Warner Electric
Boston Gear
TB Wood's
Formsprag Clutch
Wichita Clutch
Marland Clutch
Industrial Clutch
Bauer Gear Motor
Svendborg Brakes
Nuttall Gear
Warner Linear
Delroyd Worm Gear
Stieber Clutch
Ameridrives Couplings
Inertia Dynamics
Matrix International
Huco Dynatork
Bibby Turboflex
Twiflex Limited
Lamiflex Couplings
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BEST PRACTICES SERIES

# Critical Factors for Proper Product Selection and Sizing

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**Power Transmission Engineering**
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Altra® Industrial Motion
*The Power of Experience*

# Critical Factors for Proper Product Selection and Sizing

*By Greg Cober, Altra Industrial Motion Product Training Manager*

"Well begun is half done", a quote that most reference materials attribute to Aristotle, certainly applies when selecting mechanical power transmission products. A selection process that is well thought out at the start can ensure that the product selected will be properly sized and appropriate to the application at hand.

Different manufacturers have different names for them: service factor, safety factor, overload factor, load factor, etc. They all do basically the same thing: they factor or adjust for the hours of usage and the nature of irregularity, shock or vibration in the application. For our purposes, we will use the term "service factor" as that seems to be most common across the widest range of power transmission product types.

Service factors are used as a multiplier applied to the product's Horsepower or Torque rating. For example, a 1HP motor used in an application with a 1.5 service factor will be seen as having a Design HP or 1.5 HP for selection purposes.

Use of the proper service factor for an application ensures that the product selected will provide the desired life in the application as well as tolerate the levels of shock or vibration that is anticipated in the application. A few examples will illustrate this point.

The service factors for open gears such as spur gears, helical gears or worm gears will typically be provided by the manufacturer as shown in Table 1.

Looking at Table 1, we can see that the service factors for gear sizing addresses two key variables: the number of hours per day the product will be used, and the variability of shock and vibration there is in the application. For example, a liquid mixing tank motor that has a slow acceleration to full speed and very low variation in load would be considered a uniform load application. However, a stamping press or die cutter drive could easily be considered a heavy shock load application. These factors must be considered when selecting gears since each situation will apply different levels of stress and wear on the required gearing.

Some products, such as overrunning clutches, will require consideration of not just the nature of the load but the type of prime mover as well. As can be seen in Table 2, there can be an additive nature of an irregular load combined with the prime mover that will generate spikes as well. A basic AC motor will provide a much smoother output to an application than a diesel engine might and these differences can have a significant impact on the clutch's performance.

| Service Factor | Operating Conditions |
|---|---|
| .8 | Uniform – not more than 15 minutes in 2 hours. |
| 1.0 | Moderate Shock – not more than 15 minutes in 2 hours.<br>Uniform – not more than 10 hours per day. |
| 1.25 | Moderate Shock – not more than 10 hours per day.<br>Uniform – more than 10 hours per day. |
| 1.50 | Heavy Shock – not more than 15 minutes in 2 hours.<br>Moderate Shock – more than 10 hours per day. |
| 1.75 | Heavy Shock – not more than 10 hours per day. |
| 2.0 | Heavy Shock – more than 10 hours per day. |

Heavy shock loads and/or severe wear conditions may require the use of higher service factors. Consultation with factory is recommended in these applications. *(Source: Boston Gear)*

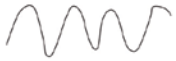
Table 1: Service Factors for Gearing

**Formsprag and Stieber Overrunning Clutches**

Clutches are suitable for many different power transmission applications. Please refer to this table for the proper service factor for your application.

Typical prime movers are listed at the left, types of loads across the top, and your service factor opposite the typical prime movers.

When torsional or linear vibration is present, use an FSO series clutch and increase the service factor at least 50%. For severe vibration, a greater service factor increase is necessary. To conform with couplings manufacturer's recommendations, use a minimum service factor of 1.5 on all Clutch Couplings.

| | | Driven Equipment Load Classifications | | | |
|---|---|---|---|---|---|
| | | **Light Steady Loads** Starting torque is equal to or slightly greater than running torque. | **Moderate Loads** High starting torque or above average running torque. | **Medium Loads** Starting torque is approximately double running torque. | **Heavy-Duty Loads** High starting torque, shock loading, light torque reversals during drive. |
| | |  |  |  |  |
| | | Centrifugal pumps, uniformly loaded conveyors, light-duty fans and blowers, liquid mixers and agitators, centrifugal compressors, lobe and vane type blowers, gear pumps, textile machinery, woodworking machinery. | Hot oil pumps, heavy-duty centrifugal pumps, cooling towers, slurry agitators, boiler feed pumps, hoists, conveyors. | Dredge pumps, dynamometer drives, light-duty hammermills, lineshafts, paper-converting machinery, rotary kilns, rotary or screw-type pumps for high viscosity fluids. | Mine ventilating fans, reciprocating pumps or compressors, papermaking machinery, heavy-duty hammermills, ore crushers, pulverizing mills. |
| **Prime Mover** | Steam, gas or air turbine | 1.00 | 1.50 | 1.50 | 2.50 |
| | AC electric motor | 1.25 | 1.50 | 1.50 | 2.50 |
| | DC electric motor with DOL start AC electric motor | 1.25 | 1.50 | 1.75 | 3.00 |
| | Gasoline, natural gas, propane or other spark ignition engine | 3.0 | 3.0 | Consult Formsprag | Consult Formsprag |
| | Diesel | Consult Formsprag | Consult Formsprag | Consult Formsprag | Consult Formsprag |

DOL = Direct on Line

*(Source: Formsprag Clutch/Stieber Clutch)*

**Table 2: Service Factors for Overrunning & Backstopping Clutches**

Products such as V-belt drives will require a combination of all three factors: variability of the application load, the hours of service and the output nature of the prime movers. Other belt considerations include factors for the use of such devices as idler pulleys and how they are mounted.

When considering service factors it is important to think about not just how a product might be used in the immediate future but further ahead as well. Note again in Table 1 that there is one factor for a uniform load at 10 hours or less per day and another that is 25% higher for more than 10 hours per day. Market demand may require that the system run only one shift now, but in the future that might change to require a two or even three shift operation. The gearing unit that provides perfectly acceptable life in one instance may become a maintenance headache in a higher usage situation. Worse, upsizing may require more than just a change in one component.

For example, a worm gearbox selected for 1 HP 20:1 ratio for single shift operation may be a 1.8 in. center distance but to provide proper life for a two shift operation that same 1 HP application would require a 2.1 in. center distance gearbox. The height to the output shaft would change from 2.06 in. to 2.28 in. with the requirement that bearings, shaft alignment and other drivetrain components change as well. The difference between the cost of the initial smaller gearbox and the cost of the larger unit may be approximately $150, but selecting the properly sized gearbox for how the system is going to be used in the future can avoid very significant machine redesign later.

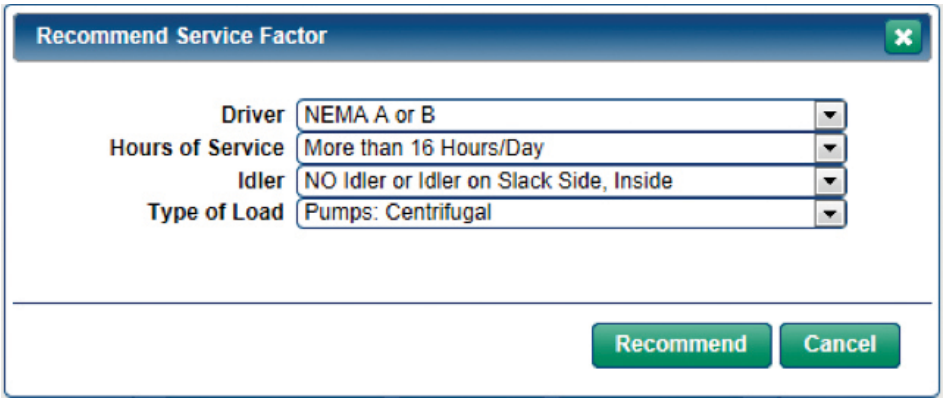
So far we have discussed how service factors can result in upsizing products. When we consider linear products, such as ball screws or linear actuators, load factoring can decrease the impact of the load. Vertical load is always comprised of the weight of the load plus any force applied by the process. But when linear movement is horizontal the load is likely supported by rails or by linear bearings of some type. Depending upon the coefficient of friction of the support, the load being moved can decrease by a very sizable amount, as shown in Table 3.

| | |
|---|---|
| Steel on Steel | ~.58 |
| Steel on Steel (greased) | ~.15 |
| Aluminum on Steel | ~.45 |
| Gibb Ways | ~.50 |
| Dove Tail Slides | ~.20 |
| Linear Bearing (Ball Bushings) | <.001 |

*(Source: Rockford Ball Screw)*

**Table 3: Coefficient of Sliding Friction for Non-Vertical Loading Applications**

Industrial component manufacturers have become more and more sophisticated in providing downloadable or online selection tool software. These include an automatic calculator that will incorporate appropriate service factors for your application parameters, as shown in the online belt drive selection tool screen.




**Online Belt Drive Selection Tool Screen** *(Source: TBWoods.com)*

Whether they are called service factors, safety factors or some other term, it is important to follow manufacturers' guidance when selecting a power transmission product. Use of proper service factors will ensure selection of correctly-sized product that will provide optimal unit life and performance. Consideration of the entire application for both today's need and next year's can ensure performance now and then. Lastly, manufacturers' tools can help simplify the selection process. Nearly all manufacturers gladly provide application assistance resources to help you make smart, cost-effective choices.

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449 Gardner Street
South Beloit, IL 61080
815-389-3771
815-389-2582 (fax)
www.AltraMotion.com

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