Masoneilan™
21000 Series
Top Guided Globe Valve
with Lo-dB™ / Anti-cavitation capabilities

Instruction Manual (Rev.E)
THESE INSTRUCTIONS PROVIDE THE CUSTOMER/OPERATOR WITH IMPORTANT PROJECT-SPECIFIC REFERENCE INFORMATION IN ADDITION TO THE CUSTOMER/OPERATOR’S NORMAL OPERATION AND MAINTENANCE PROCEDURES. SINCE OPERATION AND MAINTENANCE PHILOSOPHIES VARY, BAKER HUGHES COMPANY (AND ITS SUBSIDIARIES AND AFFILIATES) DOES NOT ATTEMPT TO DICTATE SPECIFIC PROCEDURES, BUT TO PROVIDE BASIC LIMITATIONS AND REQUIREMENTS CREATED BY THE TYPE OF EQUIPMENT PROVIDED.

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Safety Information

Important - Please read before installation

These instructions contain DANGER, WARNING, and CAUTION labels, where necessary, to alert you to safety related or other important information. Read the instructions carefully before installing and maintaining your control valve. DANGER and WARNING hazards are related to personal injury. CAUTION hazards involve equipment or property damage. Operation of damaged equipment can, under certain operational conditions, result in degraded process system performance that can lead to injury or death. Total compliance with all DANGER, WARNING, and CAUTION notices is required for safe operation.

This is the safety alert symbol. It alerts you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.

When used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, could result in property damage.

Note: Indicates important facts and conditions.

About this Manual

- The information in this manual is subject to change without prior notice.
- The information contained in this manual, in whole or part, shall not be transcribed or copied without Baker Hughes’s written permission.
- Please report any errors or questions about the information in this manual to your local supplier.
- These instructions are written specifically for the 21000 Series control valves, and do not apply for other valves outside of this product line.

Useful Life Period

The current estimated useful life period for the 21000 Series control valves is 25+ years. To maximize the useful life of the product, it is essential to conduct annual inspections, routine maintenance and ensure proper installation to avoid any unintended stresses on the product. The specific operating conditions will also impact the useful life of the product. Consult the factory for guidance on specific applications if required prior to installation.

Warranty

Items sold by Baker Hughes are warranted to be free from defects in materials and workmanship for a period of one year from the date of shipment provided said items are used according to Baker Hughes recommended usages. Baker Hughes reserves the right to discontinue manufacture of any product or change product materials, design or specifications without notice.

Note: Prior to installation:

- The valve must be installed, put into service and maintained by qualified and competent professionals who have undergone suitable training.
- All surrounding pipe lines must be thoroughly flushed to ensure all entrained debris has been removed from the system.
- Under certain operating conditions, the use of damaged equipment could cause a degradation of the performance of the system which may lead to personal injury or death.
- Changes to specifications, structure, and components used may not lead to the revision of this manual unless such changes affect the function and performance of the product.
1. Introduction

The following instructions should be thoroughly reviewed and understood prior to installing, operating or performing maintenance on this equipment. Throughout the text, safety and/or caution notes will appear and must be strictly adhered to, otherwise, serious injury or equipment malfunction could result.

Baker Hughes has a highly skilled After Sales Department available for start-up, maintenance and repair of our valves and component parts.

Arrangements for this service can be made through your local Baker Hughes’s representative or sales department. When performing maintenance use only Masoneilan replacement parts. Parts are obtainable through your local representative or spare parts department. When ordering parts, always include Model and Serial Number of the unit being repaired.

2. General

These installation and maintenance instructions apply to all sizes and ratings of the 21000 Series control valves regardless of the type of trim used.

21000 Series single ported top guided control valves are designed with built in versatility making them well-suited to handle a wide variety of process applications.

Standard construction offers a contoured plug (21100 Series) with a threaded seat ring or a quick change seat ring. The heavy top plug guiding provides maximum support to ensure plug stability.

A series of reduced area trim is available to provide wide flow range capabilities in all valve sizes.

Tight Shutoff Class IV leakage is standard. Optional constructions (one of which is the 21600 Series soft seat plug) meet IEC 534-4 and ANSI/FCI 70.2 Class V and VI requirements.

An optional Low Emission LE™ Packing is available to assure compliance with the fugitive emission containment requirements.

Replacing the conventional plug with the single stage Lo-dB design (21700 Series) provides excellent noise attenuation or anti-cavitation performance.

The 21800 Series double stage anti-cavitation valve is derived from the 21700 single stage anti-cavitation valve through a modification to the cage and plug. Substitution of the standard cage with an anti-cavitation cage permits the pressure drop to be split between the two stages efficiently.

The 21900 Series double stage Lo-dB valve is also derived from the 21700 single stage Lo-dB valve through a modification to the cage and plug. Substitution of the standard cage, with a Lo-dB cage permits the pressure drop to be split between the two stages efficiently.

In the 21800/21900 Series designs, enlargement of the plug head up to the cage diameter permits simultaneous throttling of the plug Cv and the cage Cv. It also provides optimum allocation of the pressure drop between the two stages along the entire plug travel.

Recommended spare parts required for maintenance are listed in the Parts Reference table on page 17. The model number, size, rating and serial number of the valve are shown on the identification tag located on the actuator. Refer to Figure 1 for the 21000 series numbering system.

3. Unpacking

Care must be exercised when unpacking the valve to prevent damage to the accessories and component parts. Contact the local Baker Hughes Sales office or Service Center with any issues or problems. Be sure to note the valve model number and serial number in all correspondence.

4. Installation

4.1 Piping Cleanliness

Before installing the valve in the line, clean piping and valve of all foreign material such as welding chips, scale, oil, grease or dirt. Gasket surfaces should be thoroughly cleaned to ensure leak-proof joints.

4.2 Isolation Bypass Valve

To allow for in-line inspection, maintenance or removal of the valve without service interruption, provide a manually operated...
stop valve on each side of the 21000 Series valve with a manually operated throttling valve mounted in the by-pass line (See Figure 2).

4.3 Flow Direction
The valve must be installed so that the process fluid will flow through the valve in the direction indicated by the flow arrow located on the body.

- With contoured plug (21100/21600) or Lo-dB plug (21700/21900) flow-to-open
- On anti-cavitation design (21700/21800) flow-to-close

4.4 Heat Insulation
For heat-insulated installation, do not insulate the valve bonnet. Take necessary protective measures relate to personal safety.

Welded Connections

CAUTION
Carefully review the information in this section prior to welding any valves inline. Refer any additional questions to the local Baker Hughes Sales Office or Service Center.

Pre-Weld Preparation
Carefully follow the installation steps defined in the sections noted above prior to performing weld procedures.

Welding Process
Perform welding process in accordance with the standard requirements for the materials and weld construction of the specific valve. Apply post weld heat treatment if required.

CAUTION
Internal valve components should be removed prior to performing welding or pre/post weld heat treatment; weld heat treatment in order to prevent damaging any soft goods (such as PTFE seals). If unable to remove the elastomeric components, then other methods must be employed to prevent the local temperature around the seals from exceeding the maximum material limits (typically 450°F / 232°C for PTFE based materials).

Post Weld Cleaning & Assembly
Inspect the body, bonnet, and trim components for cleanliness and surface condition. Remove any foreign materials, such as weld chips, slag or scale. Make sure there are no nicks, scratches, burrs or sharp corners on sealing and sliding surfaces. Clean all gasket interface surfaces and reassemble using new gaskets to ensure sealing integrity.

5. Air Piping
The actuators are designed to accept ¼” NPT air supply piping. Use ¼” OD tubing (4 x 6 mm) or equivalent for all air lines. If the supply air line exceeds 25 feet in length (7 meters) or if the valve is equipped with volume boosters, then ½” tubing (6 x 8 mm) is preferred. All connections must be free of leaks.

6. Body Disassembly
Access to the internal components of the body should be accomplished with the actuator removed. To remove the actuator from the body, refer to the actuator instruction Ref. 19530 for a type 87/88 multispring actuator.

CAUTION
Do not exceed supply pressure indicated on serial plate located on the yoke of the actuator.

Prior to performing maintenance on the valve, isolate the valve and vent the process pressure. Shut off the supply air line and the pneumatic or electric signal line.

6.1 Threaded Trim (Figure 12 or 14)
After removing the actuator, disassemble the body using the following procedure:

A. If there is a leak detector connection on the lateral NPT port of the bonnet, disconnect this piping as well.
B. Remove body stud nuts (10).
C. Remove bonnet (8), and plug stem (1) and plug (16) sub-assembly together as one unit.

Note: Spiral wound body gaskets (11) are standard in the 21000 Series design and it is imperative that a new gasket be installed each time the valve is disassembled.

D. Remove packing flange stud nuts (3), packing flange (4) and packing follower (5).
E. Remove plug (16) and plug stem (1) sub-assembly from the bonnet (8).

6.2 Quick-Change Trim (Figure 13 or 15)
After removing the actuator, disassemble the body using the following procedure:

A. If there is a leak detection connection on the lateral NPT port of the bonnet, disconnect this piping as well.
B. Remove body stud nuts (10).
C. Remove bonnet (8), and plug stem (1) and plug (16) sub-assembly together as one unit.
D. Since the cage (13), seat ring (14) and seat ring gasket (15) are held in place by the bonnet, they may now be removed.
   *Note: Spiral wound gaskets (11 & 15) are standard in the 21000 Series design and it is imperative that new gaskets be installed each time the valve is disassembled.*
E. Remove packing flange stud nuts (3), packing flange (4) and packing follower (5).
F. Remove plug (16) and plug stem (1) sub-assembly from the bonnet (8).

**CAUTION**

Care must be taken to avoid damage to the plug and plug guide.

G. Remove old packing (6) [and optional lantern ring (7) if a leak detection connection has been installed]. Refer to Figure 5.
H. All components may now be inspected for wear and service damage. After determining the maintenance required, proceed to the appropriate Section of this instruction manual.

### 7. Maintenance & Repair

The purpose of this section is to provide recommended maintenance and repair procedures. These procedures assume the availability of standard shop tools and equipment.

#### 7.1 Threaded Seat Ring Removal (Figure 12 or 14)

Threaded seat rings (14) are installed tightly by the manufacturer, and after years of service they may be difficult to remove.

To facilitate removal, seat ring wrenches can be fabricated to engage the seat ring lugs and adapted to a standard wrench. If the seat ring is exceptionally resistant to removal, the application of heat or penetrating oil should be helpful.

**CAUTION**

When using heating devices, ensure that proper safety practices are observed. Flammability and toxicity of the process fluid must be considered and proper precautions taken.

#### 7.2 Bushing Removal

The bushing (12) is press fit into the bonnet and does not normally require replacement. If necessary, it may be pulled or machined out. When machining the bushing out, care must be taken to maintain proper dimensions and tolerances in the bonnet. These will be furnished upon request.

#### 7.3 Lapping Seats

Lapping is the process of working the valve plug against the seat ring with an abrasive to produce a close fit. If valve leakage is excessive, lapping becomes necessary. The plug and seat ring seating surfaces should be free of large scratches or other defects, and the contact surfaces of the seats should be as narrow as possible. This may require dressing both parts in a lathe. The seating surface angle of the plug is 28 degrees and the seat ring is 30 degrees (relative to the centerline axis). A good grade of fine grinding compound is required for the lapping operation.

The compound should be mixed with a small quantity of lubricant such as graphite. This will slow the cutting rate and prevent tearing of the seating surfaces. The amount of lapping required depends on the materials, condition of seating surfaces, and accuracy of machining. If a short period of lapping does not visibly improve seating, there is usually no advantage in continuing as excessive lapping may result in rough seats. The only remedy is replacement or re-machining of one or both parts. When lapping new plugs and seat rings, begin with a medium fine (240 grit) and finish with a finer grade (600 grit).

*Note: Lapping should produce a line contact area, not the entire surface, due to the difference in seat angles.*

**CAUTION**

Before lapping, the plug and stem sub-assembly must be concentric. (See pinning operation, section 7.5).

#### 7.3.1 Threaded Trim (Figure 12 or 14)

1. Clean body gasket surface areas.
2. When seat has been removed, ensure that the sealing surface in the body bridge and the threads are thoroughly cleaned.
   *Note: A sealant compatible with the process should be applied sparingly to the seat ring threads and sealing shoulder.*
3. Install and tighten seat ring using fabricated wrench used for removal.

**CAUTION**

Do not over-tighten. Do not strike seat ring lugs directly. This could distort the seat ring resulting in seat leakage.

4. Apply lapping compound on the plug at several spots equally spaced around the seating area.
5. Insert the stem and plug sub-assembly carefully into the body until it is seated.
6. Place bonnet (8) on the body and fasten the bonnet to the body using four body stud nuts (10) spaced equally apart. Apply slight pressure and tighten evenly.

**CAUTION**

Do not tighten nuts to final torque specifications at this time. The bonnet is used temporarily for guiding purposes only.

7. Insert two or three pieces of packing (6) into the packing box to assist in guiding the stem and plug during lapping.
8. Screw a drilled and tapped rod with a T-handle onto the plug stem and secure with a locknut (see Figure 4).
   *Note: As an alternative, drill a hole through a flat steel plate and fasten to the plug stem using two locknuts.*
9. Apply slight pressure on the stem, and rotate the stem in short oscillating strokes (around 8 to 10 times). Repeat this step as necessary.

Note: The plug should be lifted and turned 90° each time before repeating Step (9). This intermittent lifting is required to keep the plug and seat ring concentric during lapping.

10. Apply slight pressure on the stem, and rotate the stem in short oscillating strokes (around 8 to 10 times). Repeat this step as necessary.

Note: The plug should be lifted and turned 90° each time before repeating Step (10). This intermittent lifting is required to keep the plug and seat ring concentric during lapping.

11. After completion of the lapping operation, remove bonnet and internal parts. The seating area of the seat ring and the plug must be cleaned of all lapping compound in preparation for reassembly. Do not remove seat ring.

7.4 Lo-dB Plug (Figure 8, 14 or 15)

The procedures used for performing maintenance on a valve equipped with Lo-dB plugs (21700/21800/21900 Series) are the same as those used for Threaded or Quick Change Trim.

CAUTION

Avoid over-lapping as this can cause damage to the seating surface rather than improve leakage performance.

7.5 Plug Stem Pinning

Plug stem pinning in the field may be required for the following:
- Replacing existing plug and stem, or
- Replacing existing stem only

Replacing Plug and Stem

If it is necessary to replace the plug, then the plug stem must be replaced at the same time. The original pin hole in an existing stem will not provide the necessary fit, and might seriously impair the strength of the assembly.

A. Reference Marking on the Plug Stem

Measure the depth of the pilot recess in the plug (Dimension X in Figure 9), and make a reference mark on the plug stem at the same distance from the thread.

Note: While pinning is being performed, care must be taken not to damage the seating surface or plug guide. Always use a soft metal or plastic vice jaws with cylindrical features to hold the plug guide area (see Figure 9).

B. Screwing Stem to Plug

- Hold the plug (with vise jaw assembly) in a vise.
- Lock two nuts against each other on the end of the new plug stem, and screw the stem solidly into the plug using a wrench on the upper nut.

When properly assembled, the reference mark (see Section A above) should be flush with the end of the plug guide.

C. Drilling the New Parts

- If the plug is already fully drilled (typical for 440 C hardened stainless steel material or solid Stellite or Equivalent), then drill the stem to the same diameter (Diameter C in Figure 9) as the plug shank hole.
D. Pinning

1. Select the correct size pin based on the plug guide diameter and pin hole diameter. Proceed as described in part D of the previous section, taking care not to damage the plug guide area.

Ensure plug stem alignment following the pinning operation.

7.6 Packing Box (Figures 12 to 15)

Packing box maintenance is one of the principle action items of routine servicing. Tightness of the packing is maintained by packing compression. Compression is achieved by evenly tightening the packing flange nuts (3) against the packing flange (4). Care must be taken not to over tighten as this could prevent smooth operation of the valve. If all compression is used up and the valve leaks, then new packing is required.

**CAUTION**

Valve must be isolated and the pressure vented before performing packing box maintenance.

Proceed as follows:

7.6.1 Braided PTFE with Carbon or Aramid Core (Standard) (Figures 12 to 15)

*Note: The Braided PTFE/Carbon or Aramid packing rings have a skive cut allowing packing replacement without disconnecting the plug stem from the actuator connector or actuator stem.*

A. Loosen and remove packing flange nuts (3).

B. Lift the packing flange (4) and packing follower (5) up the valve stem.

C. By means of a hooked instrument, remove packing (6) ensuring not to damage the sealing surfaces of the packing box or plug stem.

D. Replace packing rings (6).

E. Replace packing follower (5) and packing flange (4).

F. Replace and tighten packing stud nuts (3).

**CAUTION**

Do not overtighten.

G. Place valve back in service and only tighten packing as necessary to stop external leakage.

*Note: In an emergency, string packing may be used as a temporary repair only. It must be replaced with the correct packing as soon as possible.*
7.6.3.1 Preparation

7.6.3.1.1 Stem

Inspect stem for any nicks or scratches on the surface finish. Reject the stem for any of these reasons as they may damage packing.

**Note:** A properly etched part number on the stem in the packing area will have no adverse effect on the performance of the packing.

Stem finish should be 3-7 AARH (Ra 0,1/0,2).

7.6.3.1.2 Packing Box

**Note:** Bonnets that have a lube hole or leak detection port are unacceptable for use with the packing arrangement shown in Figure 7.

**CAUTION**

Packing box should be clean and free of burrs, rust, and any foreign matter. Parts can be cleaned with denatured alcohol.

**Note:** Packing box finish should be 125 AARH (Ra 3,2) or better.

The packing box may be bored or honed oversize by up to 0.015” (0.38 mm) above the nominal diameter to improve the finish. For instance, a nominal 0.875” (22.22 mm) packing box may be bored or honed up to 0.890” (22.60 mm) and the LE Packing will still seal properly.

Packing box must be finished to the bottom of the bore.

7.6.3.1.3 Packing

Inspect packing rings. Do not use packing if any nicks or scratches on packing are observed. Check packing and ensure that it is in the proper arrangement (see Figure below). PTFE material can be identified by the gloss black molded finish. PTFE material has a dull black machined finish.

![Diagram of LE Packing](image)

7.6.3.1.4 Spring Loaded Follower

The spring loaded follower consists of an upper and lower follower and eight (8) disc springs (see Figure below). The springs are installed inside the lower follower and positioned alternately. The assembly is held together by tape, which must be removed before installation.

![Diagram of Spring Loaded Follower](image)
7.6.3.2 Packing Installation

a. The packing must be lubricated with Krytox® fluorinated grease prior to installation (Krytox GPL206 or equivalent).

b. Packing should be lubricated as a set (not individually) to minimize getting lubricant between the rings.

c. Packing should be lubricated with a generous application to the O.D. and I.D. of the packing set.

Note: All exposed surfaces of the packing set must be covered with the lubricant.

d. PFE/PTFE is to be installed as a set. Carefully slide the packing set down the stem. Do not cock or force the packing on the threads.

If the packing set separates while on the stem, do not remove. Continue installing the remaining pieces to put the set back together.

e. Gently press the packing into the packing box. Do not tap the packing down into the box.

f. The spring loaded follower is installed on top of the packing. This follower is installed as an assembly held together by tape. This tape should be removed after assembly. Proper assembly of the packing box will leave the top of the Lower Follower 0.25 – 0.50 inches (6 to 13 mm) above the bonnet.

A groove is scribed into the O.D. of the upper follower. The packing flange is tightened evenly until the top of the Lower Follower aligns with the scribe mark (groove) in the Upper Follower.

Note: This is the optimum loading for this packing. Further tightening will shorten life of the packing. Thread locking compound can be used on packing nuts.

g. The packing should be checked for leakage.

h. Packing load should be checked after the valve has cycled approximately 500 times. Adjust if necessary. No further adjustment should be required for the life of the packing.

7.7 Soft Seat Plug (Figure 3)

The soft seat plug used in the 21000 Series valve has a replaceable insert. To remove and replace the insert, proceed as follows.

CAUTION
The shank OD is the plug guide. Extreme care must be taken to prevent scoring or marring this surface. Failure to do so could result in damage to the guide bushing and destruction of the plug. Two flats are provided for holding.

A. Loosen set screw until the head of the set screw is flush with the OD of the shank.

Note: On 3/4" - 2" size valves, the plug tip has a machined slot into which a bar can be inserted for removal. On 3" - 6" size valves, the plug tip has two machined holes into which a tool (fabricated with appropriate size pins) can be inserted for removal.

B. Carefully place plug sub-assembly into a soft jaw vise, holding the plug by the flats provided on the upper end of the shank.

CAUTION
When using a vise to hold the plug, extreme care must be taken not to damage the plug shank.

C. Using the appropriate tool, unscrew plug tip (counterclockwise) from the shank sub-assembly.

D. Remove insert O-ring (for valve sizes 3" - 8" only) and insert retainer. Discard existing insert and O-ring.

E. Thoroughly clean all remaining metallic components and install new insert and O-ring as follows (according to valve size):

For 3/4" - 2" valves:

a. Place new insert on shank and insert retainer as shown in Figure 3.

b. Install plug tip into shank sub-assembly. Hand tighten and ensure plug tip seats evenly against insert.

For 3" - 8" valves:

a. Apply a light coat of lubricant to the O-ring and install on insert retainer.

b. Install new insert on insert retainer and assemble as shown in Figure 3.

c. Install plug tip into insert retainer sub-assembly insuring the plug tip seats evenly against insert.

F. Carefully place the plug sub-assembly into a soft jaw vise, holding the plug by the flats provided on the upper end of the shank.

CAUTION
Ensure any lubricant used is compatible with service conditions.

b. Install new insert on insert retainer and assemble as shown in Figure 3.

c. Install plug tip into insert retainer sub-assembly insuring the plug tip seats evenly on the insert.

G. Using the appropriate tool used during disassembly, firmly tighten the plug tip.

CAUTION
The plug tip must be tightened, allowed to set for approximately 4 hours, re-tightened, allowed to set another 4 hours, then tightened one more time. The purpose of this tightening sequence is to allow the insert material to “cold flow” into place on the plug sub-assembly.

H. Following the above tightening sequence, securely tighten the set screw down into the plug. Plug is ready for assembly into the valve.
8. Valve Body Reassembly
After completion of the required maintenance, the valve should be reassembled using the following procedures:

Note: If any of the following steps were completed during maintenance, then proceed to the next step.

8.1 Threaded Trim (Figure 12 or 14)
A. Clean all gasket mating surfaces.
B. Apply a small amount of sealant to the seat ring threads and sealing shoulder. Install seat ring into valve body.
   Note: A sealant compatible with the process should be applied sparingly.
C. Install and tighten seat ring using wrench used for removal.

   CAUTION
   Do not overtighten. Do not strike seat ring lugs directly. This could distort the seat ring resulting in unwanted seat leakage.

D. Carefully install plug and stem assembly.
   Note: Valve should be lapped before final assembly. See Section 7.3.
E. Install body gasket (11).
   Note: Spiral wound body gaskets (11) are standard in the 21000 Series design. It is imperative that a new gasket be installed each time the valve is disassembled.
F. Assemble bonnet (8) and body stud nuts (10). Bonnet must be positioned so the packing flange studs are at 90° to the flow center line.

   CAUTION
   Tighten nuts (10) until metal to metal contact is obtained with proper bolt torque. Refer to Figure 11 for proper bolt torque and tightening sequence specifications.

G. Insert packing (6) [and lantern ring (7) on valve equipped with an optional lubricator connection]. Refer to Section 7.6 for proper packing assembly procedure for standard or optional designs.
H. Install packing follower (5) and packing flange (4).
I. Install packing flange stud nuts (3).

   CAUTION
   Do not overtighten (See Section "7.6. Packing Box").

J. If a leak detection connection was installed, connect it on the lateral NPT port in the bonnet. If not, ensure that the 1/4” NPT plug remained in place (Figure 5).
K. For actuator assembly and plug stem adjustment, proceed to the actuator instruction Ref. 19530 for a type 87/88 actuator.

8.2 Quick-Change Trim (Figure 13 or 15)
A. Clean all gasket mating surfaces.
B. Install seat ring gasket (15) and seat ring (14).
   Note: Spiral wound gaskets (11 & 15) are standard in the 21000 Series design. It is imperative that a new gasket be installed each time the valve is disassembled.
C. Install cage (13).
D. Carefully install plug and stem assembly.
   Note: Valve should be lapped before final assembly. See Section 7.3.
   Note: For 2” valves with Cv 30 Lo‑dB / Anti‑Cavitation trim only, steps C and D must be reversed such that the plug and stem assembly is installed prior to the cage.
E. Install body gasket (11).
F. Assemble bonnet (8) and body stud nuts (10) and tighten. Bonnet must be positioned so the packing flange studs are at 90° to the flow center line.

   CAUTION
   Care must be taken to ensure that the cage, seat, and bonnet are properly aligned in the body. Cage should be installed with parts at lower end, near seat ring. Tighten nuts (10) until metal to metal contact is obtained with proper bolt torque. Refer to Figure 11 for proper bolt torque and tightening sequence specifications.

G. Insert packing (6) [and lantern ring (7) on valve equipped with an optional lubricator or leak detection connection]. Refer to Section 7.6 for proper packing assembly procedure for standard or optional designs.
H. Install packing follower (5) and packing flange (4).
I. Install packing flange stud nuts (3).

   CAUTION
   Do not overtighten (See Section “7.6. Packing Box”).

J. If a leak detection connection was installed, connect it on the lateral NPT port in the bonnet. If not, ensure that the 1/4” NPT plug remained in place (Figure 5).
K. For actuator assembly and plug stem adjustment, proceed to the actuator instruction Ref. 19530 for a type 87/88 multispring actuator.

8.3 High Pressure & Angle Design (Figures 16 & 17)
Standard trim is used within these optional body configurations. Refer to the applicable sections within this instructions manual.
9. Actuators

9.1 Types 87/88 Actuators

Assemble the pneumatic actuator onto the control valve using the appropriate instructions for the specific actuator model and type. Connect air pressure lines to the actuator ports to meet intended operating mode (i.e., air-to-extend, air-to-retract, or double-acting). For further details dealing with removal, maintenance, assembly and adjustment, please refer to Instruction Manual 19530.

10. Bellows Seal Assembly

**CAUTION**

Since this is a sealing bellows, the plug stem should never be turned under any circumstances.

There is a built-in anti-rotation feature, consisting of a double flat surface machined on the plug stem that slides into a rectangular slot machined in the upper bushing (30) of the bellows (see Figure 19 – Section a).

**CAUTION**

IT IS IMPORTANT TO DISCONNECT THE ACTUATOR FROM THE VALVE BEFORE CHANGING THE ACTUATOR ROTATIONAL POSITION.
Figure 4 – Seat Lapping Device

Figure 6 – Braided Flexible Graphite Configuration

Figure 8
Lo-dB (Type 21900) and Anti-cavitation (Type 21800) Double Stage Trim (Optional)
Figure 9 – Plug Stem Pinning

Cylindrical machining diameter of the jaws = plug guide diameter “A”

Soft metal or plastic vise jaws


<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<td>in.</td>
<td>mm</td>
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<td>1/2</td>
<td>12.70</td>
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<td>.138</td>
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<td>60.32</td>
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<td>19.05</td>
<td>.197</td>
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<tr>
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<td>69.85</td>
<td>3/4</td>
<td>19.05</td>
<td>.197</td>
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Figure 10 – Packing Ring Arrangements with Optional Lubricator Connection

Valve Size

Quantity of Packing Rings (6)

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<td></td>
<td>Kevlar/PTFE</td>
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<tr>
<td>in.</td>
<td>Above</td>
</tr>
<tr>
<td>3/4 to 4</td>
<td>20 to 100</td>
</tr>
<tr>
<td>6 to 8</td>
<td>150 to 200</td>
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Packing box with Kevlar/PTFE packing rings

Packing box with Flexible Graphite packing rings and Back-up rings

Flexible Graphite Rings

Braided Back-up Rings

Lantern Ring (7)
Assembly Torque Requirements

<table>
<thead>
<tr>
<th>Valve Size</th>
<th>ANSI Class</th>
<th>Bolting Requirements</th>
<th>Torque Requirements</th>
<th>Pre-Load</th>
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<td></td>
<td>Qty.</td>
<td>Size (inch)</td>
<td>Lbs.Ft</td>
</tr>
<tr>
<td>.75 &amp; 1</td>
<td>20 &amp; 25</td>
<td>150 &amp; 300</td>
<td>4 1/2&quot;,13NC-2A</td>
<td>25</td>
</tr>
<tr>
<td>1.5 &amp; 2</td>
<td>40 &amp; 50</td>
<td>150 &amp; 300</td>
<td>8 1/2&quot;,13NC-2A</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>6  5/8&quot;,11NC-2A</td>
<td>45</td>
<td>61</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>150 &amp; 300</td>
<td>8 5/8&quot;,11NC-2A</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>150 &amp; 300</td>
<td>12 5/8&quot;,11NC-2A</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>150 – 600</td>
<td>12 1-1/4&quot;,8NC-2A</td>
<td>235</td>
</tr>
</tbody>
</table>

Notes:
1. Do not exceed Maximum Torque values listed.
2. Tighten in increments until required torque levels are reached.
3. Reject assembly if metal-to-metal contact is not achieved after reaching Maximum Torque.
4. Torque requirements shown are for standard B7 studs and 2H nuts.

Bellows Bonnet Assembly Torque Requirements

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Size (inch)</th>
<th>Lbs.Ft</th>
<th>N.m</th>
<th>Lbs.Ft</th>
<th>N.m</th>
<th>Lbs.Ft</th>
<th>N.m</th>
<th>Lbs.Ft</th>
<th>N.m</th>
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</thead>
<tbody>
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<td>8</td>
<td>1/2&quot;,13NC-2A</td>
<td>20</td>
<td>27</td>
<td>30</td>
<td>41</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>7</td>
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<td>8</td>
<td>5/8&quot;,11NC-2A</td>
<td>25</td>
<td>34</td>
<td>55</td>
<td>75</td>
<td>10</td>
<td>14</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

Notes:
1. Do not exceed Maximum Torque values listed.
2. Tighten in increments noted until required torque levels are reached.
3. Torque requirements shown are for standard B7 studs and 2H nuts.

Figure 11 – Bolting Torques and Tightening Sequence
### PARTS REFERENCE

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Part Name</th>
<th>Ref.</th>
<th>Part Name</th>
<th>Ref.</th>
<th>Part Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plug Stem</td>
<td>9</td>
<td>Body Stud</td>
<td>17</td>
<td>Plug Pin</td>
</tr>
<tr>
<td>2</td>
<td>Packing Flange Stud</td>
<td>10</td>
<td>Body Stud Nut</td>
<td>18</td>
<td>Body</td>
</tr>
<tr>
<td>3</td>
<td>Packing Flange Stud Nut</td>
<td>11</td>
<td>Body Gasket</td>
<td>19</td>
<td>Drive Nut</td>
</tr>
<tr>
<td>4</td>
<td>Packing Flange</td>
<td>12</td>
<td>Plug Guide Bushing (Incl. w/ref. 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Packing Follower</td>
<td>13</td>
<td>Cage *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Packing</td>
<td>14</td>
<td>Seat Ring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Lantern Ring (optional)</td>
<td>15</td>
<td>Seat Ring Gasket *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Bonnet</td>
<td>16</td>
<td>Plug</td>
<td></td>
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</tr>
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</table>

- Recommended spare parts: *
- Only on Quick Change Trim

---

**Figure 12**
Threaded Seat Ring - Contoured Plug - Full Capacity

**Figure 13**
Quick Change Trim - Contoured Plug - Full Capacity

**Figure 14**
Threaded Seat Ring - Lo-dB Plug

**Figure 15**
Quick Change Trim - Lo-dB Plug
10.1 Bellows Valve Disassembly
(Figure 19)

Note: Spiral wound gaskets are standard in the 21000 BS Series design. IT IS RECOMMENDED THAT NEW GASKETS ARE INSTALLED EACH TIME THE VALVE IS DISASSEMBLED.

10.1.1 Threaded Trim

After removing the actuator, disassemble the body S/A using the following procedure:

- Disconnect the leak-off circuit from the bonnet (if this option is included). Remove nuts (27) and bonnet studs (26) from the bonnet (25).
- Remove packing flange stud nuts (3), packing flange (4) and packing follower (5). Remove bonnet (25).
- Remove existing packing (6).
- Remove body stud nuts (10).
- Remove bonnet extension (29), stem bellows S/A (30) and plug (16) at the same time.
- Remove the plug pin (17), then remove the plug (16) from the plug stem (30). (See section 10.2.1.1 for unpinning the plug stem).
- Remove stem bellows S/A (30) by the top of the bonnet extension (29). If necessary, disengage the upper bushing of assembly (30) using a screwdriver in the groove provided for this purpose.

CAUTION

Be careful not to damage the seating surfaces of the bellows bushing.

• Remove the bonnet and spacer gaskets (28) and the body gasket (11).
• Bonnet extension (29), plug (16), guide bushings and seat ring (14) may now be inspected for wear and service damage. After determining the maintenance required, proceed to the appropriate section of these instructions.

10.1.2 Quick-Change Trim

Removal of the quick-change trim is accomplished using the same procedures as removal of the threaded trim.

However, after the bonnet extension (29) has been removed from the body, remove the cage (13), the seat ring (14) and the seat ring gasket (15).
10.2 Repair

The purpose of this section is to provide recommended maintenance and repair procedures. These procedures assume the availability of standard shop tools and equipment.

10.2.1 Plug/Stem Bellows/Bonnet Extension S/A

Plug stem pinning in the field may be required for:

- Replacing existing plug and stem-bellows S/A
- Replacing stem-bellows S/A only

Note: If the plug needs replacing, the stem-bellows sub-assembly should be replaced at the same time.

The original pin hole in a stem which is being reused sometimes prevents a satisfactory result being obtained and can also weaken the plug-stem assembly.

If the stem-bellows sub-assembly is being replaced, the new assembly can be fitted on an existing plug as long as it is in good condition and the removal of the pin has not deformed the hole or damaged it in any other way.

Note: Always use soft metal vise jaws to hold the plug guide surface. Failure to take this precaution could result in damage to the plug guide surface during pinning (see Figure 18).

Be careful not to damage the plug seating surface during pin removal and assembly operations.

10.2.1.1 Unpinning the Plug Stem

- Pull and hold the plug (16) out of the bonnet extension (29) to allow access to the plug pin (17). Place the plug guide on a V-block.

Note: A lower mechanical stop has been provided to prevent damage of the bellows during this step.

- Using a drift punch, drive out the existing pin (17).

Note: If it is necessary to drill out the pin, use a drill bit slightly smaller than the pin diameter. Be careful not to damage the hole of the plug guide.

- Lock two nuts against each other on the end of the plug stem, and use a flat spanner on the upper nut to prevent rotation of the stem-bellows S/A. Screw the plug onto the lower part of the stem while inserting the plug shank into the guide bushing (12) in the bonnet extension (29).

- Pull and hold the plug (16) out of the bonnet extension (29) to allow access to the plug pin (17).

B. Drilling the New Parts

- If the plug is already fully drilled, (typical for 440C hardened stainless steel material or solid Stellite or Equivalent), then drill the stem to the same diameter (Diameter C in Figure 18) as the Plug Shank Hole.

- If the plug guide area has a center mark, Place the plug guide on a V-block and use a suitable size drill to either:
  - Match the hole size in the plug, or
  - Match Diameter C (see Figure 18).

- Drill through the plug-stem assembly.

- If the plug guide area has no hole or any center mark,
  - Measure Dimension D based on the plug guide diameter and stem diameter (see Figure 18).
  - Place the plug guide on a V-block, and make a center mark on the plug guide area using a center punch.
  - Drill through the plug-stem assembly using a suitable size drill bit.

In all cases after drilling: Remove any burrs from the plug guide hole by making a slight chamfer.

C. Pinning the Plug-Stem Assembly

- Select the correct size pin based on the plug guide diameter and stem diameter (see Figure 18). Apply a small amount of grease on the pin and hand-assemble it into the hole in the plug.

- Press fit the pin into the hole using a hammer. Complete the pinning operation by ensuring that the pin is recessed by the same amount from both sides (see Figure 18).

Replacing Stem/Bellows S/A Only

A. Screw Stem into Plug

- Refer to paragraph A of the previous section “REPLACING PLUG AND STEM/BELLOWS S/A”.

B. Drilling the New Stem

- Place the plug guide on a V-block and use a suitable size drill bit to drill the stem (use the hole in the plug as a guide).

Note: If the hole in the plug guide has been slightly damaged while removing of the old pin, choose a drill bit and a pin with a slightly larger diameter than the normal pin.

C. Pinning

- Select the correct size pin based on plug guide diameter and pin hole diameter. Proceed as described in Paragraph C above, taking care not to damage the plug guide area.
10.3 Plug and Seat Ring Seating Surfaces

It is not possible to lap the plug and seat ring seating surfaces after the bellows has been assembled to the stem.

If the seat ring shows signs of minor wear, it should be turned on a lathe to clean up the worn area. The seating surface of the seat ring is 30 degrees from centerline axis. However, no more than 0.010 in. (0.25 mm) of material should be removed.

In cases where the seat ring cannot be repaired, or if the plug is also damaged the only alternative is to replace both parts.

10.4 Bonnet Reassembly

Place new gasket (28) into the groove of the bonnet spacer. Install the bonnet (25) and assemble nuts (27) and studs (26). Bonnet must be positioned so the packing flange studs are at a 90° angle to the flow centerline.

Refer to table in Figure 11 for proper bolt torque and tightening sequence.

10.5 Valve Body Reassembly

Refer to instructions stated in Section 8 for the specific trim type involved.

10.6 Actuator to Body S/A and Plug Stem Adjustment

Refer to instruction Ref. 19530.

**WARNING**

Assembly of the No. 6 actuator on a bellows seal valve requires a three-sectioned coupling. Follow coupling instructions as described for the No. 10, 16 and 23 actuators.

**CAUTION**

The bellows assembly causes a “spring back” effect. Measure this plug spring back before referring to Instruction Ref. 19530. Be sure to add this spring back length to the over seat adjustment.
Figure 19 — 21000 BS Valve

PARTS REFERENCE

<table>
<thead>
<tr>
<th>Ref.</th>
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<th>Ref.</th>
<th>Part Name</th>
<th>Ref.</th>
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- Recommended Spare Parts
- + These parts included in welded subassembly
- Quick change trim only
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