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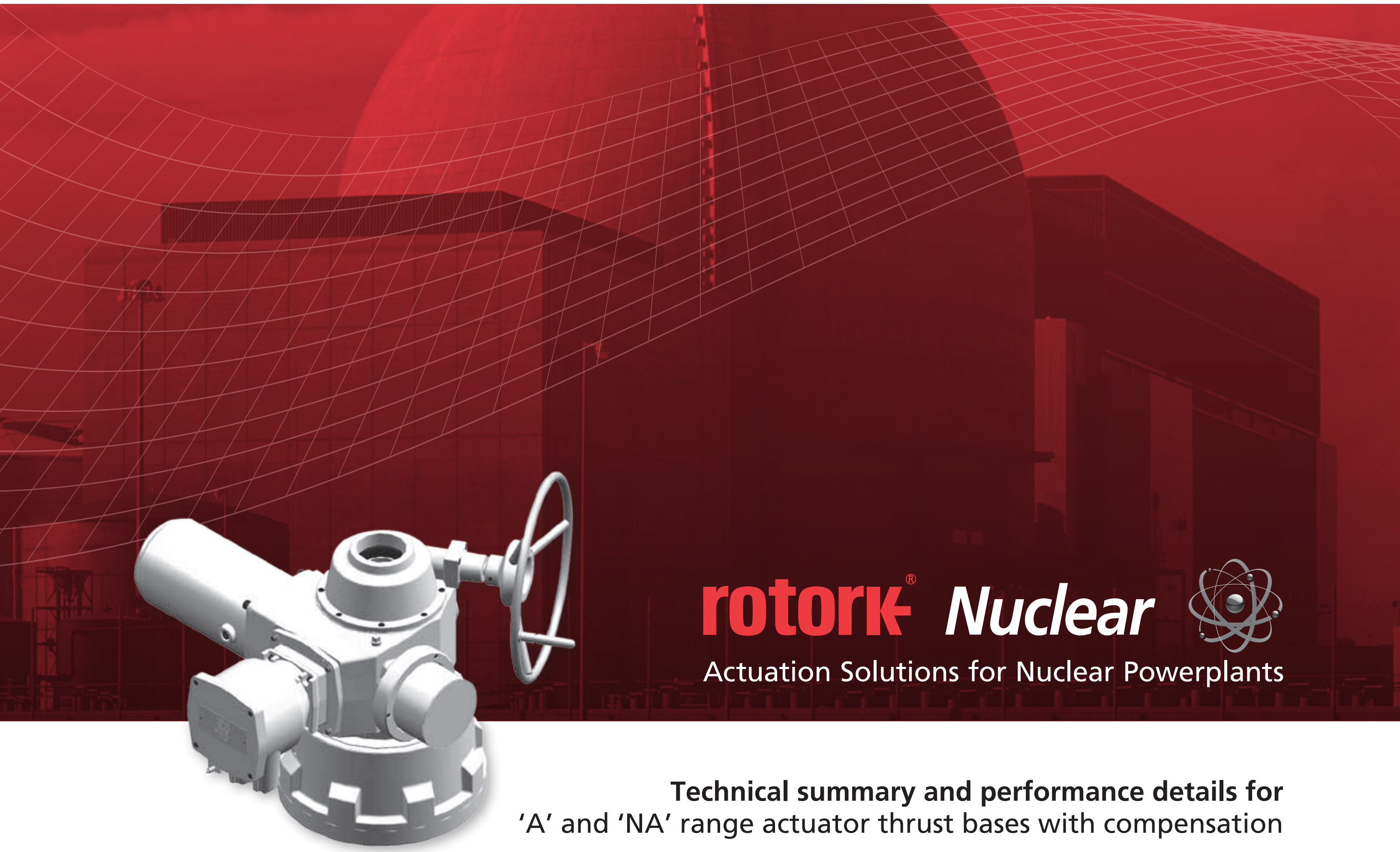
Controls

# Thrust Compensator




**Technical summary and performance details for**
‘A’ and ‘NA’ range actuator thrust bases with compensation

**Redefining** Flow Control

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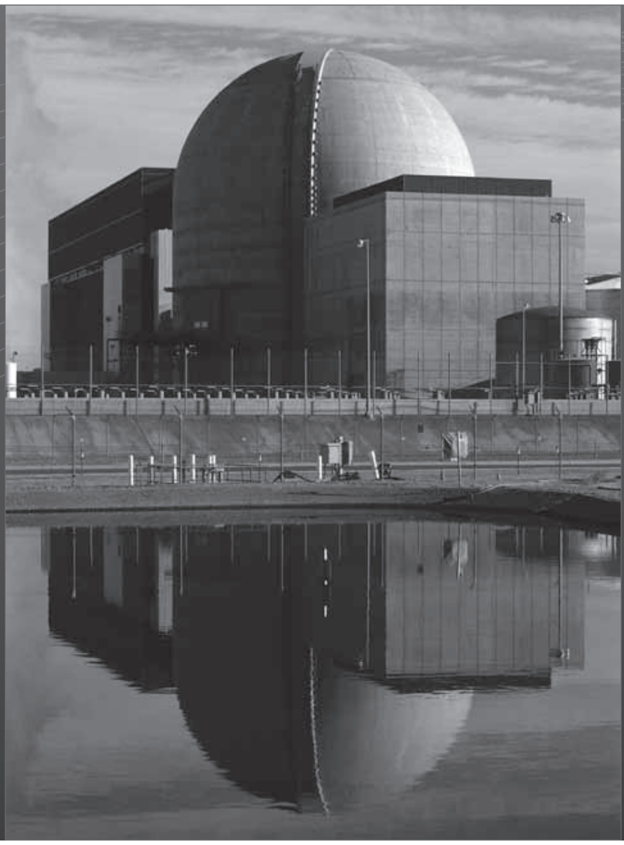
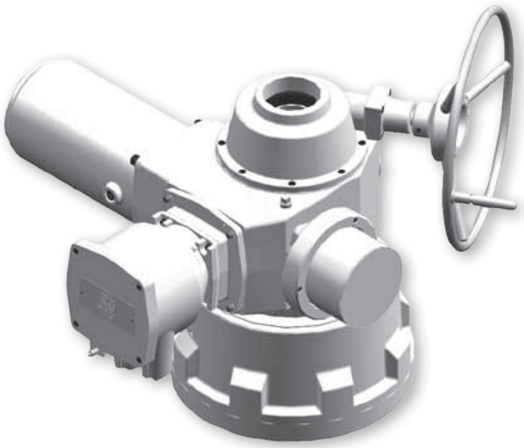




**This specification covers the performance details for 'A' range and 'NA' (NAX) range actuators fitted with thrust bases with compensation for valve stem expansion due to high temperatures or for applications where inertia due to high output speeds may cause concern.**

## Introduction

The thrust compensator assembly replaces the standard actuator thrust base and consists of a set of spring washers to locate the actuator drive bush. When the pre-load of the spring pack is exceeded in the seating of a valve, the drive bush can move and compress the spring pack thus absorbing high thrusts that may be generated. The thrust compensator requires no setup or adjustment, although heavy or light spring packs are available for specific thrust requirements. This design is ideal for those applications where valve rigidity presents difficulties in high speed operation or high temperature service.

### THRUST COMPENSATOR APPLICATIONS

The thrust compensator enables substantially the same seating torque to be applied to a valve, whether or not differential pressure is present and irrespective of operating speed. It is recommended for use if the stem speed exceeds approximately 24” per minute for gate valves, 8” per minute for globe valves (of rating ASA 600 or higher) and when the specified differential pressure is a substantial proportion of the nominal pressure classification.

At low speeds, the lower rate of thrust change means that there is less difference between the thrust delivered to the valve and the thrust corresponding to the torque switch setting. Similarly, with low differential pressures, the difference between dry run and service conditions is less significant. Fitting the thrust compensator will also allow for stem expansion or contraction and will significantly reduce the force delivered if the actuator is stalled.

### HIGH SPEED APPLICATIONS

The thrust compensator is used in applications where high speed valve and actuators are required to prevent rapid valve thrust build-up in stem and seat. The thrust compensator acts as a spring cushion or shock absorber to protect the valve and actuator from excessive force due to inertia. The thrust compensator provides no mechanical inertia protection once the maximum useable movement is exceeded.

### VALVES WITH HIGH TEMPERATURE MEDIUMS

Valves which endure large thermal transients have the basic problem that the valve stem, disc and/or seat will expand and contract as the valve medium temperature varies. The thrust compensator design allows the actuator drive bush to move and compress the spring pack as the valve expansion occurs, thus limiting the amount of thrust applied to the valve/actuator assembly. The assembly also has the added advantage that as the valve cools, the contraction of the stem, disc and/or seat will be counteracted by the stored energy in the spring pack, thereby keeping the valve tightly shut.

### CONSTRUCTION (FIGURE 1)

Actuators with the thrust compensator option have a modified base and output shaft, carrying a preloaded spring washer cartridge. This permits deflection of the threaded drive bushing once the preload is exceeded. Deflection will continue at the spring rate until the maximum useable deflection is reached. If the factory set preload value is below the valve design thrust, and the deflection can continue up to a substantially higher value, the rate of change of thrust will be related almost entirely to the spring rate during the period which matters, i.e. when torque switch operation is required. This makes the thrust delivered proportional to torque setting within the thrust range of the compensator. The thrust is insignificantly affected by valve stiffness, presence or absence of differential pressure, and relative drop-out time of contactors up to 30 ms.

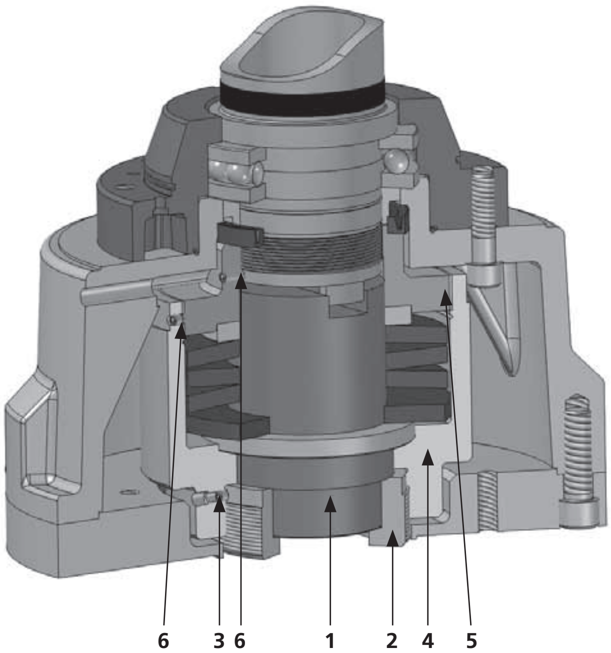



*Fig. 1 - Thrust Compensator.*

The illustration shows how the thrust compensator is added to extend the actuator base.

**Note:** the drive bushing (1) is detachable by unscrewing the drive bushing retainer (2) in exactly the same way as the standard actuator, the retainer being held in position by set screws (3). The drive bushing has one position only, with the same relationship to the base flange as the standard Type ‘A’ position 1 construction, so that no change of valve mounting flange or stem length is required; removal and replacement of drive bushing can be carried out without disturbing thrust compensator preload. This is factory set at Rotork by screwing the compensator housing (4) against thrust collar (5), which in turn is threaded to the actuator output shaft and locked by set screws (6). No special knowledge is therefore required by personnel responsible for mounting and fitting actuators to valves.

# Performance

## PERFORMANCE WITH THRUST COMPENSATOR

The following graphs show the effect of the thrust compensator, measured by a strain gauged threaded stem in a thrust rig set up to simulate the stiffness of an 8” ASA 1500 wedge gate valve.

Figure 2, Curve A shows the effect of stalling the actuator without the thrust compensator. This line shows the rate of change of thrust corresponding to a valve of this stiffness at 50” per minute.

Figure 2, Curve B shows the effect of stalling the actuator with the thrust compensator fitted. This shows the same stiffness rate until the preload is reached. Here the rate of change reduces substantially as long as spring deflection continues. When deflection ceases, the original rate of change is resumed. This time, however, so much energy has been absorbed that the ultimate stalling thrust is substantially lower.

Figure 3 and 4, values C, D and E show the effects of different contactor delay times on the same torque switch setting. It is apparent that the change in thrust delivered is very small in comparison with the change, which would have occurred by superimposing the same delay time on Curve A, because of the much lower rate of change.

Similar tests have been carried out using different rig stiffness rates. In every case the thrust compensator is much more resilient than the valve structure and such differences can be ignored.

Rotork actuator torque switches are calibrated by disc brake torque rigs where load is gradually applied. If the thrust compensator is fitted, the torque delivered to the valve (under torque switch operation with contactor delay times up to 30 ms) will not exceed torque switch calibration by more than 30%.

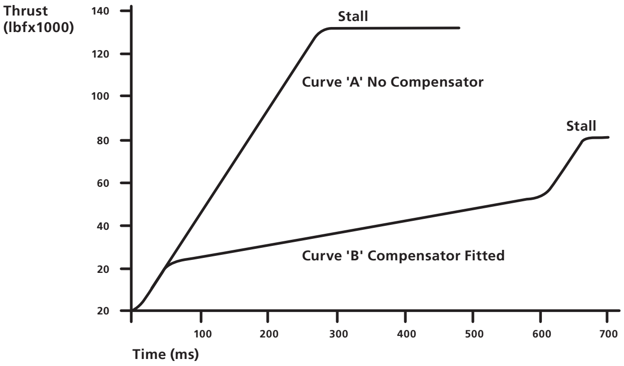



*Fig. 2 - effect of compensator during actuator stall*

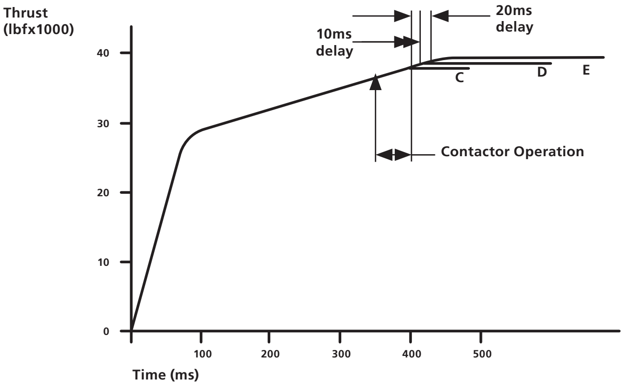



*Fig. 3 - effect of contactor delay on same torque switch setting*

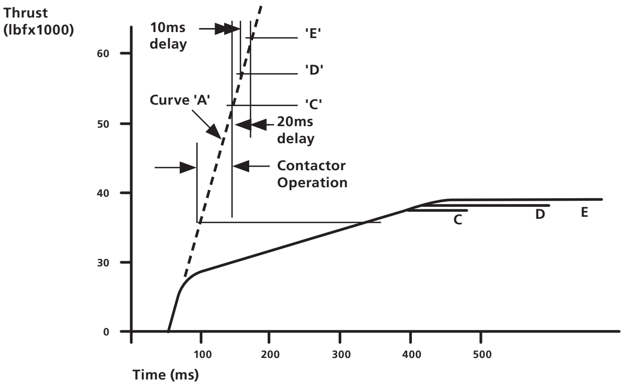


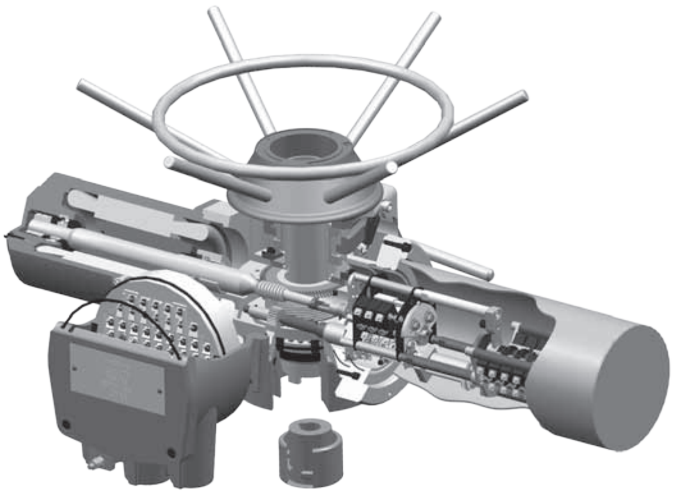

*Fig. 4 - effect of contactor delay - curves A & B compound*

# Technical Data

### TABLE 1 – THRUST COMPENSATOR TECHNICAL DATA

The following table lists the rated thrust (Tr) and the maximum thrust generated (Tm) with the maximum allowable spring deflection (Xm) for each actuator type.

| A/NA Size Base Mtg. | Maximum Stem mm (inch) | Preload/Rated Thrust (Tr) kN (Lbs) | Max. Thrust (Tm) kN (Lbs) | Max spring deflection/expansion (Xm) mm (inch) |
|---|---|---|---|---|
| 7 -13 F10/FA10 | 32 (1 1/4) | 3.11 (700) | 13.2 (2,971) | 1.8 (0.071) |
| | | 6.67 (1,500) | 16.2 (3,646) | 1.8 (0.071) |
| | | 13.34 (3,000) | 22.5 (5,064) | 1.8 (0.071) |
| | | 20.02 (4,500) | 26.04 (5,861) | 1.8 (0.071) |
| 14 - 16 F14/FA14 | 51 (2) | 8.89 (2,000) | 51.2 (11,524) | 3.8 (0.150) |
| | | 17.79 (4,000) | 60.0 (13,505) | 3.8 (0.150) |
| | | 35.58 (8,000) | 76.8 (17,286) | 3.8 (0.150) |
| | | 44.48 (10,000) | 81.8 (18,412) | 3.8 (0.150) |
| | | 53.38 (12,000) | 90.8 (20,437) | 3.8 (0.150) |
| 30 F16/FA16 | 64 (2 1/2) | 22.24 (5,000) | 73.6 (16,566) | 3.18 (0.125) |
| | | 44.48 (10,000) | 93.1 (20,955) | 3.18 (0.125) |
| | | 66.72 (15,000) | 113.8(25,614) | 3.18 (0.125) |
| 40 F25/FA25 | 73 (2 7/8) | 44.48 (10,000) | 113.0 (25,434) | 4.75 (0.187) |
| | | 80.06 18,000) | 145.2 (32,682) | 4.75 (0.187) |
| | | 111.2 (25,000) | 173.0 (38,938) | 4.75 (0.187) |
| 70 F25/FA25 | 83 (3 1/4) | 53.38 (12,000) | 145.1 (32,659) | 6.0 (0.236) |
| | | 88.96 (20,000) | 161.6 (36,373) | 6.0 (0.236) |
| | | 155.7 (35,000) | 293.3 (66,016) | 6.0 (0.236) |
| 90 F30/FA30 | 83 (3 1/4) | 53.38 (12,000) | 145.1 (32,659) | 6.0 (0.236) |
| | | 88.96 (20,000) | 161.6 (36,373) | 6.0 (0.236) |
| | | 155.7 (35,000) | 293.3 (66,016) | 6.0 (0.236) |
| | | 222.4 (50,000) | 333.6 (75,000) | 5.0 (0.197) |



# Compensator Sizing

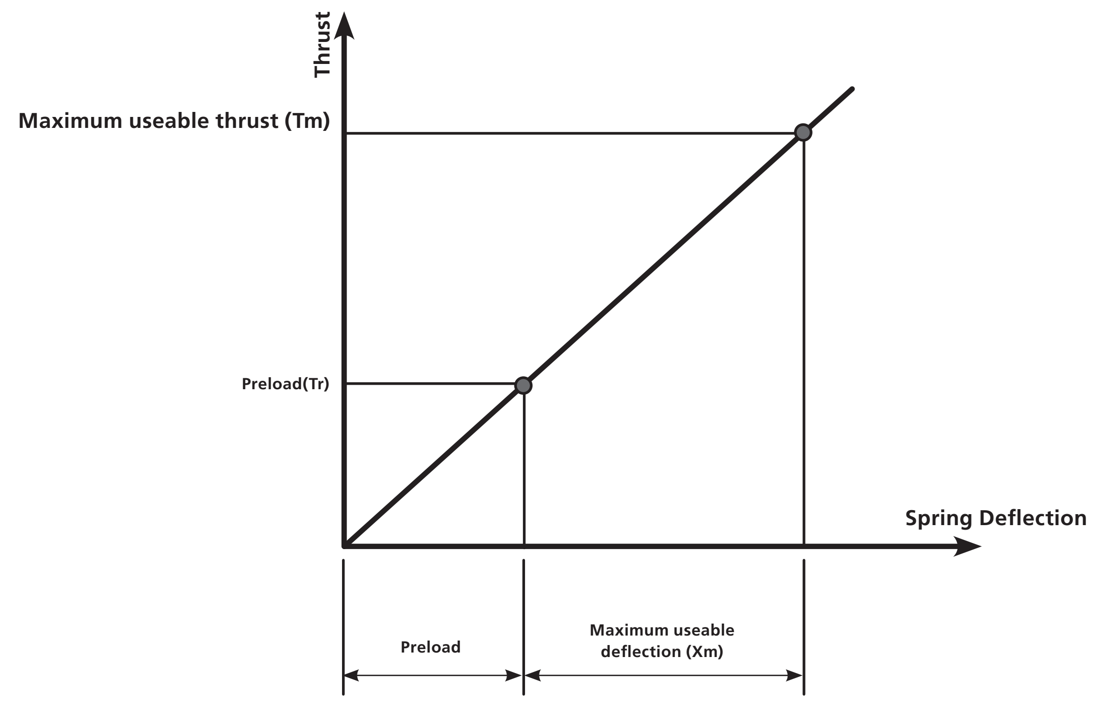



*Fig. 4*

## SIZING THRUST COMPENSATORS FOR HIGH SPEED APPLICATIONS

For high speed applications a preload (thrust rating [Tr]) shown in the Table 1 should be chosen that is as near as possible or just below the specified valve seating thrust. The maximum thrust (Tm) is the thrust at which compensator movement stops. Wherever possible the maximum thrust value (Tm) should be less than two times the specified valve seating thrust. If the spring pack chosen is too soft or too stiff then the effectiveness of the compensator will be greatly reduced.

## SIZING FOR HIGH TEMPERATURE APPLICATIONS

For high temperature applications a preload (thrust rating [Tr]) should be chosen that is as near as possible to the specified valve seating thrust, and then the thrust generated due to valve stem expansion can be calculated as detailed in the examples given below to ensure that the maximum permissible thrust for the valve is not exceed.

The approximate thrust generated due to valve expansion can be calculated from the following equation:-

$$Te = \frac{Tr + (Tm - Tr) * Xe}{Xm}$$

Table 1 lists the rated thrusts (Tr) and the maximum thrust generated (Tm) at the maximum useable valve stem expansion (Xm).



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# Compensator Sizing

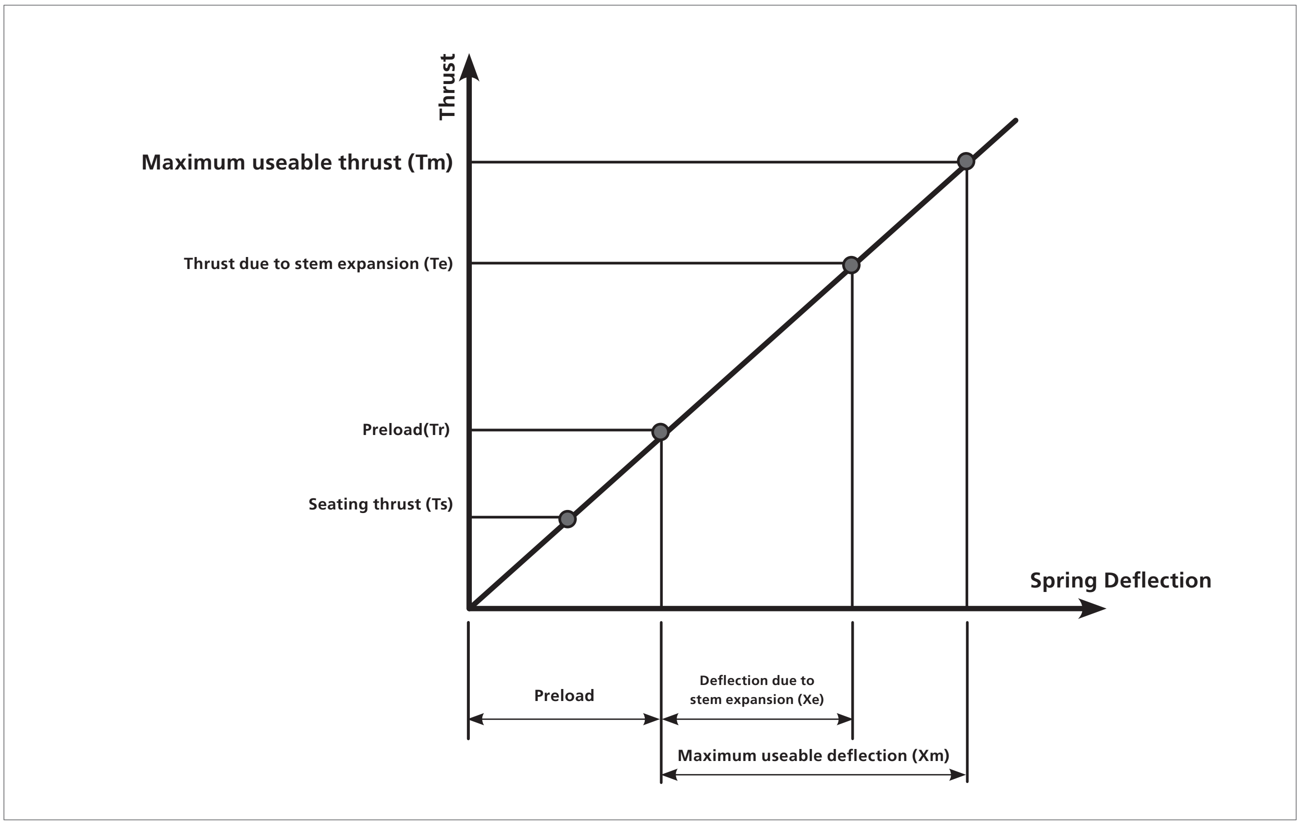


*Fig. 5*

**EXAMPLE OF TEMPERATURE COMPENSATOR SIZING WHERE THE VALVE SEATING THRUST IS LESS THAN THE COMPENSATOR PRELOAD (RATED THRUST)**

Valve Specification/Requirements

Seating thrust (Ts) = 11.5 kN

Maximum allowable thrust = 41.4 kN

Stem expansion Xe = 0.4 mm

7A Actuator using F10/FA10 assembly.

Rated Thrust (Tr) = 13.34 kN

Maximum Thrust (Tm) = 22.50 kN

Maximum Expansion (Xm) = 1.8 mm

$$Te = 13.34 + \frac{(22.5 - 13.34)}{1.8} * 0.4$$

$$Te = 15.38 \text{ kN}$$

This solution is acceptable as the maximum allowable specified thrust of 41.4 kN and the maximum thrust rating (Tm) of 22.5 kN is not exceeded.

# Compensator Sizing

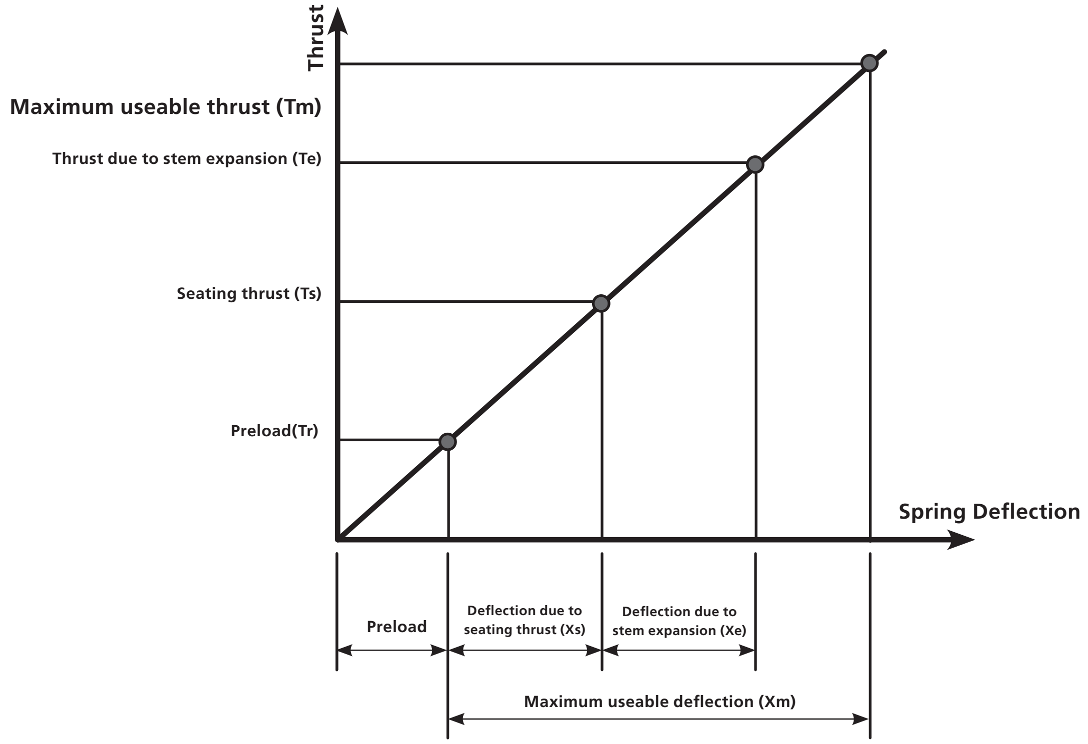


*Fig. 6*

**EXAMPLE OF TEMPERATURE COMPENSATOR SIZING WHERE THE VALVE SEATING THRUST IS GREATER THAN THE COMPENSATOR PRELOAD (RATED THRUST)**

The approximate thrust generated due to valve expansion can be calculated from the following equations:-

$$Xs = \frac{(Ts - Tr) * Xm}{(Tm - Tr)}$$

$$Te = \frac{Tr + (Tm - Tr) * (Xs + Xe)}{Xm}$$

Valve Specification/Requirements.

| | | |
|---|---|---|
| Seating Thrust (Ts) | = | 19.5 kN |
| Maximum allowable Thrust | = | 44.1 kN |
| Stem Expansion (Xe) | = | 0.4 mm |

7A Actuator using F10/FA10 assembly.

| | | |
|---|---|---|
| Rated thrust (Tr) | = | 13.34 kN |
| Maximum thrust (Tm) | = | 22.50 kN |
| Maximum expansion (Xm) | = | 1.8 mm |

$$Xs = \frac{(19.5 - 13.34) * 1.8}{(22.5 - 13.34)} = 1.266 \text{ mm}$$

$$Te = 13.34 + \frac{(22.5 - 13.34) * (1.266 + 0.4)}{1.8} = 21.8 \text{ kN}$$

This solution is acceptable as the maximum allowable specified thrust of 41.4 kN and the maximum thrust rating (Tm) of 22.5 kN is not exceeded.

# Notes

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## Notes

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Rotork plc
Brassmill Lane, Bath, UK

*tel* +44 (0)1225 733200
*fax* +44 (0)1225 333467
*email* mail@rotork.com

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