the brake has adjusted to correct air gap (2–3mm) between brake pad and brake disc. With the brake open / lifted the full air gap is on the passive side only (due to the springs (15-F) applying force).

2.9.9 Close the brake (remove hydraulic pressure) - This will lift the passive caliper towards the brake disc.



FIGURE 2.22

(No air gap)

2.9.10 Tighten bolt (10-F) firmly by hand (17Nm).

2.9.11 Unscrew the bolt (9-F) until the distance is equal to the half of the total air gap (half of 2.0 – 3.3mm). The bolt has 1.25mm pitch - meaning one complete turn results in 1.25mm gap.

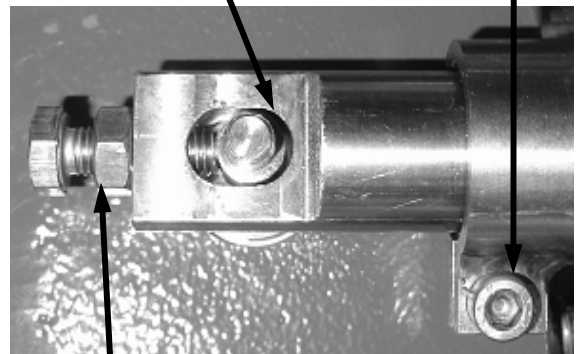


FIGURE 2.23

2.9.12 Tighten the jam (lock) nut (13-F).

2.9.13 Open brake (apply hydraulic pressure).

2.9.14 Check that the air gap is equal on both sides. If not, close the brake again and repeat section 2.9.11 and 2.9.12.

FIGURE 2.24



(Equal air gap)

2.9.15 Open and close brake 3 times to check that the air gap stays equal.

2.9.16 Mount the nut and washer (12-F, 6-F).

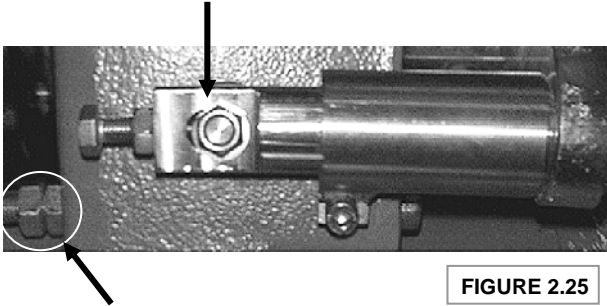


FIGURE 2.25

2.9.17 **Optional** - Tighten the nut (17-F) with the fingers until it touches the passive caliper and lock it with the counter nut.
Note - this is optional and can work as additional safety but is not necessary.

2.9.18. When replacing pads, the positioning system has to be readjusted.
For further information or spare parts list please see data sheet DEB-3000-011 / F – ‘Positioning system’.

2.10 Bleeding and flushing the caliper

Each brake caliper has been individually flushed before leaving the factory and all hydraulic power units supplied from Svendborg Brakes A/S has also been flushed before leaving the factory. Nonetheless, the hydraulic system must be flushed and bled before taking the system into full usage. Flushing of the system will remove minor particles and potential dirt in the system and prevent damages to the system.

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

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

Failure to bleed the brakes / hydraulic system will allow air to remain in the brake system. This could prevent the hydraulic pressure in the brake system from rising / increasing enough to lift the brakes correctly.

A possible result from this could be that the brake pads will remain on the brake disc and heating of the brake pads and brake disc could occur.

Air in the system could also destroy the seals (diesel effect) within the brake / caliper.

2.10.2 The caliper must be bled at the highest point on the brake through the pressure port (15-C or 15A-C).

Apply oil flow to the hydraulic system (and at low pressure) and bleed by opening the bleeding plugs.

A special bleeding plug (Mini mess / test point) 1/4" BSP and a hose can be supplied from Svendborg Brakes - see recommended spare parts list.

If the opening and closing times of the brake system are longer than expected or if the pressure does not increase smoothly there is most likely air in the system.

2.11 Installing the Indicators

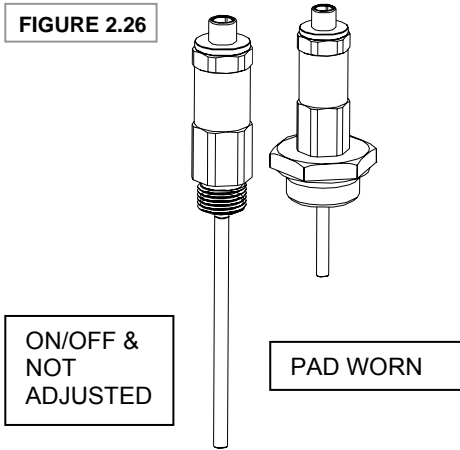
The BSFI 3090-MS35S-104 AWA brake can be mounted with up-to 2 switches for safety use.

This can be our mechanical switch with two signals per sensor, or it can be an inductive proximity switch with only one signal per indicator

The switch signal for “Brake Not Adjusted” is very important, because it will immediately give a signal if the adjuster-mechanism is out of order, or has a miss-function.

! CAUTION

To avoid damage on the “Pad Worn” - indicator it is important that the brake has been installed and has been activated 5 to 10 times before installation on the indicator.

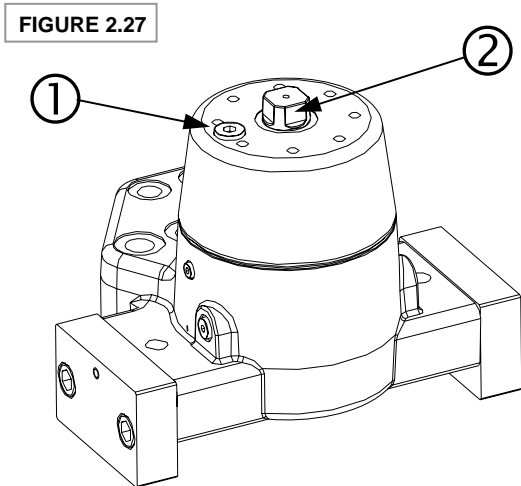


2.11.1 The indicator for “On/Off” & “Not Adjusted” must be mounted in the end cap in the hole in the outer perimeter (position 1 on figure 2.27)

Remove the plug (1/2” BSP) and fit the indicator.

2.11.2 The indicator for “Pad Worn” is for giving a signal when the brake pads are worn and needs to be replaced.

The indicator is for pad worn shall be mounted in the centre-hole of the end cap by removing the cover (position 2 on figure 2.27) and then fit the indicator and the adaptor.



2.12 Bedding in

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

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.

Sinter-metal pads:

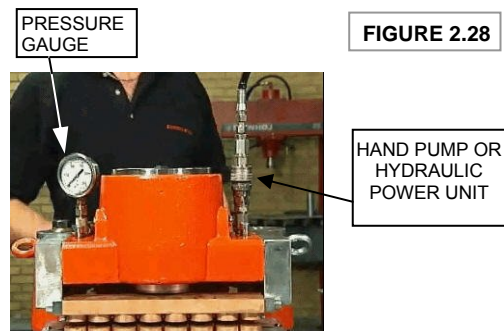
The bedding in process for sinter-metal pads is the same as for organic pads, but with a slightly higher clamping force when bedding in – approx. 40% of the rated clamping force applied.

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

Instruction for the bedding in process is packed together with the pads.

2.12.1 The clamping force can be reduced by lowering the hydraulic pressure in the active caliper to the correct percentage of the balancing pressure (see **Appendix I – ‘Technical Data’**).

Reduce the hydraulic pressure on the hydraulic power unit if possible or connect a hand pump and a pressure gauge into one of the pressure ports (13-C or 15-C).



2.12.2 Increase the hydraulic pressure to ensure that the piston is fully lifted.

- 2.12.3 Start the application / rotating of the brake disc.
- 2.12.4 Reduce the hydraulic pressure to the correct pressure level.
- 2.12.5 Continue rotating the brake disc through the brake pads until the bedding in process is completed.

Example:

25% of clamping force needed.
 The brake size / type is BSFI 3090 – the balancing pressure is 8.2MPa (82bar) (see **Appendix I – ‘Technical Data’**).
 The reduced hydraulic pressure is calculated as 100%-25% = 75% of 8.2MPa.
 The hydraulic pressure should be reduced to 6.15MPa (61.5bar) during bedding in.

2.13 Removing the brake

- 2.13.1 Remove the indicators if equipped to prevent them from being damaged.



NOTE

Be careful when removing the On/Off indicator. The extender pin / activation pin is loose – i.e. the pin is not attached to the indicator.
 Please be careful to ensure the pin do not get lost.

Store the switches so they will not be damaged.

- 2.13.2 Apply the minimum release pressure according the nameplate / sign or to Table 2.1 - ‘Minimum release pressure’ to ensure the brake is fully lifted.



WARNING

Under no circumstance place your fingers between the brake pad and the brake disc when the brake is pressurised.

- 2.13.3 Mount the air gap bolt (M24x50) and the washer in the piston (8-C).
 This will ensure that the piston is locked in lifted position when working with the brake pads.



IMPORTANT

Only tighten the air gap bolt (M24x50) with the fingers or if using tools - only use very little force.
 Tightening the bolt too much will make it almost impossible to remove it again.

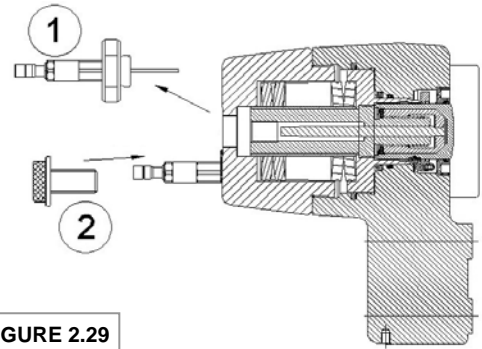


FIGURE 2.29

- 2.13.4 Remove / relieve the hydraulic pressure.
- 2.13.5 Remove the pad retractions springs and bolts from both the active and passive caliper – see section 2.4 – ‘Handling / mounting the brake pads’.
- 2.13.6 Remove the brake pad holders (4-C) and the brake pads (10-B) from both the active and the passive caliper - see section 2.4 – ‘Handling / mounting the brake pads’.
- 2.13.7 Apply hydraulic pressure to the caliper and remove the air gap bolt (M24x50).
 Release the hydraulic pressure and the piston will now move forward again.
- 2.13.8 Retract the push rod by turning the push rod clockwise using the spanner through the centre hole in the end cap – see figure 2.29.



IMPORTANT

The push rod can only be rotated, when there is no pressure on it.
 When forces are reacting on the push rod, the thread inside the AWA mechanism will lock and prevent it from rotating.

Meaning it can only be rotated when:

- the brake pads are removed
- there are no hydraulic pressure on the brake
- the push rod do not touch the brake disc

- 2.13.9 Remove the hydraulic hose and pipe connections from the brake.
- 2.13.10 Connect lifting equipment to the brake i.e. use the equipped eyebolts
 The eyebolts mounted on the brake can be moved to the back of the passive caliper half or they can be mounted in the brake pad holders for lifting.
- 2.13.11 The brake can now be removed safely by removing the 2 mounting bolts going through the base plate (M36).

3. Maintenance

3.1 Indicators

The brake can be equipped with several indicators for different purposes. They are not mandatory but highly recommended.

3.1.1 Pad worn signal

During usage the brake pads will wear, and if the brake is equipped with a "Pad Worn" indicator it will indicate when to replace the brake pads.

The standard indicator can provide two signals:

- A "Pre Pad Worn" signal that indicates that approximately 1.5mm of the brake pad material remains. This means that the brake pad needs to be replaced soon.
- A "Pad Worn" signal that indicates that the brake pad is worn and must be replaced immediately.

The "Pad Worn" indicator and adaptor are to be mounted in the centre of the end cap (see figure 3.1) after removal of the cover (27-C).

3.1.2 Not Adjusted signal

The brake can be equipped with a "Not Adjusted" indicator which will indicate defective adjusting mechanism.

This is very important because having a "Not Adjusted" signal calls for immediate repair of the brake as the nominal clamping force may not be present.

The standard indicator can provide two signals:

- A "Brake Release" signal that indicates when the brake is released / activated (On/Off).
- A "Not Adjusted" signal that indicates exceeded piston movement i.e. a defective adjusting mechanism.

The "Not Adjusted" indicator is to be mounted in the perimeter of the end cap (see figure 3.1) after removal of the hydraulic plug (10-C).

3.2 Replacing the brake pads

The brake pads must be replaced when each pad has been worn 5mm.

The brake pad thickness can always be checked with a gauge.

All brake pads for the brake consist of a steel back plate and a friction material. The brake pad has a total thickness of 32mm, i.e. all brake pads must be replaced when the thickness of friction material + back plate is minimum 27mm.

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.

See section 2.4 - 'Handling / mounting the brake pads' for proper handling of the brake pads.

- 3.2.1 Remove the indicators if fitted or plastic cover from the centre hole of the end cap.

 **NOTE**

If more than one indicator is fitted - mark the cables, so it is easy to connect them to the right indicators afterwards.

- 3.2.2 Apply the minimum release pressure according to the nameplate / sign or to Table 2.1 - 'Minimum release pressure' in order to ensure that the brake is fully lifted. Maximum pressure allowed on the brake is 21.0MPa (210bar).

- 3.2.3 Mount the air gap bolt ② (Bolt M24x50) and the washer in the centre hole of the end cap. This will ensure that the piston is locked into lifted position when working with the brake pads.

 **IMPORTANT**

Only tighten the air gap bolt (part of tool kit) with the fingers or if using tools - only use very little force.

Tightening the bolt too much will make it almost impossible to remove it again.

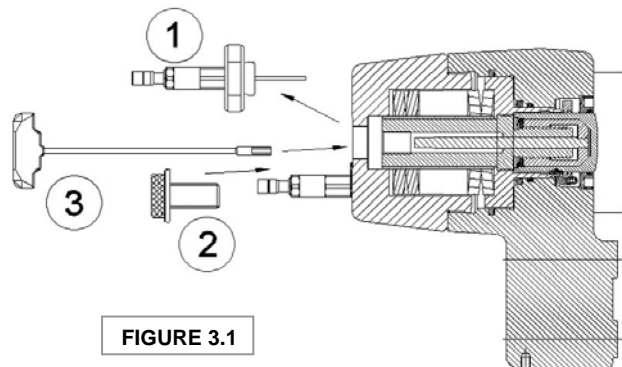


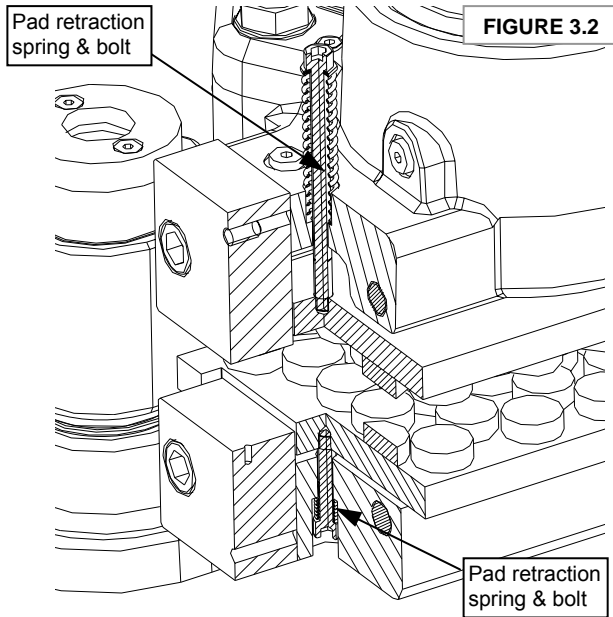
FIGURE 3.1

3.2.4 Remove / relieve the hydraulic pressure.

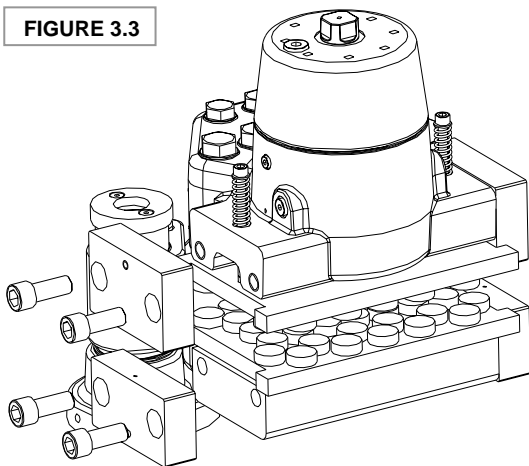
3.2.5 Remove the pad retraction springs and bolts from both active and passive caliper.

! WARNING

Under no circumstance place your fingers between the brake pad and the brake disc, when the brake is pressurized.



3.2.6 Remove the brake pad holders (4-C) and the 2 bolts (M20x50) (5-C) from both the active and passive caliper.



3.2.7 Remove the brake pads by sliding them sideways out of the brake.

3.2.8 Apply hydraulic pressure, remove the air gap bolt and relieve the hydraulic pressure again afterwards.

! IMPORTANT

Before mounting the brake pads the push rod shall be totally retracted, by the use of the spanner, see figure 3.1 - position 3.

! IMPORTANT

The push rod can only be rotated, when there is no pressure on it. When forces are reacting on the push rod, the thread inside the AWA mechanism will lock and prevent it from rotating.

Meaning it can only be rotated when:

- the brake pads are removed
- there are no hydraulic pressure on the brake
- the push rod do not touch the brake disc

3.2.9 Use the spanner to rotate the push rod clockwise. The push rod will now be retracted into the housing of the brake.

The tool must be put through the centre hole of the end cap and straight to the centre bar (hexagon end) of the push rod.

3.2.10 Replace the brake pads.

3.2.11 Slide the brake pads into position in the caliper, and mount the pad holder (20-C) and the bolts (22-C) again.

FIGURE 3.4



Use the tightening torque specified on the spare parts drawing or from the Table 2.2 – 'Bolts for brake pad holders / pads'.

3.2.12 Mount the pad retraction springs and bolts – see figure 3.3.

Use the tightening torque as specified in Table 2.3 – 'Bolts for pad retractions springs' - section 2.5 – 'Mounting the brake'.

CAUTION

- 3.2.12 Activate the brake 5-10 times before mounting the indicators (if equipped). This is very important because the indicator for Pad Worn signal may be damaged if the push-rod is not out in normal position.
- 3.2.13 Readjust the positioning system if equipped – see section 2.8 – ‘Positioning system’
- 3.2.14 Remember to bed in the brake pads before taking the brake into full load situations – see section 2.12 – ‘Bedding in’

3.3 Replacing other components

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

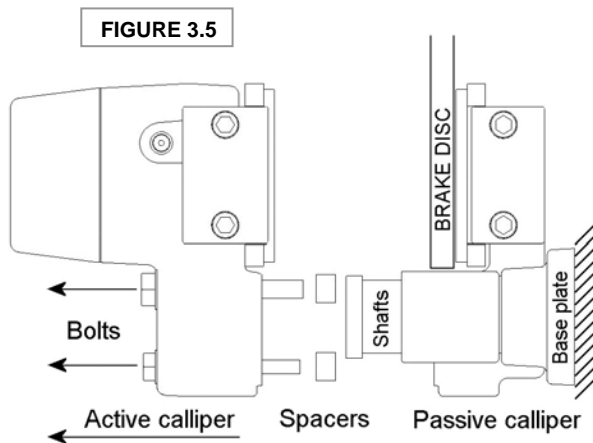


NOTE

Depending on the work that needs to be done on the brake we recommend only bringing the active caliper to the workshop.

CAUTION

When lifting please note that the total weight of the complete brake is approx. 200kg - the active caliper itself weighs approx. 80kg.



- 3.3.1 Either remove the brake completely according to section 2.13 – ‘Removing the brake’ by removing the M36 mounting bolts (2pcs) or remove the active caliper only by removing the M20 and M24 (7-B) mounting bolts instead. If only removing the caliper half - please make a note of the number of spacers between the active and the passive caliper half (if any).

WARNING

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

3.4 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 washed in solvent cleaners.

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

WARNING

Solvent cleaners can be flammable, 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.

Dirt shortens the lifetime of the seals considerably and may also damage the caliper.

The surface of the internal components i.e. push rod (2-C), lock-ring (3-C), piston (18-C) and the yoke (1-C) that are in contact with the seals, are all ground or polished.

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

A damaged piston will immediately ruin the seals resulting in leakage. A damaged push rod will most likely damage the lock ring resulting in failure in the self-adjusting mechanism.

3.5 Replacing the seals

If the brake has been leaking it is recommended to replace all seals not only single seals.



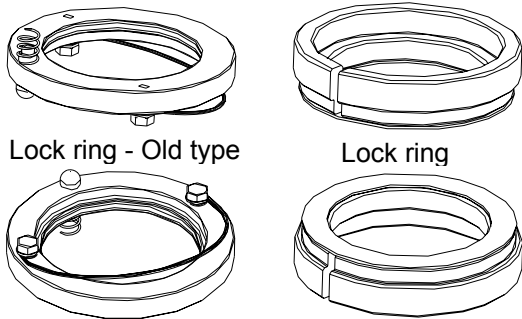
NOTE

It is highly recommended to take the brake or the caliper half to a workshop when the seals are to be replaced.

To be able to replace the seals the interior of the brake must be disassembled.

The design of the locking device for the adjusting mechanism has changed in 2004. Brakes produced with a serial number after DK040110/xx is equipped with the new lock ring.

FIGURE 3.6



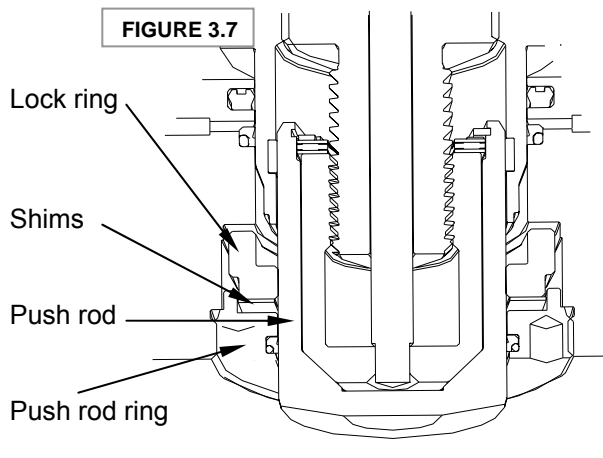
The disassembly can be carried out in the same way for both types with the exception that old type lock ring is loose on the push rod and that the new type uses shims to make the air gap.

First; remove the adjusting mechanism from the 'brake disc'-side of the brake (i.e. closest to the disc). Second; remove the piston from the other side of the brake.

IMPORTANT

Ensure that there is no pressure on the caliper.

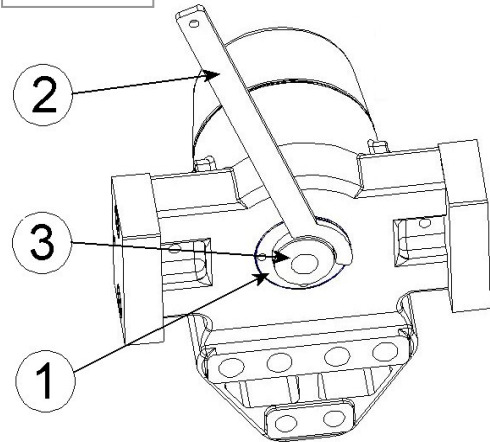
3.5.1 Remove the push rod ring (17-C) (figure 3.7) by turning it out of the yoke (1-C) by use of the push rod ring tool (2) (figure 3.8).



Please be careful not to drop the shims / spacers that are located between the push rod ring and the lock-ring. The amount of spacers determines the actual air gap on the brake (approx. 2.3mm

matches 2,5mm air gap) (not valid for old type lock ring).

FIGURE 3.8



3.5.2 Remove the push rod (2-C) (3) (figure 3.5) by turning it anti-clockwise using the spanner (4) (figure 3.9) through the end cap. Pull the push rod out of the caliper.

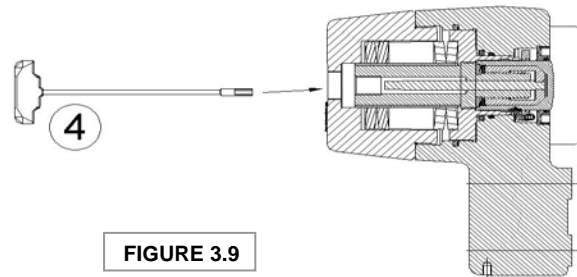


FIGURE 3.9

Please not that the lock ring will remain on the push rod - on the old type the lock ring is loose and has to be removed either before or after removal of the push rod.

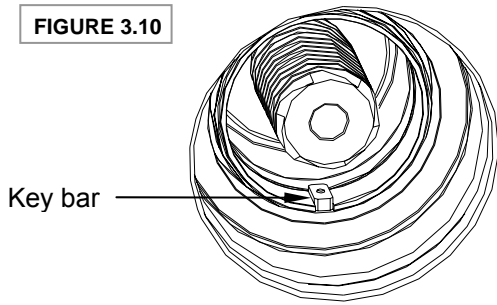
NOTE

The design of the key bar has been updated and the new type is riveted to the piston preventing it from being loose. In older systems the key bar and screw is somewhat loose and may be lost during maintenance

IMPORTANT

Please be careful not to loose the small key bar (28-C) (figure 3.10) which is mounted in the piston.

FIGURE 3.10



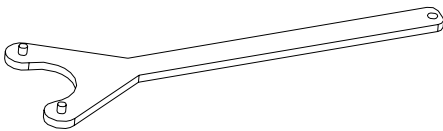
It is not necessary to remove the lock ring from the push rod.
Just leave it as it is until assembly and place the push rod somewhere safe.

IMPORTANT

Do not clean or lubricate the push rod until it is to be mounted again.

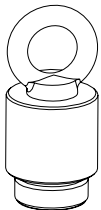
3.5.3 From the other side of the brake unscrew the end cap (11-C) from the yoke (1-C) using the end cap tool (figure 3.11).

FIGURE 3.11



3.5.4 Remove the end cap hand or by crane - use the tool for end cap removal (see recommended spare parts)

FIGURE 3.12



Tool for removal of end cap - M36 with M10 eye bolt

3.5.5 If the complete brake has been removed from site, the piston (8-C) can be lifted/removed using some wooden blocks, cloths and for example using a pipe as a lever.

FIGURE 3.13



Be careful not to damage the piston

3.5.6 If only the active caliper has been brought to the workshop it must be fixed and the piston is pulled out by using a crane, or by placing a wooden block below the piston and then push down the yoke/caliper.

To avoid scratches on the piston place some cloths between the piston and wooden block.

3.5.7 Remove the piston by hand or by crane - use the tool for piston removal (see recommended spare parts)

FIGURE 3.14



Tool for removal of piston - M24 with M10 eye bolt

IMPORTANT

Before removing the piston remove one of the plugs from the pressure ports (15-C & 15A-C).

This will allow air entering the hydraulic chamber preventing the making of a vacuum which will make it almost impossible to remove the piston.

FIGURE 3.15



IMPORTANT

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

3.5.8 Place the piston at a safe location while replacing the seals.
Leave the spring pack inside the piston.

3.5.9 Remove the seals (5-C, 6-C and 7-C) and the O-ring (5A-C).

On some older brakes with an older type of seals there might also be an o-ring in the grooves of seal 6-C and 7-C – please also remove these if present.

Remove the wear ring (4-C)

Use a screwdriver to lever the seals, the wiper and the wear ring out of the groove (a hammer might be handy in order to remove the wiper).

FIGURE 3.16



Be careful not to damage the edges on the grooves.

3.5.10 Clean and dry the involved parts, see section 2.2 - 'Cleaning the brake disc' for details.

3.5.11 Open the seal kit and place the seals on the table in correct order.

3.5.12 Mount the new O-ring (5A-C) and thereafter the seals (5-C, 6-C and 7-C) into the grooves in the yoke.



IMPORTANT

Be careful orienting the seals correctly when mounting – wrongly oriented seals will result in leakage.

Check detail drawings in figure 3.17, 3.18 and 3.19 and / or appendix C to ensure correct orientation of the seals.

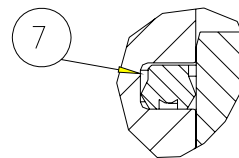
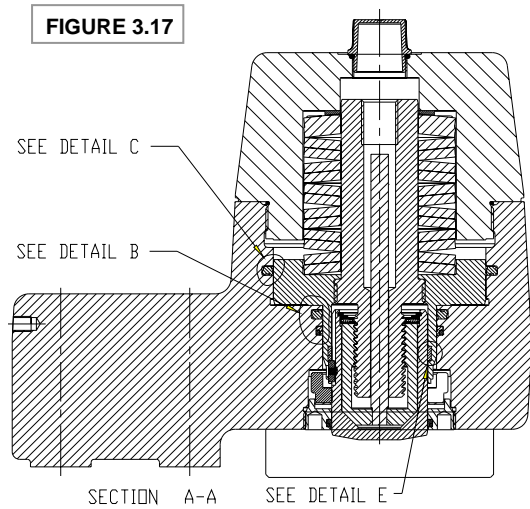


FIGURE 3.18

DETAIL C
SCALE 1:1

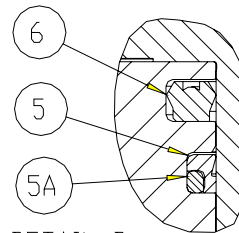
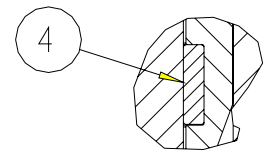


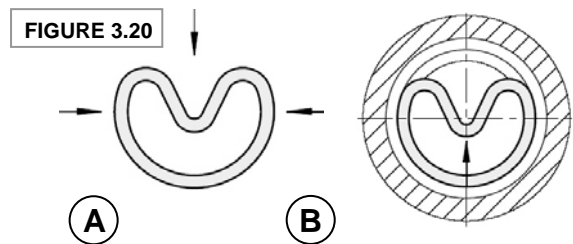
FIGURE 3.19

DETAIL B
SCALE 1:1



DETAIL E
SCALE 1:1

The O-ring (5A-C) and the lip of the wiper (5-C) must be placed so it is facing outwards from the yoke (towards the brake pad).



Place the O-Ring into the groove. Compress the seals into a kidney shape. The seal must have no sharp bends (figure 3.18A)
Place the seal ring in compressed form into the groove and push against the O-Ring in the direction of the arrow (figure 3.18B).

FIGURE 3.21



After placing into the groove, form the seal into a ring again in the groove by hand.

CAUTION

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

3.5.13 Before mounting the piston again it is highly recommended to check the condition of the spring pack and / or replace the spring pack. This is important when running an application with many activations of the piston.

If any problems with the spring pack are suspected and the condition is to be checked – please refer to section 3.6 – ‘Checking the spring pack’.

If a new spring pack is to be installed – please refer to section 3.7 – ‘Replacing the spring pack’.

If no problems are found with the spring pack, move on to the next section.

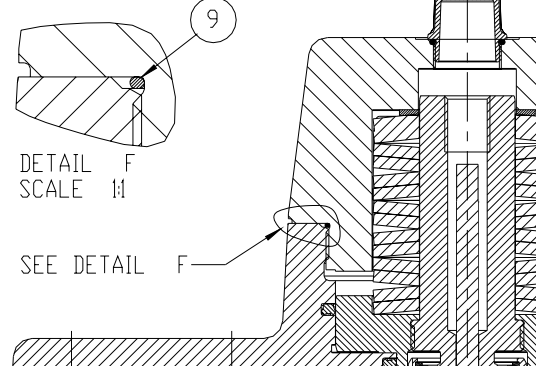
3.5.12 Lubricate the seals and yoke according to the lubrication note in Appendix C – ‘Spare parts drawing’.

3.5.15 Place the piston (8-C) in the yoke (1-C). Gently push the piston down as far as possible. The push rod (2-C) will be mounted at a later stage.

Be careful with the seals, even minor scratches can ruin the seals.

3.5.16 Fit a new O-ring (9-C) onto the thread on the end cap before mounting the end cap.

FIGURE 3.16



3.5.17 Mount the end cap (11-C) on the yoke and turn it clockwise until the end cap stops. It stops when it touches the surface of the yoke.

3.5.18 Refit the hydraulic plugs in the pressure connection 15-C and / or 15A-C to prevent dirt from entering the brake.

3.5.15 Replace the wiper in the push rod ring (17-C). Remove the wiper (16-C) and the O-ring (16A-C) from the groove.

3.5.16 Mount a new O-ring (16A-C) and a new wiper (16-C). The lip on the wiper (16-C) must be placed facing away / outwards from the yoke - see figure 3.17

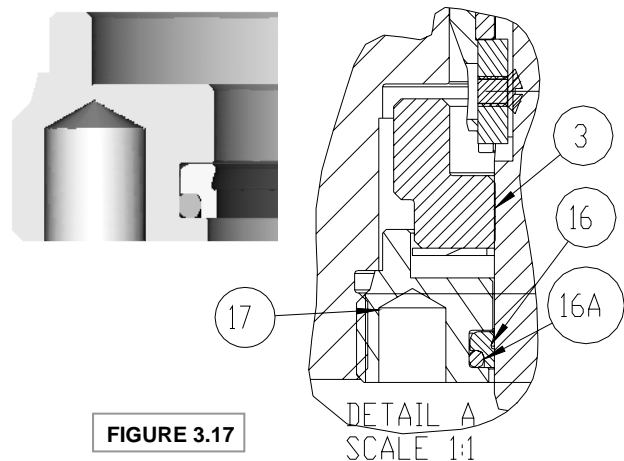
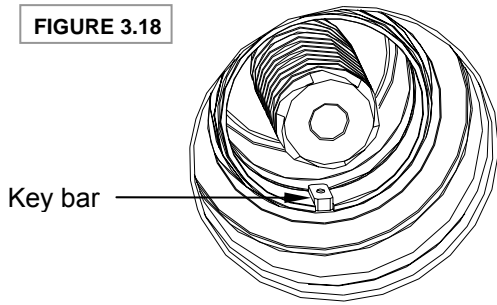


FIGURE 3.17

3.5.17 Make sure the small key bar (28-C) is mounted correctly before mounting the push rod.

FIGURE 3.18



! WARNING

Under no circumstance use a screwdriver or similar to loosen / open the lock-ring - this may damage the locking effect of the lock-ring with possible.

If the lock-ring is to be moved on the push rod this may only be done when mounted in the brake by use of the spanner in either direction - or in a press or similar where perfectly aligned forces can be applied to the push rod or lock-ring.

! IMPORTANT

The surface of the yoke (1-C), the lock ring (3-C), push rod ring (17-C) and the push rod (2-C) must be free from dust and oil. Clean using a dry and clean piece of fabric / clothing.

The old style lock ring (figure 3.6) is more sensitive to dirt than the new type - use some solvent cleaner and compressed air to clean the outer surface of the push rod and the lock ring.

3.5.18 With the lock ring mounted on the push rod fit the rod of the push rod through the centre of the piston (threaded part) – see figure 3.20.

If the lock ring was removed from the push rod during disassembly mount the lock ring again – please note that the small diameter must point against the brake pad – see figure 3.17.

! WARNING

Solvent cleaners can be flammable, poisonous and can cause burns. Please follow the manufacturer's instructions and see section 2.2 – 'Cleaning the brake disc'.

3.5.19 Make sure the key bar catch the groove in the push rod. With the spanner through the end cap - rotate the hexagon rod to catch the thread in the piston / push rod. Once the thread fits - retract the push rod into the yoke with spanner (counter clockwise).

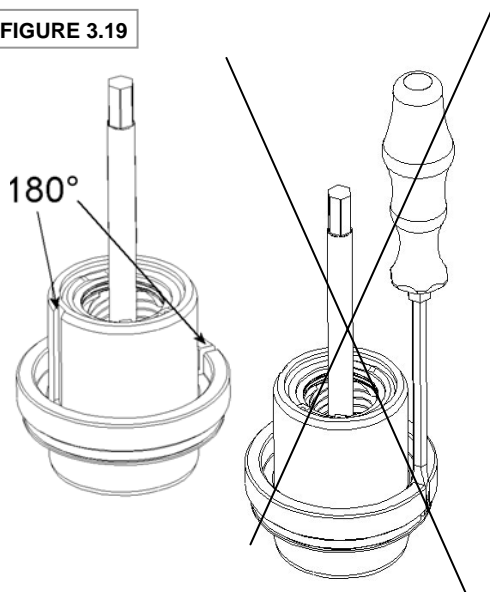
! IMPORTANT

With the new style lock ring make sure the cut in the lock ring is approx. opposite (180°) than the groove in the push rod - see figure 3.19.

3.5.20 Refit the shims located between the lock ring and the push rod ring - the amount of spacers determines the actual air gap on the brake (approx. 2.3mm matches 2,5mm air gap) (not valid for old type lock ring).

If the brake is equipped with old style locking (figure 3.6) refit the lock ring at this stage - if not skip this point. Please be careful orienting the lock ring correctly i.e. orienting the small compression spring away from the direction of the brake pads.

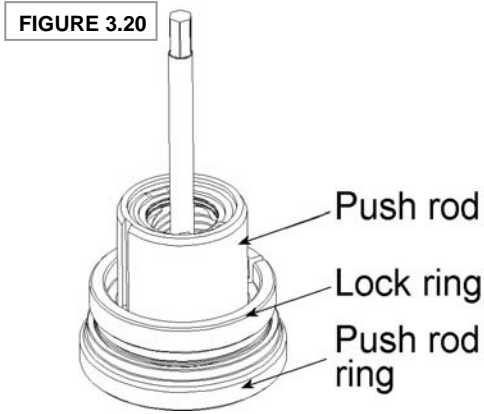
FIGURE 3.19



3.5.21 Mount the push rod ring (17-C) on the push rod and push it gently until it is possible to catch the thread in the yoke.

! NOTE

It can be easier to mount the push rod ring on the push rod before mounting it in the brake. The push rod ring should then just only be mounted on the push rod and the lock ring should be pushed almost down to it.



Tighten the push rod ring with the tool for push rod ring.



(General figure – not actual piston shown)

- 3.5.22 Depending on how the brake / active caliper has been brought to the workshop it is now ready for being mounted again. Refer to section 2.5 – ‘Mounting the brake’.
- 3.5.23 If the caliper half was removed from the complete brake the mounting bolts must be fitted again using the tightening torques from the spare-parts drawing or from Table 3.1 – ‘Mounting bolts for caliper half’.

Table 3.1				
Mounting bolts for caliper half				
Bolt size	Torque			
	Lubricated MoS2		Dry & Oiled	
M20 10.9	430	Nm	510	Nm
M24 10.9	740	Nm	880	Nm
“Lubricated” is based on Molykote – MoS2				

- 3.6.2 Remove the cup springs from the piston, making sure the orientation is noted, preferably by turning it upside down onto a fixed rod. This will prevent the orientation of the springs from getting mixed up. Remaining cup-springs and shims / spacers can be removed from the piston / end cap screw using one or two strong magnets.

Please note that shims / spacers (if any) are located inside the end cap.

- 3.6.3 Clean and dry the involved parts (piston, end cap, shims and cup springs) individually, see section 2.2 - ‘Cleaning the brake disc’ for details.
- 3.6.4 Carefully check the condition of each cup spring and shims / spacers (if any).

IMPORTANT

If the spring pack has been replaced the clamping force should be checked according to section 3.6 - ‘Checking the spring pack’ before taking the brake into production again.

3.6 Checking the spring pack

When service work has been performed on the on the brake / caliper it is highly recommended to check the condition of the spring pack.

IMPORTANT

Be aware of the placing of the individual cup springs in the spring pack when the springs are removed. Note the placement for future reference.

IMPORTANT

If any spring is broken or severely scratched, the complete spring pack must be replaced.

- 3.6.5 Lubricate the individual cup springs and the end cap according to Appendix C – ‘Spare parts drawing’. Every single cup spring and the inside of the end cap must be greased.

- 3.6.1 After removing the end cap (if not done already) remove the piston from the yoke.

FIGURE 3.22



Ideally place the newly lubricated individual springs on a second rod to ensure the stacking is still correct.

3.6.6 Fit the lubricated spring pack inside the piston.



FIGURE 3.23

(General figure – not actual piston shown)

3.6.7 The spring pack and piston is now ready for reinstallation.

3.6.8 If the checking of the spring pack was done during replacement of the seal kit then please return to section 3.5.12 and complete the process from there.

3.7 Replacing the spring pack

During the lifetime of the brake the spring pack will normally 'wear' - meaning it will become weaker and / or individual cup springs will break.

Depending on the load / stress in the spring pack this can happen on a regular basis

When a single cup spring breaks it will normally lead to several broken springs

inside the brake because the small fragments is floating around and the travel for the individual cup springs increases dramatically.

An example of broken springs can be seen in figure 3.27

FIGURE 3.27



IMPORTANT

If any spring is broken or severely scratched, the complete spring pack must be replaced.

The replacement spring pack supplied from Svendborg Brakes comes fully tested and assembled (none lubricated) in the correct stacking with the nominal amount of shims / spacers



FIGURE 3.28

3.7.1 After removing the end cap from one side and the rush rod and push rod rind from the other side (if not done already) remove the piston from the yoke – see section 3.5.



FIGURE 3.29

(General figure – not actual piston shown)

- 3.7.2 Remove the cup springs from the piston, making sure the orientation is noted, preferably by turning it upside down onto a fixed rod. This will prevent the orientation of the springs from getting mixed up. Remaining cup-springs and shims / spacers can be removed from the piston / end cap using one or two strong magnets.

Please note that shims / spacers (if any) are located inside the end cap. Make sure all (if any) is removed from the end cap as remaining shims / spacers will influence the clamping force.

- 3.7.3 Clean and dry the involved parts (piston and end cap) individually, see section 2.2 - 'Cleaning the brake disc' for details.
- 3.7.4 Compare the new spring pack with the old spring pack to check if they do match in design. Orient the new spring pack as the old spring pack.

FIGURE 3.30



- 3.7.5 Lubricate the individual cup springs and the end cap screw according to Appendix C – 'Spare parts drawing'.

Every single cup spring and the inside of the end cap must be greased.

FIGURE 3.31



Ideally place the newly lubricated individual springs on a second rod to ensure the stacking is still correct.

- 3.7.6 Fit the lubricated spring pack inside the piston

FIGURE 3.32



(General figure – not actual piston shown)

- 3.7.7 The spring pack and piston are now ready for reinstallation.



NOTE

Depending on the number of activations and the reason for removing the spring pack it is recommended to replace the seal kit while the caliper is disassembled.



NOTE

If the replacement of the spring pack is carried out during replacement of the seal kit then please return to section 3.5.12 and complete the process from there.

If the replacement of the spring pack is not carried out during replacement of the seal kit, then proceed with lubricating the seals and yoke according to the lubrication note in the Appendix C – ‘Spare parts drawing’.

maintenance / replacement of the spring pack.

When replacing the spring pack, every single cup spring must be greased.

For details on where to lubricate internally see appendix C - ‘Spare parts drawing’.

- 3.7.8 Place the piston (8-C) in the yoke (1-C)

FIGURE 3.33



(General figure – not actual piston shown)

- 3.7.9 Place the piston (8-C) in the yoke (1-C). Gently push the piston down as far as possible.
- 3.7.10 Mount the end cap (11-C) on the yoke and turn it clockwise, using the end cap tool (figure 3.11), as far into the yoke as possible. The end cap will stop when the surface touches the surface of the yoke.
- 3.7.11 Refit the plugs in the pressure connection 15-C and / or 15A-C to prevent dirt from entering the brake.
- 3.7.12 Make sure the small key bar (28-C) (figure 3.18) is mounted correctly before mounting the push rod.
- 3.7.13 Mount the push rod.
- 3.7.14 Mount the push rod ring and tighten it with the tool for push rod ring.
- 3.7.15 Depending on how the brake / active caliper has been brought to the workshop it is now ready for being mounted again. Refer to section 2.5 – ‘Mounting the brake’.

3.8 Lubrication of the brake

Lubrication is only necessary after dismantling the active caliper for internal

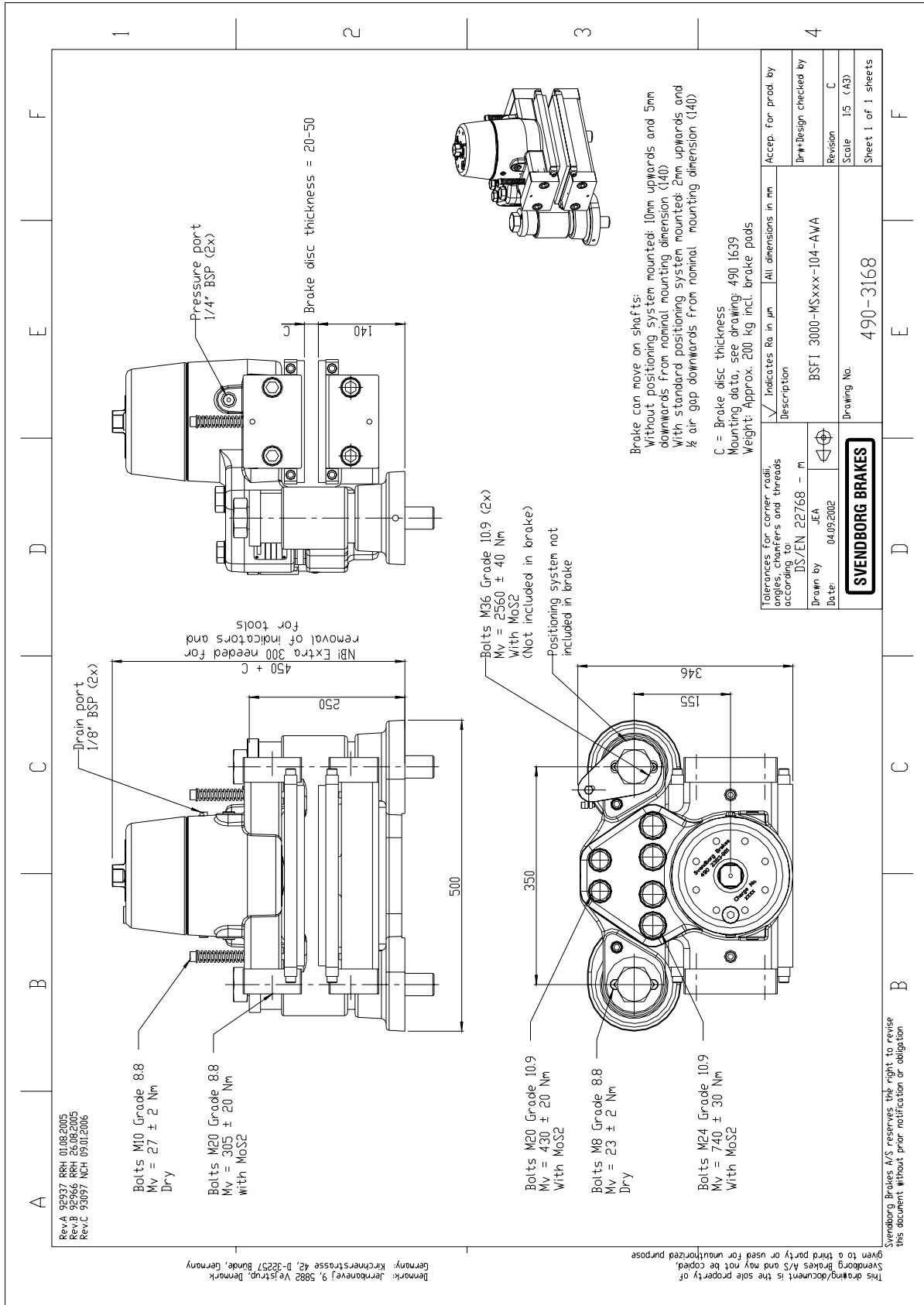
4. Trouble shooting

Fault	Cause	Action
The brake applies slowly.	Air in the hydraulic system	Bleed system at highest point and at brake
	Air gap between brake pad and disc too large Abnormal throttling in the hydraulic system, valve in wrong position Abnormal throttling in the hydraulic system, dirt Oil in lines between brake and Tank has too high viscosity (too thick)	Activate the brake a few times. The lock-ring may be defective Check that all valves are in the correct position. Clean and check pipes, hoses and valves. Check that the oil is the recommended grade and the temperature is not too cold.
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 disk - see section 2.2 Replace or clean the brake pad – see section 2.4 Check the hydraulic system does not leak.
	Not all brakes are braking / connected. Damaged or worn spring pack	Check valves where applicable – check that the individual brake is working. Replace whole spring pack, not individual cup springs.
Leakage	Worn seals	Replace seals
Uneven wear on pad.	The brake is incorrectly aligned	Check the alignment and that the passive caliper can float on the shafts
	Positioning system not adjusted correctly (if mounted) Excessive disc throw or shaft deflection	Adjust positioning system Replace the brake disc and check the shaft deflection.

Fault	Cause	Action
Abnormally heavy wear on brake pad	Increased brake utilisation.	Check that load, speed and frequency do not exceed permissible values.
	The brake does not lift properly	Check the oil pressure. Check the movements of pads and pistons and the position of cup springs and guides.
It is not possible to turn back the push rod using the spanner, when brake pads have to be changed.	There are forces reacting on the push rod either: <ul style="list-style-type: none"> • The brake is still applied / lifted • The brake pads are not removed • The push rod somehow touch the brake disc 	Remove the forces and retry
	The brake is open, Hydraulic pressure is ON.	Release the pressure, See paragraph 3.1
Indicator for AWA “Not adjusted” signal comes off when brake is lifted	Defective indicator	Check indicator and / or replace indicator
Indicator for AWA “Not adjusted” signal switches during braking	Something is wrong with the AWA mechanism – the piston is moving too far out	See below
	Oil or grease on the outside surface of the push rod or on the lock ring (old type only).	Remove the push rod – clean and mount again – see section 3.5.17
	Cir-clip in lock ring broken, so the lock-ring will not lock the push rod.	Dismantle the active caliper hydraulic unit.
	Defective bearing, wave washer or thread in the push rod. Push rod does not rotate easily.	Dismantle the active caliper / hydraulic unit, Replace damaged part(s), clean and grease the thread on the piston (8-C) and push rod (2-C) - ask for separate information.
	Extended piston movement	Locking is not locking and does not adjust
Indicator signal Not Adjusted Switches but Brake On/Off does not	Piston may not be fully lifted	Check operation pressure and increase it in steps of 5bar (0.5MPa). If not working after increasing the pressure by 20bar (2,0MPa) the indicator is most likely defective
Signal from proximity Switches (ONLY)	Indicator not adjusted correctly	Check and adjust switch(es) See data sheet.

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Appendix A - Dimension drawing



Appendix B - Assembly drawing, Brake

Drawing is also valid for 490-3168 BSFI 3000-MSxxS-104

This drawing is an exploded view of a brake assembly. It includes a motor (1), a housing (2), a brake shoe (3), a spring (4), a piston (5), a seal (6), a bracket (7), a pin (8), a plate (9), a spring (10), a pin (11), and a nut (12). The drawing is divided into sections A-F and 1-4. The motor (1) is shown on the left, and the housing (2) is on the right. The brake shoe (3) is shown in the center, and the spring (4) is shown below it. The piston (5) is shown below the spring, and the seal (6) is shown below the piston. The bracket (7) is shown below the seal, and the pin (8) is shown below the bracket. The plate (9) is shown below the pin, and the spring (10) is shown below the plate. The pin (11) and nut (12) are shown on the left side of the drawing.

Tolerances for corner radii, chamfers and threads according to DS/EN 22768 - m Drawn by NCH Date: 25.02.04	√ Indicates Ra in µm Description BSFI3000 MSxxX-100 AWA Drawing No. 490-2454-401	All dimensions in mm	Accept for prod. by DFM Design checked by
		Revision A	Scale 1:5 (A3)
SVENDBORG BRAKES		Sheet 1 of 1 sheets	

RevA 92992 NCH 20.09.2005

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Benchmark: Jernbovevej 9, 5882 Vejsrup, Denmark
Germany: Kirchenstrasse 42, D-32237 Bünde, Germany

Appendix B - Assembly parts list, brake

Please note that several of the items shown on drawing and in bill of material are optional and may not be present on actual brake.

490-3168 BSFI 3090 MS35S -104

POS.	QTY		ITEM NUMBER	ITEM NAME
1	1	PCS	490-1581-801	BASE PLATE COMPLETE
2	1	PCS	490-1583-801	PASSIVE CALIPER COMPLETE
3	1	PCS	490-3167-801	BSFI 3090-S-103 ½
4	1	PCS	490-1587-001	TOP PLATE
5	4	PCS	4490-0612-004	SCREW M8X20 8.8 CS
6	2	PCS	2152-2115-515	O-RING Ø74.2X5.7 O-RINGS HAS TO BE REMOVED BEFORE FIRST USAGE
8	1	PCS	490-1702-802	PAD RETRACTION SPRING SET

THE FOLLOWING PARTS ARE NOT INCLUDED IN 490-2454 AND 490-3356 AND MUST BE ORDERED SEPERATELY

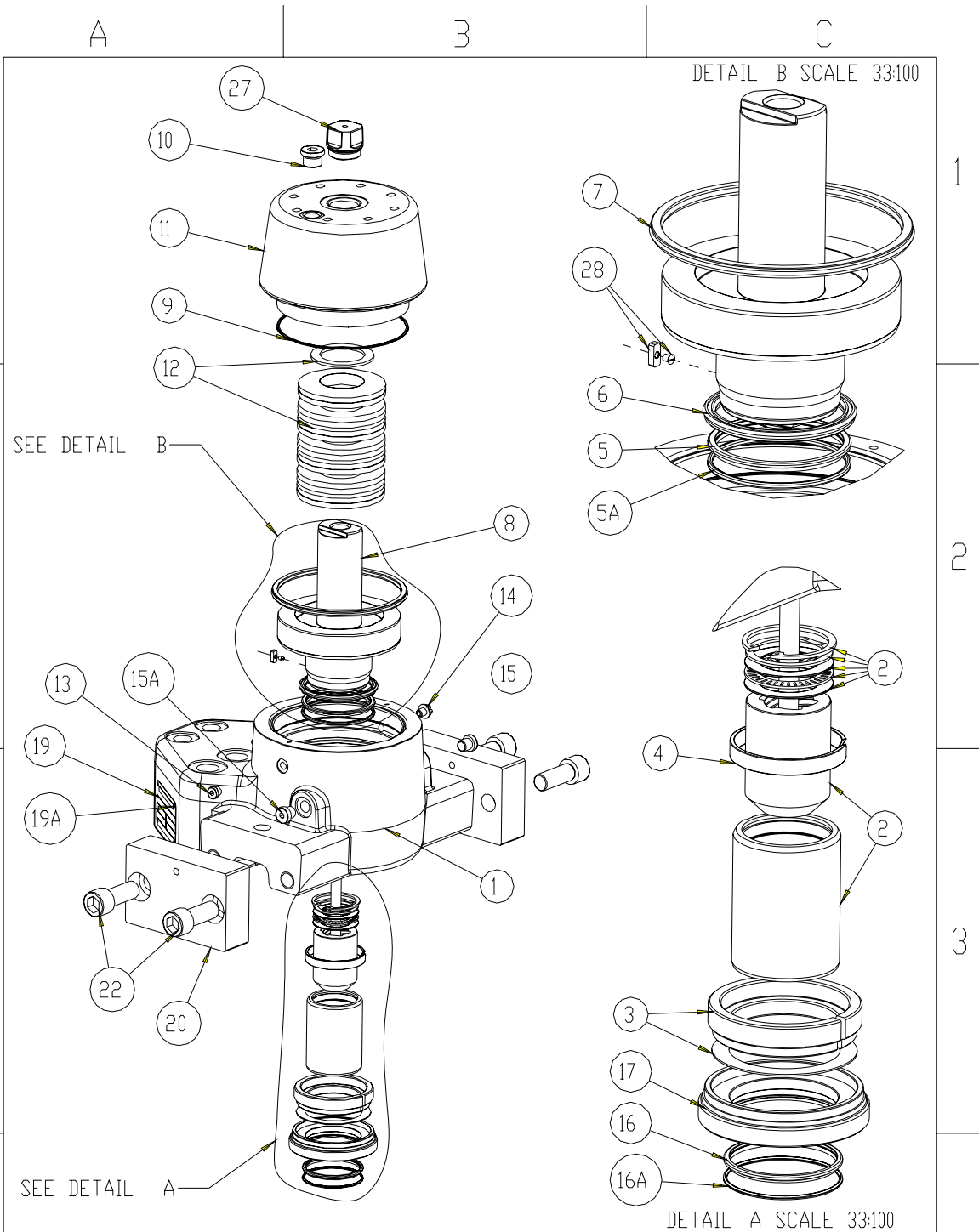
7	1	PCS	490-1670-810	BOLT SET FOR 35MM BRAKE DISC
9	1	PCS	490-2399-802	POSITIONING SYSTEM – AWA THE ACTUAL ITEM NUMBER WILL VARY ACCORDING TO TYPE USED.
10	1	PCS	490-1563-801	BRAKE PAD SET – MD550 BRAKE PAD TYPE WILL VARY ACCORDING TO BRAKE PAD SUPPLIED
11	1	PCS	490-2005-814	INDICATOR “ON/OFF” & “NOT ADJUSTED” 2,5MM WITH 5M CABLE
12	1	PCS	490-2007-804	INDICATOR “PAD WORN” WITH 5M CABLE INDICATORS ARE OPTIONAL BUT RECOMMENDED – AVAILABLE IN 30DC AND 125 VAC AND WITH DIFFERENT CABLE OPTIONS

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Appendix C - Spare parts drawing, Caliper half exploded

Denmark: Jernbanevej 9, 5882 Vejstrup, Denmark
 Germany: Kirchnerstrasse 42, D-32257 Bünde, Germany
 Spain: Polígono Industrial Los Casos, C/E, parcela R-131, 42005 Soria, Spain

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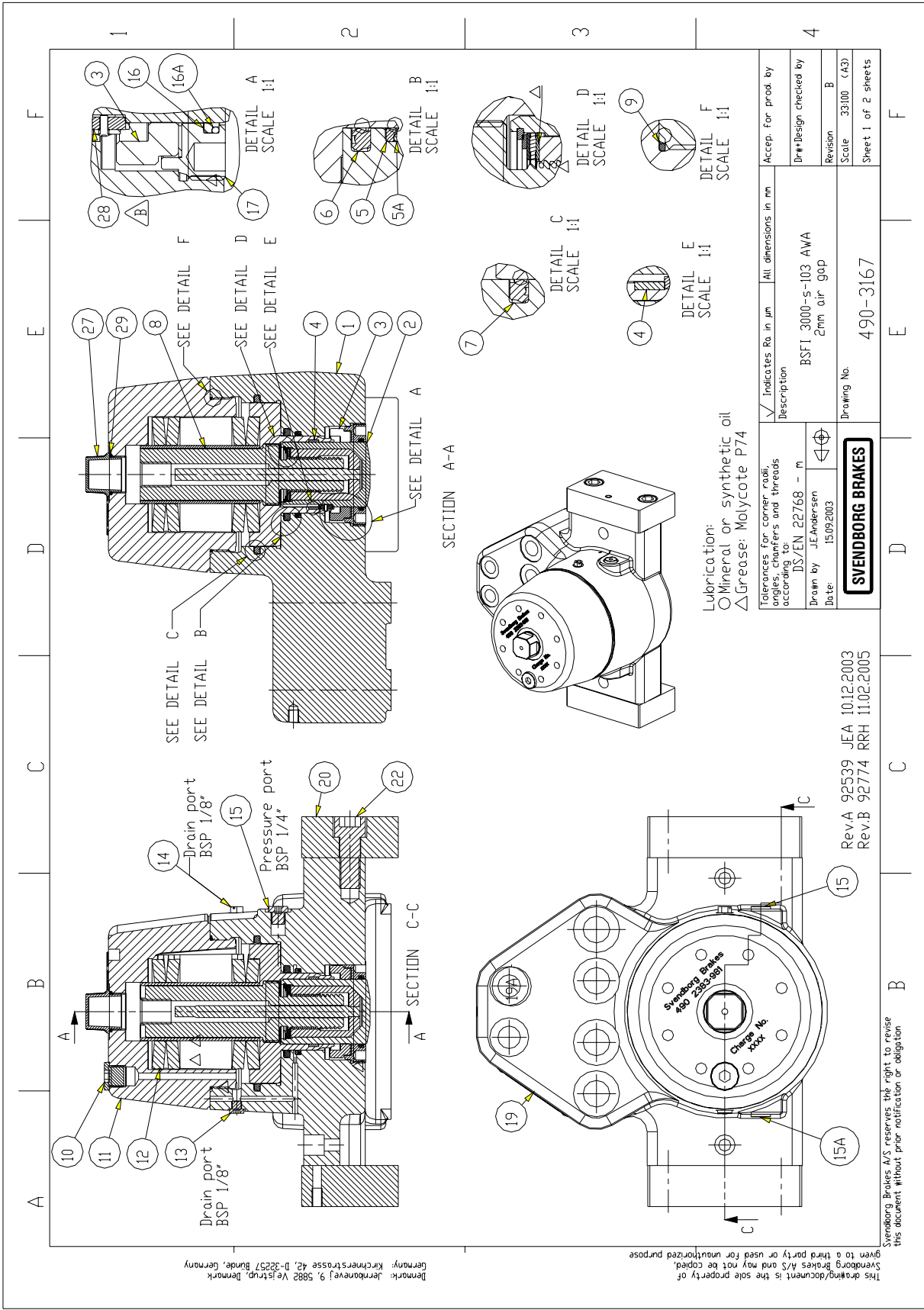
Tolerances for corner radii, angles, chamfers and threads according to: DS/EN 22768 - m		✓ Indicates Ra in µm	All dimensions in mm	Accep. for prod. by
Description		3000-S-100 AWA ½ Assembly drawing 2,5mm air gap		Drw+Design checked by
Drawn by NCH	Date 25.02.04	Drawing No. BSFI3000-AWA-HALF		Revision -
				Scale 17:100 (A4)
SVENDBORG BRAKES				Sheet 1 of 1 sheets

A

B

C

Appendix C - Spare parts drawing, Caliper half



Appendix C - Spare parts list, Caliper half

490-3167 BSFI 3000-S-103 ½ AWA

POS.	QTY	ITEM NUMBER	ITEM NAME
1	1	PCS 490-2374-802	YOKE BSFI3000-S-10X AWA
2	1	PCS 490-2362-801	PUSH ROD COMPLETE
3	1	PCS 490-3144-825	LOCK RING II COMPLETE 2,0MM
8	1	PCS 490-2361-802	PISTON COMPLETE BSFI3000-S-103 AWA
10	1	PCS 2522-2111-113	HYDRAULIC PLUG 1/2" BSP
11	1	PCS 490-2383-004	END CAP
12	1	PCS 490-3088-801	SPRING PACK BSFI3090-S-102/3
13	1	PCS 2522-2111-109	HYDRAULIC PLUG 1/8" BSP
14	1	PCS 2522-4502-109	PLUG 1/8" BSP - PLASTIC
15	1	PCS 2522-2111-110	HYDRAULIC PLUG 1/4" BSP
15A	1	PCS 2522-2111-110	HYDRAULIC PLUG 1/4" BSP
17	1	PCS 490-2366-002	PUSH ROD RING - BSFI3000 AWA II
19	1	PCS 478-0815-003	NAMEPLATE W/4 HOLES
19A	4	PCS 4490-0676-001	BLIND RIVET Ø2,4X6 RH
20	2	PCS 490-1559-001	PAD HOLDER BSXX3000-S-XXX
22	4	PCS 4490-0619-006	BOLT M20X50 8.8
27	1	PCS 490-0285-001	COVER
28	1	PCS 490-2489-801	KEY BAR COMPLETE

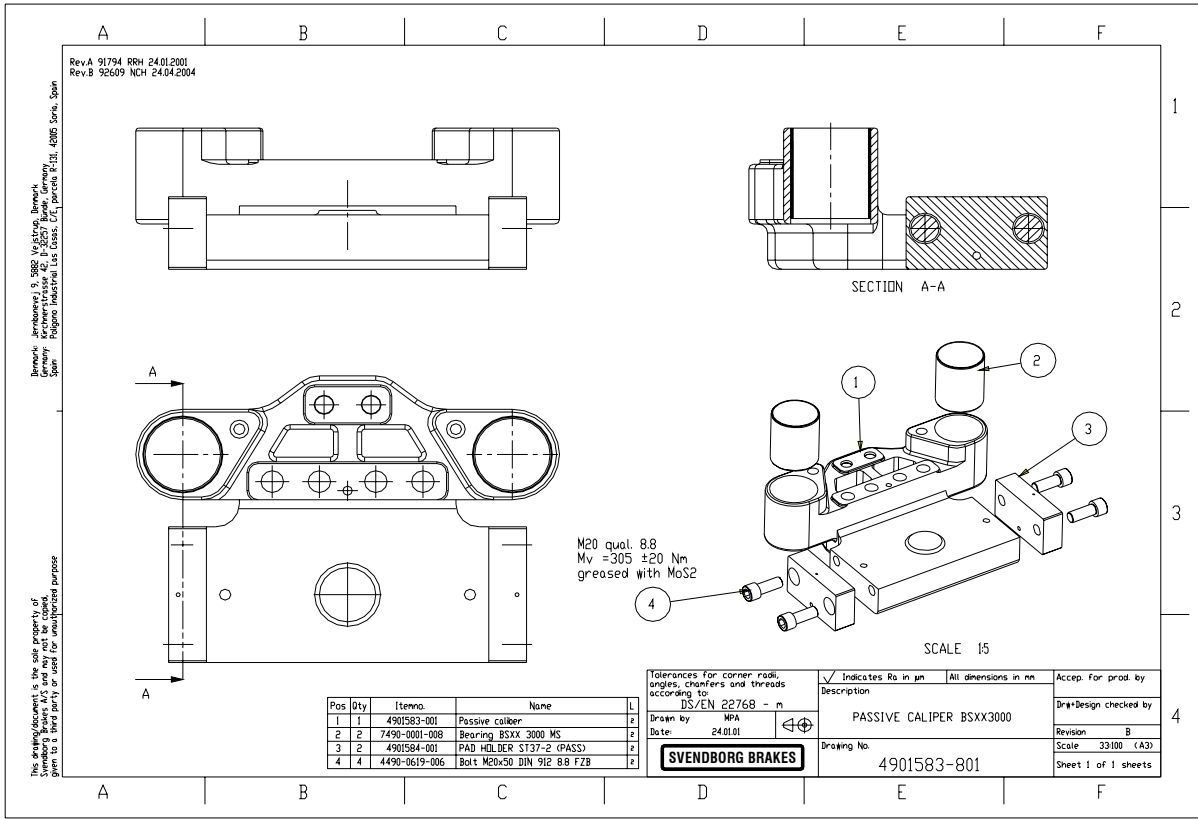
PART OF TOOL KIT – NOT MOUNTED ON BRAKE

23	1	PCS 4490-0633-015	BOLT M24X50 10.9
23A	1	PCS 4490-0201-002	FACET WASHER Ø25,5X55X5

490-1755-815 SEAL KIT BSFI 3000 AWA

4	1	PCS 7490-0006-002	WEAR RING Ø63X9,5
5	1	PCS 6490-0048-005	WIPER Ø75X6
5A	1	PCS 6490-0024-001	O-RING Ø78,97X3,53
6	1	PCS 6490-0051-011	ROD SEAL Ø75X6,3 U-CUP
7	1	PCS 6490-0051-010	ROD SEAL Ø140X6,3 U-CUP
9	1	PCS 6490-0049-003	O-RING Ø145X2,5
16	1	PCS 6490-0048-002	WIPER Ø63X5 EX2
16A	1	PCS 6490-0024-011	O-RING Ø64,77X2,62

Appendix D – Spare parts drawing, Passive Caliper



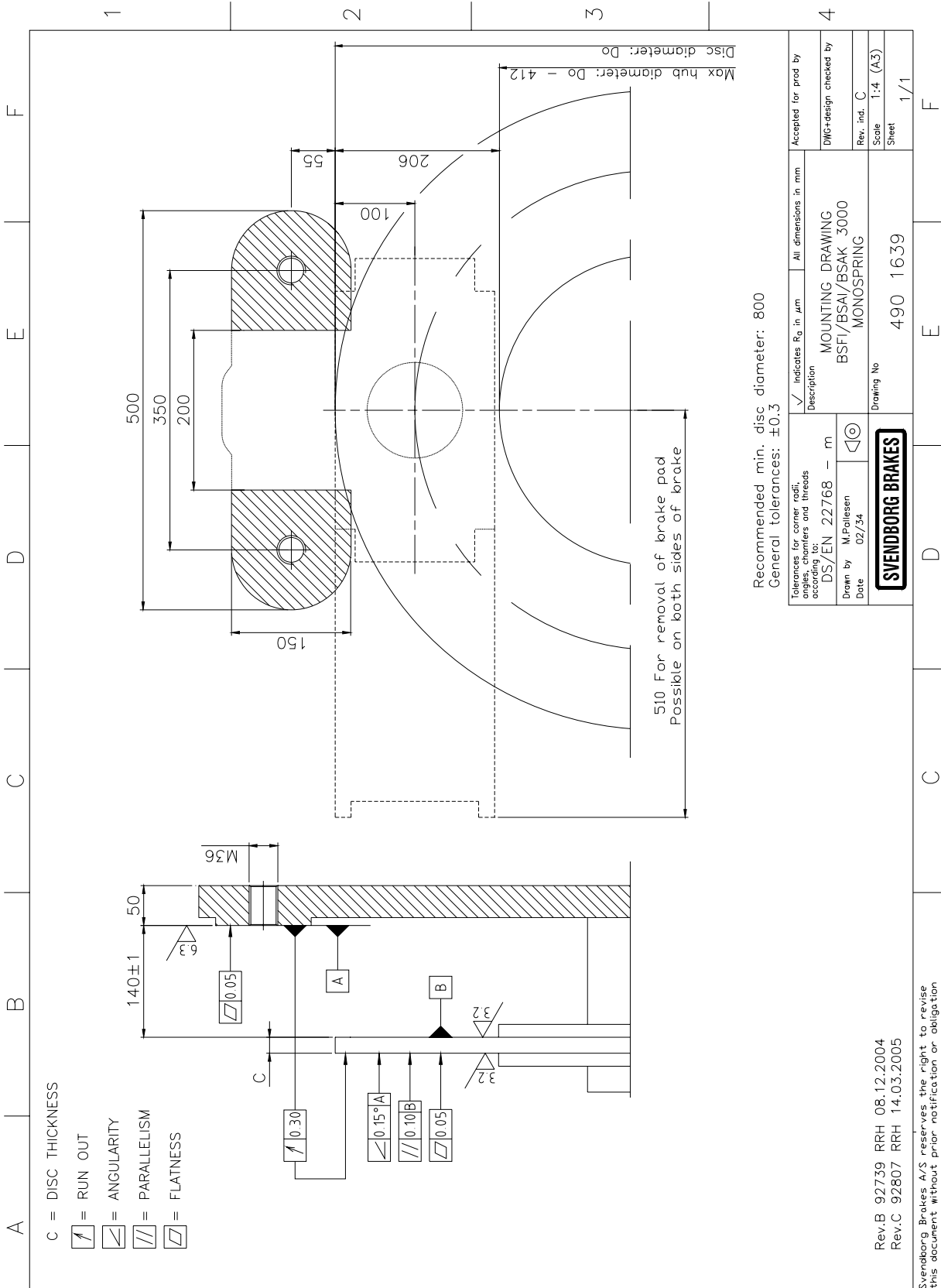
Appendix D – Spare parts list, Passive Caliper

Passive caliper

490-1583-801 PASSIVE CALIPER COMPLETE (STANDARD)

POS.	QTY	ITEM NUMBER	ITEM NAME
1	1	490-1583-001	PASSIVE CALIPER (STANDARD)
2	2	7490-0001-008	BEARING SLEEVE
3	2	490-1584-001	PAD HOLDER BSFI 3000-MS 150X80
4	4	4490-0619-006	BOLT M20X50 8.8

Appendix E – Mounting Drawing



Tolerances for corner radii, angles, chamfers and threads according to: DS/EN 22768 - m Drawn by: M.Pallesen Date: 02/34	Description: MOUNTING DRAWING BSFI/BSAI/BSAK 3000 MONOSPRING	All dimensions in mm ✓ Indicates R _e in μm	Accepted for prod by DWG+design checked by Rev. ind. C Scale 1:4 (A3) Sheet 1/1
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Rev.B 92739 RRRH 08.12.2004
 Rev.C 92807 RRRH 14.03.2005

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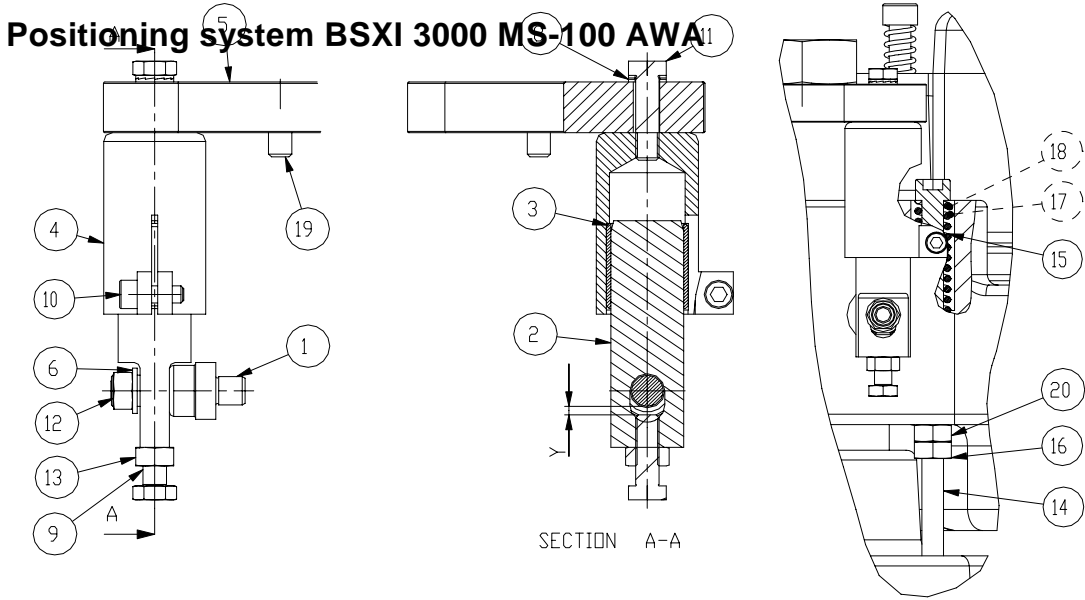
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Denmark: Jernbanevej 9, 5882 Vejstrup, Denmark
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Appendix F - Positioning system

DATA SHEET

Date: 13.09.2005
 No.: DEB-3000-011
 Replace: 13.05.2005
 Approved: N. Christensen



Drawing 490-2399-802

General:

There are two versions available of the positioning system – the standard version with a 180mm bolt (490-2399-802) and an alternative version with a 200mm bolt (490-2399-803) for systems with larger distance from mounting surface to brake pad than nominal. In case of the 490-2399-803 version washers and spacers (pos 17 & 18) should be applied to add force to the spring (pos 15) – the amount of spaces should be adjusted according to the distance from the base plate

Mounting:

- 1) Check that the bolts (14) and springs (15) are mounted – and washer (17) and shim (18) if applicable
- 2) Close the brake (remove pressure)
- 3) Loosen the bolt (10)
- 4) Remove the nut (12) and washer (6) to ease visibility of the gap between pin (1) and shaft (2)
- 5) Loosen the nut (13, at pos. 9) and tighten the screw (9) until distance y is zero
- 6) Activate the brake until it is adjusted to the correct air gap. (see manual for details)
- 7) Close the brake (remove pressure)
- 8) Tighten bolt (10) "Firmly" (17Nm)
- 9) Loosen the screw (9) until the air gap is correct / equal on both sides of the brake disc
- 10) Tighten the nut (13) to lock the bolt
- 11) Activate the brake and check the air gap
- 12) Mount the nut (12) and washer (6)
- 13) Tighten the nut (20) until it touches the passive calliper then counter the counter nut (16)

Bill of material					
490-2399-802	490-2399-803	Pos	Qty.	Itemno.	Name
x	x	1	1	490-2011-002	Pin f/pos.system
x	x	2	1	490-2009-002	Shaft f/pos.system
x	x	3	1	7490-0005-001	Glacierbearing
x	x	4	1	490-2010-003	Cylinder f/pos.system
x	x	5	1	490-2400-003	Bracket
x	x	6	1	2151-2022-163	Washer ø8.4 (A4), DIN 125A
x	x	8	2	4490-0660-002	Washer (Nordlock) ø8 (1set)
x	x	9	1	4490-0641-004	Bolt M8x25 (A2)
x	x	10	1	4490-0615-010	Bolt M6x16 CH (A4)
x	x	11	1	4490-0641-007	Bolt M8x30 (A2)
x	x	12	1	4490-0102-003	Nut M8 w/fiber (A2)
x	x	13	1	2126-2034-118	Nut M8 (A2)
x		14	2	4490-0651-001	Bolt M10x180
	x		2	4490-0651-003	Bolt M10x200
x	x	15	2	3490-0045-001	Spring 3,0x10.5, L=74
x	x	16	2	4490-0650-001	Nut M10 (A2) DIN 934
	x	17	10	4490-0681-001	Washer ø10 DIN 433 A2
	x	18	2	590-0126-001	Spacer/shim
x	x	19	2	4490-0618-004	Bolt M8x20 DIN 7984 A2
x	x	20	2	4490-0102-005	Nut M10 w/fiber (A2)

Appendix G – Indicator “On/Off” & “Not Adjusted”

DATA SHEET	Date: 17.05.2004 No.: DEB-INDI-001 Replace: 23.03.2004 Approved: NCH
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BRAKE SWITCH – 30 VDC / AC

Page 1 of 2

- “Brake Released” & “Pad Wear” - Spring applied failsafe brakes
- “Brake Released” & “Not Adjusted” - Spring applied failsafe AWA brakes

Function

Two micro-switches are mounted inside the housing of the switch. The explorer triggers these switches at two different positions. The function of the switch for “Pad Wear” and “Not Adjusted” is actually the same but the switch points are set differently and they are used for different purposes and for different brake types.
 NOTE - The indication for “Pad Wear” and “Not Adjusted” is only active during braking and disappears when the brake is lifted - therefore a holding circuit may be ideal.

Fail Safe operation

For fail-safe operations the switch should be wired to have a signal/connection when everything is ok (i.e. closing a normally open switch (NO)). The connection should disappear when switching i.e. applying the brake, having wear or in case of faults like broken cable, poor connections etc.

“Brake Release” & “Pad Wear”

The switch measures the piston movement. The “Brake Release” switch triggers when the brake is released / activated (On/Off). The switch is closed from fully lifted brake to approx. 0.4 mm of piston movement. The switch for “Pad Wear” triggers when the pad is worn to the allowed limit (1, 2, 3 or 4 mm wear), and the brake needs adjustment.

“Brake Release” & “Not Adjusted”

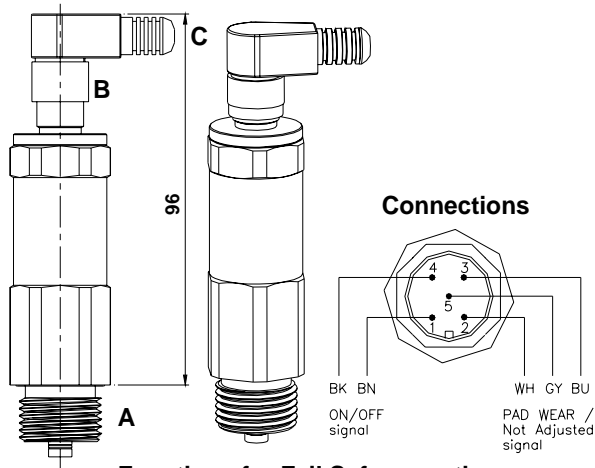
The switch measures the piston movement. The “Brake Release” switch triggers when the brake are released / activated. The switch for “Not Adjusted” triggers if the AWA mechanism are not working or have failed to adjust correctly. The distance for switching is dependent on the airgap chosen.

Mounting

1. Adjust the airgap on the brake. (Refer to manual)
2. Remove the plugs from the adjusting screw.
3. Screw the indicator tread (A) into the adjusting screw
4. Electrical connection. (See connection diagram)

Technical data

Operating temperature	:	-40°C to +85°C
Max. Voltage	:	30 VDC / AC
Max. Current	:	10 mA
Switching tolerance	:	+/- 0.3mm
Max. Stroke	:	16mm
Protection grade	:	IP 65 (mounted)
Max. Tightening torque Ø21 mm	:	20 Nm - A)
Max. Tightening torque Ø12 mm	:	finger tight - B)
Min. no. of operations	:	1 million
Cable length - C)	:	5, 10 or 15meters
Cable type/material - C)	:	PUR
Cable dimension - C)	:	5 * 0.34mm ²
Thread size - A)	:	1/2" BSP
Spanner size (SW) - A)	:	24mm



Functions for Fail Safe operations

<p><u>INDICATOR NOT MOUNTED</u> ON/OFF switch (1-4) ON/OFF switch OPEN</p> <p>PAD WEAR switch (3-2-5) PAD WEAR switch OPEN (2-3)</p>	
<p>BRAKE "OFF", NO "PAD WEAR" **) Indicator mounted AND brake is OFF Brake "Lifted" - Contact is made Brake ON/OFF switch is CLOSED (1-4) PAD WEAR contact is made PAD WEAR switch is CLOSED (2-3)</p>	
<p>BRAKE "ON", NO "PAD WEAR" *) Indicator mounted AND brake is activated Brake released - Contact is broken Brake ON/OFF switch is OPEN (1-4) PAD WEAR contact is made PAD WEAR switch is CLOSED (2-3)</p>	
<p>BRAKE "ON", "PAD WEAR" *) Indicator mounted AND brake is activated Brake released - Contact is broken Brake ON/OFF switch is OPEN (1-4) PAD WEAR contact is broken PAD WEAR switch is OPEN (2-3)</p>	
<p>BRAKE "OFF", "PAD WEAR" **) Indicator mounted AND brake is OFF Brake "Lifted" - Contact is made Brake ON/OFF switch is CLOSED (1-4) PAD WEAR switch is CLOSED (2-3) because NO indication for PAD WEAR when brake is lifted</p>	

*) = Brake "ON" = NO hydraulic pressure = brake released / activated
 **) = Brake "OFF" = MAX. hydraulic pressure = brake "lifted"

part of drawing no. 490 2796

Appendix G – Indicator “On/Off” & “Not Adjusted”

DATA SHEET	Date: 08.08.2005 No.: DEB-INDI-001 Replace: 17.05.2004 Approved: NCH
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BRAKE SWITCH – 30 VDC / AC

- “Brake Released” & “Pad Wear” - Spring applied failsafe brakes
- “Brake Released” & “Not Adjusted” - Spring applied failsafe AWA brakes

Item numbers:

BRAKE SWITCH DC

Spring applied / Failsafe / Passive / Negative

Part numbers	On / off + 1 mm wear	On / off + 2 mm wear	On / off + 3 mm wear	On / off + 4 mm wear
BSFH 200	490-2004-812	490-2005-812	490-2006-812	
BSFI 200 - opt 105/106	490-2004-811	490-2005-811	490-2006-811	
BSFH 300 "S"	490-2004-801	490-2005-801	490-2006-801	
BSFH 300 "E"	490-2004-802	490-2005-802	490-2006-802	
BSFH 300 "EE"	490-2004-803	490-2005-803	490-2006-803	490-2008-803
BSFI 300 "S"	490-2004-801	490-2005-801	490-2006-801	
BSFI 300 "E"	490-2004-802	490-2005-802	490-2006-802	
BSFI 300 "EE"	490-2004-803	490-2005-803	490-2006-803	490-2008-803
BSFI 3000	490-2004-806	490-2005-806	490-2006-806	490-2008-806
BSFH 500	490-2004-804	490-2005-804	490-2006-804	
BSFH 500 "E"	490-2004-805	490-2005-805	490-2006-805	
BSFI 500 < 230 kN	490-2004-818	490-2005-818	490-2006-818	
BSFI 500 >= 230 kN	490-2004-826	490-2005-826		
BSFA 600 < 350 kN	490-2004-815	490-2005-815	490-2006-815	
BSFA 600 >= 350 kN	490-2004-825	490-2005-825		
BSFA 600 "E" < 400 kN	490-2004-827	490-2005-827	490-2006-827	
BSFA 600 "E" >= 400 kN	490-2004-819	490-2005-819	490-2006-819	

Spring applied / Failsafe / Passive / Negative AWA

Part numbers	On / off + Not Adjusted 1.5-1.7mm airgab ± 0,3mm	On / off + Not Adjusted 2.0-2.5mm airgab ± 0,3mm
BSFH 300 AWA	490-2004-807	
BSFH 300 AWA "E"	490-2004-810	490-2005-807
BSFI 300 AWA	490-2004-813	490-2005-808
BSFI 3000 AWA		490-2005-809
BSFI 3000-x-102/103 AWA		490-2005-814

Cable information:

The brake switch is equipped with a 5 m non-shielded cable as standard. Other cable lengths/types can be ordered according to the following guide (add 30 to the 8xx number from the table above):

- 5 meter cable, part number = 490-200x-80x to 82x
- 5 meter shielded cable, part number = 490-200x-40x to 42x
- 10 meter cable, part number = 490-200x-83x to 85x
- 10 meter shielded cable, part number = 490-200x-43x to 45x
- 15 meter cable, part number = 490-200x-86x to 88x
- 15 meter shielded cable, part number = 490-200x-46x to 48x

Example:

490-2005 with different cable lengths and types:

	Regular cable (non-shielded)			Shielded cable		
	5 m (std)	10 m	15 m	5 m	10 m	15 m
490-2005-801	490-2005-831	490-2005-861		490-2005-401	490-2005-431	490-2005-461
490-2005-811	490-2005-841	490-2005-871		490-2005-411	490-2005-441	490-2005-471
490-2005-829	490-2005-859	490-2005-889		490-2005-429	490-2005-459	490-2005-489

Appendix H – Indicator “Pad Worn”

DATA SHEET	Date: 27.06.2005 No.: DEB-INDI-002 Replace: 19.05.2005 Approved: NCH
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BRAKE SWITCH – 30 VDC / AC

Brake “Pad Worn”

- Hydraulic applied (active) brakes and brakes with Automatic Wear Adjustment (AWA)

Function

Two micro-switches are mounted inside the housing of the switch. The explorer triggers these switches at two different positions.

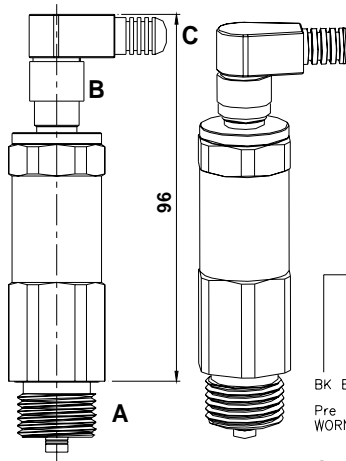
NOTE - The indication for “Pre Pad Worn” and “Pad Worn” is only active during braking and disappears when the brake is lifted - therefore a holding circuit may be ideal.

Fail Safe operation

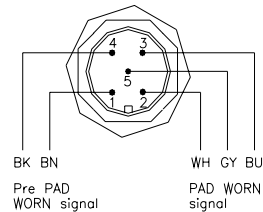
For fail-safe operations the switch should be wired to have a signal/connection when everything is ok (i.e. closing a normally open switch (NO)). The connection should disappear when switching i.e. applying the brake, having wear or in case of faults like broken cable, poor connections etc.

“Pad Worn”

The switch measures the brake pad movement. The “Pad Worn” switch triggers, when the brake pad is worn and needs to be replaced. On active brakes the signal is given by measuring directly on the pad. This is done through the threaded holes in the yoke - next to the pad holders or through a hole in the adjusting screw. On AWA brakes this is done through the push-rod in the centre of the adjusting screw.



Connections

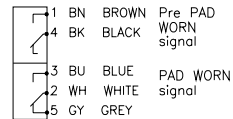


Functions for Fail Safe operations

INDICATOR NOT MOUNTED

Pre PAD WORN switch (1-4)
Pre PAD WORN switch is OPEN

PAD WORN switch (3-2-5)
PAD WORN switch is OPEN (2-3)



BRAKE “OFF”, PAD NOT WORN **)

Indicator mounted AND brake is OFF
Brake “Lifted”
Pre WORN switch is CLOSED (1-4)
PAD WORN contact is made
PAD WORN switch is CLOSED (2-3)



BRAKE “ON”, “Pre PAD WORN” *)

Indicator mounted AND brake is activated
Brake released
Pre PAD WORN switch is OPEN (1-4)
PAD WORN contact is made
PAD WORN switch is CLOSED (2-3)



BRAKE “ON”, “PAD WORN” *)

Indicator mounted AND brake is activated
Brake released
Brake Pre PAD WORN switch is OPEN (1-4)
PAD WORN contact is broken
PAD WORN switch is OPEN (2-3)



BRAKE “OFF”, “PAD WORN” **)

Indicator mounted AND brake is OFF
Brake “Lifted”
Pre PAD WORN switch is CLOSED (1-4)
PAD WORN switch is CLOSED (2-3)
because NO indication for PAD WORN or Pre PAD WORN when brake is lifted



part of drawing no. 490 2796

The switch has two switch points with 1.5mm in between.

The first switch point (1-4) is used for the “Pre Pad Worn” signal. This indicates 1mm left on the pad before it must be replaced.

The second switch point (2-3) is used for the “Pad Worn” signal. This indicates that the pad needs to be replaced.

Mounting

1. Adjust the airgap on the brake. (Refer to manual)
2. Remove the plugs from the adjusting screw.
3. Screw the indicator tread (A) into the adjusting screw
4. Electrical connection. (See connection diagram)

Technical data

Operating temperature	:	-40°C to +85°C
Max. Voltage	:	30 VDC / AC
Max. Current	:	10 mA
Switching tolerance	:	+/- 0.3mm
Max. Stroke	:	16mm
Protection grade	:	IP 65 (mounted)
Max. Tightening torque Ø21 mm	:	20 Nm - A)
Max. Tightening torque Ø12 mm	:	finger tight - B)
Min. no. of operations	:	1 million
Cable length - C)	:	5, 10 or 15meters
Cable type/material - C)	:	PUR
Cable dimension - C)	:	5 * 0.34mm ²
Thread size - A)	:	1/2" BSP
Spanner size (SW) - A)	:	24mm

*) = Brake “ON” = NO hydraulic pressure = brake released / activated
 **) = Brake “OFF” = MAX. hydraulic pressure = brake “lifted”

Appendix H – Indicator “Pad Worn”

DATA SHEET	Date: 22.08.2005 No.: DEB-INDI-002 Replace: 27.06.2005 Approved: NCH
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BRAKE SWITCH – 30 VDC / AC

Brake “Pad Worn”

- Hydraulic applied (active) brakes and brakes with Automatic Wear Adjustment (AWA)

Item numbers:

Part numbers	Pad Worn
BSFH 300 AWA	490 2007-801
BSFH 300 AWA "E"	490 2007-802
BSFI 300 AWA	490 2007-803
BSFI 3000 AWA	490 2007-804

Hydraulic applied / Active / Positive

Part numbers	Pad Worn
BSAI 300	490-2007-817
BSAK 300	490 2007-828
BSAH 300	490-2007-829
BSAK 3000	490 2007-809

Cable information:

The brake switch is equipped with a 5 m non-shielded cable as standard. Other cable lengths/types can be ordered according to the following guide (add 30 to the 8xx number from the table above):

- | | |
|---|--|
| 5 meter cable, part number = 490-2007-80x to 82x | 5 meter shielded cable, part number = 490-2007-40x to 42x |
| 10 meter cable, part number = 490-2007-83x to 85x | 10 meter shielded cable, part number = 490-2007-43x to 45x |
| 15 meter cable, part number = 490-2007-86x to 88x | 15 meter shielded cable, part number = 490-2007-46x to 48x |

Example:

490-2007 with different cable lengths and types:

	Regular cable (non-shielded)			Shielded cable		
	5 m (std)	10 m	15 m	5 m	10 m	15 m
490-2007-801	490-2007-831	490-2007-861	490-2007-401	490-2007-431	490-2007-461	
490-2007-811	490-2007-841	490-2007-871	490-2007-411	490-2007-441	490-2007-471	
490-2007-829	490-2007-859	490-2007-889	490-2007-429	490-2007-459	490-2007-489	

Appendix I - Technical data

DATA SHEET

Date: 21.09.2004
 No.: DEB-3000-010
 Replace: 20.01.2004
 Approved: NCH

DISC BRAKE BSFI 3000 AWA - TECHNICAL DATA AND CALCULATION FUNDAMENTALS.

Caliper type	Clamping force ¹⁾ [N]		Braking force ²⁾ [N]	Operating pressure [BAR]	Balancing pressure ¹⁾ MIN [BAR]	Max. air gap [mm]	Number of belleville springs	Pad surface pressure ³⁾ [N/mm ²]
	MIN	MAX						
BSFI 3027	27.000	30.000	24.000	50	24,7	2,5	13x1	0,45 – 0,75
BSFI 3030	30.000	33.500	24.000	55	27,4	2,5	13x1	0,50 – 0,83
BSFI 3032	32.000	35.500	25.600	55	29,3	2,5	13x1	0,55 – 0,89
BSFI 3035	35.000	38.500	28.000	60	32	2,5	14x1	0,59 – 0,97
BSFI 3040	40.000	44.000	32.000	65	37	2,5	14x1	0,67 – 1,11
BSFI 3045	45.000	49.000	36.000	70	41	2,5	12x1	0,76 – 1,25
BSFI 3050	50.000	55.000	40.000	75	46	2,5	12x1	0,84 – 1,39
BSFI 3056	56.000	61.000	44.800	80	51	2,5	12x1	0,94 – 1,56
BSFI 3060	60.000	66.000	48.000	85	55	2,5	12x1	1,01 – 1,67
BSFI 3065	65.000	70.000	52.000	90	59	2,5	12x1	1,09 – 1,81
BSFI 3070	70.000	77.000	56.000	95	64	2,5	7x2	1,17 – 1,94
BSFI 3080	80.000	88.000	64.000	115	73	2,5	8x2	1,34 – 2,22
BSFI 3090	90.000	98.500	72.000	125	82	2	8x2	1,51 – 2,50
BSFI 3100	100.000	109.000	80.000	135	91	2	8x2	1,68 – 2,78
BSFI 3110	110.000	119.000	88.000	160	101	2	5x3	1,85 – 3,06
BSFI 3120	120.000	130.000	96.000	175	110	2	5x3	2,01 – 3,33

¹⁾ All figures are based on 2 and 2,5mm air gap for both standard brake and monospring brake.
²⁾ Braking force is based on min. clamping force, nominal coefficient of friction $\mu = 0.4$ and 2 brake surfaces.
³⁾ Organic / sintered pads (max. clamping force).

BRAKING TORQUE

The braking torque M_B is calculated from following formula:

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

Where:

- a is the number of callipers acting on the disc
- F_B is the braking force according to table above [N]
- D_o is the disc outer diameter

The actual braking torque may vary, depending on adjustment of brake and friction coefficient.

CALCULATION FUNDAMENTALS

	Standard	Monospring
Weight of caliper without bracket incl Pads	182 kg	190 kg
Weight of caliper with bracket incl Pads	210 kg	
Pad width:	200 mm	200 mm
Pad area (organic):	59.600 mm ² (*)	59.600 mm ² (*)
Max. wear of pad (organic):	10 mm (*)	10 mm (*)
Pad area (sintered):	36.000 mm ² (*)	36.000 mm ² (*)
Max. wear of pad (sintered):	10 mm (*)	10 mm (*)
Air gab	2 mm	3 mm
Nominal coefficient of friction:	$\mu = 0.4$	$\mu = 0.4$
Total piston area each caliper	219 cm ²	109 cm ²
Volume for each caliper at 2 mm stroke:	43.8 cm ³	
Volume for each caliper at 3 mm stroke:		32.9 cm ³
Actuating time (guide value for calculation):	0,3 sec	0,3 sec
Pressure connection/port:	1/4" BSP	1/4" BSP
Drain connection port R:	1/8" BSP	1/8" BSP
Recommended pipe size:	10/8 mm	10/8 mm

Operating temperature range from -20 to +70 °C
 (For temperatures outside this range contact Svendborg Brakes)

(*) On each brake pad

Appendix J - Recommended fluid

DATA SHEET	Date: 16.01.2004 No.: DEB-DIVE-005 Replace: 19.12.2003 Approved: N. Christensen
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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 minimum and maximum temperatures for standard components are, -20°C - +60°C / -14°F - +140°F.
 Extreme temperature applications may require special options. Please contact Svendborg Brakes.

	Special option	Standard		Special option
Mineral Oil	-30°C - +20°C -22°F - +68°F	-20°C - +40°C -14°F - +104°F	+10°C - +60°C +50°F - +140°F	+30°C - +70°C +86°F - +158°F
Shell	Tellus Artic	Tellus TX32	Tellus TX46	Tellus TX68
Mobil	-	DTE 13M	DTE 15M	DTE 16M
Hydro Texaco	Rando Ashless 8401	Rando HDZ32	Rando HDZ46	Rando HDZ68
Valvoline	-	Ultramax HVLP32	Ultramax HVLP46	Ultramax HVLP68
Synthetic Oil	-30°C - +20°C -22°F - +68°F	-20°C - +40°C -14°F - +104°F	+10°C - +60°C +50°F - +140°F	+30°C - +70°C +86°F - +158°F
Mobil	-	SHC 524	SHC 525	SHC 526
Bio Oil ⁽¹⁾ <small>(Ester or Colza oil)</small>	-30°C - +20°C -22°F - +68°F	-20°C - +30°C -14°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.

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 recommended that the oil added to the system is filtered through an off-line filter unit.

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 recommended 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 be 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.

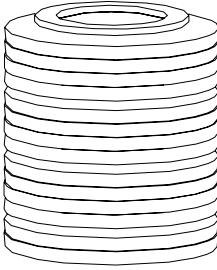
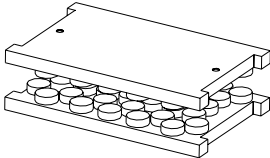
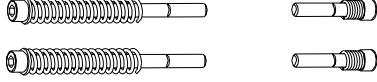

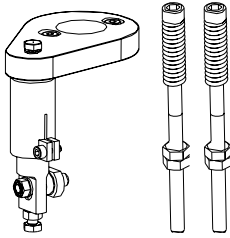
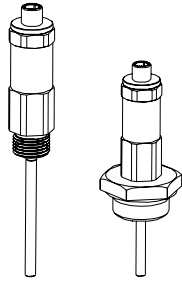
The respective manufactures should be contacted prior to changing from one pressure fluid to another.

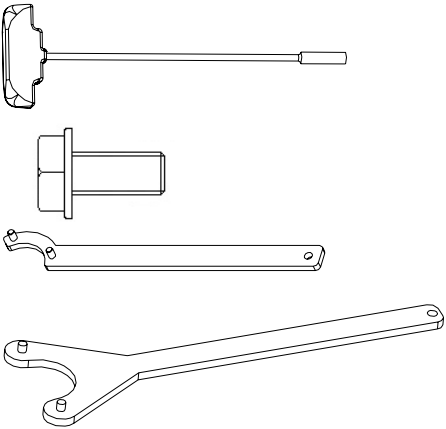

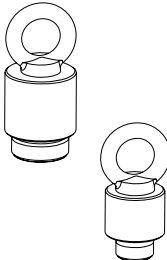
Seal material

Brakes from Svendborg Brakes A/S are normally supplied with PUR-seals (PolyURethane)
 PTFE (PolyTetraFlourEthylene) 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 K - Recommended spare parts

Recommended spare parts for one brake

<p>Spring set Spring set BSFI 3090-S-103</p>	<p>490-3088-801</p>	
<p>Brake pad set Sinter metal MD550</p>	<p>490-1563-801</p>	
<p>Brake pad retraction springs Pad retraction spring set</p>	<p>490-1702-802</p>	
<p>Seal kit Seal kit</p>	<p>490 1755-815</p>	
<p>Positioning system Pos.system (180mm bolts)</p>	<p>490-2399-802</p>	
<p>Indicators Mechanical indicators</p> <p>Brake release (On/off) and Brake Not Adjusted 2,0mm Indicator</p> <p>Brake Pad Worn indicator</p>	<p>490-2005-814</p> <p>490-2007-804</p>	

<p>Tools – part 1</p> <p>Spanner (Push rod tool)</p> <p>Air gap bolt (M24x50) Air gap washer (ø24)</p> <p>Tool for push rod ring</p> <p>Tool for end cap</p>	<p>490-2492-802</p> <p>4490 0633-015 4490 0201-002</p> <p>490-2419-001</p> <p>490-1785-001</p>	
<p>Tools – part 2</p> <p>Hand pump with 800mm test point hose</p> <p>Test point connectors (Mini mess) Test point male 1/8" BSP (drain) Test point male 1/4" BSP (pressure) Test point male 1/2" BSP</p> <p>Test point hose 800mm</p>	<p>Used for manually lifting the brake piston (hydraulically)</p> <p>0350-1019-801</p> <p>9009-1010-020 9009-1010-040 9009-1010-080</p> <p>9009-3010-008</p>	
<p>Tools – part 3</p> <p>Tool for lifting the end cap out of the yoke (M36)</p> <p>Tool for lifting piston out of the yoke (M24)</p>	<p>Used for during maintenance / overhaul (optional)</p> <p>490-3456-003</p> <p>490-3456-004</p>	
<p>Drain kit</p> <p>Drain piping set with tubing and fittings</p> <p>Drain bottle 1L plastic</p>	<p>590-0056-804</p> <p>9646-0999-002</p>	
<p>Converters (BSP on brake)</p> <p>Male BSP to male NPT 1/8" BSP to 1/8" NPT (drain) 1/4" BSP to 1/4" NPT (pressure) 3/8" BSP to 3/8" NPT</p>	<p>9040-1200-018 9040-1200-014 9040-1200-038</p>	