# Life Formulas

## Linear Ball and Roller Slides

### Rated Life

The rated life "L" of a linear slide is the length of travel endured by the slide under a specified condition. Since in reality, life varies from one slide to another, industry normally uses the L10 life rating which is defined as the length of travel that 90% of apparently identical slides will complete before the first evidence of failure.

### Speed Factor

The effect of speed on the load rating of a slide can be accounted for by a speed factor:

$$fs = \sqrt[m]{\frac{30}{V}}$$

where: V = speed of the slide movement in inches/min (when the speed varies during the cycle, the peak value should be used)

m = for ball slides, or
m = 10/3 for roller slides

**Note:** When the speed is less than 30 in/min, fs = 1.

### Temperature Factor

When the temperature of the slide exceeds certain limits, it reduces the hardness of contacting elements and consequently affects the load rating of the slide. Therefore, its load rating shall be adjusted by a temperature factor "ft". The values of this factor are presented in Table 1.

| Table 1 | | |
|---|---|---|
| **Temperature, Deg. F** | **Temperature Factor, "ft"** | |
| | Regular Bearing Steel Contacting Elements | Stainless Steel Contacting Elements |
| 220 | 1 | 1 |
| 300 | 0.9 | 1 |
| 400 | 0.75 | 0.9 |
| 500 | not recommended | 0.75 |

**Note:** When specifying slides for elevated temperature service, it should be kept in mind that the delrin retainers found in many slides are not recommended for temperatures above 180 deg.F.

### Load Type Factor

In reality, the load endured by a slide can never be absolutely smooth, but rather is a sum of variable forces that include working load, inertial forces, vibrations, impacts, occasional loads, etc. In order to have their influence taken into account, the load rating of the slide shall be adjusted by a load type factor "fw".The values of "fw" for calculations per formula (2) and (3) are presented in Table 2.

| Table 2 | |
|---|---|
| Condition of Load | Value of "fw" |
| Relatively smooth motion | 1 to 1.5 |
| Motion with impacts | 2 to 3 |

### Life Formula for Ball and Roller Slides

Based on the above definitions and role of different factors, the life of linear slides can be obtained from the following formula:

$$L10 = \left( \frac{C \times fs \times ft}{Pc \times fw} \right)^m \times 10^7 \ inches$$

Where:
L10= life of the slide at 90% or reliabiltity as defined above (in inches)
C= catalog "load capacity" of the slide in lbs. (which is a load that corresponds to an L10 life of 10 million inches, provided the factors fs, ft and fw are equal to 1.
Pc= calculated effective load slide is subjected to in lbs. (fs, ft and fw are factors as described above.)
m= 3 for ball slides, or 10/3 for roller slides.

When other than 90% reliability is required (for instance, "K"% reliability), the known alue of L10 shall be multiplied by a reliability factor "fr" so that:
Ln = fr x L1 0
Where:
n = rated life at the reliability of K%
(n = 1 OO-K).
The values of the factor "fr" are presented in Table 3.

| Table 3 | | |
|---|---|---|
| RELIABILITY K% | "Ln" rated life | "fr", reliability factor |
| 50 | L50 | 5.00 |
| 90 | L10 | 1.00 |
| 95 | L5 | 0.62 |
| 97 | L3 | 0.44 |
| 99 | L1 | 0.21 |

The general formula for the life of Del-Tron linear slides is expressed as follows:
**Example**

$$L_n = f_r \times \left( \frac{C \times f_s \times f_t}{P_c \times f_w} \right)^m \times 10^7 \text{ inches}$$

Design considerations lead to the selection of a ball slide. The available space accommodates the Del-Tron S2-4 slide. Find the life at 95% reliability (L5 life) under the following conditions:
• Peak speed during the cycle: V= 150 in/mint
• Working temperature of slide = 150 deg.F.
• Calculated effective load the slide is subjected to: Pc = 20 lbs.
• Type of load: Moderate vibration, no impacts.

Solution:
(1 ) With the formula (1 ) the speed factor "fs" is found as:

$$f_s = \sqrt[3]{\frac{30}{150}} = 0.58$$

(2) The value of the temperature factor '~' is found in Table 1 as: ft = 1.
(3) Using Table 2, the value of the type of load factor can be estimated as: fw = 1.25.
(4) The value of reliability factor "fr" is found in Table 3 as: fr= 0.62.
(5) The value of the load capacity for the Del-Tron S2-4 slide is found in the Del-Tron Catalog as:
    C= 60 lbs.
(6) The required life of the slide can then be calculated using formula (3):