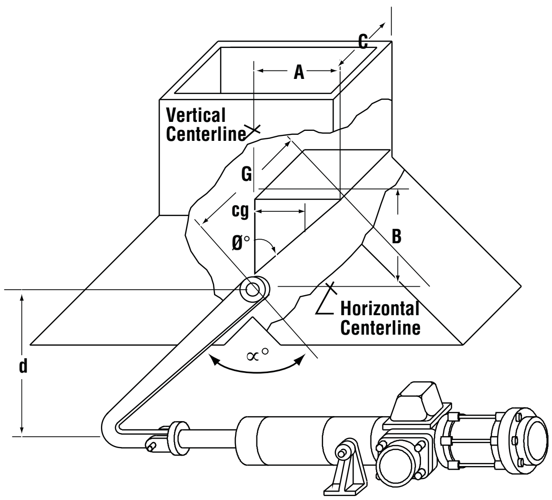
GENERAL APPLICATIONS

DIVERTER GATES



Legend	
A	projected length of gate opening (ft) (measured from vertical centerline)
B	projected height of gate (ft) (measured from horizontal centerline)
C	width of gate (ft)
cg	assumed center of gravity of the gate (ft)
d	effective lever arm length (ft) (Table 4)
G	length of gate (ft)
Ø°	maximum angular travel of the gate from the vertical center line (degrees)
$\alpha°$	total angular travel (degrees)
W1	average material specific weight (lbs/ft^3) (Table 2)
W2	assumed material weight hitting the gate (lbs). (Not used if gate is moved when no material is flowing)
W3	gate weight (lbs)
a	acceleration factor (Table 3)
Rf	required running force (lbs)
BAf	required breakaway force (lbs)

Reference Tables on Page 45.

Gate Operation:

- A diverter gate will produce a torque at the gate shaft directed away form the vertical centerline.

  Torque (ft-lbs) (gate) = total weight (lbs) (W2 + W3) x distance (ft) (A/2)

- To move the gate back toward the centerline a torque must be produced by the actuator through a lever arm that will exceed the gate torque.

  Torque (ft-lbs) (operating) = actuator force (lbs) x effective lever arm (ft) (d)

Required Information:

Dimensions C, G and angular travel Ø°. Dimensions A and B must be found.

A = G x (SIN Ø°) = _______ ft   B = G x (COS Ø°) = _______ ft

Ø°	15°	30°	45°	60°
SIN Ø°	0.26	0.50	0.71	0.87
COS Ø°	0.97	0.87	0.71	0.50

Formulas

$$cg = \frac{A\ ft}{2} \qquad W2 = \frac{A\ ft \times B\ ft \times C\ ft}{2} \times W1\ (lbs/ft^3) = \_\_\_\_\_\_\_\_ \ lbs$$

$$W3 = C\ (ft) \times G\ (ft) \times \text{total gate plate thickness (ft)} \times 490\ (lbs/ft^3) = \_\_\_\_\_\_\_\_ \ lbs$$

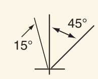
(2 plates are often used)

$$Rf = \frac{[W2\ lbs\ \text{(if applicable)} + W3\ lbs] \times (cg)\ (ft)}{d\ (ft)} = \_\_\_\_\_\_\_\_ \ lbs$$

$$BAf = Rf\ (lbs) \times a = \_\_\_\_\_\_\_\_ \ lbs$$

APPLICATION NOTES

1. Select actuator according to running force requirements.
2. If the gate is non-symmetrical use the larger of the two angles for Ø°.



Example

Find the force required to move a 6 ft. long by 4 ft. wide diverter gate through a moving stream of coal. The total angular travel is 60° (30° from the vertical centerline). The gate is fabricated from 2-3/8 inch steel plates. Due to space given requirements the actuator stroke should be 18 inch (max).

Given: C = 4 ft, G = 6 ft, Ø° = 30°, W1 = 55 lbs/ft^3

Calculations: A = 6 ft x 0.5 = 3 ft, B = 6 ft x 0.87 = 5.22 ft

$$W2 = \frac{3\ ft \times 5.22\ ft \times 4\ ft}{2} \times 55\ lbs/ft^3 = 1723\ lbs$$

$$W3 = (4\ ft \times 6\ ft) \times \left[\frac{0.375\ (inch) \times 2\ plates}{12\ (in/ft)}\right] \times 490\ (lbs/ft^3) = 735\ lbs$$

$$Rf = \frac{(1723\ lbs + 735\ lbs) \times 1.5\ ft}{1.3\ ft} = 2836\ lbs$$

$$BAf = 2836\ lbs \times 1.2^* = 3403\ lbs$$

* Acceleration factor based on velocity of 3.5 in/sec or less.

ENGINEERING TABLES

TABLE 1

Guide Type	Coefficient of Friction Between Steel Plate and Various Type Guides			
	Dry		Lubricated	
	Starting ($\mu 1$)	Running ($\mu 3$)	Starting ($\mu 1$)	Running ($\mu 3$)
Ball Bearings	–	–	0.08	0.05
Steel Rollers	–	–	0.15	0.10
Bronze	0.45	0.20	0.2	0.15
Steel	0.4-0.8	0.2-0.4	0.2-0.4	0.15-0.2

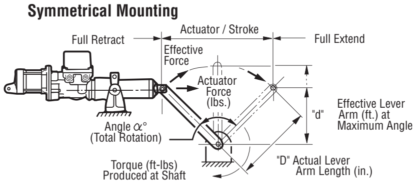
TABLE 2

Material	Coefficient of Friction Between Steel Plate and Various Materials		Specific Weights "W1" (lbs/ft3)	Column Height Factor "h"
	Starting ($\mu 2$)	Running ($\mu 4$)		
Ash (fly)	0.6-0.7	0.3	40-45	3.0
Ash (wet) (coal refuse)	0.75-0.95	0.5	45-50	2.0
Cement (portland)	0.6-0.65	0.3	95-100	3.0
Cement (clinker)	0.55-0.6	0.3	80-95	4.0
Coal (anthracite)	0.50-0.55	0.25	55-60	4.5
Coal (bituminous)	0.55-0.6	0.3	45-55	3.0
Coke	0.55-0.6	0.3	25-35	3.5
Grain	0.32-0.40	0.2	40-50	4.75
Iron Ore	0.55-0.65	0.3	125-180	3.5
Limestone (crushed)	0.55-0.65	0.3	80-90	3.5
Rock (crushed)	0.65-0.7	0.3	125-140	4.0
Sand (dry)	0.5-0.55	0.3	90-110	4.0
Sand (damp)	0.6-0.65	0.4	110-125	2.5
Slag (blast furnace)	0.4-0.45	0.2	80-90	5.5
Steel	See Table 1	See Table 1	490	–
Taconite	0.35-0.4	0.2	120-130	8.25
Wood chips	0.75-0.8	0.4	10-30	2.5

TABLE 3

Velocity (in/sec.)	0.1 to 3.5	3.6 to 6.4	6.4 to 12.2	12.3 to 25.0
Acceleration Factor (a)	1.2	1.3	1.4	1.5

Symmetrical Mounting



Non-Symmetrical Mounting

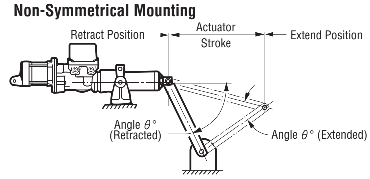


TABLE 4

Angle a	6" Stroke		12" Stroke		18" Stroke		24" Stroke	
	d'	D"	d'	D"	d'	D"	d'	D"
30°	.93	11.6	1.87	23.2	2.80	34.8	3.73	46.4
45°	.60	7.8	1.21	15.7	1.81	23.5	2.41	31.4
60°	.43	6.0	.87	12.0	1.30	18.0	1.73	24.0
90°	.25	4.2	.50	8.5	.75	12.7	1.00	17.0

Angle a	30" Stroke		36" Stroke		48" Stroke		60" Stroke	
	d'	D"	d'	D"	d'	D"	d'	D"
30°	4.67	58.0	5.60	69.5	7.46	92.7	9.33	115.9
45°	3.02	39.2	3.62	47.0	4.83	62.7	6.04	78.4
60°	2.17	30.0	2.60	36.0	3.46	48.0	4.33	60.0
90°	1.25	21.2	1.50	25.5	2.00	33.9	2.50	42.4

Angle Ø°	5°	15°	30°	45°	60°	75°	90°
Force Factor	0.09	0.26	0.50	0.71	0.87	0.97	1.00

Effective force (lbs) = Actuator force (lbs) x force factor
Effective lever arm (ft) = Actual length arm (ft) x force factor

NOTES

1. For non-symmetrical mounting the angle Ø° will change as the actuator moves through its travel. The angle Ø° is formed between the actuator drive rod centerline and the lever arm axis.

Torque (ft/lbs) = Effective lever arm (ft) x actuator force (lbs)
Force Required (lbs) = Torque (ft/lbs) ÷ Effective lever arm (ft)