

**BETTIS**

**SERVICE INSTRUCTIONS**

**DISASSEMBLY & REASSEMBLY**

**301, 301-M3, 301-M3HW, 301-135**

**301-180, 301-180-M3 & 301-180-M3HW \***

**DOUBLE ACTING SERIES**

**RACK & PINION**

**PNEUMATIC ACTUATORS**

PROCEDURE NUMBER - Service - 081

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\* INCLUDES OBSOLETE 701 SERIES DOUBLE ACTING ACTUATORS

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## 1.0 **INTRODUCTION**

This Service Procedure is offered as a guide to enable general maintenance to be performed on Bettis 301, 301-M3, 301-M3HW, 301-135, 301-180, 301-180-M3, and 301-180-M3HW Rack and Pinion Series Pneumatic Actuators. NOTE: This procedure is for all revisions of model 301 actuators, i.e. 301 basic model (no revision letter), 301A, 301B, 301C and 301D.

**COMPLETE ACTUATOR REFURBISHMENT  
REQUIRES THAT THE ACTUATOR BE  
DISMOUNTED FROM THE VALVE**

## 2.0 **BASIC TOOLS**

All tools are American Standard inch. Large adjustable wrench, snap ring pliers, chain wrench, Allen wrench set, rubber or leather mallet, non-corrosive commercial leak testing solution, and non-hardening thread sealant.

## 3.0 **BETTIS REFERENCE MATERIALS**

- 3.1 301 and 301-180 Assembly Drawing 035799 page 1 of 2.
- 3.2 301 and 301-180 Exploded Detail Drawing 035799 page 2 of 2.
- 3.3 301-M3 and 301-M3HW Assembly Drawing 035800 page 1 of 2.
- 3.4 301-M3 and 301-M3HW Exploded Detail Drawing 035800 page 2 of 2.

## 4.0 **GENERAL INFORMATION**

- 4.1 Numbers in parentheses ( ), indicate the bubble number (reference number) used on the Bettis Assembly Drawing, Exploded Detail Drawing, and actuator Parts List.
- 4.2 Mating parts should be marked for ease of reassembly, i.e. cylinder to housing, right and left stop screws, etc.
- 4.3 When removing seals from seal grooves, use a small screwdriver with the sharp edges rounded off or use a commercial seal removing tool.
- 4.4 Use a non-hardening thread sealant on all pipe threads.
- 4.5 Disassembly of actuator should be done in a clean area on a work bench.

#### 4.6 LUBRICATION REQUIREMENTS.

4.6.1 Standard and high temperature service (-20° degrees F to +350° degrees F) use Bettis ESL-5, Kronaplate 100 lubricant.

4.6.2 Low temperature service (-50° F to +150° F) use Kronaplate 50 lubricant.

### 5.0 GENERAL DISASSEMBLY

5.1 Remove all operating pressure from actuator cylinder (3) or cylinder assembly M3 (3-10).

5.2 Remove all piping and accessories mounted on actuator.

5.3 When actuator is equipped with an M3 or M3HW jackscrew assembly, make sure that jackscrew assembly (3-20) is not engaging piston and gear rack (2-10).

5.4 Actuators equipped with M3HW jackscrew with handwheel (8), remove hex nut from end of jackscrew. Unscrew and remove the handwheel (8).

5.5 The settings of the stop screws (2-20) and (2-30) should be checked and settings recorded before stop screws are loosened or removed. If the actuator is an M3 jackscrew actuator then check setting of the jackscrew assembly (3-20).

5.6 Remove actuator from valve and valve mounting bracket.

5.7 Remove snubber valve (2-50) from housing (1-10).

### 6.0 PRESSURE CYLINDER DISASSEMBLY

6.1 Secure the chain wrench around the cylinder (3) or cylinder assembly M3 (3-10) as close to the welded end cap as possible. Using the mallet, break the cylinder loose sufficiently so it can be removed.

6.2 Remove the cylinder and when setting the cylinder aside, care should be taken to protect the chamfered edge and cylinder threads.

6.3 Repeat steps 6.1 and 6.2 for second cylinder.

6.4 For actuators equipped with M3 or M3HW jackscrew override, the following steps will be used for disassembly of the M3 from cylinder assembly M3 (3-10).

6.4.1 With the cylinder assembly M3 (3-10) on a work bench, lubricate jackscrew assembly (3-20) threads with lubricant.

6.4.2 Loosen and thread nut seal (3-30) all the way back to the welded nut.

6.4.3 Thread the jackscrew assembly (3-20) into the cylinder assembly M3 (3-10) until the spiral pin (2-60) and flat washer (2-70) are exposed.

6.4.4 Using a 3/16 inch pin punch, drive out and remove pin (2-60).

6.4.5 Remove flat washer (2-70).

6.4.6 Thread the jackscrew assembly (3-20) out and remove.

6.4.7 Remove nut seal (3-30).

## **7.0 HOUSING DISASSEMBLY**

7.1 Remove piston seal (6-20) from piston and gear rack (2-10).

7.2 Loosen the set screw (1-70) and remove the position indicator (1-60) from the torque plug (1-20).

7.3 Remove snap ring (1-30) from torque plug (1-20).

7.4 Grasp actuator housing (1-10) and turn unit upside down (square stem down). By slowly pushing down on housing, the torque plug (1-20) should slide out approximately 2 inches (50 mm).

7.5 Remove the torque plug (1-20) from housing.

7.6 Remove o-ring seals (6-30) and (6-40) from the torque plug.

7.7 Remove piston and gear rack (2-10) from housing (1-10).

7.8 Remove cylinder o-ring seals (6-10) from housing (1-10). The seals are located in each end of the housing.

## **8.0 PREASSEMBLY NOTES**

8.1 Remove all old seals taking care not to scratch or damage seal grooves.

8.2 Before starting the assembly of an actuator, all parts should be thoroughly cleaned, inspected, and de-burred. Particular attention should be directed to threads, sealing surfaces, and areas that will be subjected to sliding motion.

## **9.0 HOUSING REASSEMBLY**

9.1 Coat the threads in the housing (1-10) with lubricant.

9.2 Coat the cylinder seals (6-10) with lubricant and install into the grooves provided at the end of the threaded portion in each end of the actuator housing (1-10).

9.3 Coat the torque plug bores in the housing with lubricant and arrange the housing with the large torque plug bore down and the hole for the breather (2-50) facing away.

9.4 Coat all of the teeth on the piston and gear rack (2-10) except for the space between the two center teeth. This will provide a visual alignment for later use.

- 9.5 Place the piston and gear rack (2-10) into the housing (1-10) with the gear tooth side of the rack on the side of the housing with the hole for the breather (2-50). Lengthwise, center the rack inside the housing.
- 9.6 Coat the lower torque plug o-ring seal (6-40) with lubricant and install into the bottom groove on the torque plug (1-20).
- 9.7 Coat the upper torque plug o-ring seal (6-30) with lubricant and install into the upper groove on the torque plug (1-20).
- 9.8 **TORQUE PLUG ALIGNMENT AND LUBRICATION.** (Refer to Figures 1 through 3, mid-stroke positions).
  - 9.8.1 **Figure 1 301 - 90° Degree Actuator** Coat all of the torque plug gear teeth with lubricant except for one tooth that corresponds with the centerline of one of the flats on top of the torque plug. Figure 1 shows one face of torque plug is parallel to actuator centerline.
  - 9.8.2 **Figure 2 & 3 301 - 135°/180° Degree Actuator** Coat all of the torque plug gear teeth with lubricant except for one tooth that corresponds with one of the corners on top of the torque plug. Figures 2 and 3 show corners of stem are on centerline of actuator.
- 9.9 Pick up housing, containing the piston and gear rack, and set it down over the torque plug (1-20). Engage the non lubricated gear tooth on the torque plug with the non lubricated space on the piston and gear rack. Again, refer to Figures 1 through 3 (mid-stroke position) for piston/torque plug alignment.
  - 9.9.1 Figure 1 - 301 - 90° Degree
  - 9.9.2 Figure 2 - 301 - 135° Degree
  - 9.9.3 Figure 3 - 301 - 180° Degree
- 9.10 Install the retaining ring (1-30) into the groove at the top of the torque plug.
- 9.11 Coat the piston seals (6-20) with lubricant and install into the groove provided on the piston and gear rack (2-10). Install piston U-cup seal with the lip of the seal pointing away from the housing.

## **10.0 PRESSURE CYLINDER REASSEMBLY**

- 10.1 For actuators equipped with M3 jackscrew overrides, pre-assemble the M3 into cylinder assembly M3 (3-10) using the following procedure.
  - 10.1.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with the Teflon side facing away from the welded nut.
  - 10.1.2 Thread the nut seal until it is up against the welded nut.

- 10.1.3 Apply a generous coating of lubricant to the M3 threads (3-20).
  - 10.1.4 Thread the jackscrew assembly (3-20) into the cylinder end cap. Turn the jackscrew until the end of the assembly protrudes out of the threaded end of the cylinder.
  - 10.1.5 Install flat washer (2-70) and spiral pin (2-60) as shown on assembly drawing.
  - 10.1.6 Turn the jackscrew until the flat washer (2-70) just comes into contact with the cylinder end cap.
  - 10.1.7 If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, lubricant may be left on jackscrew to provide additional corrosion protection.
  - 10.2 Apply a thin coating of lubricant to the bore of the cylinder (3) or cylinder assembly M3 (3-10).
  - 10.3 Install the cylinder (3) or cylinder assembly M3 (3-10) over the piston, screwing into the housing (1-10). Tighten with a chain wrench. Exercise caution to prevent pinching of the piston cup seal lip during installation. It is necessary to depress the seal lip while working the cylinder over it. The chain wrench should be secured as close to the welded end cap as possible.
  - 10.4 Repeat steps 10.1 through 10.3 for second cylinder.
  - 10.5 Install the stop screws (2-20) and stop screw nuts (2-40) into the cylinders (3).
  - 10.6 Adjust both of the stop screws\* (2-20) and (2-30) back to settings recorded in step 5.5 under General Disassembly. Tighten both of the, stop screw seal nuts (2-40) securely, while holding the stop screws (2-20).
- \*If actuator is equipped with a M3 jackscrew then substitute stop screw (2-40) with jackscrew assembly (3-20).

## **11.0 ACTUATOR TESTING**

- 11.1 Leakage Test - General
  - 11.1.1 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.
- 11.2 Procedure:
  - 11.2.1 Cycle the actuator five times at 65 psig air pressure. This will allow the seals to seek their proper working attitude.
  - 11.2.2 Apply 65 psig air pressure to the housing pressure inlet port.

11.2.3 Apply a leak testing soap solution to the following areas:

11.2.3.1 Cylinder stop screw seal nut or cylinder assembly  
M3 jackscrew assembly seal nut.

11.2.3.2 Housing snubber valve hole.

11.2.4 Repeat steps 11.1 through 11.2.3.2 for second cylinder (3) or (3-10).

11.2.5 If excessive leakage is noted (generally a bubble which breaks three seconds or less after starting to form), the actuator must be disassembled and the cause of leakage must be determined and corrected.

11.2.6 If an actuator was disassembled and repaired as a result of this procedure, the above leakage test must be performed again.

## **12.0 RETURN TO SERVICE**

12.1 Reinstall snubber valve (2-50).

12.2 Reinstall position indicator (1-60) and tighten socket set screw (1-20). Refer to Figure 5.

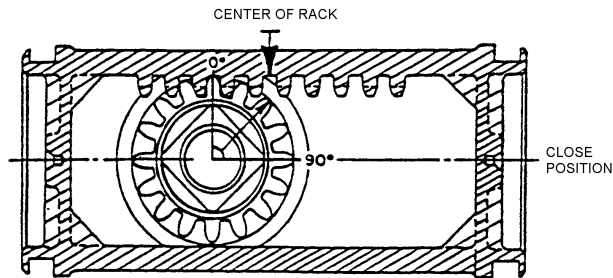
12.3 Reinstall actuator to valve mounting bracket and valve.

12.4 Reinstall any piping and accessories that were removed.

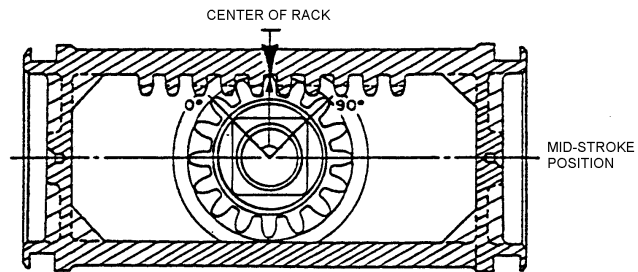
12.5 All accessories, including solenoid valves, positioners, pressure switches, etc., should be hooked up at this point and tested for proper operations and replaced if found defective.



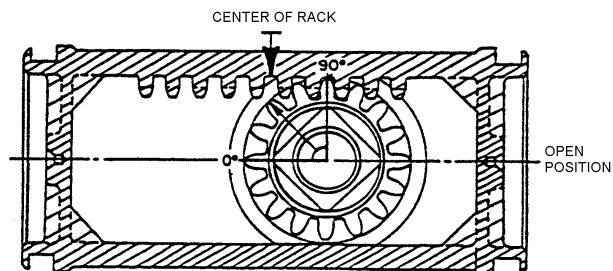
301(90° ACTUATOR) ROTATED TO CLOSED POSITION (0°)



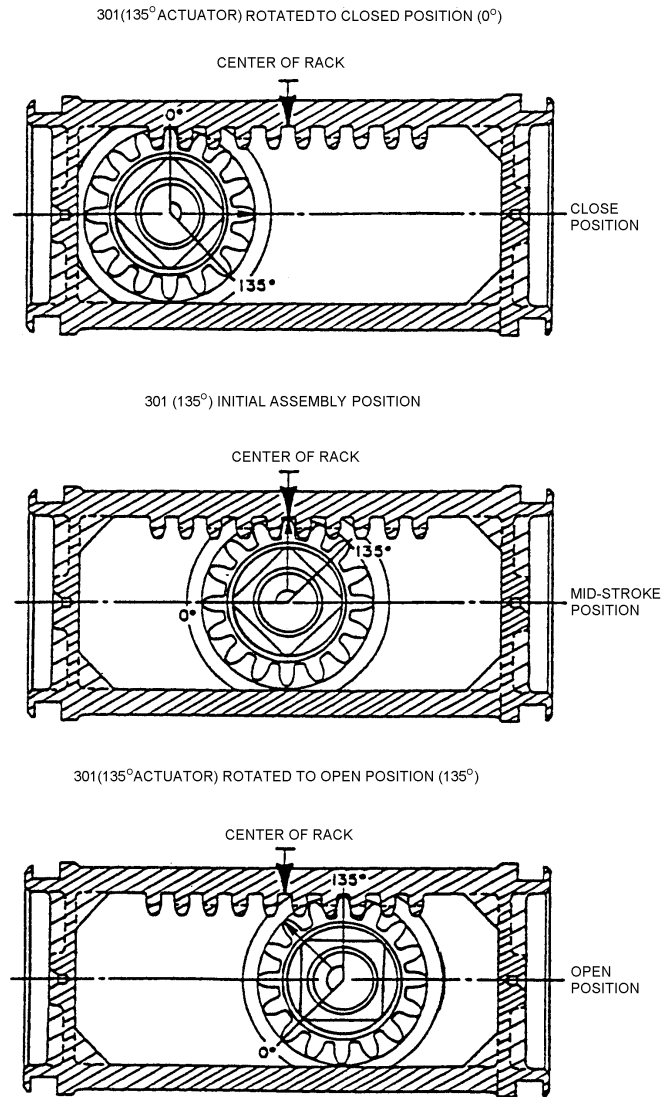
301 (90° ACTUATOR) INITIAL ASSEMBLY POSITION



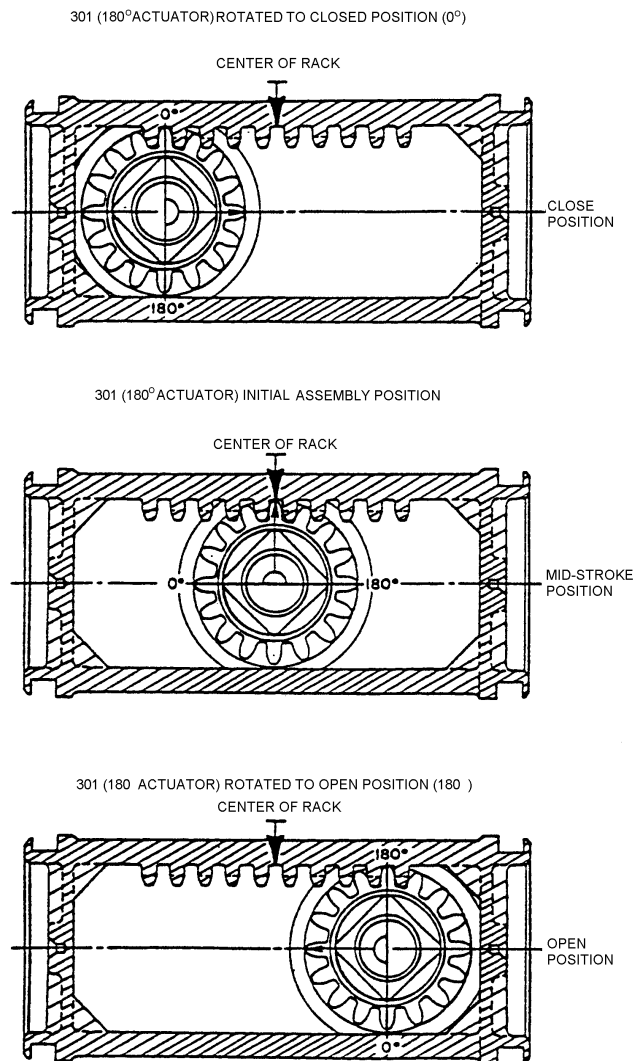
301 (90° ACTUATOR) ROTATED TO OPEN POSITION (90°)



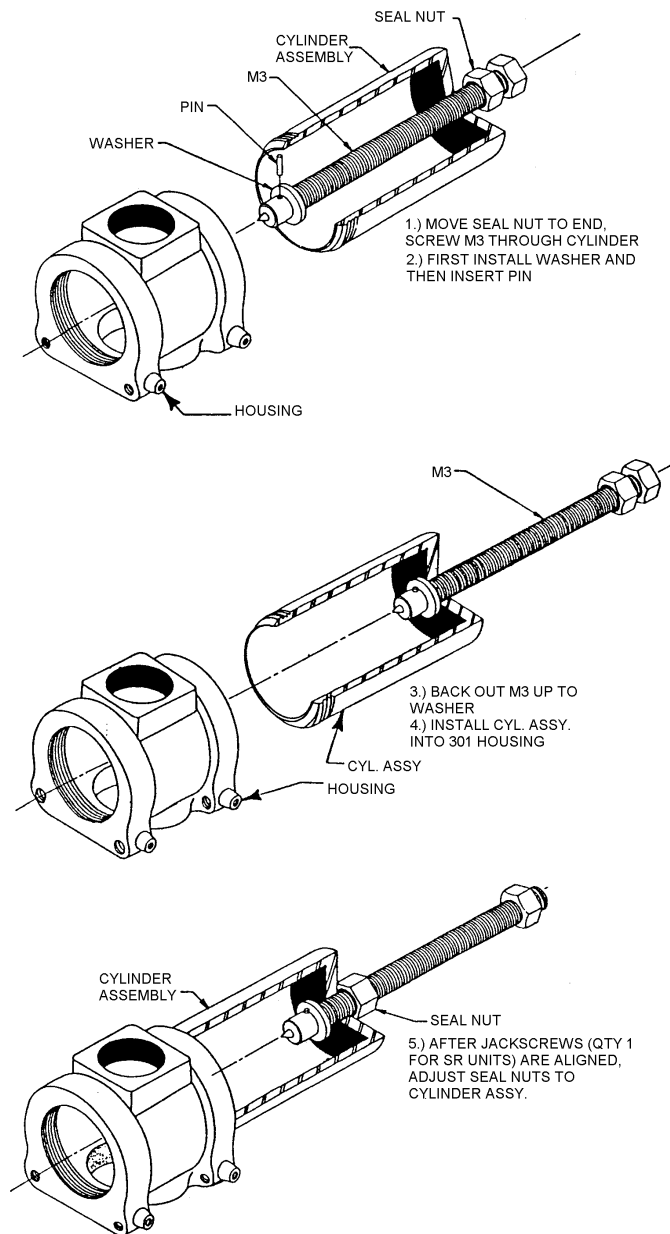
**FIGURE 1: PISTON GEAR/RACK AND TORQUE PLUG ALIGNMENT FOR 301D-90°/ 301-SR-90°**



**FIGURE 2: PISTON GEAR/RACK AND TORQUE PLUG ALIGNMENT FOR 301D-135°/ 301D-SR-135°**



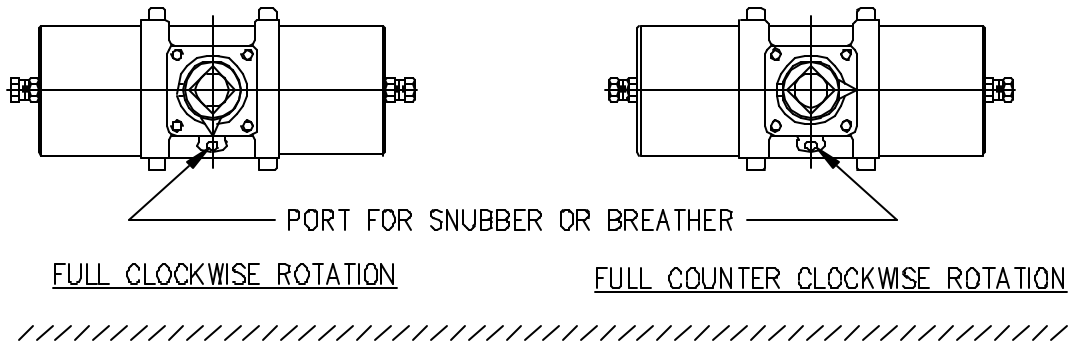
**FIGURE 3: PISTON GEAR/RACK AND TORQUE PLUG ALIGNMENT FOR 301D-180°/ 301D-SR-180°**



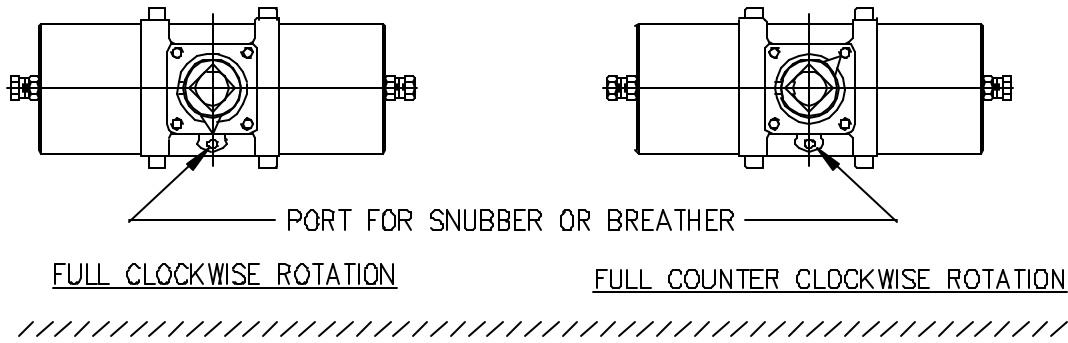
\*INTERNAL HOUSING COMPONENTS DELETED FOR CLARITY.\*

**FIGURE 4 - M3 ASSEMBLY EXPLODED DRAWING**

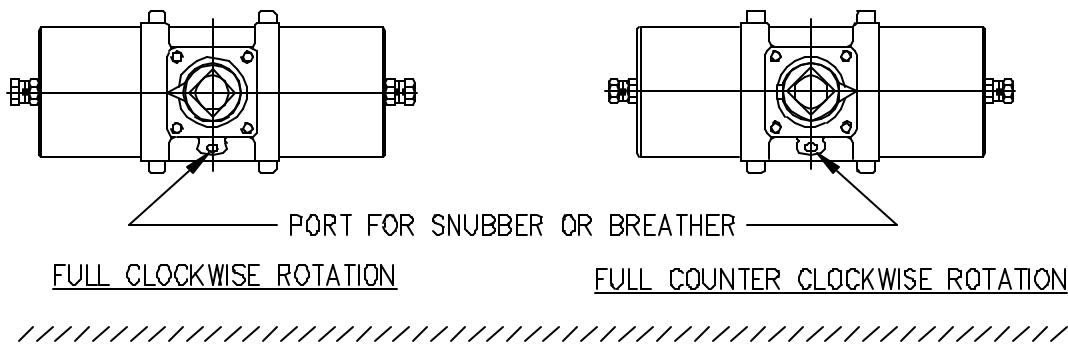
301 DOUBLE ACTING ACTUATOR



301-135 DOUBLE ACTING ACTUATOR



301-180 DOUBLE ACTING ACTUATOR



301 SERIES ACTUATOR  
POSITION INDICATION

FIGURE NUMBER 5

## CHART 1

### PRESSURE REQUIREMENT & LIMITATIONS FOR MODELS

#### 301 – DOUBLE ACTING ACTUATORS

<u>ACTUATOR MODEL (1)</u>	NOMINAL OPERATING PRESSURE <u>NOP</u>	MAXIMUM OPERATING PRESSURE <u>(MOP)</u>	MAXIMUM
301	(2)	250	300
301-180	(2)	250	300
301-135	(2)	250	300

(1) Includes actuator models that have M3 and M3HW included in their model numbers, i.e. 301-M3 or 301-180-M3HW

(2) Per customer specification or not applicable