

## 2 Lubrication

There are two types of lubricating method -- grease and oil -- for ball screws and linear guides.

Use a lubricant agent and method most suitable to condition requirements and purpose to optimize functions of the ball screws and linear guides.

In general, lubricants with low base oil kinematic viscosity are used for high speed operation, in which thermal expansion has large impact, and in low temperatures.

Lubrication with high base oil kinematic viscosity is used for oscillating operations, low speed and high temperature.

The following are lubrication methods by grease and by oil.

### 2-1 Grease Lubrication

Grease lubrication is widely used because it does not require special oil supply system or piping. Grease lubricants made by NSK are:

- Various types of grease in bellowed container which can be instantly attached to the grease pump;
- NSK Grease Unit which comprise a hand grease pump and various nozzles. They are compact and easy to use.

#### 1. NSK grease lubricants

Table 2-1.1 shows the marketed general grease widely used for linear guides and ball screws, in specific uses, conditions and purposes.

Table 2-1.1 Grease lubricant for linear guides and ball screws

Type	Thickener	Base oil	Base oil kinematic viscosity mm <sup>2</sup> /s (40°C)	Range of use temperature (°C)	Purpose
AV2	Lithium type	Mineral oil	130	-10~110	For ball screws and linear guides for general use at high load.
PS2	Lithium type	Synthetic oil + mineral oil	15	-50~110	For ball screws and linear guides for low temperature and high frequency operation.
LR3	Lithium type	Synthetic oil	30	-30~130	For ball screws at high speed, medium load.
LG2	Lithium type	Synthetic oil + synthetic hydrocarbon oil	30	-10~80	For ball screws and linear guides for clean environment.
LGU	Diurea	Synthetic hydrocarbon oil	100	-30~120	For ball screws and linear guides for clean environment.
NF2	Urea composite type	Synthetic oil + mineral oil	27	-40~100	For fretting resistant ball screws and linear guides.

#### (1) NSK Grease AV2

##### • Features

It is a mineral-oil based grease widely used in high load applications. It contains a lithium type thickener, and a special additive to provide superb resistance to wear and high contact pressure. It has superb load resistance, as well as stability in oxidation. It not only maintains good lubrication over a long period of time, but also provides long lubrication life. It is also superb in retaining water. Even containing a large volume of water, it does not lose grease when the grease is softened.

##### • Application

It is a standard grease for general NSK linear guides and ball screws. It is prevalently used in many

applications, for its high base oil viscosity, high load resistance, and stability in oxidation.

##### • Nature

Thickener	Lithium soap base
Base oil	Mineral oil
Consistency	273
Dropping point	182°C
Volume of evaporation	0.32% (99°C, 22hr)
Copper plate corrosion test	Satisfactory (Method B, 100°C, 24hr)
Oil separation	2.9% (100°C, 24hr)
Base oil kinematic viscosity	130mm <sup>2</sup> /s (40°C)

#### (2) NSK Grease LR3

##### • Features

It contains a special synthetic oil for high temperature and stability, and a carefully selected anti-oxidation agent. This grease dramatically increases lubrication life under high temperature conditions. It is used for high speed, medium load. Lubrication life exceeded 2,000 hours in the endurance test at 150 °C. Its rust prevention capacity in severe conditions such as water and moist environments is further strengthened.

##### • Application

It is a standard grease for NSK standard linear guides and ball screws in FA Series. It is ideal for operation with medium load, at high speed such as positioning

in high tact material handling equipment. (Previous reference number is NSK Grease No.1)

##### • Nature

Thickener	Lithium soap base
Base oil	Mineral oil
Consistency	227
Dropping point	208°C
Volume of evaporation	0.30% (99°C, 22hr)
Copper plate corrosion test	Satisfactory (Method B, 100°C, 24hr)
Oil separation	1.9% (100°C, 24hr)
Base oil kinematic viscosity	30mm <sup>2</sup> /s (40°C)

#### (3) NSK Grease PS2

##### • Features

The major base oil component is synthetic oil with mineral oil. It is an excellent lubrication especially for low temperature operation. It is for high speed and light load.

##### • Application

It is a standard grease for NSK miniature linear guides and ball screws. It is especially superb for low temperature operation, but also functions well in normal temperatures, making it ideal for small equipment with light load.

(Previous reference number is NSK Grease No.2)

##### • Nature

Thickener	Lithium soap base
Base oil	Synthetic oil + mineral oil
Consistency	275
Dropping point	190°C
Volume of evaporation	0.60% (99°C, 22hr)
Copper plate corrosion test	Satisfactory (Method B, 100°C, 24hr)
Oil separation	3.6% (100°C, 24hr)
Base oil kinematic viscosity	15mm <sup>2</sup> /s (40°C)

**(4) NSK Grease LG2**

**• Features**

This grease was developed by NSK to be exclusively used for linear guides and ball screws in clean room. Compared to the fluorine grease which are commonly used in clean room, LG2 has several advantages such as:

- Higher in lubrication function
- Longer lubrication life
- More stable torque (resistant to wear)
- Higher rust prevention.

In dust generation, LG2 is more than equal to fluorine grease in keeping dust volume low. Since the base oil is not a special oil but a mineral oil, LG2 can be handled in the same manner as general greases.

**• Application**

LG2 is a lubrication grease for rolling element products such as linear guides and ball screws for semiconductor and liquid crystal display (LCD) processing equipment which require a highly clean environment. Because LG2 is exclusively for a clean environment at normal temperatures, however, it cannot be used in a vacuum environment.

Refer to "Special environment" in Page D8 for detailed data on superb characteristics of NSK Grease LG2.

**• Nature**

Thickener	Lithium soap base
Base oil	Mineral oil + Synthetic hydrocarbon oil
Consistency	207
Dropping point	200°C
Volume of evaporation	1.40% (99°C、22hr)
Copper plate corrosion test	Satisfactory (Method B, 100°C, 24hr)
Oil separation	0.8% (100°C、24hr)
Base oil kinematic viscosity	30mm <sup>2</sup> /s (40°C)

**(5) NSK Grease LGU**

**• Features**

This is a proprietary urea base grease of NSK featuring low dust emission exclusively for ball screws and linear guides which are used in clean rooms.

In comparison with fluorine base grease, which has been used commonly in clean rooms, LGU has better

lubricating property, longer duration of lubricant, better torque variation, much better anti-rust property, and equivalent or better dust emission. In addition, this grease can be handled in the same way as the other common grease because high-grade synthetic oil is used as the base oil.

LGU grease contains much less metallic elements compared to LG2 grease. It can be used in high temperature environment.

**• Application**

This is exclusive lubrication grease for ball screws and linear guides that are installed in equipment that requires cleanliness, as same as LG2 grease, and it can be used in high temperature range of -30° to 180°C.

This cannot be used in vacuum.

**• Nature**

Thickener	Diurea
Base oil	Synthetic hydrocarbon oil
Consistency	209
Dropping point	260°C
Volume of evaporation	0.09% (99°C、22hr)
Copper plate corrosion test	Satisfactory (Method B, 100°C, 24hr)
Oil separation	0.6% (100°C、24hr)
Base oil kinematic viscosity	100mm <sup>2</sup> /s (40°C)

**(6) NSK Grease NF2**

**• Features**

It uses high-grade synthetic oil as the base oil and urea base organic compound as the thickener. It has remarkable anti-fretting corrosion property. It can be used in wide temperature range, from low to high, and has superior lubrication life.

**• Application**

This grease suites for ball screws and linear guides of which application include oscillating operations. Allowable temperature range is -40° to 130°C.

**• Nature**

Thickener	Diurea
Base oil	Synthetic hydrocarbon oil
Consistency	288
Dropping point	269°C
Volume of evaporation	7.9% (177°C、22hr)
Copper plate corrosion test	Satisfactory (Method B, 100°C, 24hr)
Oil separation	0.6% (100°C、24hr)
Base oil kinematic viscosity	27mm <sup>2</sup> /s (40°C)

**• Precautions for handling**

- Wash the linear guides and ball screws to remove oil prior to applying Clean Grease LG2 or LGU, so the grease functions are fully utilized.
- Clean grease is exclusively used for clean environments at normal temperatures.

**2. How to replenish grease**

Use grease fitting to linear guide ball slide or to ball screw nut if exclusive grease supply component is not used. Supply required amount to grease fitting by a grease gun (pump).

Wipe off old grease and accumulated dust before supplying new grease. If grease fitting is not used, apply grease directly to the rail or to the ball groove of the screw shaft. Remove the seal if possible, and move a ball slide or ball nut few strokes so the grease permeates into the ball slide and inside the nut. A hand grease pump, an exclusive and easy lubrication device to linear guides and ball screws, is available at NSK.

**3. Volume of grease to be replenished**

Once grease is replenished, another supply is not required for a long period of time. But under some operational conditions, it is necessary to periodically replenish grease. The following are replenishing methods.

\* When there is an exclusive grease supply system and the volume from the spout can be controlled, the criterion is:

- All at once, replenish the amount which fills about 50% of the internal space of the ball slide, or the internal space of the ball nut. This method eliminates waste of grease, and is efficient.

Tables 2-1.2 and 3 show internal spaces of ball slide and ball nut for reference.

\* When replenishing using a grease gun:

Use a grease gun and fill the inside of ball slide and the ball nut with grease. Supply grease until it comes out from the ball slide or ball nut area. Move the ball slide or ball nut by hand while filling them with grease, so the grease permeates all areas. Do not operate the machine immediately after replenishing. Always try the system a few times to spread the grease throughout the system and to remove excess grease from inside. Trial operations are necessary because the resistance to sliding force of linear guide and the ball screw torque greatly increase immediately after replenishment (full-pack state) and may cause problems. Grease's agitating resistance is accountable for this phenomenon. Wipe off excess grease that accumulates at the end of the rail and screw shaft after trial runs, so the grease does not scatter to other areas.

**Table 2-1-2 Inside space of the ball slide of linear guide**

**LS, LH Series** Unit: cm<sup>3</sup>

Series Model number	LH		LS	
	High load type	Ultra-high load type	Medium load type	High load type
15	1.5	2	0.5	1
20	3	3	1	1.5
25	5	6	2	3
30	7	8	4	5
35	11	12	8	8
45	25	30	—	—
55	45	50	—	—
65	80	95	—	—
85	160	195	—	—

**LY, LA Series** Unit: cm<sup>3</sup>

Series Model number	LY		LA	
	High load type	Ultra-high load type	High load type	Ultra-high load type
15	1	—	—	—
20	2	2	—	—
25	4	6	5	7
30	6	7	8	11
35	9	11	12	17
45	14	18	21	27
55	27	34	41	51
65	52	70	82	108

**LW Series** Unit: cm<sup>3</sup>

Series Model number	LW
17	0.7
21	2
27	2
35	6
50	14

**LE, LU Series** Unit: cm<sup>3</sup>

Series Model number	LE	LU	
		Standard type	Long type
05	—	0.05	—
07	0.1	0.10	—
09	0.2	0.15	0.25
12	0.3	0.25	0.35
15	0.7	0.60	0.80

**Table 2-1-3 Inside space of ball nut**

**Return tube type (single nut)** Unit: cm<sup>3</sup>

Nut model	Inside space	Nut model	Inside space	Nut model	Inside space	Nut model	Inside space
1004-2.5	0.8	2005-5	4.3	2525-1.5	7.5	4005-10	14
1205-2.5	1.2	2010-2.5	4.7	2805-5	6	4010-5	30
1210-2.5	1.4	2020-1.5	4.2	3205-5	7	4012-5	34
1405-2.5	2.2	2504-5	3.2	3206-5	9.5	4510-5	34
1510-2.5	2.3	2505-5	5	3210-5	22	5010-5	37
1605-2.5	2.6	2506-5	7	3225-2.5	17	5010-10	59
1616-1.5	2.1	2510-3	9.5	3232-1.5	15		
2004-5	2.7	2520-2.5	12	3610-5	32		

**Deflector type (single nut)** Unit: cm<sup>3</sup>

Nut model	Inside space
2505-6	6.5
2510-4	10
3205-8	9.5
3210-6	28
4010-8	42
5010-8	52

**End cap type** Unit: cm<sup>3</sup>

Nut model	Inside space
1520-1.5	1.9
2040-1	2.8
2550-1	4.2

Remarks: Nut model: shaft diameter, lead, total number of turns of balls  
Please consult NSK for other specifications.

**4. Intervals of checks and replenishments**

Although the grease is of high quality, it gradually deteriorates and its lubrication function diminishes. Also, the grease in the ball slide and ball nut is gradually removed by stroke movement. In some environments, the grease becomes dirty, and foreign

objects may enter. New grease should be replenished depending on frequency of use. The following is a guide of intervals of grease replenishments to linear guides and ball screws.

**Table 2-1-4 Intervals of checks and replenishments for grease lubrication**

Intervals of checks	Items to check	Intervals of replenishments
3-6 months	Dirt, foreign matters such as cutting chip	Usually once per year Every 3000 km for material handling system which travels more than 3000 km per year. Replenish if checking results warrant it necessary.

\*1) As a general rule, do not mix greases of different brands. Grease structure may be destroyed if greases of different thickeners are mixed. Even when greases have the same thickener, different additives in them may have an adverse effect on each other.

\*2) Grease viscosity varies by temperature. Viscosity is particular high in winter due to low temperature. Pay attention to increase in linear guide's sliding resistance and ball screw torque in such occasion.

## 2-2 Oil Lubrication

Required amount of new oil is regularly supplied by:

- Manual or automatic intermittent supply system;
- Oil mist lubricating system via piping.

Equipment for oil lubrication is more costly than grease lubrication. However, oil mist lubricating system supplies air as well as oil, raising the inner pressure of the ball slide. This prevents foreign matters from entering, and the air cools the system. Use an oil of high atomizing rate such as ISO VG 32-68 for the oil mist lubrication system.

ISO VG 68-220 are recommended for common intermittent replenishment system. Approximate volume of oil Q for a ball slide of linear guide per hour can be obtained by the following formula.

$$Q = n/150 \text{ (cm}^3\text{/hr)}$$

*n*: Linear guide code

e.g. When LH45 is used,

Therefore,

$$Q = 45/150 = 0.3 \text{ cm}^3\text{/hr}$$

Similarly, approximate oil supply volume Q to ball screw can be obtained by the following formula.

$$Q = d/15 \text{ (cm}^3\text{/hr)}$$

*d*: Nominal shaft diameter of the ball screw

e.g. When the shaft diameter is 50,

$$d = 50$$

Therefore,

$$Q = 50/15 = 3.3 \text{ cm}^3\text{/hr}$$

For oil lubrication by gravity dripping, the oil supply position and installation attitude of the ball slide or ball nut are crucial. In case of linear guide, unless it is installed to a horizontal position, the oil flows only on the down side, and does not spread to all ball grooves. This may cause insufficient lubrication. For ball screw lubrication as well, oil does not spread if the oil orifice is installed at the bottom, causing insufficient lubrication. Please consult NSK to correct such situations prior to use. NSK has internal design which allows oil lubricant flows throughout the system. Table 2-2.1 shows the criterion of intervals of oil checks and replenishments.

Table 2-2-1 Intervals of checks and replenishments

Method	Intervals of checks	Items to check	Replenishment or intervals of changes
Automatic intermittent supply	Weekly	Volume of oil, dirt, etc.	Replenish at each check. Suitable volume for tank capacity.
Oil bath	Daily before operation	Oil surface	Make a suitable criterion based on consumption

\*1) As with grease lubrication, do not mix oil lubricant with different types.

\*2) Some components of the linear guide and ball screw are made of plastic. Avoid using an oil that adversely affects synthetic resin.

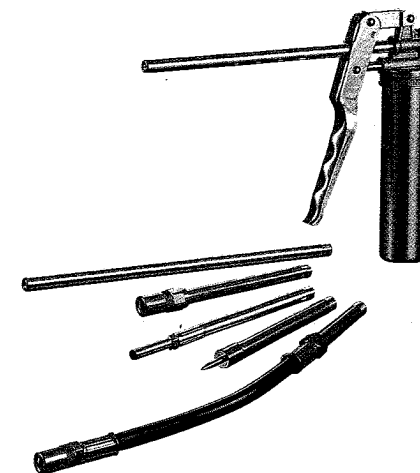
## 2-3 NSK Grease Unit

Replenish grease to NSK linear guides and ball screws by a manual type hand grease pump. Install

the grease in bellows tube to the pump. Several types of grease (80 g) are available.

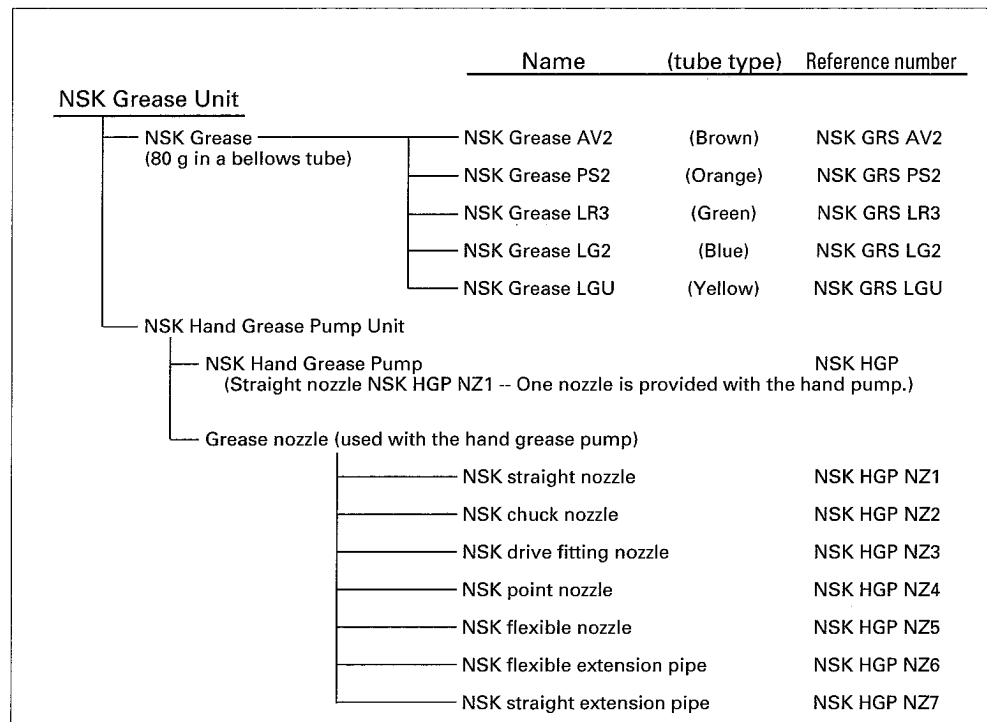


Grease in a bellows tube



### 1. Composition of NSK Grease Unit

Components and grease types are shown below.



## 2. NSK Greases (80 g in a bellows tube)

Refer to Page C14 for their natures and details.

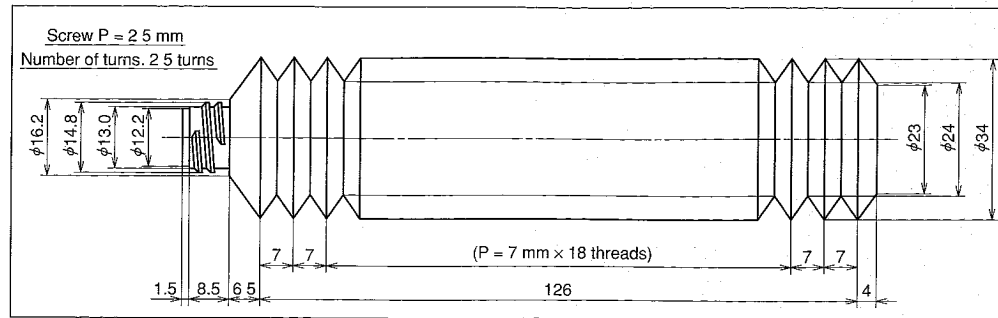


Fig. 2-3-1 Bellows tube

## 3. NSK manual Grease Pump Unit

### (1) NSK Hand Grease Pump Unit (Reference number: NSK HGP)

#### ● Features

- Light-weight ..... Can be operated by one hand, yet there is no worry to making a mistake.
- Inserting by high pressure.....Insert at 15 Mpa.
- No leaking ..... Does not leak when held upside down.
- Easy to change grease .... Simply attach the grease in bellows tube.
- Remaining grease ..... Can be confirmed through slit on the tube.
- Several nozzles ..... Five types of nozzles to choose from.

#### ● Specifications

- Spout volume .....0.35 g/stroke
- Mass of main body ...393 g
- Overall length .....About 200 mm
- Overall width.....About 200 mm
- Grease tube outer diameter ..  $\phi$  38.1
- Accessory.....Several nozzles for a unique application can be attached

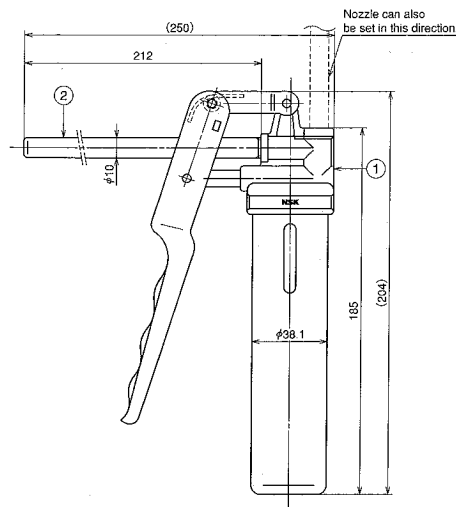


Fig. 2-3-2 NSK Hand Grease Pump with NSK straight nozzle

## (2) Nozzles

Table 2-3-1 Nozzles that can be attached to NSK Hand Grease Pump

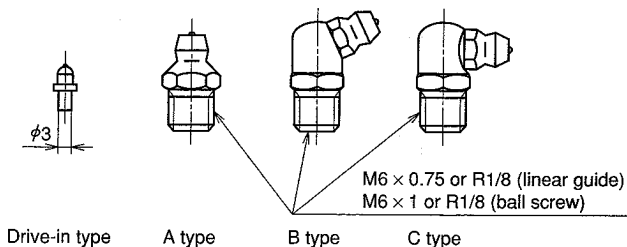
Name	Designation code	Use	Dimensions
NSK straight nozzle	NSK HGP NZ1	Can be used with grease fitting A, B, and C under JIS B1575 standard.	
NSK chuck nozzle	NSK HGP NZ2	Same as above. However, there is no need to press the hand pump because the grease fitting and the nozzle come to contact due to the chucking mechanism at the tip.	
NSK fitting nozzle	NSK HGP NZ3	Dedicated for the $\phi$ 3 drive-in grease fitting.	
NSK point nozzle	NSK HGP NZ4	Used for linear guides and ball screws which do not have grease fitting. Supplies grease directly to the ball grooves, or through the opening of ball slide or ball slide to inside.	
NSK flexible nozzle	NSK HGP NZ5	The tip of the flexible nozzle is chuck nozzle. Used to supply grease to the area where hand cannot reach.	
NSK flexible extension pipe	NSK HGP NZ6	Flexible extension pipe connects the grease pump and the nozzle	
NSK straight extension pipe	NSK HGP NZ7	Straight extension pipe connects the grease pump and the nozzle.	

**Table 2-3-2 Grease fittings used for NSK linear guide**

Linear guide model	Tap hole for grease fitting	Standard grease fitting	Straight nozzle NZ1	Chuck nozzles (two) NZ	Drive-in nipple nozzle NZ3	Point nozzle NZ4	Flexible nozzle NZ5
LS15	φ3	Drive-in type			○		
LS20~35 *1)	M6×0.75	B type	○	○			○
LH15	φ3	Drive-in type			○		
LH20~35 *1)	M6×0.75	B type	○	○			○
LH45~85	Rc1/8	B type	○	○			○
LA25~35	M6×0.75	B type	○	○			○
LA45~65	Rc1/8	B type	○	○			○
LY15,20	φ3	Drive-in type			○		
LY25~35 *1)	M6×0.75	B type	○	○			○
LY45~65	Rc1/8	B type </tr					

\*1) LS20, LS25, LH20, LY25, LY30: Use straight nozzle. (Point nozzle tip cannot be used because it interfere with the rail top surface.)

\*2) LU and LE Series: Apply grease directly to ball groove, etc. using a point nozzle.



**Fig. 2-3-3 Grease fittings**

**Remarks :** Normally, grease fitting is not provided to NSK ball screw. However, ball nut has a tap hole to install a grease fitting. The user should install a grease fitting if necessary. If there is no tap hole, apply grease directly to the screw shaft and ball grooves.