



INSTALLATION, OPERATION & MAINTENANCE MANUAL
HIGH PRESSURE GAS-HYDRAULIC ACTUATOR

© ATI

4950 Cranswick

Houston, TX 77041

Phone +1 (713) 934-0171 • Fax +1 (713) 934-9099 • Toll Free +1 (800) 924-8037

TABLE OF CONTENTS

1	Introduction	2
1.1	Company Background	2
1.2	Scope	2
1.3	Applicable Product	2
2	Warning Statement	3
3	Handling and Storage	4
3.1	Receiving the Product	4
3.2	Storage and Preservation	4
4	Product Description	5
4.1	General Description	5
4.2	Product Operation	5
5	Installation Instructions	6
5.1	Assembly to Valve	6
5.2	Setting the Stroke Length	9
5.3	Setting the Stroke Time	10
6	Preparation for Start-up	10
6.1	Pneumatic Connections	10
6.2	Electrical Connections	10
6.3	Start-up	11
7	Maintenance	11
7.1	Warning	11
7.2	Checking Oil Level in Oil Tanks	16
7.3	Hydraulic Oil Features	16
7.4	Lubricating Mechanism	16
8	Terms and Conditions/Warranty	18
9	Revision Record	20

Appendices



1 Introduction

1.1 *Company Background*

Automation Technology was founded in 1995 as a manufacturer of pneumatic and hydraulic valve actuators. With products in a wide range of applications such as petrochemical, pipelines, refineries, pulp and paper, agriculture, pharmaceutical, municipalities, mining, power plants and marine transportation, ATI has succeeded in becoming a global leader in automation technology.

1.2 *Scope*

This manual is intended to assist those who are involved with the installation, operation and maintenance of the ATI High Pressure Gas-Hydraulic Actuator, also described as gas-over-oil actuators. This manual should be reviewed and thoroughly understood PRIOR to installing, operating or providing maintenance on the device. If you have any questions or need clarification, contact ATI at +1 (713) 934-0171, or US Toll Free (800) 924-8037.

1.3 *Applicable Product*

This manual is strictly intended for the ATI High Pressure Gas-Hydraulic Actuators of a linear piston design, including scotch-yoke (model SY) hydraulic actuators and linear (model H/HDH) hydraulic actuators. Failure to read and comply with installation, operation and maintenance instructions may result in bodily injury or equipment damage and will void the manufacturer's warranty.



2 Warning Statement

THIS MANUAL DOES NOT CLAIM TO ADDRESS ALL SAFETY FACTORS ASSOCIATED WITH ATI PRODUCTS. IT IS THE RESPONSIBILITY OF THE USER TO ENSURE PROPER SAFETY. ALWAYS TAKE NECESSARY PRECAUTIONS AND UTILIZE PROPER PERSONAL PROTECTIVE EQUIPMENT (PPE) WHEN DEALING WITH COMPRESSED GAS, PRESSURIZED HYDRAULIC FLUID, PINCH POINTS, AND ELECTRICITY.

VALVE, ACTUATOR, AND OTHER SKID-MOUNTED EQUIPMENT MUST BE RIGGED AND LIFTED SEPARATELY, NEVER AT THE SAME TIME. BEFORE RIGGING, ENSURE THE CRANE/HOIST/RIGGING HARDWARE LIFTING CAPACITY CAN SAFELY ACCOMMODATE THE DESIRED LOAD.

ACTUATORS AND VALVES COME INTO CONTACT WITH CAUSTIC GASES AND FLUIDS IN MANY APPLICATIONS. AS A RESULT, ALL TOXIC OR FLAMMABLE FUMES MUST BE VENTED AND LIQUIDS MOVED TO A SAFE LOCATION. THIS WILL HELP PREVENT PERSONNEL INJURY. THE INSTANTANEOUS RELEASE OF PRESSURE AND VENTING CAN PRODUCE NOISES DUE TO THE DISCHARGE AT SONIC VELOCITY. IT IS THE USER'S RESPONSIBILITY TO UTILIZE APPROPRIATE PROTECTION AGAINST HEARING DAMAGE TO ANY AND ALL NEAR THE ACTUATOR.

WARNING LABELS AND TAGS LOCATED ON THE PRODUCTS ARE MADE OF METAL FOILS THAT VARY IN THICKNESS. BECAUSE THE METAL TAGS HAVE SHARP EDGES, PERSONNEL INSTALLING, HANDLING, OR WORKING AROUND THE TAGS SHOULD PROTECT AGAINST CUTS OR INJURY.

PROPER INSTALLATION OF THE PRODUCT IS CRITICAL TO PERFORMANCE AND SAFETY. DUE TO THE MANY VARIATIONS OF ACTUATORS, VALVES, AND RELATED CONTROLS, THE FOLLOWING ARE GENERAL INSTRUCTIONS. EACH TECHNICIAN FOLLOWING THESE INSTRUCTIONS MUST BE COMPETENT, TRAINED, AND HAVE A WORKING KNOWLEDGE OF VALVES, VALVE ACTUATORS AND ACTUATOR CONTROLS.

FOLLOWING THE ABOVE INSTRUCTIONS WILL HELP IN PREVENTING PERSONAL INJURY, PROPERTY DAMAGE, AND DAMAGE TO THE PRODUCT.



3 Handling and Storage

3.1 Receiving the Product

Proper care and precautions should be taken when unloading and handling the actuator, especially when rigging and lifting. Ensure that the valve is not connected to the actuator.

- Check that the actuator has not been damaged during transport.
- Check that the model, serial number and performance data on the data-plate match those in the order acknowledgement, test certificate and delivery note.
- Check that the fitted accessories comply with those listed in the order acknowledgement and the delivery note.
- For actuators shipped assembled to the valve, the settings of the mechanical stops and the settings of limit switches (if applicable) have been completed during assembly of the actuator to the valve. These settings should be checked before start-up and, if necessary, adjusted to requirements of the application.
- For actuators shipped separately from the valve, the settings of the mechanical stops and the settings of limit switches (if applicable) must be checked and adjusted while assembling the actuator onto the valve.

3.2 Storage and Preservation

ATI actuators leave the factory in excellent working condition and with an excellent finish (these conditions are guaranteed by an individual inspection certificate). To maintain these characteristics until the actuator is installed, it is necessary to take appropriate measures during the storage period.

- Plugs must be fitted in all ports for air connections, hydraulic connections, and cable entries. Plastic plugs are typically used to protect against the entry of foreign matter during transport, and these plastic plugs do not have a weatherproof function. If equipment is stored outdoors, the plastic protection plugs must be replaced by metal plugs to ensure weatherproof protection.
- If the actuators are supplied separately from the valves, they must be placed onto a wooden pallet so as not to damage the coupling flange to the valve. In case of long-term storage, the coupling parts (flange, drive sleeve, insert bush) must be coated with protective oil or grease. If possible, cover the mounting flange with a protection disk
- In case of long-term storage, it is advisable to keep the actuators in a dry place or to provide at least some means of weather protection. Periodically operate the actuator with filtered, dehydrated and lubricated air; after such operations all the threaded connections of the actuator and the valves of the control panel (if existing) should be carefully plugged. For long-term storage, all plastic protection plugs must be replaced by metal plugs to ensure weatherproof protection.

4 Product Description

4.1 General Description

ATI gas-hydraulic piston actuators are suitable for operating valves and dampers, in On-Off and Modulating heavy-duty service.

For quarter-turn valves, the actuator piston drives a scotch-yoke mechanism. The actuator stroke of the yoke is adjustable between 85° and 95° by means of external mechanical stops that are screwed into the end flange of the hydraulic cylinder and into the actuator housing.

For linear, rising-stem valves, the actuator piston drives the valve stem directly. Mechanical stops in the stem coupling may be adjusted approximately +/- 1/2 inch up to 1 inch.

The actuator is designed for assembly of optional accessories (positioner, signaling limit switches, position transducer, etc.) by means of mechanical linkages. These accessories are generally operated by the quarter-turn actuator's drive sleeve/indicator and by the linear actuator's stem coupling.

The actuator includes a flange that will mount directly to the valve or to an adapter flange that mounts to the valve.

The actuator scotch yoke or piston rod is selected or manufactured to order to fit the shape and dimensions of the valve stem.

The high pressure hydraulic manual override, connected with the actuator hydraulic cylinder, allows valve operation to open or to close in the case of gas supply failure.

ATI can supply different types of control systems following customer requirements.

4.2 Product Operation

Refer to the drawing, OPER-RP, in Appendix A for the parenthetical references in the below subsections 4.2.1 through 4.2.4.

Note that the actuator displayed in OPER-RP is a linear piston driving a scotch yoke mechanism for a quarter turn operation. Omit the scotch-yoke, and this same linear piston can be directly connected to a rising-stem valve for linear service.

4.2.1 Pneumatic Operation with Hydraulic Manual Override

To allow the actuator pneumatic operation, the hand operated directional control valve (D) must be in its automatic control position with both hand knobs pulled out, as shown by the handpump instruction plate.

4.2.2 Pneumatic Opening Operation

When high-pressure gas is applied to the "Open" oil tank (2), hydraulic fluid is forced through the handpump into the outer compartment of the cylinder, via the speed control valve (Fa). As the piston in the cylinder moves, hydraulic fluid is forced out of the inside compartment of the



cylinder through the speed control valve (Fc) in the free flow direction, through the handpump and into the “Close” oil tank (3).

The speed control valve (Fa) allows the setting of the actuator operation speed in opening independently from the actuator speed in closing.

4.2.3 Pneumatic Closing Operation

When high-pressure gas is applied to the “Close” oil tank (3), hydraulic fluid is forced through the handpump into the inner compartment of the cylinder, via the speed control valve (Fc). As the piston in the cylinder moves, hydraulic fluid is forced out of the outer compartment of the cylinder through the speed control valve (Fa) in the free flow direction, through the handpump and into the “Open” oil tank (2).

The speed control valve (Fa) allows the setting of the actuator operation speed in closing, independently from the actuator speed in opening.

4.2.4 Manual Operation

With the hand operated directional control valve (D), select the operation (opening or closing) to be performed by pushing the corresponding handle.

Actuate the hand pump (P) until the desired position is obtained.

When complete, push down on the ram relief valve button, according to the instruction nameplate, to lower the ram into the handpump body and also to return the handpump to the auto position by pulling out the handle that was engaged to perform the selected operation.

The ATI standard handpump has an Auto Reset function that automatically resets the handpump to the Auto position when it senses hydraulic pressure from the force of a pneumatic operation. It is good practice to manually reset the pump to Auto when manual operation is completed.

5 Installation Instructions

5.1 *Assembly to Valve*

5.1.1 Model SY Actuators (quarter turn, scotch yoke)

The actuator can be assembled onto the valve flange either by using the actuator housing flange with threaded holes or by an adapter flange or a spool piece. The actuator drive sleeve is generally connected to the valve stem by an insert bushing or a stem extension. The assembly position of the actuator, with reference to the valve, must comply with the plant requirements (cylinder axis parallel or perpendicular to the pipeline axis).

To assemble the actuator onto the valve proceed as follows:

- 1) Check that the coupling dimensions of the valve flange and stem, or of the relevant extension, meet the actuator coupling dimensions.
- 2) Bring the valve to the “Closed” position.
- 3) Lubricate the valve stem with oil or grease in order to make the assembly easier. Be careful not to pour any oil or grease onto the flange.
- 4) Clean the valve flange and remove anything that might prevent a perfect adherence to the actuator flange.

NOTE: Be sure there are no traces of grease, since the torque is transmitted by friction.

- 5) If an insert bushing or stem extension for the connection to the valve stem was supplied separately, assemble it onto the valve stem.
- 6) Bring the actuator to the “Closed” position.
- 7) Connect a sling to the support points of the actuator and lift it. Make sure the sling is suitable for the actuator weight. When possible, it is easier to assemble the actuator to the valve if the valve stem is in the vertical position. In this case, the actuator must be lifted while keeping the flange in the horizontal position.
- 8) Clean the actuator flange and remove anything that might prevent a perfect adherence to the valve flange.
- 9) Lower the actuator onto the valve in such a way that the valve stem enters the actuator drive sleeve. This coupling must take place without force, using only the weight of the actuator. Once the valve stem has entered the actuator drive sleeve, check the holes of the valve flange. If they do not meet with the holes of the actuator flange or the stud bolts screwed into them, the actuator drive sleeve must be rotated; actuate the manual override until coupling is possible.

Tighten the nuts of the connecting stud bolts evenly with the appropriate torque. ATI recommends load-bearing fasteners per ASTM A-449, SAE Grade 5 or better.

- 10) If possible, operate the actuator to check that it moves the valve smoothly.

5.1.2 Model H/HDH Actuators (linear)

Refer to the sketch in Appendix B for the parenthetical references that follow in this section.

The instruction that follows is applicable for assembling linear actuators to rising stem valve that require an actuator that extends to the valve closed position and that retracts to the valve open position. For other configurations, refer to instructions in IOM1004, IOM1005 or IOM1006—linear hydraulic model H/HDH for Spring Return Extend (SRE), Spring Return Retract (SRR) or Double Acting (DA) service.

- 1) Position the subject valve to the full closed position (tight shut off).

- 2) Remove the valve hand wheel and hand wheel drive assembly. (See valve manufacturer's assembly/disassembly instructions).
- 3) Position the actuator in the full closed (piston rod (Item 1) fully extended) position.
- 4) Remove the coupling block assembly (Item 2) by removing the coupling block bushing retaining cap screw and lock washer (Items 3 & 4) from the coupling block.
- 5) Remove the pin spanner wrench (Item 5) from inside the adaption bracket.
- 6) Position spanner wrench (Item 5) in holes located in the coupling block bushing (Item 6) and turn counter clockwise until completely out of the coupling block. It is not necessary to remove the piston rod insert (Item 7) or set screw (Item 8).
- 7) Position the actuator in the full open position.
- 8) Remove position indicator guide (Item 9) screws (Item 10) and lock washers (Item 11).
- 9) Remove position indicator (Item 12) and stud (Item 13).
- 10) Position actuator and adaption bracket to final adaption or valve as per application. Attach with appropriate fasteners to recommended torque specs.
- 11) Position coupling block assembly over valve stem and thread on clockwise for right hand threads or counter clockwise for left hand threads. Thread down on valve stem until bottom of coupling block assembly is within 1/8" to 1/4" of the bottom of the adaption bracket. It is not necessary to remove threaded insert (Item 15).
- 12) Align the coupling block assembly to locate the position indicator hole with centerline of the adaption bracket.
- 13) Position the actuator in the full closed position (piston rod (Item 1) fully extended) position very slowly to install piston rod into the coupling block assembly.
- 14) Reinstall coupling block bushing (Item 6) with pin spanner wrench (Item 5). NOTE: DO NOT FULLY TIGHTEN UNTIL STEP 16 IS COMPLETED.
- 15) Reinstall position indicator (Item 12) and stud (Item 13).
- 16) Reinstall position indicator guide (Item 9) screws (Item 10) and lock washers (Item 11).
- 17) Tighten coupling block bushing (Item 6) with pin spanner wrench (Item 5), then install coupling block bushing retaining cap screw and lock washer (Items 3 & 4).
- 18) Cycle actuator and check for full open and full close. Adjustment may be necessary.
- 19) Adjustment may be made by repositioning the stop adjustment bolts (Item 14).
- 20) Reinstall pin spanner wrench on inside adaptation bracket.



5.2 *Setting the Stroke Length*

5.2.1 Model SY Actuators (quarter turn, scotch yoke)

It is important that the mechanical stops of the actuator (and not those of the valve) stop the angular stroke at both ends of travel (fully open and fully closed), except when this is required by the valve operation (e.g. metal seated butterfly valves).

The setting of the open valve position is performed by adjusting the travel stop screw in the actuator housing.

The setting of the closed valve position is performed by adjusting the travel stop screw in the end flange of the hydraulic cylinder.

Proceed as follows:

- 1) Remove the travel stop cover.
- 2) Loosen the lock nut.
- 3) If the actuator angular stroke stops before reaching the end position (fully open or closed), turn the stop screw counterclockwise until the valve reaches the correct position.
NOTE: When unscrewing the stop screw, keep the lock nut still with a wrench so that the sealing washer, if equipped, does not withdraw together with the screw.
- 4) Tighten the lock nut and replace travel stop cover.
- 5) If the actuator angular stroke travels beyond the end position (fully open or closed), turn the stop screw clockwise until the valve reaches the correct position.
- 6) Tighten the lock nut and replace travel stop cover.

5.2.2 Model H/HDH Actuators (linear)

Refer to the sketch in Appendix B, items 2 & 14, for the references in this section to travel stops and actuator stem coupling.

This instruction is applicable for adjusting travel stops on linear actuators for rising stem valves that require an actuator that extends to the valve closed position and that retracts to the valve open position. For other configurations, refer to instructions in IOM1004, IOM1005 or IOM1006—linear hydraulic model H/HDH for Spring Return Extend (SRE), Spring Return Retract (SRR) or Double Acting (DA) service.

The setting of the open valve position is performed by adjusting the upper travel stop screws in the actuator stem coupling. For many valve configurations and application requirements, it is common to eliminate the external open (up) travel stops and instead install the actuator so that the actuator piston stops against the upper head in the full open (retract) position.

The setting of the closed valve position is performed by adjusting the lower travel stop screws in the actuator stem coupling. For many valve configurations and applications, it is common to eliminate the external close (down) travel stops so long as the valve seat is suitable as a hard stop at the maximum actuator thrust at Maximum Allowable Working Pressure (MAWP).



5.3 *Setting the Stroke Time*

Setting actuator operating times in opening and in closing is performed by adjusting the speed control valves (items Fa and Fc on Drawing OPER-RP in Appendix A) assembled into the tubing of hydraulic cylinder. Fa is the speed control for the actuator opening time. Fc is the speed control for the actuator closing time.

As the speed controls are unidirectional type, the actuator operating times can be set independently in opening and in closing.

To perform the setting of the flow regulators proceed as follows:

- 1) Loosen the lock nut.
- 2) Rotate the setting screw clockwise to increase the operating time; rotate counterclockwise to decrease the operating time.
- 3) Check that the operating time is acceptable.
- 4) Tighten the lock nut.

6 Preparation for Start-up

6.1 *Pneumatic Connections*

Connect the actuator oil tanks to the pneumatic feed line with fittings and/or pipes in accordance to the plant specifications. They must be sized correctly in order to guarantee the necessary airflow for the operation of the actuator, with pressure drops not exceeding the maximum allowable value. The shape of the connecting piping must not cause excessive stress to the inlets of the actuator. The piping must be suitably fastened so as not to cause excessive stress or cause the threaded connections to loosen if the system undergoes strong vibrations.

IMPORTANT: Every precaution must be taken to ensure that any solid or liquid contaminants that may be present in pneumatic fill lines and pipework are removed before connection and pressurization, to avoid possible damages or other loss of performance to the product.

The inside of the pipes used for the connections must be cleaned before use. Wash them with suitable substances and blow through them with air or nitrogen. The ends of the tubes must be de-burred and cleaned.

Once the connections are completed, operate the actuator and check that it functions correctly, that the operation times meet the plant requirements and that there are no leakages in the pneumatic connections.

6.2 *Electrical Connections*

Connect the electrical feed, control and signal lines to the actuator by linking them with the terminal blocks of the electrical components. In order to do this, the housing covers must be removed without damaging the coupling surfaces, the O-rings or the gaskets.

Remove the plugs from the cable entries.

For electrical connections, use components (cable glands, cables, hoses, conduits), that meet the requirements and codes applicable to the plant specifications (mechanical protection and/or explosion-proof protection).

Screw the cable glands tightly into the threaded inlets, so as to guarantee the weatherproof and explosion-proof protection (when applicable).

Insert the connection cables into the electrical enclosures through the cable glands and connect the cable wires to the terminals according to the applicable wiring diagram.

If conduits are used, it is advisable to carry out the connection to the electrical enclosures by inserting flexible conduit so as not to cause anomalous stress on the housing cable entries.

Replace the plastic plugs of the unused enclosure entries with metal ones, to guarantee perfect weatherproof tightness and to comply with the explosion-proof protection codes (where applicable).

Once the connections are completed, check that the controls and signals work properly.

6.3 **Start-up**

During the start-up of the actuator, proceed as follows:

- 1) Check that the pressure and quality of the power supply (filtering degree, dehydration) are as prescribed. Check that the feed voltage values of the electric components (solenoid valve coils, micro-switches, pressure switches, etc.) are as prescribed.
- 2) Check that the actuator controls work properly (remote control, local control, emergency controls).
- 3) Check that the required remote signals (valve position, air pressure, etc.) are correct.
- 4) Check that the setting of the actuator control unit components, (pressure regulator, pressure switches, flow control valves, etc.) meet the plant requirements.
- 5) Check that there are no leaks in the pneumatic and hydraulic connection.
- 6) In accordance with the applicable painting specifications, repair any paint-coat that has been damaged during transport, storage or assembly.

7 **Maintenance**

7.1 **Warning**

IMPORTANT: Before carrying out any maintenance operation, it is necessary to isolate pneumatic feed lines and exhaust all pressure from the actuator and all control manifolds and vessels, to ensure safety of maintenance staff.

7.1.1 Routine Maintenance

ATI actuators have been designed to work for long periods in the severest conditions with no need for maintenance. However, it is advisable to periodically check the actuator as follows:

- 1) Check that the actuator operates the valve correctly and with the required operating times. If the actuator operation is infrequent, carry out a few opening and closing operations with all existing controls (remote control, local control, emergency controls, etc.), if site conditions allow.
- 2) Check that the signals to the remote control device are correct.
- 3) Check that the air supply pressure value is within the required range.
- 4) If there is an air filter in the pneumatic control circuit, disassemble the cup periodically and wash it with soap and water. Disassemble the filter. If this is made up of a sintered cartridge, wash it with nitrate solvent and blow through with air. If the filter is made of cellulose, it must be replaced when clogged.
- 5) Check that the external components of the actuator are in good conditions.
- 6) Check the paint-coat of the actuator. If some areas are damaged, repair the paint-coat according to the applicable specification.
- 7) Check that there are no leaks in the pneumatic and hydraulic connections.
- 8) Check that there are no leaks into the actuator housing, (oil, water, etc.); by removing the inspection plug located in the actuator housing cover.

7.1.2 Replacing Hydraulic Seals in Model SY Actuators (quarter turn, scotch yoke)

If there are leaks in the cylinder or a malfunction in the mechanical components, or in case of scheduled preventive maintenance, the actuator must be disassembled and seals must be replaced with reference to the drawing, SY-ASSY-2, in Appendix A and adopting the procedures in the following sections.

7.1.2.1 Disassembly

- 1) Remove housing cover (27).
- 2) Remove guide block pin retaining screw and guide block pin (7).
- 3) Rotate yoke (5) away from guide block (8).
- 4) Unscrew the piston rod (16) threaded end from the guide block (8).
- 5) Unscrew cylinder mounting bolts (14).
- 6) Remove cylinder from housing.
- 7) Remove tie rod nuts (20) from cylinder (17).
- 8) Remove end flange (19).
- 9) Slide off cylinder (17).
- 10) Slide out piston rod (16) from head flange (13).

7.1.2.2 Seals Replacement

For this section, refer to the drawing, SY-ASSY-2, in Appendix A.

Prior to reassembling, check that the actuator components are in good condition and clean. Lubricate all the surfaces of the parts that move in contact with other components by a recommended grease. If the O-ring must be replaced, remove the existing one from its groove, clean the groove carefully and lubricate it with a protective oil or grease film. Assemble the new O-ring into its groove and lubricate it with a protective oil or grease film.

- 1) Replace the O-rings (7) of the head flange and end flange (5 and 13).

For replacement of piston rod seal ring (14) and of the wiper ring (17) proceed as follows:

- 1) Remove retainer plate (16)
- 2) Remove the existing rod seal ring (14) and the wiper ring (17) from their groove.
- 3) Clean the groove carefully and lubricate it with a protective oil or grease film.
- 4) Assemble the new rod seal ring (14) into the flange groove.
- 5) Assemble the rod wiper ring (17) into the retainer plate (16).
- 6) Assemble the retainer plate (16) onto the head flange (13).

To replace the piston seal ring (9) proceed as follows:

- 1) Remove the existing Teflon® seal ring (9) from the groove.
- 2) Clean the groove carefully and lubricate it with a protective oil or grease film.
- 3) Assemble the new seal ring into its groove and lubricate it with a protective oil or grease film.
- 4) Assemble the new Teflon seal ring (9) by introducing one side of it into the groove and then enlarge it with your fingers so as to introduce it into the groove: take care to enlarge it uniformly without any tools which could possibly damage it. The elastic memory of the Teflon® type seal ring allows the ring to shrink back to its previous dimension after a short time.

If the sealing nut (2) has to be replaced, measure the protrusion of the stop screw (1) with reference to the end flange (5) surface, so as to be able to easily restore the setting of the actuator mechanical stop in the same valve position, once the maintenance procedures have been completed.

- 1) Loosen the seal nut (2) and unscrew the stop screw (1) until it is removed together with the nut (2).
- 2) Remove the seal nut (2) from the stop screw (1). Carefully clean and lubricate the stop screw thread and the surface of the end flange area, on which the sealing washer works.
- 3) Screw the new seal nut onto the stop screw.
- 4) Screw the stop screw into the end flange until it reaches its original position (the same protrusion with reference to the flange surface).
- 5) Tighten the seal nut (2).

7.1.2.3 Reassembly

- 1) Clean and lubricate the piston rod (12) surface, particularly that of the bevel, with a protective oil or grease film and introduce it into the head flange hole, taking care not to damage the seal rings (14 and 17).
- 2) Carefully clean the inside of the cylinder (11) and check that the entire surface, particularly that of the bevels, is not damaged. Lubricate, with protective oil or a grease film, the cylinder inside surface and the bevels at the ends. Slide the cylinder onto the piston taking care not to damage the seal ring (9); the tube bevel has to smoothly compress the seal ring.
- 3) Assemble the end flange (5) by centering it on the inside diameter of the tube, taking care not to damage the O-ring (7).
- 4) Assemble the tie rod nuts (4) onto the tie rods (3). Tighten the nuts to the recommended torque, alternating between opposite corners.
- 5) Assemble the new gasket (12) after cleaning the surfaces of housing (11) and head flange (13), which are in contact.
- 6) Assemble the cylinder to the housing and tighten the screws (14) only hand tight.
- 7) Carefully clean the threaded end of the piston rod and the threaded hole of the guide block (8). Spread some sealant LOCTITE®, or equivalent, on the rod threaded end and screw into the guide block threaded hole.
- 8) Restore a generous coating of grease on the contact surfaces of the yoke (5), on the yoke grooves, on the sliding blocks (6), on guide bar (10).
- 9) Tighten the cylinder mounting bolts (14) to the recommended torque.
- 10) Lubricate the yoke bushing O-ring (24) with protective oil or grease.
- 11) Assemble the cover (27). Tighten the screws to the recommended torque. Take care to not cut the yoke bushing O-ring (24).

IMPORTANT: After maintenance operations, carry out a few actuator operations to confirm that the movement is regular and that there is no oil leakage through the seals.

7.1.3 Replacing Hydraulic Seals in Model H/HDH Actuators (linear)

If there are leaks in the cylinder or a malfunction in the mechanical components, or in case of scheduled preventive maintenance, the actuator must be disassembled and seals must be replaced.

Refer to the sketch in Appendix C for the parenthetical references that follow in this section.

The Standard contents in the ATI Maintenance Seal Kit for linear H/HDH model actuators are listed below. If additional seals are required for a customized design, they will be provided with the ATI Maintenance Seal Kit for the actuator serial number.

The instruction that follows is applicable for seal replacement in a standard linear hydraulic, double acting (DA) actuator. For other configurations, refer to instructions in IOM1004, IOM1005 or IOM1006—linear hydraulic model H/HDH for Spring Return Extend (SRE), Spring Return Retract (SRR) or Double Acting (DA) service.

Manufacturer's Maintenance Seal Kit

Item # (App. C)	Description	Qty
4	O-ring + Parbak	1
8	Wear Band	2
9	T-Seal	1
10	O-ring + Parbak	1
12	O-ring + Parbak	1
14	T-Seal	1
16	O-ring + Parbak	1
17	Wiper Ring	1

- 1) Before rigging, ensure the crane/hoist/rigging hardware lifting capacity can safely accommodate the desired load.
- 2) Thread lifting eyes into upper head.
- 3) Detach the actuator from valve and place actuator in an upright position on a disassembly platform.
- 4) Loosen the tie rod nuts (Item 1) in a criss-cross pattern.
- 5) Remove nuts and lock washers (Items 1 and 2).
- 6) Lift upper head (Item 3) off of actuator with crane and place on a flat surface.
- 7) Remove tie-rods (Item 5) from lower head (Item 13).
- 8) Thread lifting eye into piston rod (Item 11).
- 9) Attach lifting straps and extract piston/piston rod assembly (Items 7 and 11) from cylinder tube (item 6).
- 10) Place piston/piston rod assembly (Items 7 and 11) on a flat surface.
- 11) Remove wear bands (Items 8), T-Seal (Item 9) from piston (Item 7).
- 12) Attach lifting hardware and rigging straps to cylinder tube (Item 6). Take extra precaution to avoid scarring the inner diameter of the metal cylinder tube. Lift cylinder vertically and place on a flat surface
- 13) Remove O-ring/Parbak (Item 12) from lower head (Item 13) and clean the groove with a light degreaser.
- 14) Flip lower head (Item 13) upside down.
- 15) Extract cap screws (Item 19) from lower head (Item 13).
- 16) Remove bearing retaining ring (Item 18) and rod bearing (Item 15) from bearing housing.
- 17) Remove wiper ring (Item 17), O-ring/Parbak (Item 16), and T-seal (Item 14) from the rod bearing (Item 15).
- 18) Clean the rod bearing (Item 15) with a light degreaser.
- 19) Lightly grease the new bearing O-ring/Parbak (Item 16) and T-seal (Item 14) and install on rod bearing (Item 15).
- 20) Without grease, install the new wiper ring (Item 17) on the rod bearing (Item 15).
- 21) Lightly grease new O-ring/Parbak (Item 12) and install on lower head (Item 13).
- 22) Thread locking compound is applied to the threads by the manufacturer during initial assembly. As a result, disassembly will require heating to loosen the thread locking compound. To remove the piston rod seal (Item 10), heat the piston assembly using a torch and unthread piston rod (Item 11) from piston (Item 7).
- 23) After the piston rod has completely cooled, remove piston rod seal (Item 10).
- 24) Clean the piston rod seal groove with a light degreaser.
- 25) Clean piston seal grooves. With light hydraulic oil, lubricate and install new T-Seal (Item 9).
- 26) Without grease, trim to length and then install new wear band (Item 8).

- 27) Remove O-ring/Parbak (Item 4) from the upper head (Item 3). Clean seal groove.
- 28) Install lightly greased O-ring/Parbak (Item 4) to upper head (Item 3) seal groove.

7.1.4 Oil Tank Maintenance

The oil tanks should be periodically checked for any accumulation of condensate. The frequency of this maintenance procedure is dependent on the wetness of power gas and certain climatic conditions. However, always check the tanks before freezing weather sets in. Each oil tank is fitted with a bottom “diffuser” insert. Remove this insert and allow any condensate to drain from the tank. After draining, refill oil tank to proper operating level per Section 7.2. Annual preventative maintenance prevents corrosion caused by accumulation of condensate.

7.2 Checking Oil Level in Oil Tanks

During the actuator operation the oil tanks are closed (not in connection with the atmosphere). To avoid cavitation it is necessary to proceed as follows to check the oil level in the tank:

- 1) Move the actuator into open position.
- 2) Unscrew the tube fitting at the top of the “open” oil tank.
- 3) Check that the oil level into the reservoir is at least 20% - 25% full.
- 4) Add oil if necessary.
- 5) Reassemble pneumatic connection to the top of the “open” oil tank.
- 6) Repeat check of the “closed” oil tank when actuator is in the close position.

7.3 Hydraulic Oil Features

The following oil is used by ATI for standard working temperature and suggested re-lubrication.

Manufacturer:	Chevron
Type:	AW Hydraulic Oil 32
Viscosity at 40°C:	30 cSt – 100cSt
Flash Point:	400°F
Pour Point:	-10°F
Specific Gravity:	0.8856

NOTE: For special working conditions and for working temperatures beyond the standard range, consult ATI.

7.4 Lubricating Mechanism

For normal duty the actuator’s scotch yoke mechanism is lubricated for the life of the product. In case of high load and high frequency of operation it may be necessary to periodically restore the lubrication. It is advisable to apply a generous coating of grease on the contact surfaces of the yoke and bushings, on the yoke link grooves, on the sliding blocks, and on the guide bar. For

this operation it is necessary to disassemble the mechanism cover. In larger actuators the lubrication can be performed through the inspection holes of cover after removing the plugs.

The following grease is used by ATI for standard working temperature and suggested re-lubrication:

Manufacturer:	Mobil
Type:	Mobil Grease CM-P
Viscosity at 40°C:	320 cSt
Flash Point:	400°F
Drop Point:	500°F

8 Terms and Conditions/Warranty

Except as otherwise expressly agreed to in writing by an authorized representative of Automation Technology, LLC. (hereinafter "ATI"), the following terms and conditions (these "Terms and Conditions") shall apply to all offers for the purchase or sale of products manufactured or supplied by ATI under brand names including, but not limited to "ATI", "Gevalco", etc.

A. **CONDITIONAL ACCEPTANCE; REJECTION OF PURCHASER TERMS** – All orders and acknowledgements of Purchaser shall constitute only consent to these Terms and Conditions and a representation that Purchaser is solvent. All quotations and offers of sale by ATI are expressly limited to these Terms and Conditions and are subject to written acceptance by ATI. Any such acceptance by ATI is expressly conditioned upon assent of Purchaser to these Terms and Conditions, and ATI hereby expressly objects to and rejects as material alterations to these Terms and Conditions any terms or conditions of Purchaser, whether contained in Purchaser's order, acknowledgement or otherwise, that are different from or in addition to these Terms and Conditions.

B. **PRICES** - ATI quotations are valid for thirty (30) days from date of issuance, unless otherwise stated by ATI in writing, and are subject to withdrawal or change at any time prior to acceptance by ATI. Prices are ex works, in United States Dollars, and firm for thirty (30) days from date of ATI's written acceptance of Purchaser's order and an unconditional authorization for the immediate manufacture based on customer supplied information. If for any reason authorization does not commence within such thirty (30) days, prices in effect at the time of release for manufacture will apply, unless otherwise stated in writing. All sales, use, excise, value-added, import, export and other taxes, duties, customs and the like (collectively "Taxes") are the responsibility of Purchaser and will be added to the price to the extent that ATI pays on Purchaser's behalf or is required by law to pay in connection with the sale. ATI reserves the right to invoice and be paid for any Tax at the time of shipment or any time thereafter. All orders are subject to laws and regulations that are in effect and that become effective prior to delivery. Typographical or clerical errors in quotations, orders and acknowledgements are subject to correction by ATI. Prices do not include installation or any other service, unless so stated expressly in the quotation or ATI's order acknowledgement. Prices include one (1) copy of any applicable manuals. Any additional manuals or other printed materials requested by Purchaser are subject to additional cost, to be quoted at or near the time that such materials are requested by Purchaser.

C. **PAYMENT** - Payment from Purchaser is due within thirty (30) days from date of first invoice, unless otherwise stated on ATI's quotation or order acknowledgement. For international orders, ATI reserves the right to require, before commencing filling the order, security in the form of a letter of credit or the like, in a form and from a bank or guarantor acceptable to ATI. Subject to any applicable usury law that would void or render invalid or unenforceable this sentence, in which case the specified rate will be deemed to be reduced to the maximum allowed by law, simple interest at the rate of 1.5 percent per month will apply to balances unpaid within 30 days from date of first invoice. ATI will invoice upon making available for shipment. ATI reserves the right to payment and Purchaser will be responsible for any cost associated with storage of products or delay in making products available for pickup that occurs at the request of Purchaser.

D. **FORCE MAJEURE** – In no event shall ATI be liable for non-delivery or delay in delivery, or for failure or delay in the performance of any obligation contained herein, that arises directly or indirectly from acts of God, unforeseeable circumstances, acts (including delays or failure to act) of any governmental authority (de jure or de facto), war (declared or undeclared), terrorism, riot, revolution, priorities, fires, floods, weather, strikes, labor disputes, sabotage, epidemics, factory shutdowns or alterations, embargoes, delays or shortages in transportation, delay in obtaining or procuring or inability to obtain or procure labor, materials or manufacturing facilities, delay in obtaining or inability to obtain timely instructions or information from the Purchaser, or any other cause or circumstance of any other kind beyond ATI's reasonable control. The foregoing provision shall apply even though such causes or circumstances may occur after ATI's performance has been delayed for other causes or circumstances.

E. **SHIPPING** – (a) Products are sold ex works. Risk of loss is the responsibility of and title transfers to Purchaser once products are made available at Seller's facility for pickup by Purchaser or its carrier.

(b) Acknowledged ship dates represent the estimated date of availability for pickup, rather than actual shipment or delivery at destination for which Purchaser is responsible. All indicated shipping dates are estimates, based on prompt receipt of all necessary information from Buyer necessary to process the order. ATI will use its best reasonable efforts to make products available for pickup by such dates, but there is no guarantee to do so. Indicated time periods for pickup availability are estimated from the latest to occur of: 1) ATI's acceptance of Purchaser's order, 2) ATI's receipt of valve dimensional information, if applicable, 3) ATI's receipt of Purchaser supplied components required to manufacture or supply the products, if applicable, or 4) ATI's receipt of drawings approved by Purchaser. Products ordered on an "in stock" basis are subject to prior sale to other customers. Acknowledged ship dates are subject to changes caused by additions to or modification of the original order agreed to by both Purchaser and ATI.

(c) Under no circumstances shall ATI have any liability whatsoever for loss of use or for any indirect or consequential damages as a result of delayed delivery.



(d) Purchaser is responsible for payment of carrier and all other shipping costs and for making all arrangements necessary for pickup, transport, export, import and delivery to Purchaser's destination. Without prejudice to any ex works rights of ATI and obligations of Purchaser, Purchaser consents in advance to ATI shipping collect any products that Purchaser fails to pick up, and Purchaser will remain responsible for all associated pickup, transport, export, import and delivery costs, including any unknown to ATI or Purchaser at the time of shipment.

F. DESIGN - Due to continuous product development, ATI reserves the right to modify designs, materials and specifications without prior notice.

G. CANCELLATION - Orders acknowledged by ATI are not subject to cancellation or suspension except with the advance written consent of ATI and upon terms which will compensate ATI for and indemnify ATI from and against loss or damage occasioned by such cancellation or suspension, including without limitation for all costs and expenses already incurred or commitments made by ATI in connection with the processing, purchasing, handling, and fabrication of equipment for the order and a reasonable profit thereon. ATI's determination of such termination charges shall be conclusive.

H. INSPECTION - Final inspection and acceptance of products must be made at ATI's facility and shall constitute a waiver by Purchaser of any claim for loss or damage, except for latent defects not reasonably discoverable by such inspection. Purchaser's representative may inspect products during normal business hours and must do so in a manner that does not interfere with ATI operations.

I. ATI WARRANTY; EXCLUSIVE PURCHASER REMEDY – All products manufactured by ATI are warranted against defects in material and workmanship for a period of two (2) years after the date that the products were made available for pickup by Purchaser. ATI's warranty excludes any defects resulting from improper or abnormal shipping, operation or maintenance. Purchaser must immediately, and in no event later than thirty (30) days after becoming aware of a suspected defect, notify ATI in writing of any such suspected defect. Within a reasonable time following ATI's receipt of such notice, investigation and confirmation of a defect, ATI will have the right and the obligation, in its sole discretion, to repair at no cost to Purchaser such defect or replace the defective product or component thereof with a non-defective product or component thereof. Repair or component replacement by non-ATI authorized agents WILL VOID all remaining warranty on the product. Products purchased by ATI from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. ATI's repair or replacement obligations under this Paragraph I do not extend to any labor or other loss or damage occasioned by, incidental to, or in consequence of any such defect. Purchaser's sole and exclusive remedy and ATI's obligation and liability for breach of warranty are expressly limited to such repair or replacement. Goods repaired or replaced during the warranty period shall be in warranty for the remainder of the original warranty or ninety (90) days, whichever is longer. All other remedies of Purchaser are hereby expressly excluded. THE WARRANTY CONTAINED IN THIS PARAGRAPH I IS THE SOLE AND EXCLUSIVE WARRANTY PROVIDED BY ATI WITH RESPECT TO ITS PRODUCTS AND SUPERSEDES AND IS IN LIEU OF ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE, ALL OF WHICH ARE HEREBY EXPRESSLY DISCLAIMED. Purchaser acknowledges and agrees that ATI Manuals, printed materials and any other documentation do not constitute warranties of any kind, including with respect to quality or performance. Purchaser is expected to determine the suitability of ATI products for ordinary and Purchaser's particular purposes.

J. EXCLUSION OF CONSEQUENTIAL DAMAGES; LIMITATION OF DIRECT DAMAGES - ATI shall not be liable for and Purchaser shall have no right to recover from ATI for any indirect, special or consequential damages, even if ATI has actual notice of any special circumstances from which any such damages might arise. Moreover, subject to Paragraph I which would completely bar any such recovery of direct damages if ATI honors its warranty, in no event shall any recovery of direct damages against ATI exceed the amount of the order price attributable to the portion of the product or products that is determined to have caused any alleged loss, damage or injury that is compensable under these Terms and Conditions and not remedied by ATI.

K. RETURNS – No product may be returned for credit or adjustment without written permission and tagging instruction from ATI. Upon receipt of approved returns, any handling/restocking charges and/or cost to recondition for resale, will be the responsibility of Purchaser.

L. GOVERNING LAW; VENUE AND JURISDICTION - All sales of products by ATI and any disputes arising out of or related to such sales or products or these Terms and Conditions shall be governed by, and these Terms and Conditions shall be construed in accordance with, the laws of the State of Texas, without regard to its conflicts of law principles that would apply the law of another jurisdiction. The United Nations Convention on Contracts for the International Sale of Goods is expressly disclaimed by and excluded from these Terms and Conditions. ATI's offer of sale may only be accepted in Harris County, Texas and any resulting contract is performable in whole or in part in Harris County, Texas. Venue for any litigation arising out of such sale, products or contract shall be proper in the state or federal district courts of Houston, Harris County, Texas, U.S.A., to the exclusive jurisdictions of which Purchaser hereby expressly submits.

M. NON-WAIVER – Any waiver by ATI of any breach of any of these Terms and Conditions must be set forth in a writing signed by an authorized representative of ATI and shall not constitute a waiver of or otherwise prejudice ATI's right to demand strict performance of any other term or condition of these Terms and Conditions.



N. **REMEDIES CUMULATIVE** – ATI’s remedies pursuant to these Terms and Conditions and applicable law are cumulative in nature and election or pursuit of any such remedy shall not prohibit ATI from electing or pursuing any other such remedy.

O. **SEVERABILITY** – In the event that any provision or portion of any provision of these Terms and Conditions is held void, invalid or unenforceable, such void, invalid or unenforceable provision or portion thereof shall be deemed severed from these Terms and Conditions, and the balance of these Terms and Conditions shall remain in full force and effect.

P. **EXPORT / IMPORT** - Buyer agrees that all applicable import and export control laws, regulations, orders, and requirements, including without limitations those of the United States will apply to the receipt and use of the Goods and Services provided by ATI. In no event shall Buyer use, transfer, release, import, export, re-export Goods in violation of such applicable laws, regulations, orders, or requirements.

Q. **BUYER SUPPLIED DATA** – To the extent that Seller has relied upon any specification, information, representation of operating conditions or other data or information supplied by Buyer to ATI, in the selection, or design of the Goods and the preparation of ATI’s quotation, and in the event that actual operating conditions or other data differ from those represented by Buyer and relied on by ATI, any warranties or other provisions contained herein are null and void. To the degree such data errors cause re-design or re-manufacture of the Goods, Buyer shall be responsible for additional costs incurred by ATI.

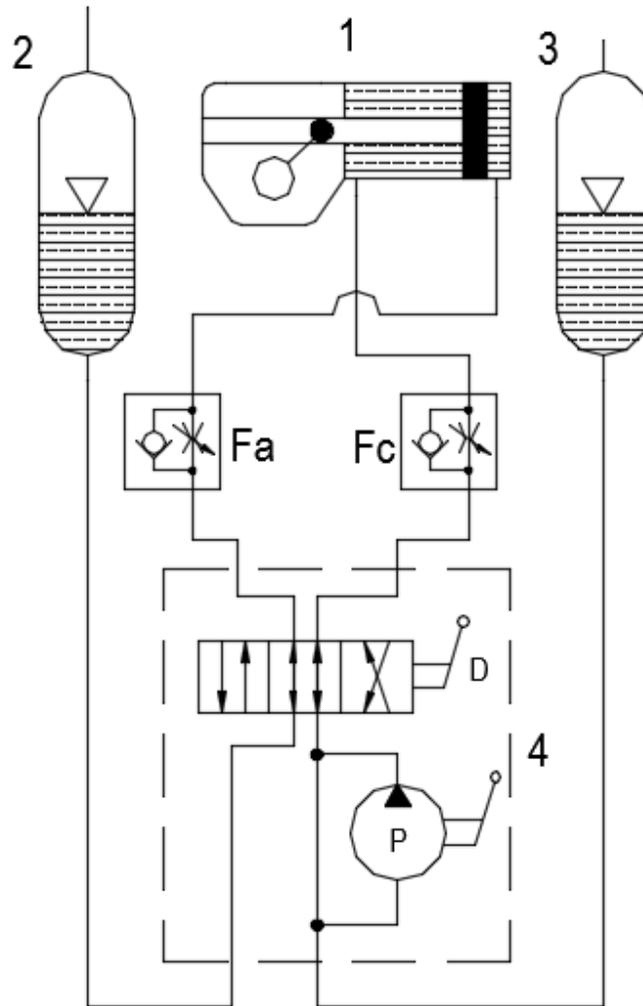
9 Revision Record

Rev #	Issue Date	Description	Reviewed By & Date	Approved By & Date
I.R.	6/04/2014	Initial Release	TRH 6/4/2014	AEG/DPL 6/4/2014
B	5/29/2015	Added detail for linear actuators. Reorder sections and update warning statements to standardize with other IOM’s.	DAR/EBW 5/29/2015	DPL 5/29/2015



APPENDIX A

SECTIONAL DRAWINGS WITH PARTS LISTS, OPER-RP



- 1. SCOTCH YOKE MECHANISM
- 2. GAS/OIL TANK (OPENING)
- 3. GAS/OIL TANK (CLOSING)
- 4. HYDRAULIC MANUAL OVERRIDE

P - PUMP
D - DIRECTIONAL CONTROL VALVE
Fa - SPEED CONTROL VALVE (CLOSING)
Fc - SPEED CONTROL VALVE (OPENING)

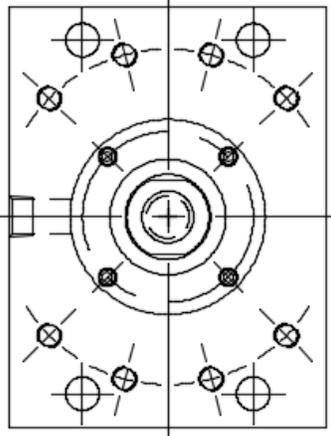
TITLE
GAS HYDRAULIC ACTUATOR WITH
HYDRAULIC MANUAL OVERRIDE

DRAWN BY	DATE	SCALE	DRAWING NO.
TH	2/6/03	NTS	OPER-RP



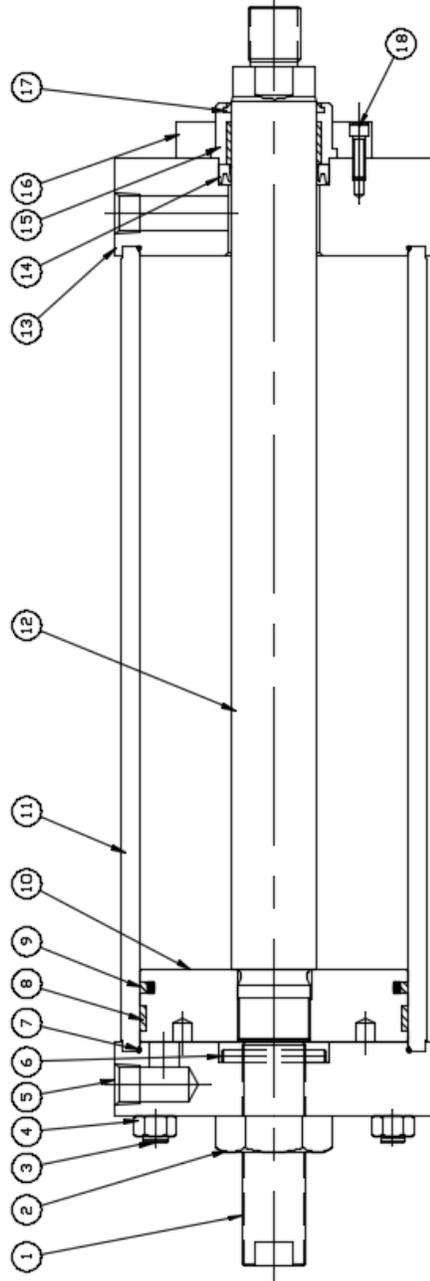


ITEM	PART NAME	QTY.	MATERIAL	PART NUMBER
1	STROKE ADJ. ROD	1	#303 STAINLESS STEEL	106-40473-017
2	SEAL NUT	1	STEEL/POLYURETHANE	506-00195-020
3	TIE ROD	8	ETD 150 STEEL	106-00254-028
4	TIE ROD NUT	8	ALLOY STEEL	D23555-5
5	BACK HEAD	1	STEEL/NITROTEC COATING	306-40475-000
6	SPRING PIN	1	STEEL	D21635H-17
7	O-RING (TUBE)	2	BUNA 'N'	001-00003-160B
8	WEAR STRIP	1	TEFLON/BRONZE	006-00012-344
9	GLYD RING	1	TEFLON/FIBERGLASS	006-00008-036
10	PISTON	1	DUCTILE IRON/NITROTEC COATING	106-40278-658
11	TUBE	1	STEEL/CHROME PLTD. I. D.	106-40282-732
12	PISTON ROD	1	ALLOY STEEL/CHROME PLTD.	06001-5518-000
13	FRONT HEAD	1	STEEL/NITROTEC COATING	306-40474-000
14	ROD PACKING	1	POLYURETHANE	D28218-28
15	GLAND	1	STEEL/DURALON	706-80100-005
16	RETAINER PLATE	1	STEEL	306-80045-021
17	ROD WIPER	1	POLYURETHANE	D29405-5
18	RETAINER SCREW	4	ALLOY STEEL	D25727F-6



1500 P. S. I. MAX. NATURAL GAS
OR OIL OPERATING PRESSURE

TIE ROD TORQUE=35 FT-LBS
GLAND SCREW TORQUE=10 FT-LBS



DATE	REVISIONS	EN
A		
B		
C		
D		
E		
F		
G		

DIMENSIONS ARE IN INCHES. THESE
DIMENSIONS SHOULD BE SPECIFIED. LIMITS
APPLY TO EACH PART. DIMENSIONS
ARE SPECIFIED UNLESS OTHERWISE
DIMENSIONS ARE AS FOLLOWS:

TIE PLATE THREE PLATE
TOLERANCE: 0.0015 0.0015 0.0015
SURF 0.005 0.005 0.005

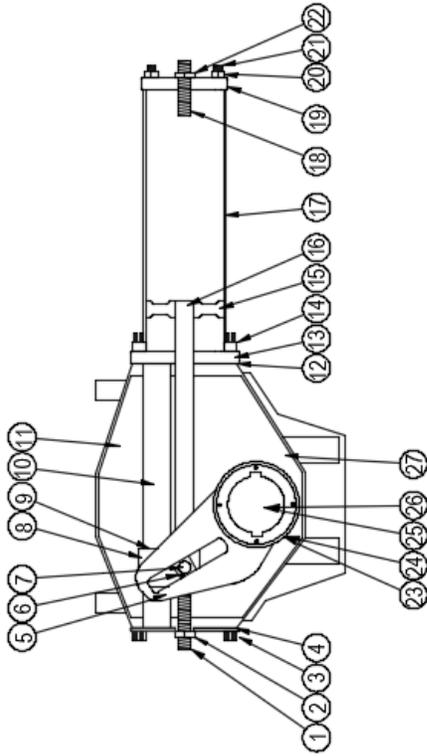
ANGULARITY, SQUARENESS AND
PARALLELISM:
0.010 INCHES PER FOOT

DOMESTIC THREADS, T.J.P. DETAILS
UNLESS OTHERWISE SPECIFIED.

PARTS LIST

DESIGN BY	SCALE
DRAWN BY TH	DATE 7/3/07
CHECKED BY	

SY-ASSY-2

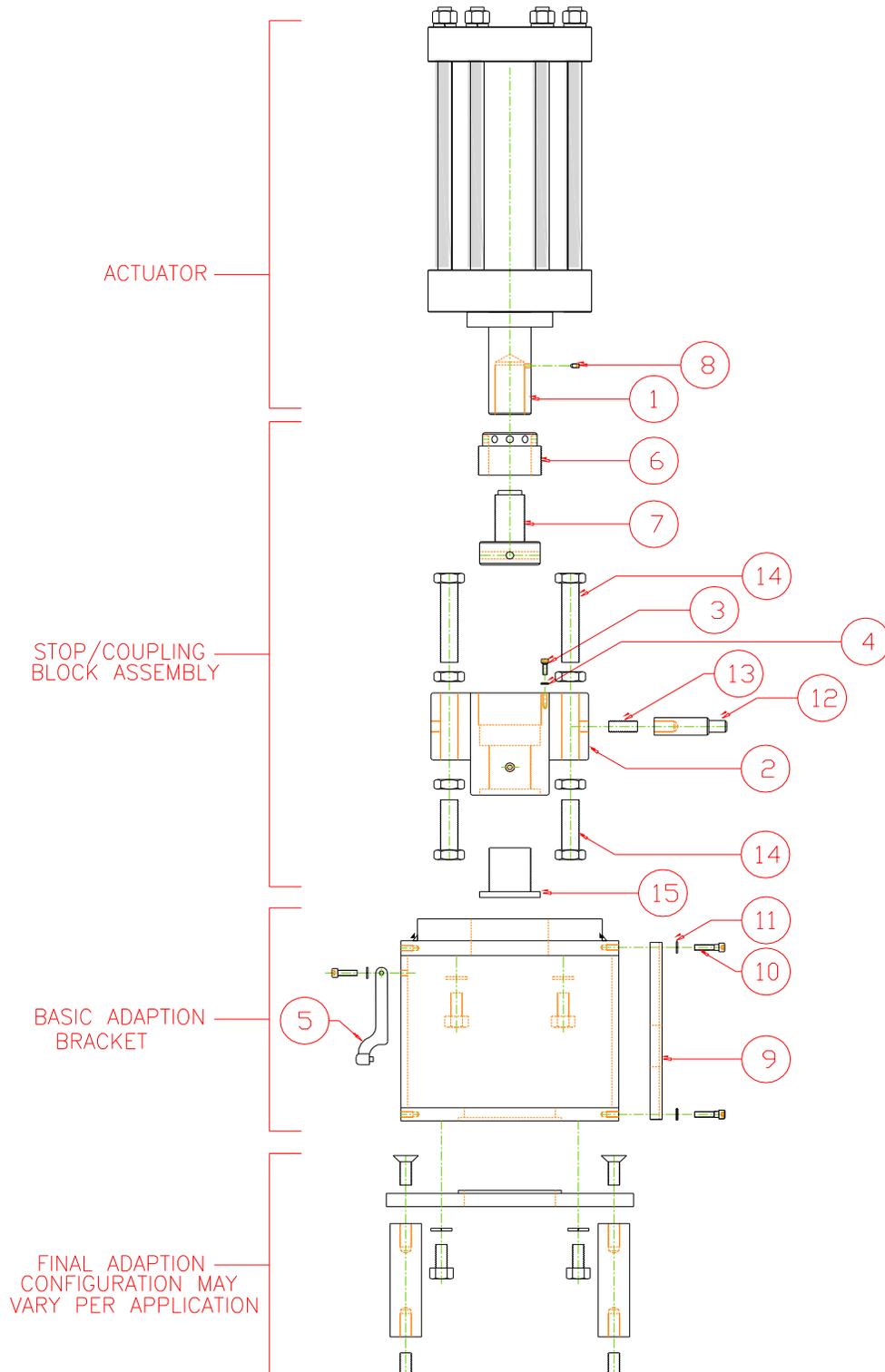


ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
1	1	TRAVEL STOP SCREW (OPEN)	15	1	PISTON
2	2	TRAVEL STOP SCREW LOCK NUT	16	1	PISTON ROD
3	4	COVER PLATE MOUNTING BOLTS	17	1	CYLINDER
4	1	COVER PLATE	18	1	TRAVEL STOP SCREW (CLOSE)
5	1	YOKE	19	1	END FLANGE
6	1	SLIDING BLOCK	20	6	TIE ROD NUT
7	1	GUIDE BLOCK PIN	21	6	TIE ROD
8	1	GUIDE BLOCK	22	1	TRAVEL STOP SCREW LOCKNUT
9	1	GUIDE BLOCK BUSHING	23	2	YOKE BUSHING
10	1	GUIDE BAR	24	4	YOKE BUSHING O-RING
11	1	HOUSING	25	1	INDICATOR
12	1	CYLINDER GASKET	26	1	INDICATOR SEAL
13	1	HEAD FLANGE	27	1	HOUSING COVER
14	4	CYLINDER MOUNTING BOLTS			

TITLE			
SCOTCH YOKE ACTUATOR			
ASSEMBLY BILL OF MATERIAL			
DRAWN BY	DATE	SCALE	DRAWING NO.
TH	7/3/07	NTS	SY-ASSY-3

APPENDIX B

EXPLODED VIEW OF LINEAR ACTUATOR



APPENDIX C

SEAL MAINTENANCE, MODEL H/HDH

Adapted from Drawing 2845

