General Description

THK General Catalog

A Technical Descriptions of the Products

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Selection Flow Chart

1. Setting Conditions
   - Dimensions of machines and systems
   - Speed
   - Operating frequency (duty cycle)
   - Required service life
   - Kinetic frequency
   - Environment
   - Space in the guide section
   - Installation direction
     (horizontal, vertical, slant mount, wall mount, suspended)
   - Magnitude and direction of the working load
   - Stroke length
   - Operating frequency (duty cycle)

2. Selecting a Type
   - Select a type that meets the conditions
     - LM Guide
     - Miniature Guide
     - Slide Pack
     - Ball Spline
     - Linear Bushing
     - LM Stroke
     - Cross Roller Guide
     - Linear Stage
     - Roller Type
     - etc.

3. Predicting the Service Life
   - Selecting a size
   - Selecting a number of blocks/nuts
   - Determining a number of rails/shafts

4. Rigidity
   - Selecting a clearance
   - Selecting a preload
   - Determining a fixing method
   - Determining the rigidity of the mounting section

5. Accuracy
   - Selecting an accuracy grade
     (feeding accuracy, runout accuracy)
   - Accuracy of the mounting surface

6. Lubrication and Safety Design
   - Determining a lubricant (grease, oil, special lubricant)
   - Determining a lubrication method (regular lubrication, forced lubrication)
   - Determining a material (standard material, stainless steel, high temperature material)
   - Determining a surface treatment (anti-rust, appearance)
   - Designing contamination protection (bellows, telescopic cover)

7. Calculating the Thrust Force
   - Obtaining the thrust force required for linear motion

Selection Completed
# Types and Features of LM Systems

<table>
<thead>
<tr>
<th>Type</th>
<th>LM Guide</th>
<th>Ball Spline</th>
<th>Linear Bushing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>![LM Guide Image]</td>
<td>![Ball Spline Image]</td>
<td>![Linear Bushing Image]</td>
</tr>
</tbody>
</table>
| **Features** | • Ideal Four Raceway, Circular-Arc Groove, Two-Point Contact Structure  
• Superb error-absorbing capability with the DF design  
• Accuracy Averaging Effect by Absorbing Mounting Surface Error  
• Large Permissible Load and High Rigidity  
• Low Friction Coefficient | • Large torque load capacity  
• Optimal for torque-transmitting mechanisms and locations where torque and radial load are simultaneously applied  
• No angular backlash  
• Ball Retaining Type | • Interchangeable type  
• LM system capable of performing infinite linear motion at low price |
| **Stroke** | Infinite stroke | Infinite stroke | Infinite stroke |
| **Major Applications** | • Surface grinder  
• Electric discharge machine  
• High-speed transfer equipment  
• NC lathe  
• Injection molding machine  
• Woodworking machine  
• Semiconductor manufacturing equipment  
• Inspection equipment  
• Food-related machine  
• Medical equipment | • Z axis of assembly robot  
• Automatic loader  
• Transfer machine  
• Automatic conveyance system  
• Wire winder  
• Spindle drive shaft of grinding machine  
• Steering of construction vehicle  
• Blood test equipment  
• ATC  
• Golf training machine | • Measuring instruments  
• Digital 3D measuring instrument  
• Printing machine  
• OA equipment  
• Automatic vending machine  
• Medical equipment  
• Food packaging machine |
<p>| <strong>Page introducing the product</strong> | A-25 onward | A-447 onward | A-523 onward |</p>
<table>
<thead>
<tr>
<th>Type</th>
<th>LM Stroke</th>
<th>Precision Linear Pack</th>
<th>Cross Roller Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td><img src="Image1.png" alt="Image" /></td>
<td><img src="Image2.png" alt="Image" /></td>
<td><img src="Image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>
| Features           | • Capable of performing rotary motion, straight motion and complex motion  
                      • Capable of performing rolling motion with an extremely small friction coefficient  
                      • Low cost  
                      ![Image](Image4.png)  
                      ![Image](Image5.png) | • Ultra-thin lightweight type  
                      • Reduced design and assembly costs  
                      ![Image](Image6.png) | • Long service life, high rigidity  
                      • Easy clearance adjustment type  
                      ![Image](Image7.png) |
| Stroke             | Finite stroke                                  | Infinite stroke                              | Finite stroke                                           |
| Major Applications | • Press die setting  
                      • Ink roll unit of printing machine  
                      • Optical measuring instrument  
                      • Spindle  
                      • Solenoid valve guide  
                      • Press post guide  
                      • Load cell  
                      • Photocopiers  
                      • Inspection machines  
                      ![Image](Image8.png) | • Magnetic disc device  
                      • Electronic equipment  
                      • Semiconductor manufacturing equipment  
                      • Medical equipment  
                      • Measuring equipment  
                      • Plotting machine  
                      • Photocopiern  
                      ![Image](Image9.png) | • Measuring instruments  
                      • Insertion machine  
                      • Printed circuit board drilling machine  
                      • Inspection equipment  
                      • Small stage  
                      • Handling mechanism  
                      • Automatic lathe  
                      • Tool grinder  
                      • Internal grinding machine  
                      • Small surface grinding machine  
                      ![Image](Image10.png) |
| Page introducing the product | A-553 onward                                  | A-565 onward                                 | A-571 onward                                           |
### Types and Features of LM Systems

#### General Description

<table>
<thead>
<tr>
<th>Type</th>
<th>Cross Roller Table</th>
<th>Linear Ball Slide</th>
<th>LM Roller</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td><img src="image1" alt="Cross Roller Table" /></td>
<td><img src="image2" alt="Linear Ball Slide" /></td>
<td><img src="image3" alt="LM Roller" /></td>
</tr>
</tbody>
</table>
| **Features**             | • Easily installable unit type  
   • Allows selection of diverse uses | • Easily installable unit type  
   • Lightweight and Compact  
   • Capable of performing rolling motion with an extremely small friction coefficient  
   • Capable of operating without lubrication  
   • Low cost | • Compact, large load capacity type  
   • Self skewing-adjusting type |
| **Stroke**               | Finite stroke | Finite stroke | Infinite stroke |
| **Major Applications**   | • Measuring equipment stage  
   • Optical stage  
   • Tool grinder  
   • Printed circuit board drilling machine  
   • Medical equipment  
   • Automatic lathe  
   • Tool grinder  
   • Internal grinding machine  
   • Small surface grinding machine | • Small electronic part assembly machine  
   • Handler  
   • Automatic recorder  
   • Measuring equipment stage  
   • Optical stage  
   • Medical equipment | • Precision press ram guide  
   • Press metal mold exchanger  
   • Heavy load conveyor systems  
   • Vendor machine |
<p>| <strong>Page introducing the product</strong> | A-585 onward | A-593 onward | A-603 onward |</p>
<table>
<thead>
<tr>
<th>Type</th>
<th>Flat Roller</th>
<th>Slide Pack</th>
<th>Slide Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td><img src="image1" alt="Flat Roller" /></td>
<td><img src="image2" alt="Slide Pack" /></td>
<td><img src="image3" alt="Slide Rail" /></td>
</tr>
<tr>
<td>Features</td>
<td>• Large Load Capacity&lt;br&gt;• Combined accuracy of 90°&lt;br&gt;V-shape surface and flat surface available as standard</td>
<td>• Interchangeable type&lt;br&gt;• Low-cost, simple type</td>
<td>• Thin, compact design&lt;br&gt;• Low-cost, simple type&lt;br&gt;• High strength, high durability</td>
</tr>
<tr>
<td>Stroke</td>
<td>Finite stroke</td>
<td>Infinite stroke</td>
<td>Finite stroke</td>
</tr>
<tr>
<td>Major Applications</td>
<td>• Planer&lt;br&gt;• Horizontal milling machine&lt;br&gt;• Roll grinding machine&lt;br&gt;• Surface grinder&lt;br&gt;• Cylindrical grinder&lt;br&gt;• Optical measuring instrument</td>
<td>• Amusement machine&lt;br&gt;• High-grade furniture&lt;br&gt;• Light and heavy doors&lt;br&gt;• Tool cabinet&lt;br&gt;• Kitchen fitments&lt;br&gt;• Automatic feeder&lt;br&gt;• Computer peripherals&lt;br&gt;• Photocopier&lt;br&gt;• Medical equipment&lt;br&gt;• Office equipment</td>
<td>• Amusement machine&lt;br&gt;• High-grade furniture&lt;br&gt;• Light and heavy doors&lt;br&gt;• Office equipment&lt;br&gt;• Store fixture&lt;br&gt;• Stocker</td>
</tr>
</tbody>
</table>

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Load Rating

Service Life of an LM System

When an LM system rolls under a load, its raceway and rolling elements (balls or rollers) constantly receive repetitive stress. If a limit is reached, the raceway fractures from fatigue and part of the surface exfoliates like scales. This phenomenon is called flaking.

The service life of an LM system refers to the total travel distance until the first event of flaking occurs due to rolling fatigue of the material on the raceway or the rolling element.

Nominal Life

The service life of an LM system is subject to slight variations even under the same operating conditions. Therefore, it is necessary to use the nominal life defined below as a reference value for obtaining the service life of the LM system.

The nominal life means the total travel distance that 90% of a group of identical LM system units can achieve without flaking.

Basic Load Rating

An LM system has two types of basic load ratings: basic dynamic load rating (C), which is used to calculate the service life, and basic static load rating (C_0), which defines the static permissible limit.

Basic Dynamic Load Rating C

The basic dynamic load rating (C) indicates the load with constant direction and magnitude, under which the rated life (L) is L = 50 km for an LM system using balls, or L = 100 km for an LM system using rollers, when a group of identical LM system units independently operate under the same conditions.

The basic dynamic load rating (C) is used to calculate the service life when an LM system operates under a load.

Specific values of each LM system model are indicated in the specification table for the corresponding model number.
Basic Static Load Rating $C_0$

If an LM system receives an excessively large load or a large impact when it is stationary or operative, permanent deformation occurs between the raceway and the rolling element. If the permanent deformation exceeds a certain limit, it will prevent the LM system from performing smooth motion.

The basic static load rating is a static load with a constant direction and magnitude whereby the sum of the permanent deformation of the rolling element and that of the raceway on the contact area under the maximum stress is 0.0001 times the rolling element diameter. With an LM system, the basic static load rating is defined for the radial load.

Therefore, the basic static load rating is considered the limit of the static permissible load.

Specific values of each LM system model are indicated in the specification table for the corresponding model number.

Static Permissible Moment $M_0$

When an LM system receives a moment, the rolling elements on both ends receive the maximum stress due to uneven distribution of the stress on the rolling elements within the LM system.

The permissible static moment ($M_0$) means the moment with constant direction and magnitude, under which the sum of the permanent deformation of the rolling element and the permanent deformation of the raceway accounts for 0.0001 times of the rolling element's diameter in the contact area where the maximum stress is applied.

With an LM system, the static permissible moment is defined in three directions: $M_A$, $M_B$ and $M_C$.

Thus, the static permissible moment is considered the limit of the static moment applied.

\[ P_c : \text{Radial load} \quad M_{A1} : \text{Moment in the pitching direction} \]
\[ T_c : \text{Moment in the torque direction} \quad M_{A2} : \text{Moment in the pitching direction} \]

The specific static permissible moment value of each LM system model is provided in the section on the permissible moments of each model.
**Static Safety Factor \( f_s \)**

The Linear Motion system may receive an unexpected external force while it is stationary or operative due to the generation of an inertia caused by vibrations and impact or start and stop. It is necessary to consider a static safety factor against such a working load.

**[Static Safety Factor \( f_s \)]**

The static safety factor \( f_s \) is determined by the ratio of the load capacity (basic static load rating \( C_0 \)) of an LM system to the load applied on the LM system.

\[
f_s = \frac{f_c \cdot C_0}{P} \quad \text{or} \quad f_s = \frac{f_c \cdot M_0}{M} \quad (1)
\]

- \( f_s \): Static safety factor
- \( f_c \): Contact factor (see Table 2 on A-11)
- \( C_0 \): Basic static load rating
- \( M_0 \): Static permissible moment (\( M_A \), \( M_B \), and \( M_C \))
- \( P \): Calculated load
- \( M \): Calculated moment

**[Measure of Static Safety Factor]**

Refer to the static safety factor in Table 1 as a measure of the lower limit under the service conditions.

<table>
<thead>
<tr>
<th>Kinetic conditions</th>
<th>Load conditions</th>
<th>Lower limit of ( f_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constantly stationary</td>
<td>Impact is small, and deflection of the shaft is also small</td>
<td>1.0 to 1.3</td>
</tr>
<tr>
<td></td>
<td>Impact is present, and a twisting load is applied</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>Normal motion</td>
<td>A normal load is applied, and the deflection of the shaft is small</td>
<td>1.0 to 1.5</td>
</tr>
<tr>
<td></td>
<td>Impact is present, and a twisting load is applied</td>
<td>2.5 to 7.0</td>
</tr>
</tbody>
</table>
Life Calculation Formula

The nominal life (L) of an LM system is obtained from the following equation using the basic dynamic load rating (C) and the applied load (P).

[LM System Using Balls]

\[ L = \left( \frac{C}{P} \right)^3 \times 50 \quad \text{......... (2)} \]

[LM System Using Rollers]

\[ L = \left( \frac{C}{P} \right)^{10/3} \times 100 \quad \text{......... (3)} \]

\[ \begin{align*}
L & : \text{Nominal life} \quad \text{(km)} \\
C & : \text{Basic dynamic load rating} \quad \text{(N)} \\
P & : \text{Applied load} \quad \text{(N)}
\end{align*} \]

In most cases, it is difficult to calculate a load applied on an LM system.

In actual use, most LM systems receive vibrations and impact during operation, and fluctuation of the loads applied on them is assumed. In addition, the hardness of the raceway and the temperature of the LM system unit greatly affect the service life.

With these conditions considered, the practical service life calculation formulas (2) and (3) should be as follows.

[LM System Using Balls]

\[ L = \left( \frac{f_H \cdot f_T \cdot f_C}{f_W \cdot f_C} \times \frac{C}{P} \right)^3 \times 50 \quad \text{......... (4)} \]

[LM System Using Rollers]

\[ L = \left( \frac{f_H \cdot f_T \cdot f_C}{f_W \cdot f_C} \times \frac{C}{P} \right)^{10/3} \times 100 \quad \text{......... (5)} \]

\[ \begin{align*}
L & : \text{Nominal life} \quad \text{(km)} \\
C & : \text{Basic dynamic load rating} \quad \text{(N)} \\
P & : \text{Applied load} \quad \text{(N)} \\
f_H & : \text{Hardness factor} \quad \text{(see Fig.1 on A-11)} \\
f_T & : \text{Temperature factor} \quad \text{(see Fig.2 on A-11)} \\
f_C & : \text{Contact factor} \quad \text{(see Table2 on A-11)} \\
f_W & : \text{Load factor} \quad \text{(see Table3 on A-12)}
\end{align*} \]
- **$f_H$: Hardness Factor**
  To maximize the load capacity of the LM system, the hardness of the raceways needs to be between 58 and 64 HRC. If the hardness is lower than this range, the basic dynamic load rating and the basic static load rating decrease. Therefore, it is necessary to multiply each rating by the respective hardness factor ($f_H$).

- **$f_T$: Temperature Factor**
  If the temperature of the environment surrounding the operating LM System exceeds 100 °C, take into account the adverse effect of the high temperature and multiply the basic load ratings by the temperature factor indicated in Fig.2. In addition, the LM system must be of high-temperature type.

  Note) If the temperature of the service environment exceeds 80 °C, it is necessary to change the materials of the seal and end plate to high-temperature materials.

  Note) If the temperature of the environment exceeds 120°C, it is necessary to provide dimensional stabilization.

- **$f_C$: Contact Factor**
  If multiple LM Guide blocks are closely arranged with each other, it is difficult to achieve uniform load distribution due to a moment load and the accuracy of the mounting surface. In such applications, multiply basic load ratings “C” and “C0” by the corresponding contact factors in Table2.

  Note) If uneven load distribution is expected in a large machine, take into account the respective contact factor indicated in Table2.

---

**Table2 Contact Factor ($f_C$)**

<table>
<thead>
<tr>
<th>Number of blocks used in close contact</th>
<th>Contact factor $f_C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.81</td>
</tr>
<tr>
<td>3</td>
<td>0.72</td>
</tr>
<tr>
<td>4</td>
<td>0.66</td>
</tr>
<tr>
<td>5</td>
<td>0.61</td>
</tr>
<tr>
<td>6 or greater</td>
<td>0.6</td>
</tr>
<tr>
<td>Normal use</td>
<td>1</td>
</tr>
</tbody>
</table>
In general, reciprocating machines tend to involve vibrations or impact during operation. It is extremely difficult to accurately determine vibrations generated during high-speed operation and impact during frequent start and stop. Therefore, where the effects of speed and vibration are estimated to be significant, divide the basic dynamic load rating (C) by a load factor selected from Table3, which contains empirically obtained data.

<table>
<thead>
<tr>
<th>Vibrations/impact</th>
<th>Speed(V)</th>
<th>( f_w )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faint</td>
<td>Very low ( V \leq 0.25 \text{m/s} )</td>
<td>1 to 1.2</td>
</tr>
<tr>
<td>Weak</td>
<td>Slow ( 0.25 &lt; V \leq 1 \text{m/s} )</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium ( 1 &lt; V \leq 2 \text{m/s} )</td>
<td>1.5 to 2</td>
</tr>
<tr>
<td>Strong</td>
<td>High ( V &gt; 2 \text{m/s} )</td>
<td>2 to 3.5</td>
</tr>
</tbody>
</table>
Rigidity

When using an LM system, it is necessary to select a type and a clearance (preload) that meet the service conditions in order to achieve the required rigidity of the machine/equipment.

Selecting a Clearance/Preload for an LM System

Since clearances and preloads of LM systems are standardized for different models, you can select a clearance and a preload according to the service conditions.
For separate-type models, THK cannot adjust their clearances at shipment. Therefore, the user must adjust the clearance when installing the product.
Determine a clearance/preload while referring to the following section.

Clearance and Preload

[Clearance (internal clearance)]
Clearance of an LM system is a play between the block (nut), the rail (shaft) and the ball (or roller).
The sum of vertical clearances is called radial clearance, and the sum of circumferential clearances is called angular backlash (clearance in the rotational direction).

1) Radial clearance
With the LM Guide, a radial clearance refers to the value of a movement of the block center when the LM block is gently moved vertically with constant force applied in the center of the fixed LM rail in the longitudinal direction.

2) Angular backlash (clearance in the rotational direction)
With the Ball Spline, angular backlash (clearance in the rotational direction) refers to the value of a rotational motion of the nut when the nut is gently rotated forward and backward with constant force with the spline shaft fixed.
Preload is a load that is preliminarily applied to the rolling elements in order to eliminate a clearance of an LM system and increase its rigidity. A negative clearance indication (negative value) of an LM system means that a preload is provided.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Normal</th>
<th>Light preload</th>
<th>Medium preload</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSR 15</td>
<td>-4 to +2</td>
<td>-12 to -4</td>
<td>---</td>
</tr>
<tr>
<td>HSR 20</td>
<td>-5 to +2</td>
<td>-14 to -5</td>
<td>-23 to -14</td>
</tr>
<tr>
<td>HSR 25</td>
<td>-6 to +3</td>
<td>-16 to -6</td>
<td>-26 to -16</td>
</tr>
<tr>
<td>HSR 30</td>
<td>-7 to +4</td>
<td>-19 to -7</td>
<td>-31 to -19</td>
</tr>
<tr>
<td>HSR 35</td>
<td>-8 to +4</td>
<td>-22 to -8</td>
<td>-35 to -22</td>
</tr>
</tbody>
</table>

For specific clearances and preloads, see the section concerning the corresponding model.

Preload and Rigidity

Providing a preload to an LM system will increase the rigidity according to the amount of the preload. Fig. 5 shows deflection of clearances (normal clearance, clearance C1 and clearance C0) (with LM Guide model HSR).

Thus, a preload has an effect of up to approximately 2.8 times greater than the applied preload itself. The deflection with a preload under a given load is smaller, and the rigidity is much greater, than that without a preload.

Fig. 6 shows how the radial deflection of an LM Guide changes with a preload. As indicated in Fig. 6, when an LM Guide block receives a radial load of 2.45 kN, the radial deflection is 9μm if the radial clearance is zero (normal clearance) or 2μm if it the radial clearance is -30μm (clearance C0), thus increasing the rigidity by 4.5 times.

For selecting a specific clearance, see the section concerning selection of a radial clearance for the corresponding LM system model.
Friction coefficient

Since an LM system makes rolling motion via its rolling elements such as balls and rollers between the raceways, its frictional resistance is 1/20 to 1/40 smaller than a sliding guide. Its static friction is especially small and almost the same as dynamic friction, preventing the system from experiencing “stick-slip.” stick-slip. Therefore, the system is capable of being fed by the submicron distance? Not sure what we're trying to say here.

The frictional resistance of an LM system varies according to the type of the LM system, preload, viscosity resistance of the lubricant and the load applied on the LM system.

In particular, when a moment is given or a preload is applied to increase rigidity, the frictional resistance increases.

Normal friction coefficient by LM systems are indicated in Table 5.

![Fig.7 Relationship between Applied Load Ratio and Frictional Resistance](image)

<table>
<thead>
<tr>
<th>Types of LM systems</th>
<th>Representative types</th>
<th>Frictional resistance (μ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM Guide</td>
<td>SSR, SHS, SNR/SNS, SRS, RSR, HSR, NR/NRS SRG, SRN</td>
<td>0.002 to 0.003 0.001 to 0.002</td>
</tr>
<tr>
<td>Ball Spline</td>
<td>LBS, LBF, LT, LF</td>
<td>0.002 to 0.003</td>
</tr>
<tr>
<td>Linear Bushing</td>
<td>LM, LMK, LMF, SC</td>
<td>0.001 to 0.003</td>
</tr>
<tr>
<td>LM Stroke</td>
<td>MST, ST</td>
<td>0.0006 to 0.0012</td>
</tr>
<tr>
<td>LM Roller</td>
<td>LR, LRA</td>
<td>0.005 to 0.01</td>
</tr>
<tr>
<td>Flat Roller</td>
<td>FT, FTW</td>
<td>0.001 to 0.0025</td>
</tr>
<tr>
<td>Cross-roller Guide/Cross-roller Table</td>
<td>VR, VRU, VRT</td>
<td>0.001 to 0.0025</td>
</tr>
<tr>
<td>Linear Ball Slide</td>
<td>LS</td>
<td>0.0006 to 0.0012</td>
</tr>
<tr>
<td>Cam Follower/Roller Follower</td>
<td>CF, NAST</td>
<td>0.0015 to 0.0025</td>
</tr>
</tbody>
</table>
Accuracy

The motion accuracy of an LM system is defined in running accuracy for models that are fixed on the flat surface and in runout accuracy for models whose shafts are supported, and accuracy grades are established for each of them.
For details, see the page concerning the corresponding model.

Lubrication

When using an LM system, it is necessary to provide effective lubrication. Using the product without lubrication may increase wear of the rolling elements or shorten the service life.

A lubricant has the following effects.
1. Minimizes friction in moving elements to prevent seizure and reduce wear.
2. Forms an oil film on the raceway to decrease stress acting on the surface and extend rolling fatigue life.
3. Covers the metal surface to prevent rust formation.

To fully bring out an LM system's functions, it is necessary to provide lubrication according to the conditions.
Even with an LM system with seals, the internal lubricant gradually seeps out during operation. Therefore, the system needs to be lubricated at an appropriate interval according to the conditions.

[Types of Lubricants]
LM systems mainly use grease or sliding surface oil for their lubricants.
The requirements that lubricants need to satisfy generally consist of the following.
(1) High oil film strength
(2) Low friction
(3) High wear resistance
(4) High thermal stability
(5) Non-corrosive
(6) Highly anti-corrosive
(7) Minimal dust/water content
(8) Consistency of grease must not be altered to a significant extent even after it is repeatedly stirred.

Lubricants that meet these requirements include the following products.

<table>
<thead>
<tr>
<th>Lubricant</th>
<th>Type</th>
<th>Brand name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>Sliding surface oil or turbine oil ISOVG32 to 68</td>
<td>Super Multi 32 to 68 (Idemitsu) Vactra No.2S (ExxonMobile) DT Oil (ExxonMobile) Tonner Oil (Showa Shell Sekiyu) or equivalent</td>
</tr>
</tbody>
</table>
### Table 7: Lubricants Used under Special Environments

<table>
<thead>
<tr>
<th>Service environment</th>
<th>Lubricant characteristics</th>
<th>Brand name</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-speed moving parts</td>
<td>Grease with low torque and low heat generation</td>
<td>AFG Grease (THK) see A-968  &lt;br&gt; AFA Grease (THK) see A-959  &lt;br&gt; NBU15 (NOK Kluba)  &lt;br&gt; Multemp (Kyodo Yushi)  &lt;br&gt; or equivalent</td>
</tr>
<tr>
<td>Vacuum</td>
<td>Fluorine based vacuum grease or oil (vapor pressure varies by brand)</td>
<td>Fomblin Grease (Solvay Solexis)  &lt;br&gt; Fomblin Oil (Solvay Solexis)  &lt;br&gt; Barrierta IEL/V (NOK Kluba)  &lt;br&gt; Isoflex (NOK Kluba)  &lt;br&gt; Krytox (Dupont)</td>
</tr>
<tr>
<td>Clean room</td>
<td>Grease with very low dust generation</td>
<td>AFE-CA Grease (THK) see A-963  &lt;br&gt; (The above vacuum grease products also applicable)  &lt;br&gt; AFF Grease (THK) see A-965</td>
</tr>
<tr>
<td>Environments subject to microvibrations or microstrokes, which may cause fretting corrosion</td>
<td>Grease that easily forms an oil film and has high fretting resistance</td>
<td>AFC Grease (THK) see A-961</td>
</tr>
<tr>
<td>Environments subject to a spattering coolant such as machine tools</td>
<td>Highly anti-corrosive, refined mineral oil or synthetic oil that forms a strong oil film and is not easily emulsified or washed away by coolant  &lt;br&gt; Water-resistant grease</td>
<td>Super Multi 68 (Idemitsu)  &lt;br&gt; Vactra No.2S (ExxonMobile)  &lt;br&gt; or equivalent</td>
</tr>
</tbody>
</table>

Note 1) When using a vacuum grease, be sure that some brands have starting resistances several times greater than ordinary lithium-based greases.

Note 2) In an environment subject to a spattering water-soluble coolant, some brands of intermediate viscosity significantly decrease their lubricity or do not properly form an oil film. Check the compatibility between the lubricant and the coolant.

Note 3) Do not mix greases with different physical properties.

Note 4) For THK original grease products, see A-958.
## Safety Design

LM systems are used in various environments. If using an LM system in a special environment such as vacuum, anti-corrosion, high temperature and low temperature, it is necessary to select a material and surface treatment that suit the service environment.

To support use in various special environments, THK offers the following materials and surface treatments for LM systems.

<table>
<thead>
<tr>
<th>Description</th>
<th>Model No.</th>
<th>Features/Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martensite stainless steel</td>
<td>HSR, SSR, RSR, SHW, RSH</td>
<td>Anti-rust property ★★★★★★</td>
</tr>
<tr>
<td>Martensite stainless steel</td>
<td>SR-M1, HSR-M1, RSR-M1</td>
<td>High temperature support ★★★★★★ up to 150°C</td>
</tr>
<tr>
<td>Austenite stainless steel</td>
<td>HSR-M2</td>
<td>Anti-rust property ★★★★★★</td>
</tr>
<tr>
<td><strong>Surface Treatment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AP-HC</td>
<td>THK AP-HC TREATMENT</td>
<td>Low dust generation ★★★★★★ Anti-rust property ★★★★★ Surface hardness ★★★★★</td>
</tr>
<tr>
<td>AP-C</td>
<td>THK AP-C TREATMENT</td>
<td>Anti-rust property ★★★★★</td>
</tr>
<tr>
<td>AP-CF</td>
<td>THK AP-CF TREATMENT</td>
<td>Anti-rust property ★★★★★</td>
</tr>
</tbody>
</table>

* If you desire a surface treatment other than the above, contact THK.
Determining a Material

In normal service conditions, LM systems use a type of steel that suits LM systems. If using an LM system in a special environment, it is necessary to select a material that suits the service environment.

For locations that require high corrosion resistance, a stainless steel material is used.

Material Specifications

Stainless Steel LM Systems

Material: martensite stainless steel/austenite stainless steel

For use in environments where corrosion resistance is required, some LM system models can use martensite stainless steel.

If the model number of an LM system contains symbol M, it means that the model is made of stainless steel. See the section concerning the corresponding model.

Model number coding

<table>
<thead>
<tr>
<th>HSR25</th>
<th>A</th>
<th>2</th>
<th>QZ</th>
<th>UU</th>
<th>C0</th>
<th>M+1200L</th>
<th>P</th>
<th>M - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model number</td>
<td>No. of LM blocks used on the same rail</td>
<td>Radial clearance symbol</td>
<td>No. of LM blocks</td>
<td>Dust prevention accessory symbol</td>
<td>LM rail length (in mm)</td>
<td>Symbol for No. of rails used on the same plane</td>
<td>Accuracy symbol</td>
<td>Stainless steel LM rail</td>
</tr>
</tbody>
</table>

Stainless steel LM rail

Stainless steel LM block
Surface Treatment

The surfaces of the rails and shafts of LM systems can be treated for anti-corrosive or aesthetic purposes. THK offers THK-AP treatment, which is the optimum surface treatment for LM systems. The THK-AP treatment consists of the following 3 types.

**AP-HC**
- Surface treatment: industrial-use hard chrome plating
- Film hardness: 750 Hv or higher

Equivalent to industrial-use hard chrome plating, AP-HC achieves almost the same level of corrosion resistance as martensite stainless steel. In addition, it is highly wear resistant since the film hardness is extremely high, 750 Hv or higher.

**AP-C**
- Surface treatment: industrial-use black chrome coating

A type of industrial-use black chrome coating designed to increase corrosion resistance. It achieves lower cost and higher corrosion resistance than martensite stainless steel.

**AP-CF**
- Surface treatment: industrial-use black chrome coating / special fluorine resin coating

A compound surface treatment that combines black chrome coating and special fluorine resin coating and is suitable for applications requiring high corrosion resistance. In addition to the above treatments, other surface treatments are sometimes performed on areas other than the raceways, such as alkaline coloring treatment (black oxidizing) and color anodize treatment. However, some of them are not suitable for LM systems. For details, contact THK. If using an LM system whose raceways are surface treated, set a higher safety factor.

**Model number coding**

<table>
<thead>
<tr>
<th>Model number</th>
<th>Type of LM block</th>
<th>No. of LM blocks used on the same rail</th>
<th>LM rail length (in mm)</th>
<th>With surface treatment on the LM block</th>
<th>With surface treatment on the LM block</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR15 V 2 F + 640L F</td>
<td>2</td>
<td></td>
<td>640</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note) Note that the inside of the mounting hole is not provided with surface treatment.
[Data on Comparison of Dust Generation with AP Treatment]

[Test conditions]

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM Guide model number</td>
<td>SSR20WF+280LF (AP-CF, without seal)</td>
</tr>
<tr>
<td></td>
<td>SSR20UUF+280LF (AP-CF, with seal)</td>
</tr>
<tr>
<td></td>
<td>SSR20WUUF+280LF (AP-HC, with seal)</td>
</tr>
<tr>
<td>Grease used</td>
<td>THK AFE-CA Grease</td>
</tr>
<tr>
<td>Grease quantity</td>
<td>1cc (per LM block)</td>
</tr>
<tr>
<td>Speed</td>
<td>30m/min(MAX)</td>
</tr>
<tr>
<td>Stroke</td>
<td>200mm</td>
</tr>
<tr>
<td>Flow rate during measurement</td>
<td>1l/min</td>
</tr>
<tr>
<td>Clean room volume</td>
<td>1.7 liter (acrylic casing)</td>
</tr>
<tr>
<td>Measuring instrument</td>
<td>Dust counter</td>
</tr>
<tr>
<td>Measured particle diameter</td>
<td>0.3μm or more</td>
</tr>
</tbody>
</table>

THK AP-HC treatment provides high surface hardness and has high wear resistance. The high level of wear in the early stage in the graph above is considered to be due to the initial wear of the end seal.

Note) THK AP-HC treatment (equivalent to hard chrome plating)
THK AP-CF treatment (equivalent to black chrome plating + fluorine resin coating)
**[Data on Comparison of Rust Prevention]**

*<Salt-water spray resistance cycle test>*

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray liquid</td>
<td>1% NaCl solution</td>
</tr>
<tr>
<td>cycles</td>
<td>Spraying for 6 hours, drying for 6 hours</td>
</tr>
<tr>
<td>Temperature conditions</td>
<td>35°C during spraying</td>
</tr>
<tr>
<td></td>
<td>60°C during drying</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen material</th>
<th>Time</th>
<th>Austenite stainless steel</th>
<th>Martensite stainless steel</th>
<th>THK AP-HC</th>
<th>THK AP-C</th>
<th>THK AP-CF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 hours</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>24 hours</td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>96 hours</td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td><img src="image15.png" alt="Image" /></td>
</tr>
<tr>
<td>Test Result</td>
<td>Anti-rust property</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
</tr>
<tr>
<td></td>
<td>Wear Resistance</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
</tr>
<tr>
<td></td>
<td>Surface hardness</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
<td>⊃</td>
</tr>
<tr>
<td></td>
<td>Adherence</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>⊃</td>
<td>⊃</td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td>Metallic luster</td>
<td>Metallic luster</td>
<td>Metallic luster</td>
<td>Black luster</td>
<td>Black luster</td>
</tr>
</tbody>
</table>

*Image placeholders*
Contamination protection is the most important factor in using an LM system. Entrance of dust or other foreign material into the LM system will cause abnormal wear or shorten the service life. Therefore, when entrance of dust or other foreign material is predicted, it is necessary to select a sealing device or contamination protection device that meets the service environment conditions.

(1) Dedicated seals for LM systems
For LM systems, seals made of special synthetic rubber with high wear resistance (e.g., Laminated Contact Scraper LaCS) and a wiper ring are available as contamination protection seals. For locations with adverse service environments, dedicated bellows and dedicated covers are available for some models. For details and symbols of these seals, see the section concerning options (contamination protection) for the corresponding model.

To provide contamination protection also for Ball Screws in service environments subject to cutting chips and cutting fluids, it is advisable to use a telescopic cover that covers the whole system and a large-size bellows.

(2) Dedicated bellows
For LM Guides, standardized bellows are available. THK manufactures dedicated bellows also for other LM systems such as Ball Screws and Ball Splines. Contact THK for details.