Correct sizing of actuators is necessary for proper control of dampers. The area of damper that can be controlled by a given actuator is dependent upon the quality of the damper, the pressure drop across the damper in the closed position and the velocity of air flow through the damper. Tables 1 and 2 show nominal torque per square foot of damper area. These factors are for an average quality damper, and may be used as a guide for determining the damper area that an actuator can handle.

## ELECTRIC ACTUATORS

To determine the nominal damper area that an electric actuator can handle proceed as follows:

1. Determine the pressure differential across the damper in the closed position.
2. Determine the velocity of air flow through the damper in the open position.
3. Determine any additional torque required for such things as jack shafting, interconnection linkage between damper frames, etc.
4. From catalog sheets find the torque rating of the actuator being considered.
5. Subtract from the actuator torque rating any torque determined in Step 3.
6. On Table 1 or 2 locate the pressure differential determined in Step 1, then read right until you reach the column under the velocity determined in Step 2.

**Table 1. Opposed Blade Damper Torque/sq. ft of Damper**

| In $H_2O$ | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|
| 0.5 | 0.98 | 1.06 | 1.22 | 1.51 |
| 1.0 | 1.29 | 1.40 | 1.56 | 1.74 |
| 1.5 | 1.48 | 1.50 | 2.03 | 2.30 |
| 2.0 | 1.69 | 1.71 | 2.03 | 2.90 |
| 2.5 | 1.88 | 2.03 | 2.19 | 2.90 |
| 3.0 | 2.01 | 2.03 | 2.28 | 2.96 |

**Table 2. Parallel Blade Damper Torque/sq. ft. of Damper**

| In $H_2O$ | 1000 FPM | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|
| 0.5 | 1.05 | 1.16 | 1.37 | 1.49 | 1.88 |
| 1.0 | 1.40 | 1.40 | 1.80 | 1.94 | 2.31 |
| 1.5 | 1.55 | 1.93 | 2.34 | 2.64 | 2.73 |
| 2.0 | 1.84 | 2.14 | 2.93 | 3.41 | 3.55 |
| 2.5 | 2.01 | 2.23 | 2.93 | 3.41 | 3.76 |
| 3.0 | 2.53 | 2.74 | 3.55 | 4.47 | 4.85 |

7. Divide the usable torque of the actuator obtained in Step 5 by the factor read on the appropriate Table 1 or 2 to obtain square footage of damper the actuator can handle.

## HYDRAULIC ACTUATORS

These actuators are different from the electric actuators in that they do not produce maximum torque at all points in their stroke. Maximum torque is available in the hydraulic actuators only at full retracted or full extended positions. Therefore, a nominal torque value must be determined for which the actuator can be rated. The nominal torque value for proportioning control is the torque resultant from a specific hydraulic pressure change. This pressure change is that which is produced by a temperature change equivalent to $0.6F^{o}$ at a controller with a $4F^{o}$ throttling range. To determine the temperature change required to produce the rated torque at other throttling ranges, use the following formula:

$$\frac{\text{Throttling Range of Controller} \times 0.6}{4} = \text{Temp. change required to produce rated torque}$$

The following are the rated torque values for hydraulic actuators.

MP-5220 type = 1.86 lb. in. proportional control
MP-511 type = 9.2 lb. in. proportional control
MP-517 type = 22.7 lb. in. proportional control

For two position control use the following factors to determine usable torque. Multiply torque listed above by the appropriate factor.

MP-5220 Type – 4.4
MP-511 Type – 2.8
MP-517 Type – 2.9

To determine the nominal damper area (sq. ft.) that a hydraulic actuator can handle, proceed as follows:

1. Determine the pressure differential across the damper in the closed position.
2. Determine the velocity of air flow through the damper.
3. Determine any additional torque required for such things as jack shafting, interconnection linkage between damper frames, etc.
4. From the torque ratings given in this EN Bulletin find the nominal torque rating of the actuator for the application being considered (proportional or two position).
5. Subtract from the actuator torque rating any torque determined in Step 3.
6. On Table 1 or 2 locate the pressure differential determined in Step 1, and the velocity determined in Step 2. At this point in the Table read the torque/sq. ft. of damper area required.

7. Divide the usable torque of the actuator Step 5 by the factor read on the appropriate Table 1 or 2 to obtain square footage of damper the actuator can handle.

## PNEUMATIC ACTUATOR

These actuators are similar to the hydraulic actuators because they, also, do not produce maximum torque at all points in their stroke. Maximum torque is available only at the full retracted or full extended positions. Therefore a nominal torque value must be determined for which the actuator can be rated. The nominal torque value for proportioning control is the torque resultant from a specific hydraulic pressure change. This pressure change is that which is produced by a temperature change equivalent to $0.6F^{o}$ at a controller with a $4F^{o}$ throttling range. To determine the temperature change at other throttling ranges required to produce rated torque, use the following formula:

$$\frac{\text{Throttling Range of Controller} \times 0.6}{4} = \text{Temp. change required to produce rated torque}$$

Tables 3 and 4 list the nominal damper area ratings of pneumatic actuators. These ratings are based on the rated torque developed by the actuator for proportional controls. The rated torque values are:

MK-3000 Series 21 lb. in. proportional control
MK-4400 Series 7.9 lb. in. proportional control
MP-7000 Series 67.5 lb. in. proportional control

For two position control on proportional control or with positive positioners refer to Tables 5, 6, 7, and 8.

Tables 3 and 4 are used regardless of spring range of the actuator unless jack shaft or interconnecting linkage between frames is used. When these conditions exist proceed as follows:

1. Determine the pressure differential across the damper in the closed position.
2. Determine the velocity of air flow through the damper in the open position.
3. Determine any additional torque required for such things as jack shafting, interconnecting linkage between damper frames, etc.
4. From the torque ratings given in this EN Bulletin find the nominal torque rating of the actuator being considered.
5. Subtract from the actuator rating any torque determined in Step 3.
6. On Table 1 or 2 locate the pressure differential determined in Step 1, then read right until you reach the column under the velocity determined in Step 2.
7. Divide the usable torque of the actuator Step 5 by the factor read on the appropriate Table 1 or 2 to obtain the damper area the actuator can handle.

Pneumatic damper actuators for two position control or proportional control with positive positioner.

**Table 3. Parallel Blade Damper sq. ft./Pneumatic Actuator – Prop. Control W/O Posn. Based on Table 2**

| | Static Press. | 1000 FPM | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|---|
| MK-3000 | 0.5" | 20.0 | 18.1 | 15.3 | 14.1 | 11.2 |
| MK-4400 | | 7.5 | 6.8 | 5.8 | 5.3 | 4.2 |
| MK-7000 | | 64.2 | 58.1 | 49.2 | 45.3 | 35.9 |
| MK-3000 | 1.0" | 15.0 | 15.0 | 11.6 | 10.8 | 9.1 |
| MK-4400 | | 5.6 | 5.6 | 4.4 | 4.1 | 3.4 |
| MK-7000 | | 48.2 | 48.2 | 37.5 | 34.7 | 29.2 |
| MK-3000 | 1.5" | 13.5 | 10.9 | 9.0 | 8.0 | 7.7 |
| MK-4400 | | 5.1 | 4.1 | 3.4 | 3.0 | 2.9 |
| MK-7000 | | 43.5 | 34.9 | 28.8 | 25.5 | 24.7 |
| MK-3000 | 2.0" | 11.4 | 9.8 | 7.2 | 6.2 | 5.9 |
| MK-4400 | | 4.3 | 3.7 | 2.7 | 2.3 | 2.2 |
| MK-7000 | | 36.6 | 31.5 | 23.0 | 19.7 | 19.0 |
| MK-3000 | 2.5" | 10.4 | 9.4 | 7.2 | 6.2 | 5.6 |
| MK-4400 | | 3.9 | 3.5 | 2.7 | 2.3 | 2.1 |
| MK-7000 | | 33.5 | 30.2 | 23.0 | 19.7 | 17.9 |
| MK-3000 | 3.0" | 8.3 | 7.7 | 5.9 | 4.7 | 4.3 |
| MK-4400 | | 3.1 | 2.9 | 2.2 | 1.8 | 1.6 |
| MK-7000 | | 26.6 | 24.6 | 19.0 | 15.1 | 13.9 |

**Table 4. Opposed Blade Damper sq. ft./Pneumatic Actuator – Prop. Control W/O Posn. Based on Table 1**

| | Static Press. | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|
| MK-3000 | 0.5" | 21.4 | 19.8 | 17.2 | 13.9 |
| MK-4400 | | 8.1 | 7.5 | 6.5 | 5.2 |
| MK-7000 | | 68.8 | 63.6 | 55.3 | 44.7 |
| MK-3000 | 1.0" | 16.3 | 15.0 | 13.5 | 12.1 |
| MK-4400 | | 6.1 | 5.6 | 5.1 | 4.5 |
| MK-7000 | | 52.3 | 48.2 | 43.2 | 38.7 |
| MK-3000 | 1.5" | 14.2 | 14.0 | 10.3 | 9.1 |
| MK-4400 | | 5.3 | 5.2 | 3.9 | 3.4 |
| MK-7000 | | 45.6 | 45.0 | 33.2 | 29.3 |
| MK-3000 | 2.0" | 12.4 | 12.3 | 10.3 | 7.2 |
| MK-4400 | | 4.7 | 4.6 | 3.9 | 2.7 |
| MK-7000 | | 39.9 | 39.4 | 33.2 | 29.2 |
| MK-3000 | 2.5" | 11.2 | 10.3 | 9.6 | 7.2 |
| MK-4400 | | 4.2 | 3.9 | 3.6 | 2.7 |
| MK-7000 | | 35.9 | 33.2 | 30.8 | 23.2 |
| MK-3000 | 3.0" | 10.4 | 10.3 | 9.2 | 7.1 |
| MK-4400 | | 3.9 | 3.9 | 3.5 | 2.7 |
| MK-7000 | | 33.5 | 33.2 | 29.6 | 22.8 |

### Two Position Control

When using pneumatic actuators for two position control the ratings will vary with the spring range of the actuator. This is due to the fact that we now may use a greater pressure change on some spring ranges than other spring ranges.

The amount of air change usable is the smaller of the (lower limit of the spring – the minimum controlled air pressure) – pressure change required for sealing; or the (maximum controlled air pressure – upper limit of the spring) – pressure change required for sealing. A nominal safe pressure change required for sealing is 1 to 2 PSI at the ratings of the actuator. Therefore the following pressures are available on the various spring ranges for control.

3-7 spring 1.5 PSIG @ 15 or 20 PSIG supply
3-8 spring 1.5 PSIG @ 15 or 20 PSIG supply
5-10 spring 3 PSIG @ 15 or 20 PSIG supply
8-13 spring 1.5 PSIG @ 15 PSIG supply
8-13 spring 4.5 PSIG @ 20 PSIG supply
3-13 spring 1.5 PSIG @ 15 or 20 PSIG supply

Therefore when using a 3-7, 3-8, 3-13 or 8-13 spring with 15 PSI supply, the square footage ratings given on Tables 3 and 4 should be used.

Recommended spring ranges for two position control are 5-10 when 15 PSI supply is available at any time, 8-13 when 20 PSI supply is available at all times. For ratings on the 5-10 and 8-13 springs refer to Tables 5, 6, 7 or 8.

### Proportional Control with a Positive Positioner

When using a positive positioner on an actuator the same facts are true as for two position control. However, there are certain advantages to the use of a positive positioner.

1. Start point is adjustable up to the limits of the positioner adjustment regardless of spring in the actuator.

2. Air pressure change from the controller to produce full travel is adjustable up to the limits of the positioner adjustment regardless of spring in the actuator.

3. Repeatable, accurate actuator positioning is obtained by the feedback from the actuator shaft to the positioner. This insures that at any given pilot pressure to the positioner the same shaft position is obtained.

We can see however, since the same ratings apply to positive positioner control as two position control that the square footage ratings of the 3-7, 3-8, 3-13 springs with 15 or 20 PSI supply and the 8-13 spring with 15 PSI supply cannot be increased over the ratings given on Tables 3 and 4. Therefore, it is recommended that when using a positive positioner that the 5-10 spring be used when there is 15 PSIG being supplied to the actuator at any time and the 8-13 spring be used when 20 PSIG is available at all times. The ratings for these springs are shown on Tables 5, 6, 7 and 8.

The ratings on Tables 5, 6, 7 and 8 must be reduced if jack shafting or interconnecting linkage is used. To do this proceed as follows:

1. Determine damper area as previously outlined under pneumatic actuators, depending on the type of action required.

2. When using a 3-7, 3-8, 3-13 spring with 15 or 20 PSIG or an 8-13 spring with 15 PSIG this is the rating of the actuator.

3. When using a 5-10 spring multiply the rating in Step 1 by 2 to obtain new damper rating.

4. When using a 8-13 spring with 20 PSIG supply multiply the rating in Step 1 by 3 to obtain the new damper rating.

**Table 5. Parallel Blade Damper sq. ft./Pneumatic Actuator – Two Posn. Control or with Pos. Posn. 5-10 Spring 15 or 20 PSI Supply Based on Table 2**

| | Static Press. | 1000 FPM | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|---|
| MK-3000 | 0.5" | 40.0 | 36.2 | 30.6 | 28.2 | 22.4 |
| MK-4400 | | 15.0 | 13.6 | 11.6 | 10.6 | 8.4 |
| MK-3000 | 1.0" | 30.0 | 30.0 | 23.2 | 21.6 | 18.2 |
| MK-4400 | | 11.2 | 11.2 | 8.8 | 8.2 | 6.8 |
| MK-3000 | 1.5" | 27.0 | 21.8 | 18.0 | 16.0 | 15.4 |
| MK-4400 | | 10.2 | 8.2 | 6.8 | 6.0 | 5.8 |
| MK-3000 | 2.0" | 22.8 | 19.6 | 14.4 | 12.4 | 11.8 |
| MK-4400 | | 8.6 | 7.4 | 5.4 | 4.6 | 4.4 |
| MK-3000 | 2.5" | 20.8 | 18.8 | 14.4 | 12.4 | 11.2 |
| MK-4400 | | 7.8 | 7.0 | 5.4 | 4.6 | 4.2 |
| MK-3000 | 3.0" | 16.6 | 15.4 | 11.8 | 9.4 | 8.6 |
| MK-4400 | | 6.2 | 5.8 | 4.4 | 3.6 | 3.2 |

**Table 6. Parallel Blade Damper sq. ft./Pneumatic Actuator – Two Posn. Control or with Pos. Posn. 8-13 Spring 20 PSI Supply Based on Table 2**

| | Static Press. | 1000 FPM | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|---|
| MK-3000 | 0.5" | 60.0 | 54.3 | 45.9 | 42.3 | 33.6 |
| MK-4400 | | 22.5 | 20.4 | 17.4 | 15.9 | 12.6 |
| MK-7000 | | 192.6 | 174.3 | 147.6 | 135.9 | 107.7 |
| MK-3000 | 1.0" | 45.0 | 45.0 | 34.8 | 32.4 | 27.3 |
| MK-4400 | | 16.8 | 16.8 | 13.2 | 12.3 | 10.2 |
| MK-7000 | | 144.6 | 144.6 | 112.5 | 104.1 | 87.6 |
| MK-3000 | 1.5" | 40.5 | 32.7 | 27.0 | 24.0 | 23.1 |
| MK-4400 | | 15.3 | 12.3 | 10.2 | 9.0 | 8.7 |
| MK-7000 | | 130.5 | 104.7 | 86.4 | 76.5 | 74.1 |
| MK-3000 | 2.0" | 34.2 | 29.4 | 21.6 | 18.6 | 17.7 |
| MK-4400 | | 12.9 | 11.1 | 8.1 | 6.9 | 6.6 |
| MK-7000 | | 109.8 | 94.5 | 69.0 | 59.1 | 57.0 |
| MK-3000 | 2.5" | 31.2 | 28.2 | 21.6 | 18.6 | 16.8 |
| MK-4400 | | 11.7 | 10.5 | 8.1 | 6.9 | 6.3 |
| MK-7000 | | 100.5 | 90.6 | 69.0 | 59.1 | 53.7 |
| MK-3000 | 3.0" | 24.9 | 23.1 | 17.7 | 14.1 | 12.9 |
| MK-4400 | | 9.3 | 8.7 | 6.6 | 5.4 | 4.8 |
| MK-7000 | | 79.8 | 73.8 | 57.0 | 45.3 | 41.7 |

**Table 7. Opposed Blade Damper sq. ft/Pneumatic Actuator - Two Posn. Control or with Pos. Posn. 5-10 Spring 15 or 20 PSI Supply Based on Table 1**

| | Static Press. | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|
| MK-3000 | 0.5" | 42.8 | 39.6 | 34.4 | 27.8 |
| MK-4400 | | 16.2 | 15.0 | 13.0 | 10.4 |
| MK-3000 | 1.0" | 32.6 | 30.0 | 27.0 | 24.2 |
| MK-4400 | | 12.2 | 11.2 | 10.2 | 9.0 |
| MK-3000 | 1.5" | 28.4 | 28.0 | 20.6 | 18.2 |
| MK-4400 | | 10.6 | 10.4 | 7.8 | 6.8 |
| MK-3000 | 2.0" | 24.8 | 24.6 | 20.6 | 14.4 |
| MK-4400 | | 9.4 | 9.2 | 7.8 | 5.4 |
| MK-3000 | 2.5" | 22.4 | 20.6 | 19.2 | 14.4 |
| MK-4400 | | 8.4 | 7.8 | 7.2 | 5.4 |
| MK-3000 | 3.0" | 20.8 | 20.6 | 18.4 | 14.2 |
| MK-4400 | | 7.8 | 7.8 | 7.0 | 5.4 |

**Table 8. Opposed Blade Damper sq. ft/Pneumatic Actuator – Two Posn. Control or with Pos. Posn. 8-13 Spring 20 PSI Supply Based on Table 1**

| | Static Press. | 1500 FPM | 2000 FPM | 2500 FPM | 3000 FPM |
|---|---|---|---|---|---|
| MK-3000 | 0.5" | 64.2 | 59.4 | 51.6 | 41.7 |
| MK-4400 | | 24.3 | 22.5 | 19.5 | 15.6 |
| MK-7000 | | 206.4 | 190.8 | 165.9 | 134.1 |
| MK-3000 | 1.0" | 48.9 | 45.0 | 40.5 | 36.3 |
| MK-4400 | | 18.3 | 16.8 | 15.3 | 13.5 |
| MK-7000 | | 156.9 | 144.6 | 129.6 | 116.1 |
| MK-3000 | 1.5" | 42.6 | 42.0 | 30.9 | 27.3 |
| MK-4400 | | 15.9 | 15.6 | 11.7 | 10.2 |
| MK-7000 | | 136.8 | 135.0 | 99.6 | 87.9 |
| MK-3000 | 2.0" | 37.2 | 36.9 | 30.9 | 21.6 |
| MK-4400 | | 14.1 | 13.8 | 11.7 | 8.1 |
| MK-7000 | | 119.7 | 118.2 | 99.6 | 69.6 |
| MK-3000 | 2.5" | 33.6 | 30.9 | 28.8 | 21.6 |
| MK-4400 | | 12.6 | 11.7 | 10.8 | 8.1 |
| MK-7000 | | 107.7 | 99.6 | 92.4 | 69.6 |
| MK-3000 | 3.0" | 31.2 | 30.9 | 27.6 | 21.3 |
| MK-4400 | | 11.7 | 11.7 | 10.5 | 8.1 |
| MK-7000 | | 100.5 | 99.6 | 88.8 | 68.4 |

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