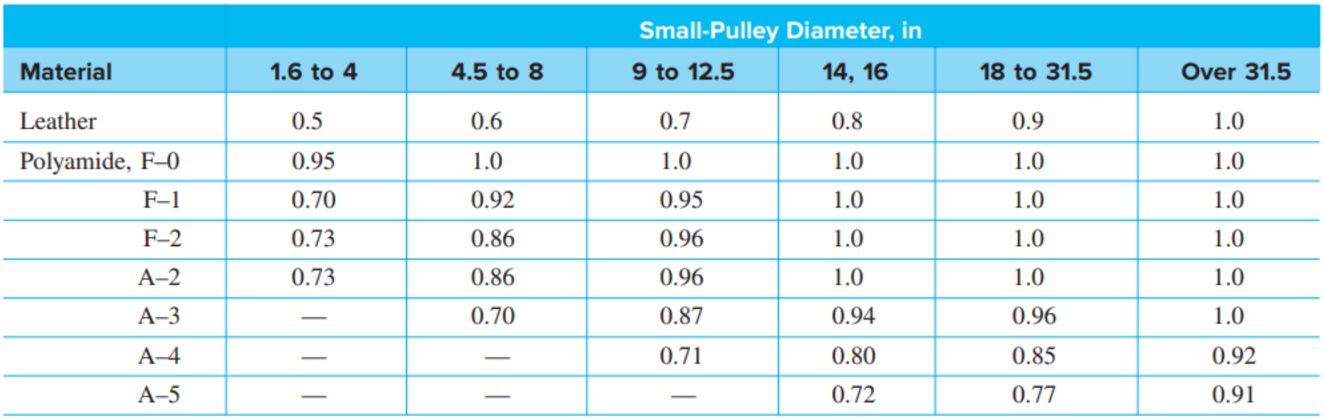
$C_v = 1$ for polyamide and urethane belts

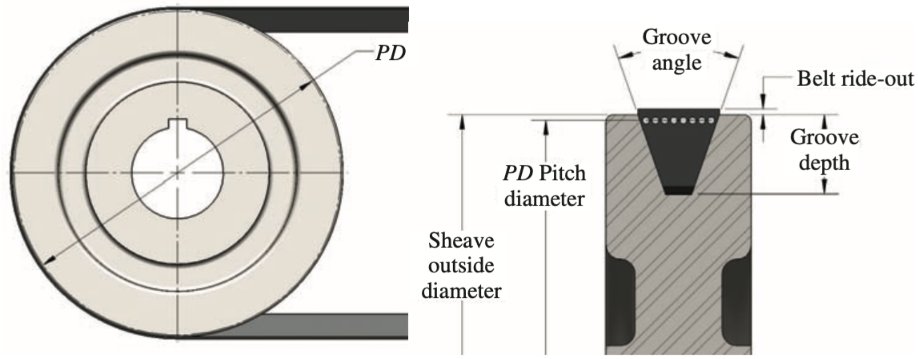
**Table 17–4 Pulley Correction Factor $C_P$ for Flat Belts***



|  | Small-Pulley Diameter, in |  |  |  |  |  |
|---|---|---|---|---|---|---|
| **Material** | **1.6 to 4** | **4.5 to 8** | **9 to 12.5** | **14, 16** | **18 to 31.5** | **Over 31.5** |
| Leather | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| Polyamide, F–0 | 0.95 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| F–1 | 0.70 | 0.92 | 0.95 | 1.0 | 1.0 | 1.0 |
| F–2 | 0.73 | 0.86 | 0.96 | 1.0 | 1.0 | 1.0 |
| A–2 | 0.73 | 0.86 | 0.96 | 1.0 | 1.0 | 1.0 |
| A–3 | — | 0.70 | 0.87 | 0.94 | 0.96 | 1.0 |
| A–4 | — | — | 0.71 | 0.80 | 0.85 | 0.92 |
| A–5 | — | — | — | 0.72 | 0.77 | 0.91 |

## 1.4 V-Belt Drives

### 1.4.1 Anatomy



### 1.4.2 Design Selection

1. Compute the design power

    (a) Find the service factor based from this table:

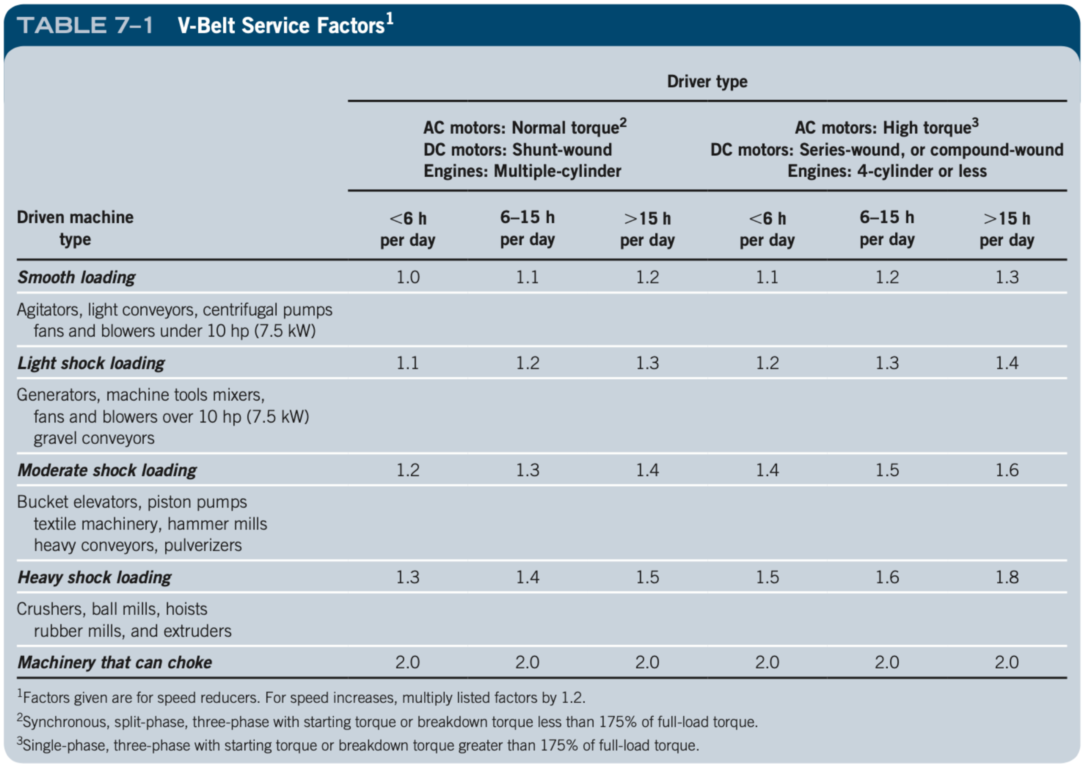


**TABLE 7–1 V-Belt Service Factors**[1]

| | Driver type | | | | | |
|---|---|---|---|---|---|---|
| | AC motors: Normal torque[2]<br>DC motors: Shunt-wound<br>Engines: Multiple-cylinder | | | AC motors: High torque[3]<br>DC motors: Series-wound, or compound-wound<br>Engines: 4-cylinder or less | | |
| Driven machine type | <6 h per day | 6–15 h per day | >15 h per day | <6 h per day | 6–15 h per day | >15 h per day |
| ***Smooth loading*** | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.3 |
| Agitators, light conveyors, centrifugal pumps<br>fans and blowers under 10 hp (7.5 kW) | | | | | | |
| ***Light shock loading*** | 1.1 | 1.2 | 1.3 | 1.2 | 1.3 | 1.4 |
| Generators, machine tools mixers,<br>fans and blowers over 10 hp (7.5 kW)<br>gravel conveyors | | | | | | |
| ***Moderate shock loading*** | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.6 |
| Bucket elevators, piston pumps<br>textile machinery, hammer mills<br>heavy conveyors, pulverizers | | | | | | |
| ***Heavy shock loading*** | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.8 |
| Crushers, ball mills, hoists<br>rubber mills, and extruders | | | | | | |
| ***Machinery that can choke*** | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |

[1] Factors given are for speed reducers. For speed increases, multiply listed factors by 1.2.

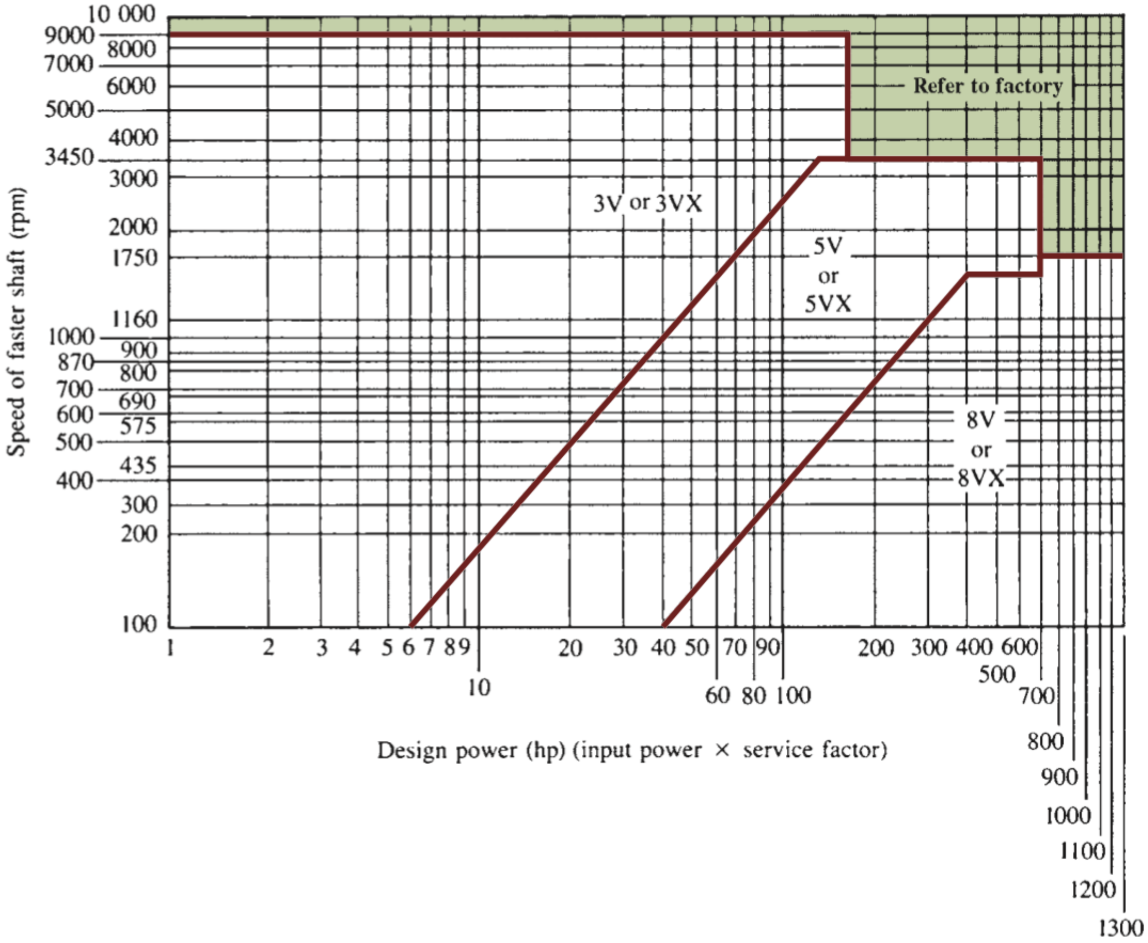
[2] Synchronous, split-phase, three-phase with starting torque or breakdown torque less than 175% of full-load torque.

[3] Single-phase, three-phase with starting torque or breakdown torque greater than 175% of full-load torque.

(b) Compute design power using:

$$P_{des} = H_{in} \cdot SF$$

2. Select the belt section
   If at the boundary between two different types of belts, be conservative and choose the larger one



3. Compute the nominal speed ratio

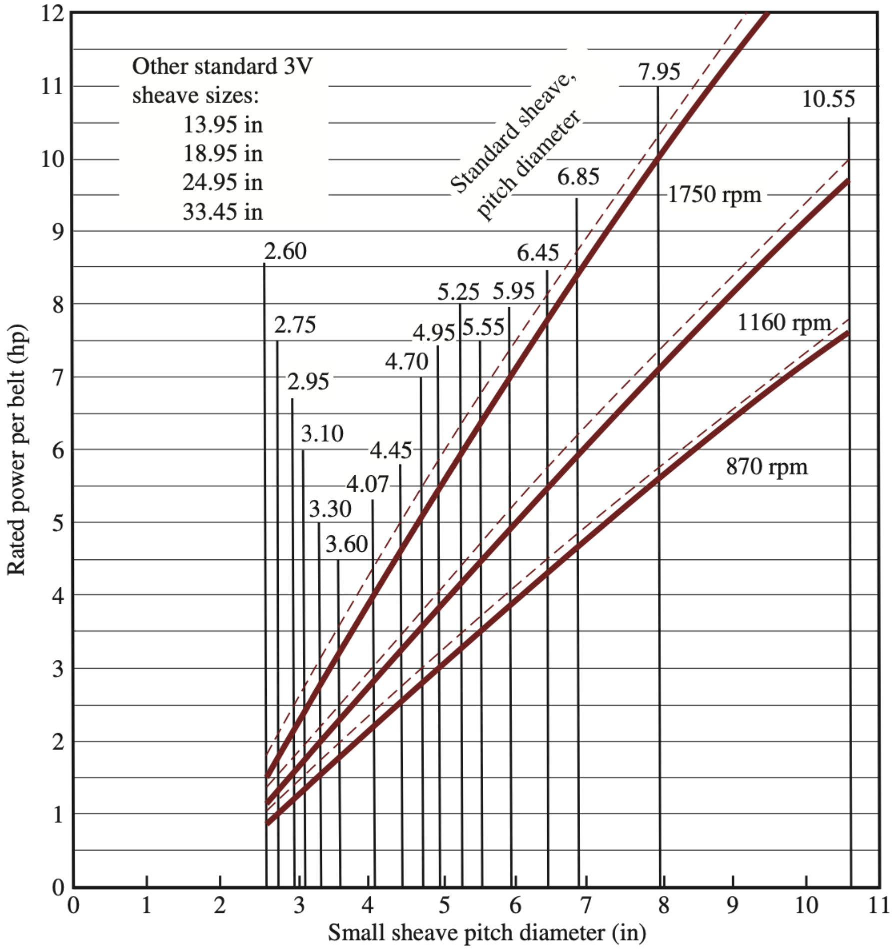
$$VR = \frac{n_1}{n_2} \text{ where } n_1 > n_2$$

4. Select the driving sheave size to produce a belt speed of 4000 ft/min (this is a standard speed we use since belt speed should not surpass 5000 ft/min, with a hard max at 6500 ft/min)

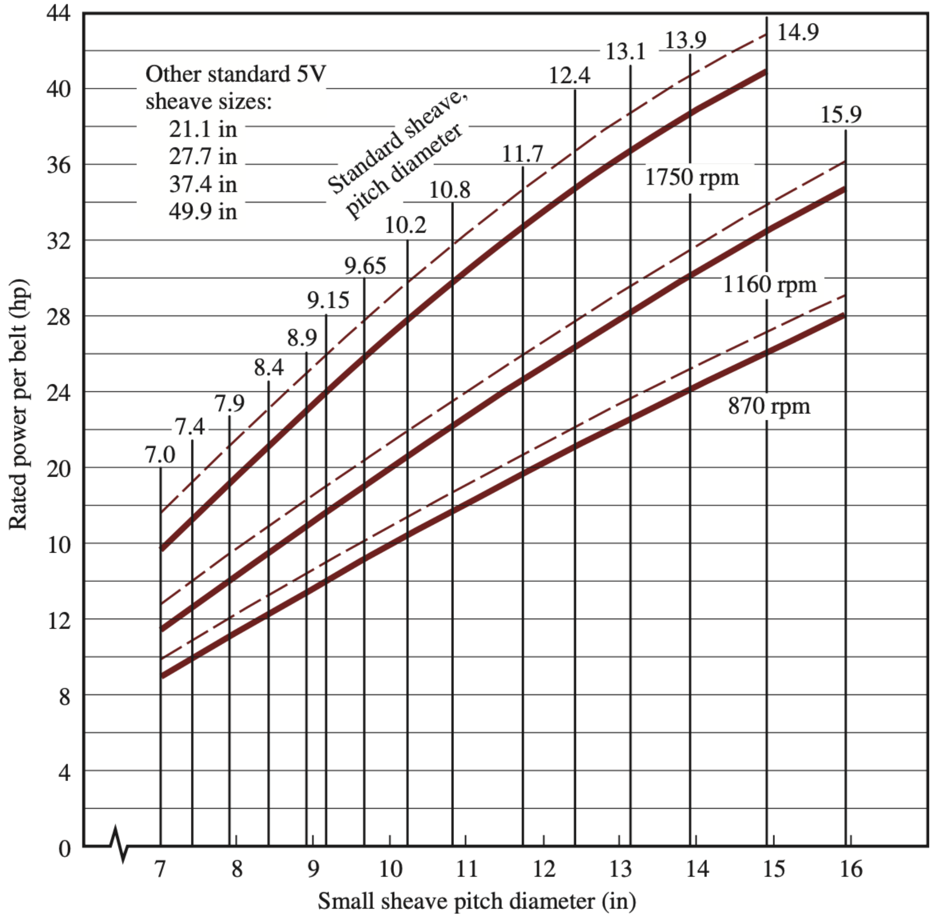
$$v_b = \frac{D_1 n_1}{2} \cdot (12 \text{ in/ft})(1 \text{ rev}/(2\pi \text{ rad}))$$

5. Select the standard sizes for the input and output sheaves

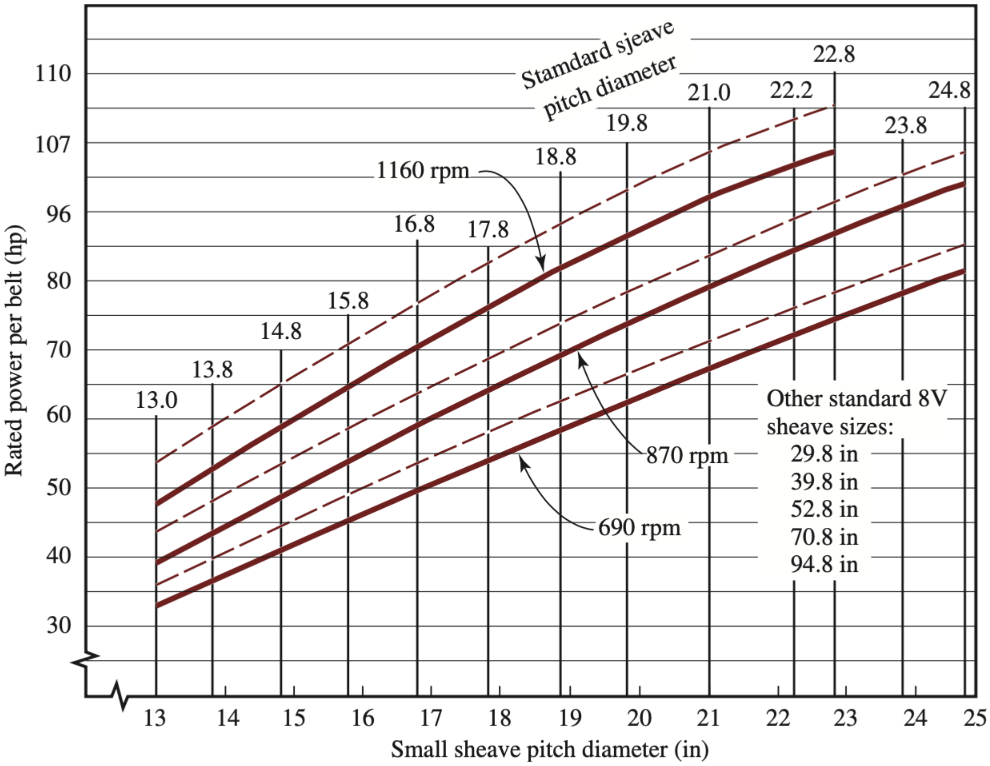
   (a) Select the closest standard size to the input sheave For 3V belts:


Other standard 3V
sheave sizes:
13.95 in
18.95 in
24.95 in
33.45 in
Standard sheave, pitch diameter
2.60
2.75
2.95
3.10
3.30
3.60
4.07
4.45
4.70
4.95
5.25
5.55
5.95
6.45
6.85
7.95
10.55
1750 rpm
1160 rpm
870 rpm
Rated power per belt (hp)
Small sheave pitch diameter (in)
0
1
2
3
4
5
6
7
8
9
10
11
12

For 5V belts:


Other standard 5V
sheave sizes:
21.1 in
27.7 in
37.4 in
49.9 in
Standard sheave, pitch diameter
7.0
7.4
7.9
8.4
8.9
9.15
9.65
10.2
10.8
11.7
12.4
13.1
13.9
14.9
15.9
1750 rpm
1160 rpm
870 rpm
Rated power per belt (hp)
44
40
36
32
28
24
20
10
12
8
4
0
7
8
9
10
11
12
13
14
15
16
Small sheave pitch diameter (in)

For 8V belts:



(b) Find the output sheave size using $D_2 = D_1 \cdot VR$ where $D_2 > D_1$

(c) Find the closest standard size to the output sheave using the same figures as above

6. Compute the actual speed ratio and belt speed

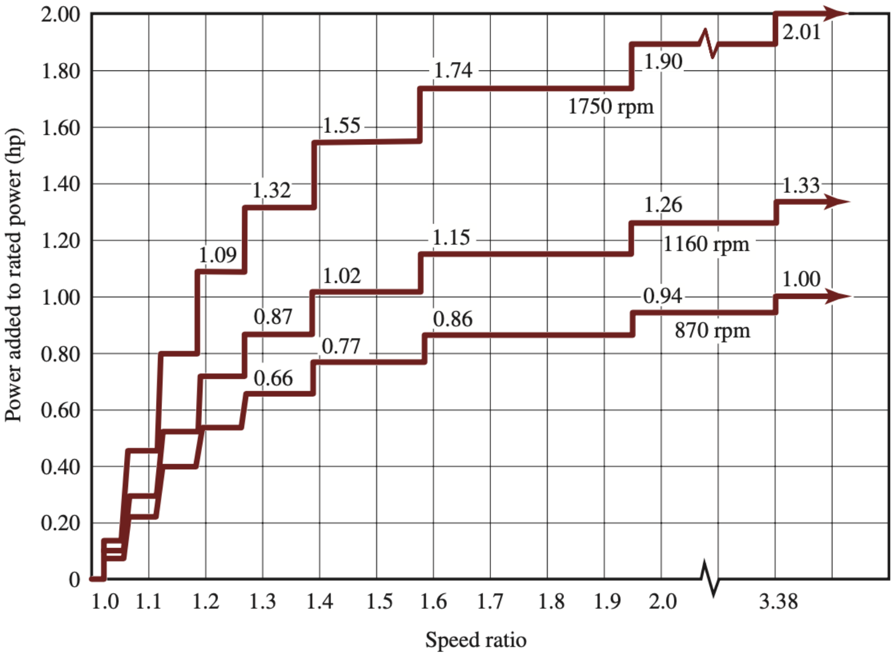
$$VR = \frac{D_2}{D_1}$$

$$v_b = \frac{D_1 n_1}{2} \cdot (12 \text{ in/ft})(1 \text{ rev}/(2\pi \text{ rad}))$$

7. Determine the rated power per belt

(a) Use the above figures to find the rated power per belt

(b) If the actual speed ratio is higher than 1, use the following table to find the power added:



(c) The total rated power per belt ($P_{rated}$) is the sum of both

8. Specify a trial center distance, CD, that is within the following range:

$$D_2 < CD < 3(D_2 + D_1)$$

9. Compute the required belt length

$$L_p = 2CD + 1.57(D_2 + D_1) + \frac{(D_2 - D_1)^2}{4C}$$

10. Select the closest standard belt length value from the following table:

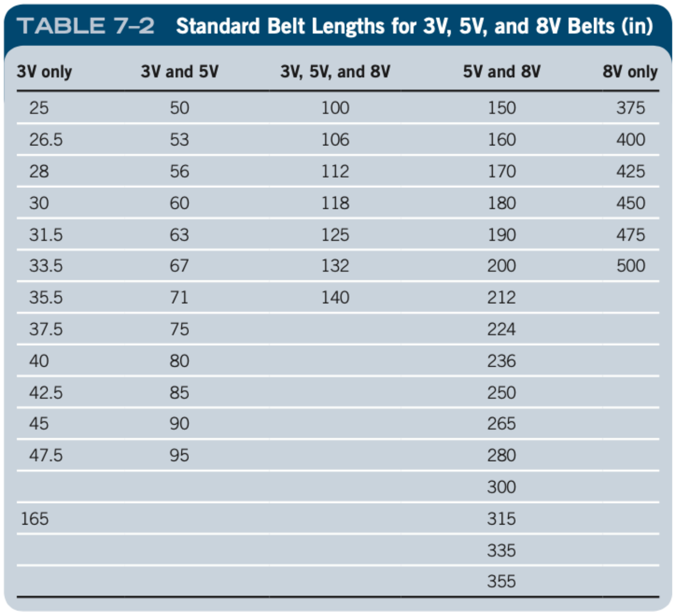


**TABLE 7–2 Standard Belt Lengths for 3V, 5V, and 8V Belts (in)**

| 3V only | 3V and 5V | 3V, 5V, and 8V | 5V and 8V | 8V only |
|---|---|---|---|---|
| 25 | 50 | 100 | 150 | 375 |
| 26.5 | 53 | 106 | 160 | 400 |
| 28 | 56 | 112 | 170 | 425 |
| 30 | 60 | 118 | 180 | 450 |
| 31.5 | 63 | 125 | 190 | 475 |
| 33.5 | 67 | 132 | 200 | 500 |
| 35.5 | 71 | 140 | 212 | |
| 37.5 | 75 | | 224 | |
| 40 | 80 | | 236 | |
| 42.5 | 85 | | 250 | |
| 45 | 90 | | 265 | |
| 47.5 | 95 | | 280 | |
| | | | 300 | |
| 165 | | | 315 | |
| | | | 335 | |
| | | | 355 | |

11. Using the standard belt length, compute the actual CD. First compute B (a random constant) cause it'll help simplify the CD expression

$$B = 4L_p - 6.28(D_2 + D_1)$$

$$CD = \frac{B + \sqrt{B^2 - 32(D_2 - D_1)^2}}{16}$$

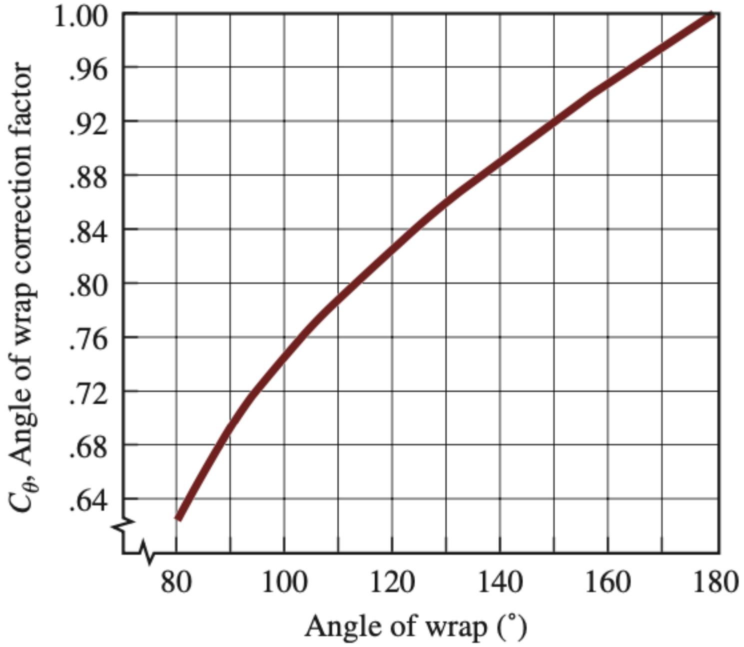
12. Compute the angle of wrap of small sheave

$$\theta_1 = 180^\circ - 2\sin^{-1}\left(\frac{D_2 - D_1}{2CD}\right)$$

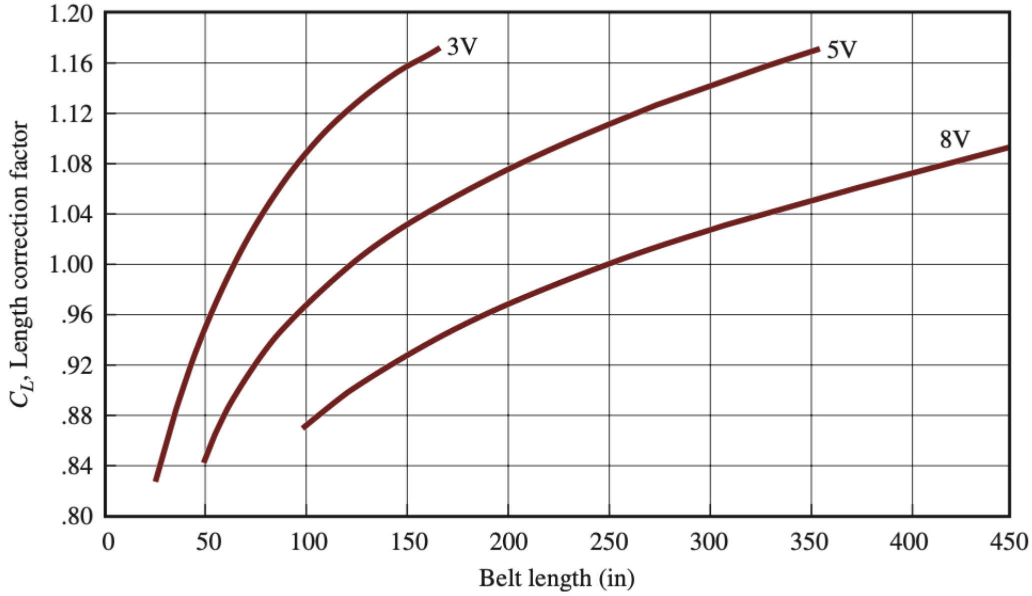
Probably won't be asked to compute the angle of wrap for the big sheave, but just in case, here is the formula:

$$\theta_2 = 180^\circ + 2\sin^{-1}\left(\frac{D_2 - D_1}{2CD}\right)$$

13. Determine the angle of wrap correction factor $C_\theta$



14. Determine the belt length correction factor $C_{L_p}$



15. Determine the required number of belts

   (a) Calculate the corrected power rating $= C_\theta C_{L_p} P$

(b) Calculate the minimum number of belts required

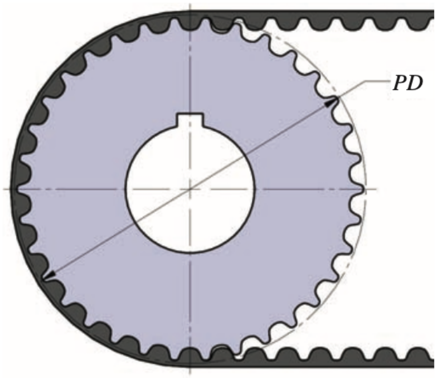
$$\text{min number of belts} = \frac{\text{design power}}{\text{corrected power rating}}$$

(c) Round up to the nearest integer

And that's it! You're doing great!!!

## 1.5 Synchronous Belt Drives

### 1.5.1 Anatomy



### 1.5.2 Design Selection

1. Compute the design power

   (a) Find the service factor from this table