

# Series 244 Hydraulic Actuators



## Features

- ▶ Superior reliability and versatility in actuator force ratings from 3.3 to 220 kip (15 to 1000 kN)
- ▶ Actuator design interfaces directly with modular MTS swivels, transducers, and servovalves to simplify system configuration and ensure consistent test results
- ▶ Proprietary MTS seal and bearing designs have set an industry standard for durability, long life, and performance
- ▶ Double-ended, fatigue rated actuator design combines balanced dynamic performance and robust sideload tolerance to provide unmatched strength and durability
- ▶ MTS exclusive direct-bonded polymer bearings reduce friction and ensure maximum heat dissipation during high frequency operation
- ▶ Hydraulic cushions help prevent the piston rod from accidentally hitting the end cap during high velocity operation
- ▶ In many applications, the combination of reduced weight and advanced design can produce performance levels that rival hydrostatic bearing actuators
- ▶ Backed by a worldwide network of field service engineers and technicians familiar with the demands of rigorous dynamic testing applications

## Description

Series 244 Hydraulic Actuators provide an integrated, high-performance solution to your dynamic force generation requirements. Each of the actuator components and options helps simplify the process of designing and building high performance testing systems. 244 Actuators are used worldwide in demanding vehicle dynamics, structural fatigue, and component test applications.

244 Actuators are manufactured for years of reliable operation in servohydraulic test systems. MTS engineers use proprietary materials and processes to minimize friction and stiction, while maximizing reliability, wear resistance, and ease of maintenance. Our ongoing commitment to research and development has earned MTS a worldwide reputation for uncompromising quality and leadership in the design and manufacture of reliable high-performance actuators.



Series 244 Hydraulic Actuator with Optional Load Cell, Servovalve, Manifold, and Swivels

## Design Characteristics

Series 244 Hydraulic Actuators are optimized to provide the components and capabilities required by dynamic testing applications. The following list of features illustrates why the performance, precision, and reliability of our actuators far exceed the minimal standards of typical NFPA (National Fluid Power Association) cylinders. Figure 1 shows the location of each item.

1. Piston rod end—The piston rod has a replaceable, hardened-steel insert that provides an internal thread for mounting force transducers, grips, swivels, etc. This feature improves actuator reliability by allowing you to quickly replace damaged threads or switch between metric and English components.\*
2. Porting—Large ports are designed to accept servovalve flow rates up to 90 gpm (340 L/min). A variety of servovalve mounting options are available that enable you to configure just the performance level you want. Single and double manifolds are available for Series 252 Servovalves, and special high flow manifolds can be used with the Series 256 Servovalves.
3. Piston rod—Series 244 Hydraulic Actuators use one-piece, double-ended piston rods. The double-ended design improves performance by eliminating the compromises caused by unequal tension and compression piston areas. The single-piece piston rod is heat-treated alloy steel that is hard chrome plated, then ground and polished to a precision surface finish using a proprietary MTS machining process. This process improves wear resistance and extends seal and bearing life. The gun-drilled rod permits convenient installation and accurate alignment of a linear variable displacement transducer (LVDT).
4. Cushions—Upper and lower hydraulic cushions protect the actuator from the adverse effects of accidental high velocity impacts between the piston rod and end cap.†

### Options

In addition to the versatile range of standard accessories, MTS can create a custom Series 244 Hydraulic Actuator design that incorporates custom features specific to your application. Consult with your MTS sales representative on the combination of features that will help you create an ideal test system.

### Stroke and Piston Lengths

► The standard stroke lengths for the Series 244 Hydraulic Actuators are 6 and 10 inches (152.4 and 254.0 mm) with approximately 1 in. (25.4 mm) of piston rod protruding from the front end cap when fully retracted. These specifications can be altered to adapt the actuator to a variety of testing requirements and configurations. If the actuator is equipped with an optional longer stroke length, additional length must also be added to the LVDT accessory to make it compatible with the actuator stroke length.

### Porting for Flows Greater than 90 gpm (340 L/min)

► Standard Series 244 Hydraulic Actuators accept servovalves with flow ratings up to 90 gpm (340 L/min). Optional porting can be provided to accommodate flow requirements greater than 90 gpm (340 L/min).

### Pedestal Bases

► A pedestal base can be attached to the closed housing LVDT. This configuration allows the Series 244 Hydraulic Actuator to be rigidly mounted to a reaction mass.

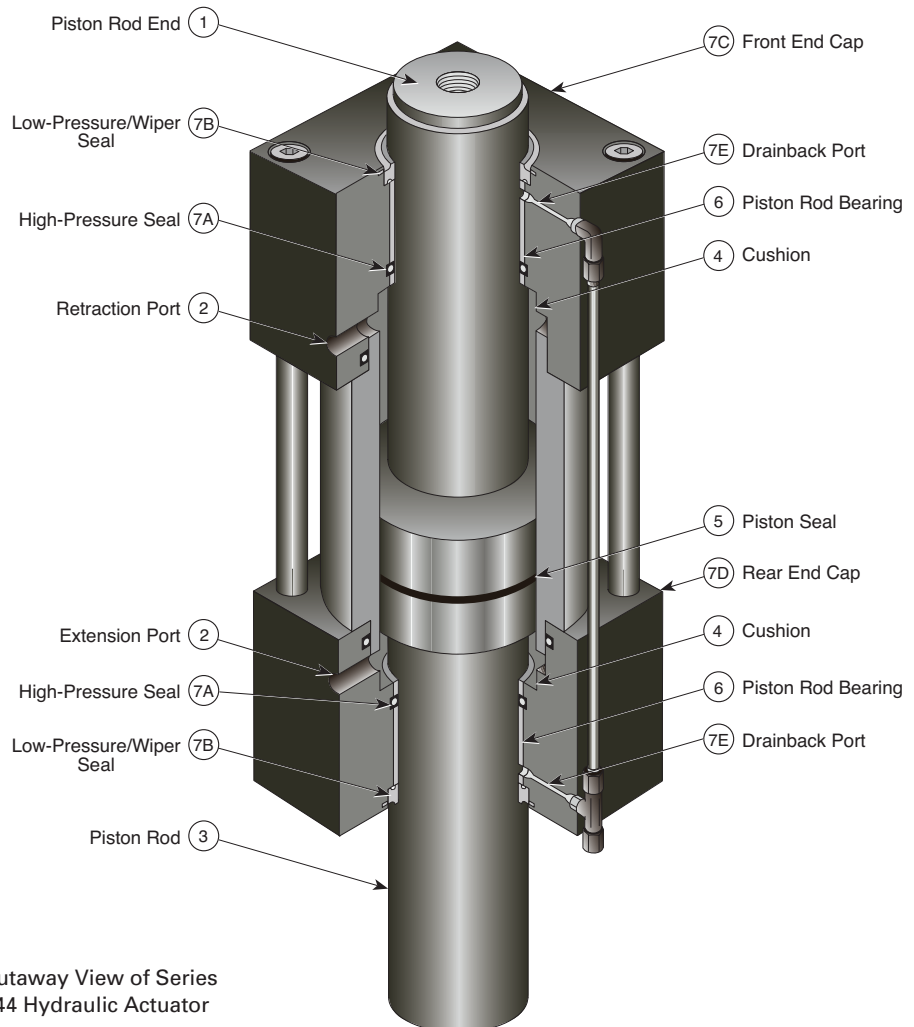
5. Piston seal—A reinforced polytetrafluoroethylene (PTFE) seal on the piston provides a positive seal and reduces friction.
6. Piston rod bearings—Series 244 Hydraulic Actuators are supplied with high-capacity polymer bearings bonded directly to the end caps. The integral bonded bearing design is standard because of its high sideload tolerance and resistance to failure from galling and seizure.
7. Piston rod seals—The proprietary MTS piston rod seals are designed for long life, low friction and exceptional performance in high-frequency, low-displacement applications. The piston rod seals consist of a high-pressure seal (item 7A)

and a low-pressure/wiper seal (item 7B) in both the front end cap (item 7C) and the rear end cap (item 7D).

A small amount of hydraulic fluid is allowed to flow past the high-pressure seal for continuous bearing lubrication. Drainback ports (item 7E) return the hydraulic fluid passed by the high-pressure seal back to the system drain line.

The inner part of the low-pressure/wiper seal wipes hydraulic fluid passed by the high-pressure seal from the piston rod and guides it to the drainback ports. The outer part of the seal functions as a scraper ring to minimize external contamination of the seals and bearings.

\* Model 244.51 has no insert. The internal threads are machined directly into the piston rod end.  
 † Models 244.41 and 244.51 do not have hydraulic cushions



Cutaway View of Series 244 Hydraulic Actuator

### Accessories

244 Actuators accept a complete range of pre-engineered, modular accessories that can improve the quality and repeatability of your test results. Consider the following items:

#### Swivel Rod Ends

A swivel rod end is a spherical bearing with a patented adjustable preload mechanism to minimize backlash. Proper adjustment of the bearing preload reduces impact noise, minimizes friction, and improves the waveform during load reversals encountered in dynamic tension/compression testing. The swivel rod end uses a connector stud and one set of spiral washers. Actuator sizes of 110 kip (500 kN) or greater use an adapter and torque nut in place of spiral washers.

#### Spiral Washers

Spiral washers fit over the studs at each connection and are rotated in opposite directions (producing a camming effect) to a position that places a constant preload on the stud. They create a backlash free assembly that fully preloads the connections between the actuator, swivel, and force transducer.

#### Force Transducers

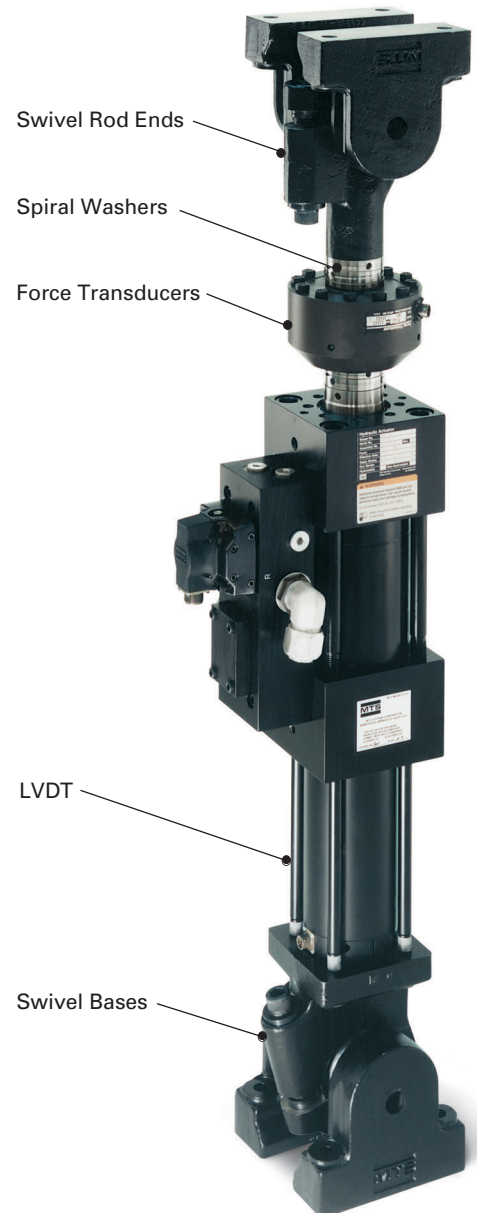
MTS Series 661 Force Transducers produce an electrical signal proportional to the force exerted by the actuator. They achieve at least 99% accuracy throughout the actuator force range. A low profile design makes them easy to integrate into your system.

#### LVDT

A linear variable differential transformer (LVDT) provides a piston rod displacement feedback signal to the system control electronics. The LVDT is coaxially mounted within the actuator piston rod and produces an analog signal with excellent linearity. It is available in both open and closed housing configurations.

#### Swivel Bases

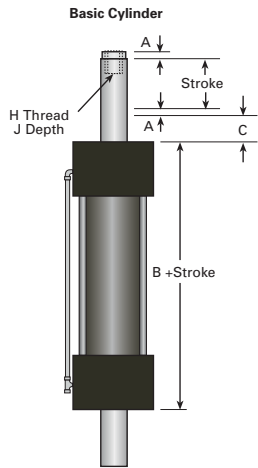
A swivel base provides the same features as the swivel rod end. For structural testing applications, a Series 244 Hydraulic Actuator equipped with a swivel rod end and a swivel base allows the actuator to pivot freely at both ends. This configuration reduces moment loads on the test specimen and load cell. The swivel base design attaches to a closed housing LVDT.



## Specifications

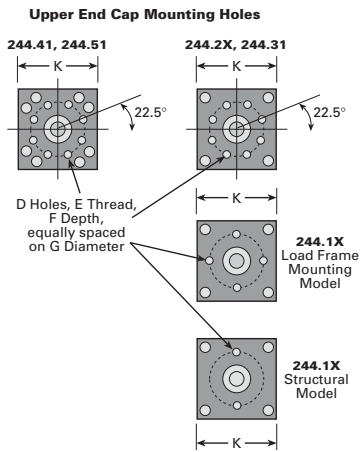
The specifications for the Series 244 Hydraulic Actuator models are shown on the following pages. To determine the overall dimensions of an actuator equipped with swivels, refer to the Series 249 Swivels

Product Specification and add the swivel height to the closed housing LVDT height. Similarly, the overall length of a pedestal base actuator is determined by adding the pedestal base height to the closed housing LVDT height.



## Specifications for Basic Cylinder Size and Mounting

Model	Force Rating*		Rod Diameter		Piston Area		Cushions (A)	
	kip	kN	in.	mm	in. <sup>2</sup>	cm <sup>2</sup>	in.	mm
244.11	3.3	15	1.75	44.5	1.17	7.50	0.60	15.2
244.12	5.5	25	1.75	44.5	2.10	13.50	0.60	15.2
244.21	11	50	2.75	69.9	3.90	25.16	0.40	10.2
244.20	15	68	2.75	69.9	5.22	33.68	0.40	10.2
244.22	22	100	2.75	69.9	7.57	48.84	0.30	7.6
244.23	35	150	2.75	69.9	12.73	82.13	0.25	6.4
244.31	55	250	3.75	95.3	19.63	126.65	0.20	5.1
244.41	110	500	5.25	133.4	38.48	248.28	None	None
244.51	220	1000	6.00	152.4	75.60	487.70	None	None



Basic Cylinder Size and Mounting

Model	B		C†		D#	E	F		G	
	in.	mm	in.	mm			in.	mm	in.	mm
244.11	9.38	238.3	1.00	25.4	2 or 4	3/8-16	0.75	19.1	3.20	81.3
244.12	9.38	238.3	1.00	25.4	2 or 4	3/8-16	0.75	19.1	3.20	81.3
244.21	9.70	246.4	1.00	25.4	8	1/2-13	0.75	19.1	4.10	104.1
244.20	9.70	246.4	1.00	25.4	8	1/2-13	0.75	19.1	4.10	104.1
244.22	9.20	233.7	1.00	25.4	8	1/2-13	0.75	19.1	4.10	104.1
244.23	9.20	233.7	1.00	25.4	8	1/2-13	0.75	19.1	4.10	104.1
244.31	10.10	256.5	1.00	25.4	8	5/8-11	1.00	25.4	5.50	139.7
244.41	12.27	311.6	1.12	28.4	8	1-8	1.75	44.5	10.37	263.4
244.51	13.49	342.6	1.50	38.1	8	1-8	1.75	44.5	10.37	263.4

Model	H		J‡		K	
	U.S. Customary	SI Metric	in.	mm	in.	mm
244.11	1/2-20	M12 x 1.25 mm	1.75	44.5	4.00	101.6
244.12	1/2-20	M12 x 1.25 mm	1.75	44.5	4.00	101.6
244.21	1-14	M27 x 2 mm	2.25	57.2	5.00	127.0
244.20	1-14	M27 x 2 mm	2.25	57.2	5.50	139.7
244.22	1-14	M27 x 2 mm	2.25	57.2	6.00	152.4
244.23	1-14	M27 x 2 mm	2.25	57.2	6.50	165.1
244.31	1 1/2-12	M36 x 2 mm	2.75	69.9	8.50	215.9
244.41	2-12	M52 x 2 mm	2.75	69.9	11.75	298.5
244.51	3-12	M76 x 2 mm	4.50	114.3	15.25	387.4

\* Dynamic force achieved with 3000 psi (21.0 MPa) hydraulic pressure.

† Length of piston rod that extends from the cylinder with the rod is fully retracted. Load frame extensions are greater.

‡ Dimension from end of piston rod to bottom of internal threads. The 244.51 does not use a threaded rod insert.

# Must specify structural or load frame model for specific mounting requirements.

Specifications are subject to change. Contact MTS for verification of specifications critical to your needs.

## LVDT and Pedestal Base Assemblies

### Typical Actuator Configurations

Series 244 Hydraulic Actuators are used every day in labs throughout the world for rigorous testing of materials, structures, and components. Some of the most common configurations are listed below:

#### Structural Actuator

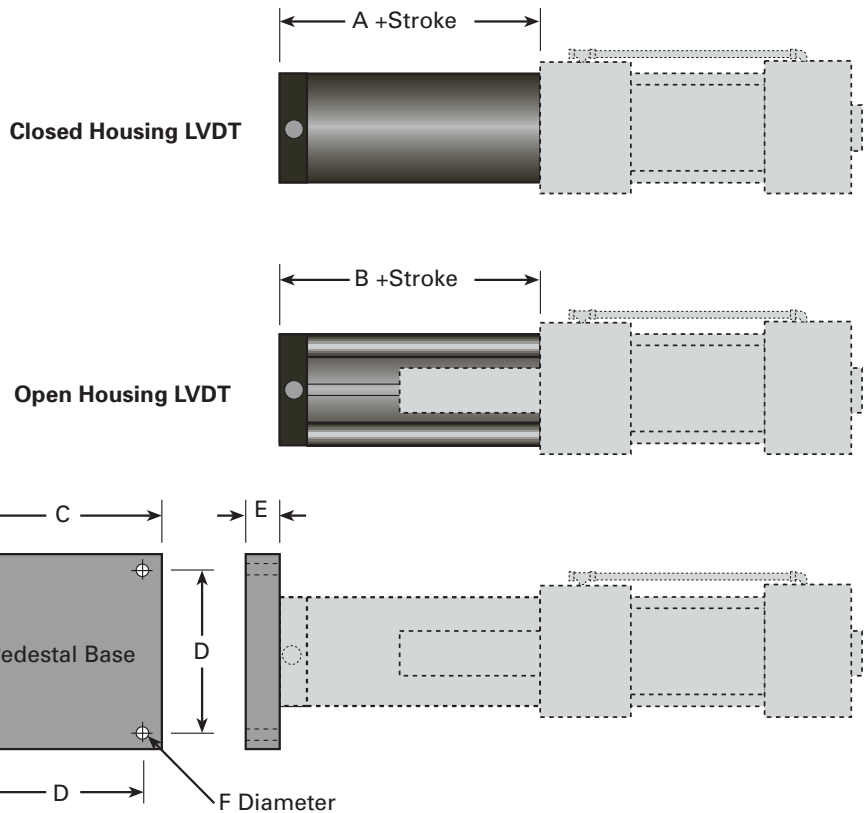
►The most common configuration for the Series 244 Actuator is as a component in a structural testing system. By adding a swivel rod end, load cell, closed housing LVDT, and swivel base to the basic actuator assembly, you can mount the actuator in any position. The pivoting ability of the swivels, lightweight materials, and rugged construction make this configuration a competitive alternative to more complex hydrostatic bearing actuators.

#### Load Frame Actuator

►The compact size, high sideload tolerance, and high force capacity of the Series 244 Actuators make them ideal for load frame applications. If you are designing your own fixturing and need an actuator configuration with extra stroke or rod length, the 244 may be just what you need. If you prefer a proven load frame design, MTS 318 and 322 Load Units incorporate Series 244 Actuators into a complete, versatile testing system.

#### Pedestal Base Actuator

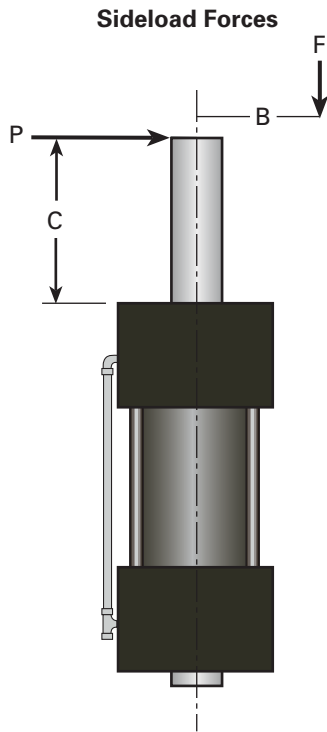
►Although most applications profit from at least a small degree of pivotal freedom, others require rigid actuator fixturing. Pedestal bases are available for all actuator models to handle these situations. Vibration testing, seismic tables, and horizontal cantilever installations are common applications for pedestal bases. Check with your sales representative for help in determining the effect of sideloading on pedestal base installations.



### Specifications for LVDT and Pedestal Base

Model	A		B		C		D		E		F	
	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
244.11	3.18	80.8	2.70	68.6	5.50	139.7	4.50	114.3	1.50	38.1	0.56	14.2
244.12	3.18	80.8	2.70	68.6	5.50	139.7	4.50	114.3	1.50	38.1	0.56	14.2
244.21	2.76	70.1	2.70	68.6	7.38	187.4	5.75	146.0	1.75	44.4	0.68	17.3
244.20	2.76	70.1	2.70	68.6	7.38	187.4	5.75	146.0	1.75	44.4	0.68	17.3
244.22	2.76	70.1	2.70	68.6	7.38	187.4	5.75	146.0	1.75	44.4	0.68	17.3
244.23	2.76	70.1	2.70	68.6	7.38	187.4	5.75	146.0	1.75	44.4	0.68	17.3
244.31	2.36	59.9	2.70	68.6	9.00	228.6	7.25	184.2	2.50	63.5	0.94	23.9
244.41	1.96	49.8	2.70	68.6	13.88	352.6	11.00	279.4	2.50	63.5	1.31	33.3
244.51	3.88	98.6	2.70	68.6	14.00	355.6	11.00	279.4	3.00	76.2	1.56	39.6

Specifications are subject to change. Contact MTS for verification of specifications critical to your needs.



### Determining Actuator Sideload

Before selecting a Series 244 Hydraulic Actuator, ensure that it can meet the needs of your testing program. The chief constraints on your actuator selection are the force rating and sideload tolerance. Sideload occurs when the forces acting on the actuator piston rod (F and P in the figure at right) are not parallel to the direction of piston rod motion. This situation can reduce the life of the actuator and distort test results.

The Series 244 Hydraulic Actuator is designed to endure significant sideload forces and rarely requires special force alignment fixturing other than swivels. If you suspect that your application may induce significant sideload forces, then there are four items that should be considered to determine the suitability of the actuator for your tests:

- ▶ Bearing pressure generated during test
- ▶ Piston rod stress caused by sideload
- ▶ Maximum allowable piston rod velocity
- ▶ Minimum allowable sideload frequency

The following procedure should help you determine the suitability of a particular model for sideloaded tests. Table 4 lists the constants used in the procedure.

### Sideload Calculation Procedure

1. Determine the magnitude of non-axial loads F and P and the point of application of these loads (B and C respectively). These parameters are dependent on the test setup configuration. If any parameter is variable during the test, use maximum values. F and P should be in pounds force. B, C, and S (actuator stroke) should be in inches.

2. Calculate the actuator bearing load (L) using the following formula:

$$L = \frac{P(S + A + D + C) + (F \times B)}{(S + A)}$$

where:

**S** = actuator stroke

**A** = a constant based on the actuator bearing spacing (refer to Table 4)

**D** = a constant based on the actuator bearing size (refer to Table 4)

3. Divide the actuator bearing load (L) by the actuator area constant (E) to determine the bearing pressure (V). The maximum allowable pressure is 950 psi. If the value produced by this step exceeds 950 psi, then you will have to select an actuator with a larger piston rod diameter.

$$\text{bearing pressure (V)} = \frac{L}{E}, \text{ which must be less than 950 psi}$$

where:

**E** = a constant based on the actuator bearing area (refer to Table 4)

### Sideload Constants

Model	Bearing Spacing (A)	Bearing Length (D)	Bearing Area (E)	Rod Diameter (G)	Cyclic Sideload (K)
244.11	5.960	1.7100	3.50	1.75	0.600
244.12	5.960	1.7100	3.50	1.75	0.600
244.21	5.820	1.9380	6.26	2.75	0.140
244.22	5.475	1.8630	5.84	2.75	0.140
244.23	5.425	1.8880	5.98	2.75	0.140
244.31	5.825	2.1340	10.03	3.75	0.068
244.41	6.530	2.8700	22.37	5.25	0.026
244.51	7.865	2.8125	24.69	6.00	0.015

4. Calculate the bending stress placed on the actuator piston rod. The maximum allowable piston rod bending stress is 40,000 psi. If the value produced by this step exceeds 40,000 psi, then you will have to select an actuator with a larger piston rod diameter.

**piston rod stress =**

$$\frac{32 [P (D + C) + (F \times B)]}{\pi \times G^3},$$

which must be less than 40,000 psi

where:

**G** = actuator piston rod diameter  
(refer to Table 4)

5. If the sideload force is applied to the actuator continuously, then determine the maximum allowable actuator piston rod velocity for the bearing pressure (V) calculated in step 3. This is the highest velocity that the actuator can be allowed to experience when the current sideload is present. Use the following equation:

$$\text{maximum allowable piston rod velocity} = \frac{5200}{V} \text{ in./sec}$$

6. If the sideload force is applied to the actuator cyclically (sideload varies equally through zero), then determine the minimum frequency for the sideload force. If the test parameters require a lower sideload frequency, then you will have to select an actuator with a larger piston rod diameter. Use the following equation:

$$\text{minimum sideload frequency} = (K \times L \times 0.01)$$

### Sample Calculations

The following example uses the sideload calculation procedure to determine the suitability of a Model 244.31 Actuator with a 6 in. stroke (S) for a specific test. The numbered steps of this example correspond to the numbered steps of the procedure.

1. The following test conditions are determined by the setup configuration and test parameters:

- F** = 3000 lbf
- P** = 500 lbf
- B** = 3.00 in.
- C** = 3.50 in.
- S** = 6.00 in.

2. Calculate the actuator bearing load (L).

$$L = \frac{500 \text{ lbf} (6.00 \text{ in.} + 5.825 \text{ in.} + 2.1340 \text{ in.} + 3.50 \text{ in.}) + (3000 \text{ lbf} \times 3.00 \text{ in.})}{(6.00 \text{ in.} + 5.825 \text{ in.})}$$

$$L = 1499.32 \text{ lbf}$$

3. Divide the actuator bearing load (L) by the bearing area constant (E) and ensure that the value is less than 950 psi.

$$\text{bearing pressure (V)} = \frac{1499.32 \text{ lbf}}{10.03 \text{ in.}^2} = 149.48 \text{ psi, which is less than 950 psi}$$

4. Calculate the piston bending stress and ensure that the value is less than 40,000 psi.

$$\begin{aligned} \text{piston rod stress} &= \frac{32 [500 \text{ lbf} (2.1340 \text{ in.} + 3.50 \text{ in.}) + (3000 \text{ lbf} \times 3.00 \text{ in.})]}{3.14 \times 3.75 \text{ in.}^3} \\ &= 2283.67 \text{ psi, which is less than 40,000 psi} \end{aligned}$$

5. The maximum allowable piston rod velocity is given by the following equation:

$$\text{maximum allowable piston rod velocity} = \frac{5200}{149.3248 \text{ lbf}} = 34.79 \text{ in./sec}$$

6. The minimum cyclical sideload frequency is determined by the following equation:

$$\text{minimum sideload frequency} = 0.068 \times 1499.32 \times 0.01 = 1.02 \text{ Hz}$$



### **Ordering Information**

When ordering a Series 244 Hydraulic Actuator, please specify the desired force rating of the cylinder assembly and whether you prefer U.S. customary or SI metric piston rod end threads. The following items are also available:

- ▶ Custom stroke and piston lengths
- ▶ Special piston rod end inserts
- ▶ Porting for flows greater than 90 gpm
- ▶ Transducers
- ▶ Spiral washers
- ▶ Pedestal bases
- ▶ Swivel rod ends
- ▶ Swivel bases

### **Related Products**

For more information on other MTS products that can be used with MTS Series 244 Hydraulic Actuators, refer to the following product specifications:

- ▶ Series 249 Swivels
- ▶ Series 252 Servovalves
- ▶ Series 256 Servovalves
- ▶ Series 257 Servovalves
- ▶ Series 297 Overload Protection Modules
- ▶ Series 298 Actuator Manifolds
- ▶ Series 318 Load Units
- ▶ Series 322 Load Units
- ▶ Series 661 Force Transducers