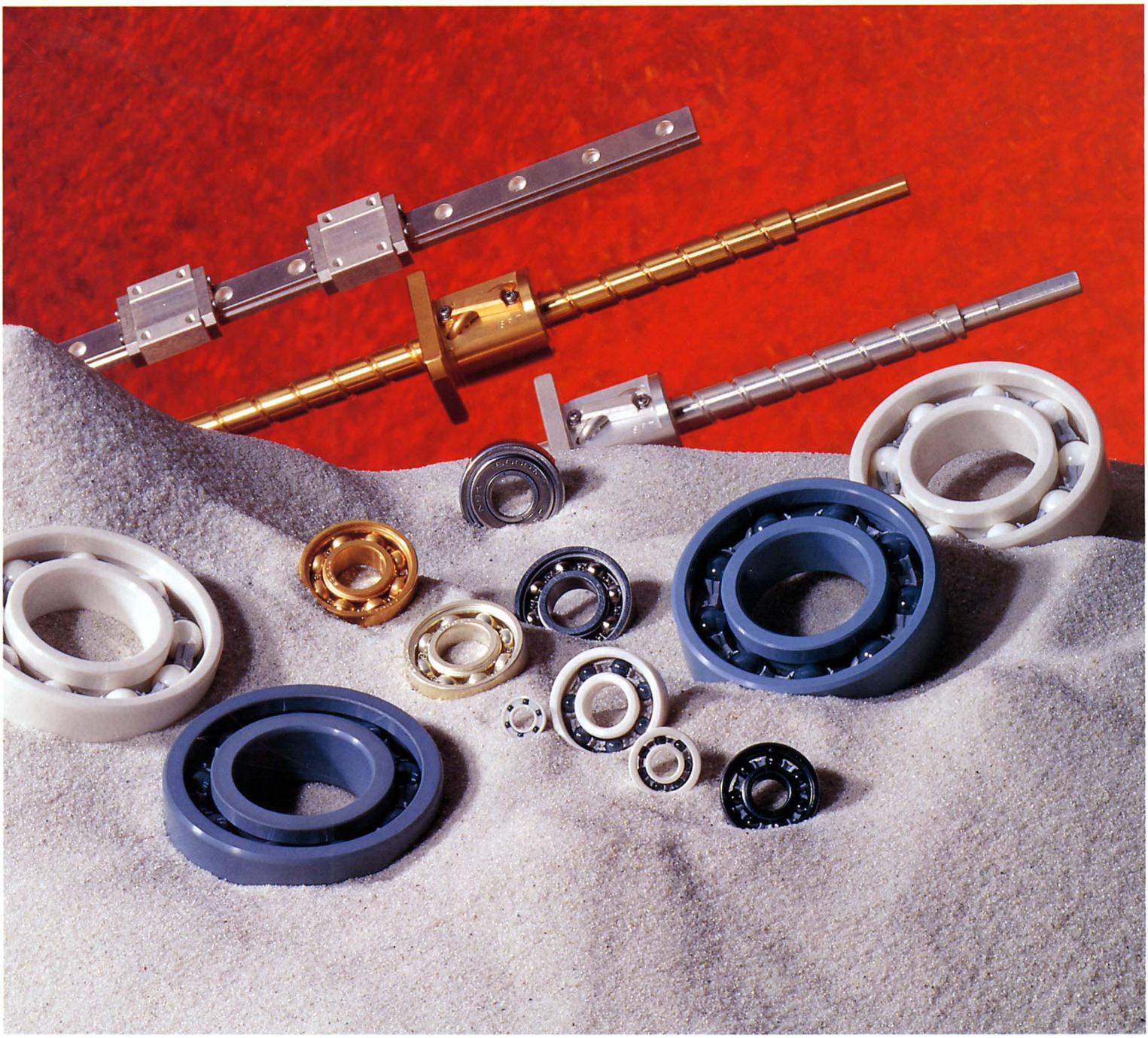
MOTION & CONTROL
NSK

Bearings, Ball Screws and Rolling Guides for Special Environments

The SPACEA™ Series

Outstanding performance in special environments



Bearings, Ball Screws & NSK Linear Guides® for Special Environments

The SPACEA™ Series

The NSK SPACEA Series is a range of bearings, ball screws and NSK Linear Guides designed for special operating environments such as clean environments for semiconductor production, water environments for food processing, environments where corrosive substances are present, and vacuum conditions where conventional methods of lubrication are unsuitable.

This brochure presents the new expanded SPACEA Series lineup and includes examples of the applications and performance of SPACEA products under demanding conditions .

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The SPACEA™ Series

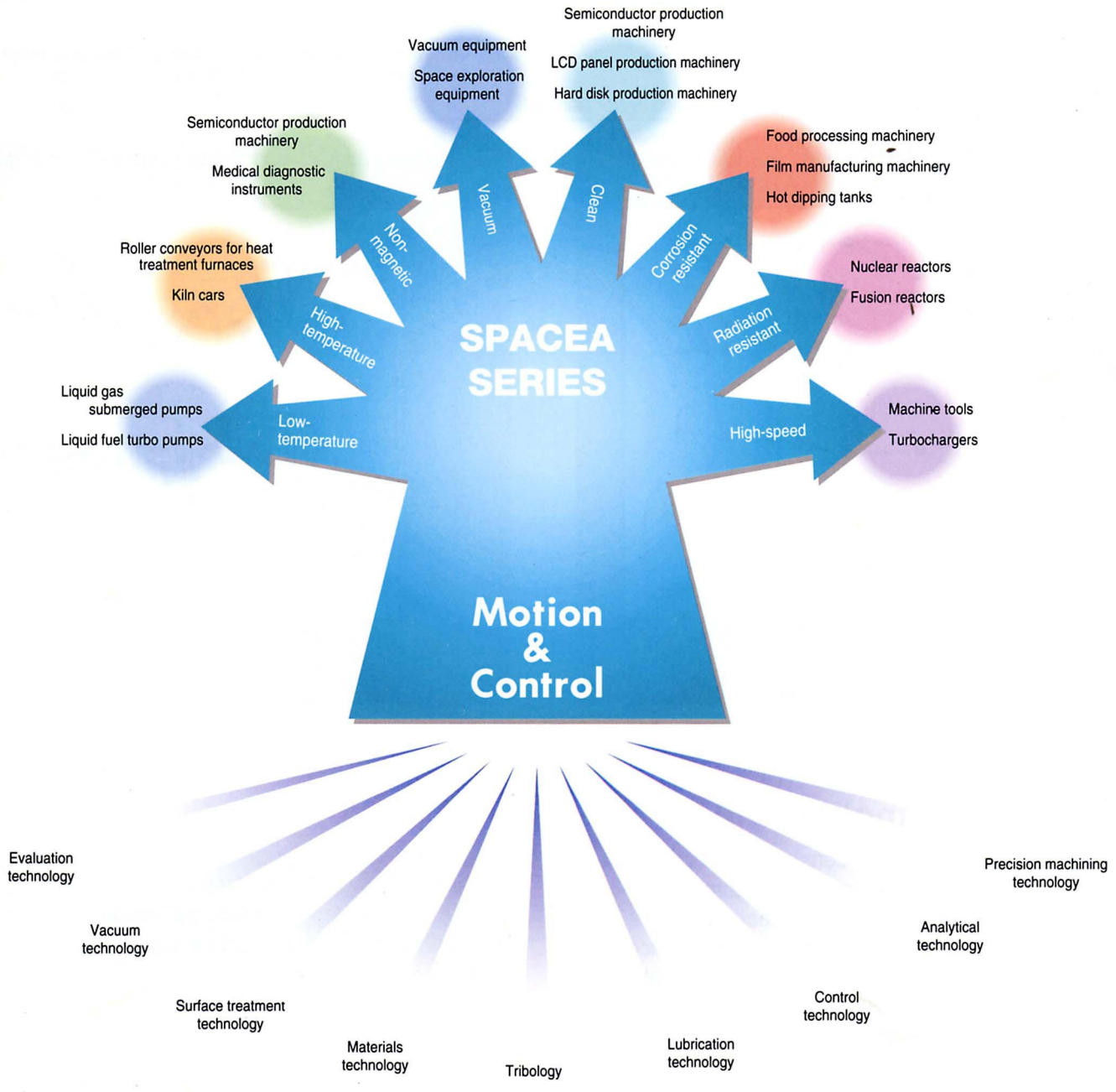
NSK's response to the ever-increasing demands of high-tech industry

For the past ten years, NSK has been designing advanced motion & control products to support the increasingly sophisticated needs of high-tech industry. Over this period, we have developed unique material, lubrication and surface treatment technologies to suit the demanding conditions under which our products must perform. These efforts have resulted in the creation of the SPACEA Series, a range of bearings, ball screws and NSK Linear Guides for special operating environments.

SPACEA Series products are ideally suited for use in clean rooms for the production of semiconductors, environments where corrosive substances are present, or vacuum conditions where conventional methods of lubrication are unsuitable. The SPACEA Series is being expanded and improved on a constant basis to incorporate new technology and keep pace with the needs of science and industry.

The diagram below shows the range of technologies incorporated in SPACEA Series products and their applications. For more information on applications see the individual product sections or the list on page 33 of this brochure.

Fig. 1 The SPACEA Series



New technology used in the SPACEA Series

NSK strives constantly to improve the SPACEA Series lineup. This section outlines some of the latest technology incorporated in the series.

THE SPACEA SERIES USES NSK'S LATEST LUBRICANT TECHNOLOGY

New lubricant technology

NSK Clean Grease LG2

Created for use in air conditions, NSK Clean Grease LG2 is a special grease which reduces dust generation in bearings, ball screws and linear guides to a minimum. NSK Clean Grease LG2 is used to lubricate many SPACEA Series. It outperforms fluorine greases across the board and has drawn widespread acclaim from our customers.

NSK Clean Grease LG2 features

- **an extremely low dust count,**
- **low and stable torque (less than 20% of that of fluorine greases),**
- **long service life (10 times longer than fluorine greases), and**
- **superior rust prevention.**

Table 1 Characteristics of NSK Clean Grease LG2

Product name	Thickener	Base oil	Base oil dynamic viscosity (mm^2/s at 40°C)	Consistency NLGI No.	Dropping point (°C)
Clean Grease LG2	Lithium soap	Mineral oil + synthetic hydrocarbon oil	30	3	200

Fig. 2 Dust count: Clean Grease LG2 with bearing

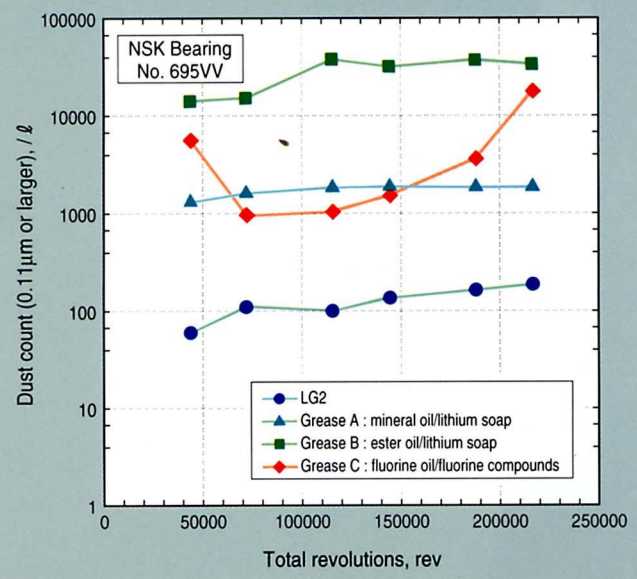
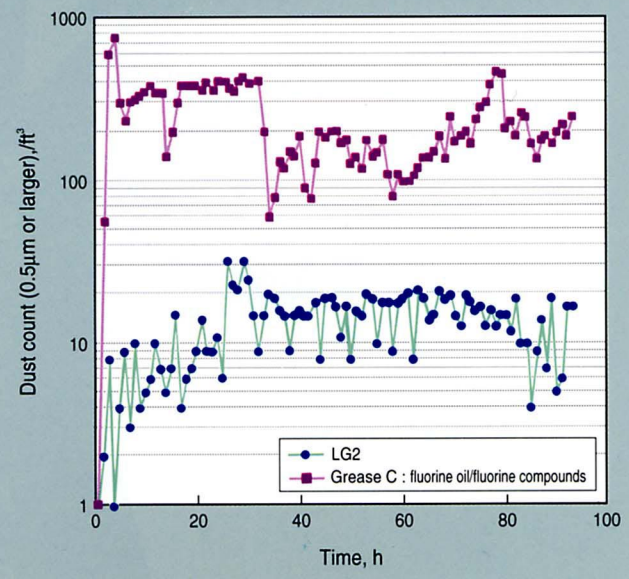


Fig. 3 Dust count: Clean Grease LG2 with linear guide



Note: For data on performance of LG2 with ball screws, see pages 23-24.

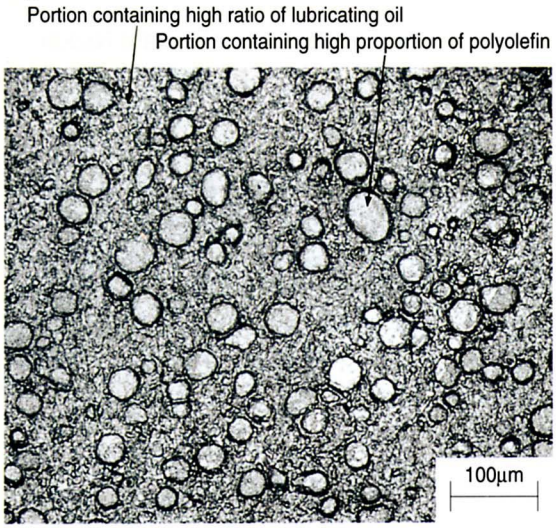
NSK K1 Seal (molded oil)

"Molded oil" is a solid material consisting of at least 50% lubricating oil by weight combined with a compatible polyolefin resin. NSK's K1 Seals for linear guides are made of molded oil and the combination of their excellent sealing properties and continuous supply of lubricating oil has made it possible to use linear guides in wet or dusty conditions where lubrication is otherwise difficult.

NSK K1 Seals features

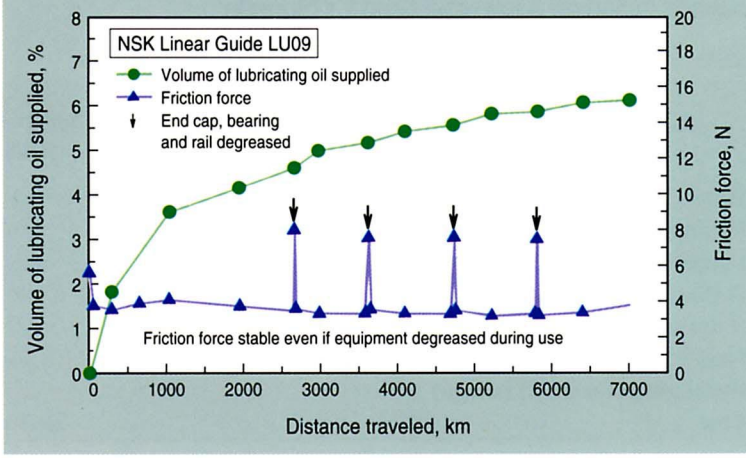
- **continuous supply of lubricating oil,**
- **superior sealing properties, and**
- **long endurance life.**

Fig. 4 Structure of molded oil



Note: For data on performance of K1 Seals with linear guides, see pages 29-30.

Fig. 5 Change in volume of lubricating oil supply and friction force:



Surface treatment technology

NSK has developed a range of advanced surface treatments to meet a wide range of technical needs. SPACEA Series products can be coated with a range of solid lubricants such as lead, silver, gold, and molybdenum disulfide for use in vacuum conditions, with NSK Special Fluororesin Coating for lubrication in clean environments, or Cold Cr Fluoride Coating or Nickel Alloy Coating for corrosive environments.

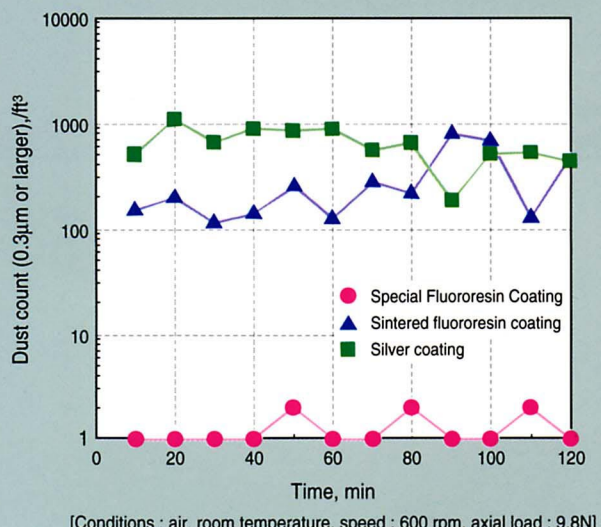
NSK Special Fluororesin Coating

NSK Special Fluororesin Coating combines low dust count and gas evaporation with long endurance life and is the ideal coating for clean environments, whether in air or vacuum conditions.

NSK Special Fluororesin Coating features

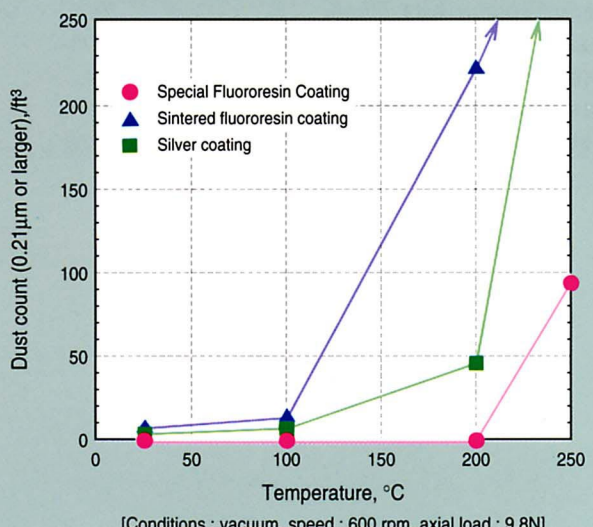
- **low dust count in air or vacuum,**
- **outstanding heat resistance,**
- **long endurance life, and**
- **low gas evaporation.**

Fig. 6 Dust count: NSK Special Fluororesin Coated Bearing



[Conditions : air, room temperature, speed : 600 rpm, axial load : 9.8N]

Fig. 7 Dust count: NSK Special Fluororesin Coated Bearing



[Conditions : vacuum, speed : 600 rpm, axial load : 9.8N]

New technology used in the SPACEA Series

Corrosion resistant coatings

NSK has developed a range of corrosion resistant coatings including a low-cost Cold Cr Fluoride Chrome Coating and a highly corrosion resistant Nickel Alloy Coating.

Table 2 Performance of NSK corrosion resistant coatings

	Stainless steel SUS440C	Hardened Chrome Coating	Cold Cr Fluoride (Low cost)	Nickel Alloy Coating (High corrosion resistance)
Water	×	△	○	○
Hydrochloric acid (1 normal)	×	○	○	○
Hydrochloric acid (5 normal)	×	○	△	○
Sulfuric acid (5 normal)	×	×	○	○
Nitric acid (10 normal)	○	○	○	○
Fluoric acid (1 normal)	×	△	△	○
Hydrogen peroxide (1 normal)	○	○	○	○
Cost	—	Moderate	Low	Moderate

Key: ○ no corrosion △ some corrosion × extensive corrosion

Notes: Nitric acid at 5 normal destroys the corrosion resistant coating. For more information on Cold Cr fluoride plating, see page 31.

Corrosion resistant ceramic materials

The ceramic material, silicon nitride, is highly resistant to corrosion and offers excellent protection against substances other than hydrogen fluoride and molten metal. NSK has also developed a number of ceramic materials offering even greater protection, including High Corrosion Resistance Ceramics and Low-Cost Ceramics.

Table 3 Characteristics and performance of ceramics v. bearing steel

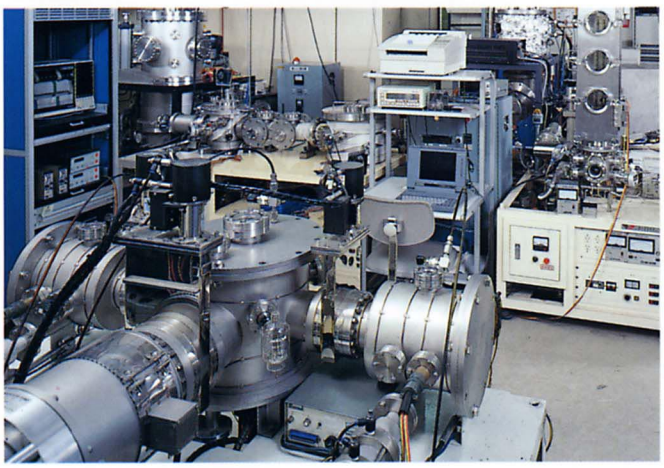
	Bearing steel	High-reliability Ceramics (silicon nitride)	High Corrosion Resistance Ceramics (carbide based)	Low-cost Ceramics (oxide based)
Density, g/cm^3	7.8	3.23	3.14	5.9
Young's modulus, GPa	208	330	390	210
Poisson ratio	0.3	0.27	0.14	0.31
Fracture toughness, MPa•m$^{1/2}$	18	6.0	2.5	7.5
Vickers hardness (HV)	700	1500	≧2000	1300
Ratio of linear expansion, x 10^{-6}/°C	12.5	2.8	4.3	10.5
Thermal conductivity, W/m•k	50	31	60	3
Flexural strength, MPa	≧2500	900	600	1100
Ease of rotation in water	Poor	Excellent	Moderate	Good
Ease of rotation in acidic solution	Poor	Moderate	Excellent	Good
Cost	Very low	Moderate	Moderate	Low

Endurance tests

SPACEA Series bearings are used in a wide range of applications. By evaluating the performance of bearings under simulated conditions as close as possible to those found in actual use, NSK has earned the trust of its customers. For instance, the range of equipment used to test bearings for vacuum conditions alone includes devices for testing bearings for X-ray tube applications, space exploration applications and ordinary vacuum applications, as well as, devices for testing ball screws, dust counting machines, and gas emission measuring devices.

Fig. 8 Tests rigs for ceramic bearings

Fig. 9 Tests rigs for bearings for vacuum conditions



Endurance life of SPACEA Series bearings

NSK carries out extensive tests of the endurance life of SPACEA Series bearings. On the basis of these tests, we have devised the following formulae for the endurance life of SPACEA Series bearings using solid lubricants and ceramic materials.

Endurance life formula for bearings using solid lubricants

The formula below gives an approximate indication of the endurance life of a SPACEA Series bearing in which the raceway surface and rolling elements have been coated with silver (Ag), lead (Pb) or molybdenum disulfide (MoS_2). In this context, endurance life is defined as the number of revolutions of the inner ring before the coating is worn away and torque increases.

$$L = a_{SL} \cdot a_{SV} \cdot (C_r/P)^d$$

- L : Rated life (90% of reliable life), x 10^6 rev
- C_r : basic load rating of steel bearing of same dimensions (x 0.85 for stainless steel bearing), N
- P : equivalent load, N
- a_{SL} : lubricity coefficient (Ag= 1, Pb=0.7, MoS_2=0.0005)
- a_{SV} : speed coefficient (Ag, Pb= 2 where speed is 100 rpm or less, 3 where speed over 100 rpm, MoS_2=1)
- d : Ag, Pb=0.5, MoS_2=2

Endurance life formula for ceramic bearings

The endurance life of ceramic ball bearings (hybrid bearings and all-ceramic bearings) depends on the operating conditions, but can be estimated using the following formula.

Lubrication conditions	a_{CL}	Type of bearing[1]	a_{CM}
Oil or grease	1	Hybrid bearings	4
		All-ceramic bearings	1
Water	0.02	Hybrid bearings	0.1
		All-ceramic bearings	1

Note: Hybrid bearings have steel innèr and outer rings and ceramic balls. In all-ceramic bearings, inner and outer rings and balls are all made of ceramic materials.

$$L = a_{CL} \cdot a_{CM} (C_r/P)^3$$

- L : Rated life (90% of reliable life), x 10^6 rev
- C_r : basic load rating of steel bearing of same dimensions, N
- P : equivalent load, N
- a_{CL} : lubricity coefficient
- a_{CM} : materials combination coefficient

Important : The effects of temperature, speed, rotation mode, loading, and foreign particle contamination mean that the endurance life of SPACEA Series bearings may not conform to these formulae. Please contact NSK for more accurate data on endurance life.

Bearing lubrication and materials

Bearing lubrication

Grease can be used as a lubricant in applications where bearings turn at high speeds or in magnetic fields. In special environments such as vacuums, or at high and low temperatures, however, grease can easily evaporate or harden and is therefore unsuitable as a lubricant. In such conditions, it is better to use solid lubricants. The lubricating performance of solid lubricants varies considerably according to operating conditions, and care should therefore be exercised in the choice of a solid lubricant.

Fig. 10.1 Lubrication in clean environments

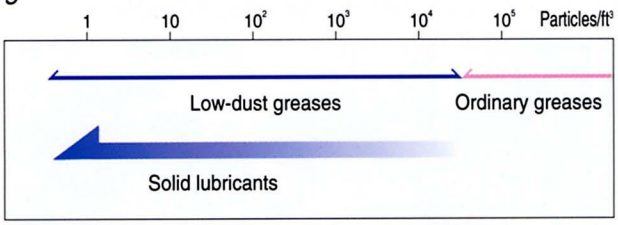


Fig. 10.2 Lubrication in vacuums

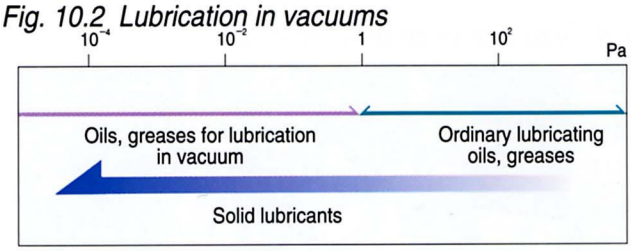


Fig. 10.3 Lubrication in corrosive environments

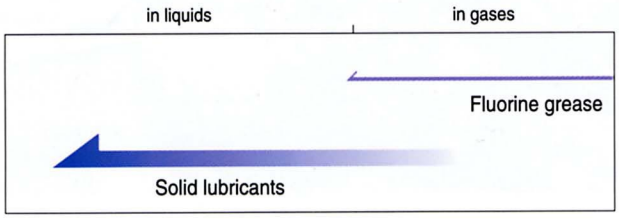


Fig. 10.4 Lubrication at high temperatures

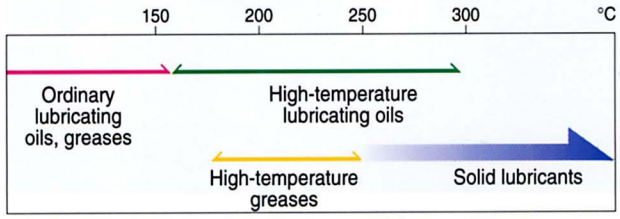


Fig. 10.5 Lubrication at low temperatures

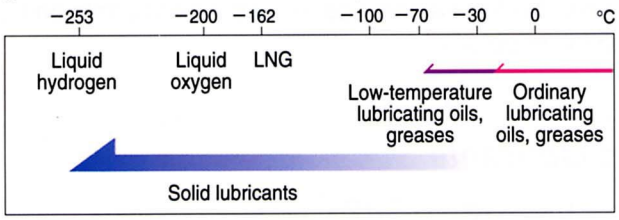


Fig. 10.6 Lubrication in radioactive environments

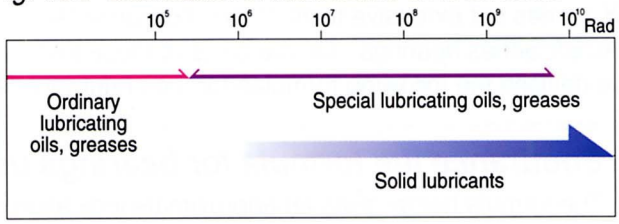


Fig. 10.7 Lubrication at high speeds

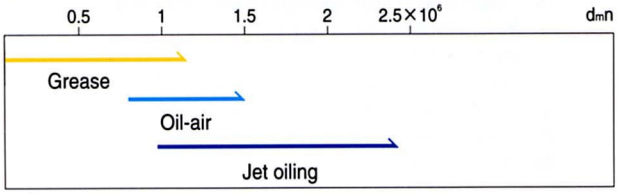
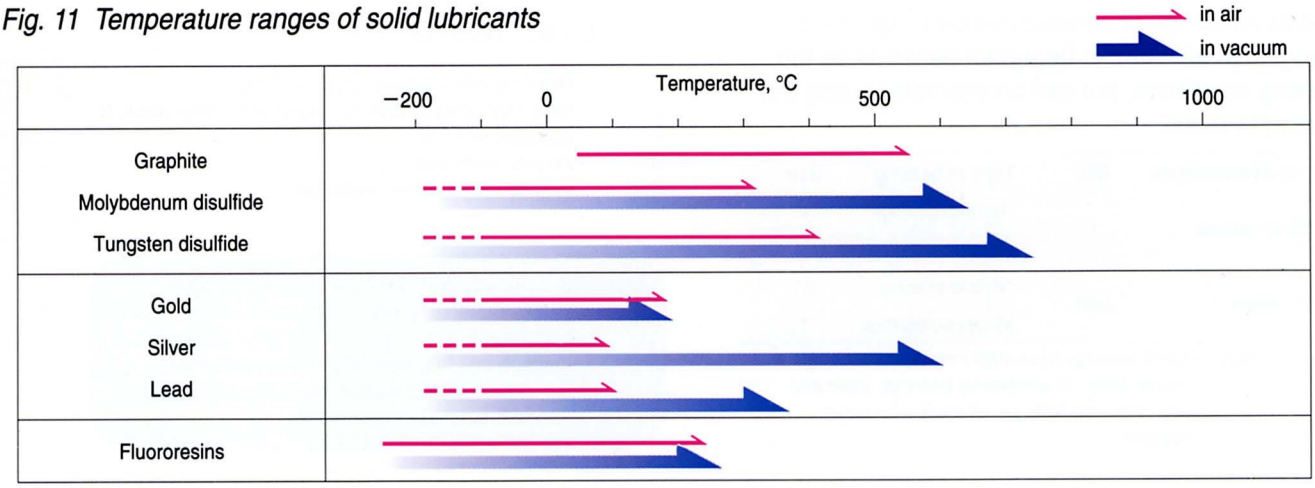


Fig. 11 Temperature ranges of solid lubricants



Ceramic materials

Ceramic materials offer superior corrosion resistance, heat resistance and dimensional stability compared to steel. Therefore, ceramic materials are ideally suited to corrosive, high-temperature and high-speed conditions. As Silicon nitride has excellent material characteristics at high temperatures silicon nitride bearings can be used where all-metal bearings would fail. The figures below show the performance of ceramic bearings under high temperature conditions.

Fig. 12 Temperature/hardness of silicon nitride and bearing steel

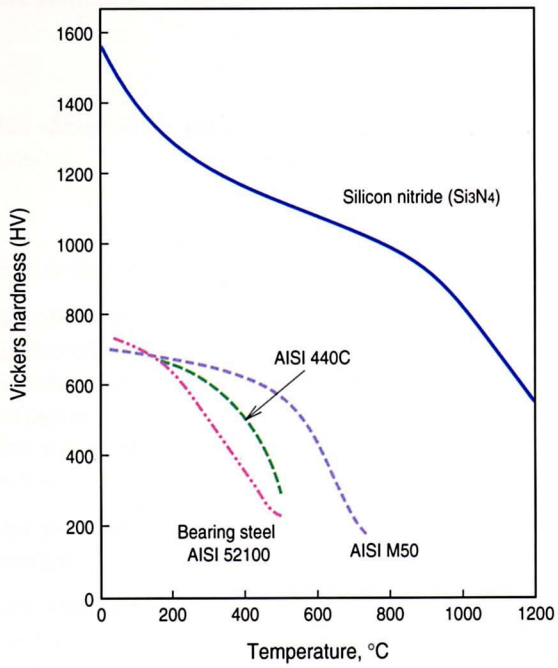
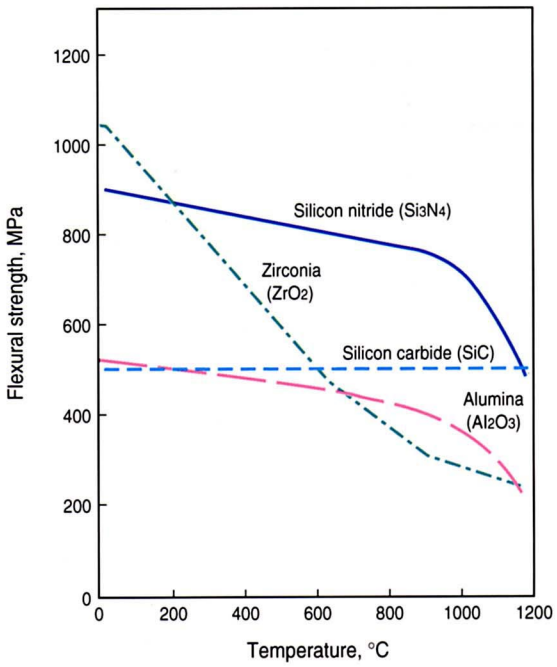


Fig. 13 Temperature/flexural strength of ceramic materials



Metallic materials

SPACEA Series bearings for use in vacuum conditions, at high temperatures or at high speeds are made chiefly of ferrous metals. NSK's non-magnetic bearings are made of non-magnetic stainless steel and beryllium copper.

Table 4 Properties of metallic materials in SPACEA Series bearings

Application	Metal	Ratio of linear expansion, x 10^{-6}/°C	Young's modulus of elasticity, GPa	Brinell hardness (HB)
High speeds **Radioactive environments**	Bearing steel AISI 52100	12.5	208	650-740
Clean environments	Martensite stainless steel AISI 440C	10.1	200	580
Vacuum conditions **Corrosive environments**	Austenite stainless steel AISI 304	16.3	193	150
Low temperatures **High temperatures**	Precipitation hardened stainless steel AISI S17400	10.8	200	277-363
High temperatures	High resistant steel T5	9.4	210	≧800
Non-magnetic environments	Non-magnetic stainless steel	17.0	195	420
	Beryllium copper alloys	16.3	135	300-380

Note: Hardness is normally expressed using the Rockwell C scale, but for ease of comparison this table uses the Brinell scale.

SPACEA Series Bearings

Specifications of SPACEA Series Bearings

The table below shows the principal specifications of NSK's SPACEA Series bearings and indicates their suitability for various operating conditions.

	Operating conditions					Requirements	Bearing		conditions		Technical data on page(s) ...	Table of dimensions on page ...	Remarks
	Temperature	Air	Vacuum	Corrosive conditions	Magnetic fields		Inner ring / Outer ring	Balls	Cages	Grease			
Bearings for clean environments	Room temperature	○				Low dust	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel or resin	Clean Grease	3, 15, 23	11	• In corrosion resistant bearings, balls and inner and outer rings are ceramic • In non-magnetic bearings, balls and inner and outer rings are ceramic • In insulated bearings, either only balls or balls and inner and outer rings are ceramic
		○	○							Fluorine grease	3, 15		
		○							Austenite stainless steel				
	up to 200˚C	○	○			Low dust, Corrosion resistance, Non-magnetism, Insulation	Martensite stainless steel or Ceramics	Martensite stainless steel or Ceramics	Fluororesin	–			
	up to 250˚C	○	○						Austenite stainless steel + special fluororesin coating	–	4, 6, 15	11, 12	
	up to 300˚C	○	○						High-temperature self-lubricating resin	–		12	
Bearings for vacuum conditions	Room temperature		○			Lubricity	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Fluorine grease		12	For details on bearing applications in X-ray rooms, see page 17.
	up to 300˚C	○	○			Lubricity, Heat resistance		Martensite stainless steel + molybdenum disulfide coating	Austenite stainless steel + molybdenum disulfide coating	–	18, 19		
			○					Martensite stainless steel + lead coating	Austenite stainless steel	–	17, 18		
	up to 400˚C		○					Martensite stainless steel + silver coating		–			
Bearings for corrosive environments	Room temperature	○		○		Corrosion resistance	Martensite stainless steel	Martensite stainless steel or Ceramics	Austenite stainless steel or Fluororesin	Waterproof grease	5, 16, 17	13	
		○	○	○						–			
	up to 200˚C	○	○	○			Martensite stainless steel + corrosion resistant coating	Martensite stainless steel + corrosion resistant coating or Ceramics	Fluororesin	–			
		○	○	○			Precipitation hardened stainless steel	Ceramics		–		14	
		○	○	○	○		Ceramics			–			
Bearings for high temperatures	up to 400˚C	○				Heat resistance	Martensite stainless steel	Martensite stainless steel or Ceramics	Graphite-based self-lubricating material	–	19	14	
	up to 500˚C	○					Ceramics	Ceramics		–			
Non-magnetic bearings	Room temperature	○	○		○	Non-magnetism	Non-magnetic materials	Ceramics	Austenite stainless steel or resin	Fluorine grease		14	
	up to 200˚C	○	○	○	○		Ceramics		Fluororesin	–			
Bearings for low temperatures	down to –270˚C	○				Lubricity	Martensite stainless steel	Martensite stainless steel	Fluororesin	–	20	20	For applications of bearings in liquid gas submerged pumps, see page 20.
Radiation resistant bearings	up to 120˚C	○				Radiation resistance	Bearing steel	Bearing steel	Cold-rolled steel	Radiation resistant grease			
Bearings for high speeds	Room temperature	○				High speed tolerance	Bearing steel or Martensite stainless steel	Ceramics	Resin	High-speed grease, Oil-air or Jet oiling	20		For details of bearings for use in machine tools, see page 20.

Notes: The parts of the bearing coated with special fluororesin coating, molybdenum disulfide, lead, or silver vary according to the conditions in which the bearing is to be used. For details, please contact NSK.

Dimensions of SPACEA Series Bearings

The tables on the following four pages show the principal dimensions, materials and operating conditions of SPACEA Series bearings.

Operating conditions					Bearings for clean environments							Bearings for vacuum conditions			
					Room temperature Air	Room temperature Air-vacuum/ up to 200°C Air	up to 200°C Air-vacuum	up to 200°C Air-vacuum	up to 250°C Air-vacuum	up to 250°C Air-vacuum	up to 300°C Air-vacuum	up to 300°C Air-vacuum	Room temperature	up to 300°C Air-vacuum	up to 300°C Vacuum	up to 400°C Vacuum
				Inner & outer rings	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Stainless steel	Ceramics	Stainless steel	Stainless steel	Stainless steel	Stainless steel
				Balls	Stainless steel	Stainless steel	Stainless steel	Ceramics	Ceramics	Stainless steel	Stainless steel	Ceramics	Stainless steel	Stainless steel + MoS_2 coating	Stainless steel + lead coating	Stainless steel + silver coating
				Cage	Stainless steel	Stainless steel	Fluororesin	Fluororesin	Special fluororesin coating	High temperature self-lubricating resin	High temperature self-lubricating resin	High temperature self-lubricating resin	Stainless steel	Stainless steel + MoS_2 coating	Stainless steel	Stainless steel
				Grease	Clean Grease	Fluorine grease	–	–	–	–	–	–	Fluorine grease	–	–	–
Shaft diameter	Basic bearing number	Boundary dimensions, mm Bore diameter *d*	Outside diameter *D*	Width *B*	■■■-H-□□	■■■-H-□□	■■■-H-T36	■■■-H-S□T36 (depends on ceramic material)	■■■-H-S8PF	U-■■■-H-S□S8PF (depends on ceramic material)	■■■-H-T□ (depends on cage material)	■■■S□T□ (depends on cage material / depends on ceramic material)	■■■-H-□□	U-■■■-H-S8MO	U-■■■-H-S4PB	U-■■■-H-S4AG
4	604	4	12	4	604-H-□□	604-H-□□	604-H-T36	604-H-S□T36	U-604-H-S8PF	U-604-H-S□S8PF	604-H-T□	604S□T□	604-H-□□	U-604-H-S8MO	U-604-H-S4PB	U-604-H-S4AG
	624	4	13	5	624-H-□□	624-H-□□	624-H-T36	624-H-S□T36	U-624-H-S8PF	U-624-H-S□S8PF	624-H-T□	624S□T□	624-H-□□	U-624-H-S8MO	U-624-H-S4PB	U-624-H-S4AG
5	605	5	14	5	605-H-□□	605-H-□□	605-H-T36	605-H-S□T36	U-605-H-S8PF	U-605-H-S□S8PF	605-H-T□	605S□T□	605-H-□□	U-605-H-S8MO	U-605-H-S4PB	U-605-H-S4AG
	625	5	16	5	625-H-□□	625-H-□□	625-H-T36	625-H-S□T36	U-625-H-S8PF	U-625-H-S□S8PF	625-H-T□	625S□T□	625-H-□□	U-625-H-S8MO	U-625-H-S4PB	U-625-H-S4AG
6	686	6	13	5	686-H-□□	686-H-□□	686-H-T36	686-H-S□T36	U-686-H-S8PF	U-686-H-S□S8PF	686-H-T□	686S□T□	686-H-□□	U-686-H-S8MO	U-686-H-S4PB	U-686-H-S4AG
	696	6	15	5	696-H-□□	696-H-□□	696-H-T36	696-H-S□T36	U-696-H-S8PF	U-696-H-S□S8PF	696-H-T□	696S□T□	696-H-□□	U-696-H-S8MO	U-696-H-S4PB	U-696-H-S4AG
	606	6	17	6	606-H-□□	606-H-□□	606-H-T36	606-H-S□T36	U-606-H-S8PF	U-606-H-S□S8PF	606-H-T□	606S□T□	606-H-□□	U-606-H-S8MO	U-606-H-S4PB	U-606-H-S4AG
	626	6	19	6	626-H-□□	626-H-□□	626-H-T36	626-H-S□T36	U-626-H-S8PF	U-626-H-S□S8PF	626-H-T□	626S□T□	626-H-□□	U-626-H-S8MO	U-626-H-S4PB	U-626-H-S4AG
7	687	7	14	5	687-H-□□	687-H-□□	687-H-T36	687-H-S□T36	U-687-H-S8PF	U-687-H-S□S8PF	687-H-T□	687S□T□	687-H-□□	U-687-H-S8MO	U-687-H-S4PB	U-687-H-S4AG
	697	7	17	5	697-H-□□	697-H-□□	697-H-T36	697-H-S□T36	U-697-H-S8PF	U-697-H-S□S8PF	697-H-T□	697S□T□	697-H-□□	U-697-H-S8MO	U-697-H-S4PB	U-697-H-S4AG
	607	7	19	6	607-H-□□	607-H-□□	607-H-T36	607-H-S□T36	U-607-H-S8PF	U-607-H-S□S8PF	607-H-T□	607S□T□	607-H-□□	U-607-H-S8MO	U-607-H-S4PB	U-607-H-S4AG
	627	7	22	7	627-H-□□	627-H-□□	627-H-T36	627-H-S□T36	U-627-H-S8PF	U-627-H-S□S8PF	627-H-T□	627S□T□	627-H-□□	U-627-H-S8MO	U-627-H-S4PB	U-627-H-S4AG
8	688	8	16	5	688-H-□□	688-H-□□	688-H-T36	688-H-S□T36	U-688-H-S8PF	U-688-H-S□S8PF	688-H-T□	688S□T□	688-H-□□	U-688-H-S8MO	U-688-H-S4PB	U-688-H-S4AG
	698	8	19	6	698-H-□□	698-H-□□	698-H-T36	698-H-S□T36	U-698-H-S8PF	U-698-H-S□S8PF	698-H-T□	698S□T□	698-H-□□	U-698-H-S8MO	U-698-H-S4PB	U-698-H-S4AG
	608	8	22	7	608-H-□□	608-H-□□	608-H-T36	608-H-S□T36	U-608-H-S8PF	U-608-H-S□S8PF	608-H-T□	608S□T□	608-H-□□	U-608-H-S8MO	U-608-H-S4PB	U-608-H-S4AG
	628	8	24	8	628-H-□□	628-H-□□	628-H-T36	628-H-S□T36	U-628-H-S8PF	U-628-H-S□S8PF	628-H-T□	628S□T□	628-H-□□	U-628-H-S8MO	U-628-H-S4PB	U-628-H-S4AG
9	689	9	17	5	689-H-□□	689-H-□□	689-H-T36	689-H-S□T36	U-689-H-S8PF	U-689-H-S□S8PF	689-H-T□	689S□T□	689-H-□□	U-689-H-S8MO	U-689-H-S4PB	U-689-H-S4AG
	699	9	20	6	699-H-□□	699-H-□□	699-H-T36	699-H-S□T36	U-699-H-S8PF	U-699-H-S□S8PF	699-H-T□	699S□T□	699-H-□□	U-699-H-S8MO	U-699-H-S4PB	U-699-H-S4AG
	609	9	24	7	609-H-□□	609-H-□□	609-H-T36	609-H-S□T36	U-609-H-S8PF	U-609-H-S□S8PF	609-H-T□	609S□T□	609-H-□□	U-609-H-S8MO	U-609-H-S4PB	U-609-H-S4AG
	629	9	26	8	629-H-□□	629-H-□□	629-H-T36	629-H-S□T36	U-629-H-S8PF	U-629-H-S□S8PF	629-H-T□	629S□T□	629-H-□□	U-629-H-S8MO	U-629-H-S4PB	U-629-H-S4AG
9.525	R6	9.525	22.225	7.142	SR6□□	SR6□□	SR6T36	SR6S□T36	U-SR6S8PF	U-SR6S□S8PF	SR6T□	R6S□T□	SR6□□	U-SR6S8MO	U-SR6S4PB	U-SR6S4AG
10	6800	10	19	5	6800-H-□□	6800-H-□□	6800-H-T36	6800-H-S□T36	U-6800-H-S8PF	U-6800-H-S□S8PF	6800-H-T□	6800S□T□	6800-H-□□	U-6800-H-S8MO	U-6800-H-S4PB	U-6800-H-S4AG
	6900	10	22	6	6900-H-□□	6900-H-□□	6900-H-T36	6900-H-S□T36	U-6900-H-S8PF	U-6900-H-S□S8PF	6900-H-T□	6900S□T□	6900-H-□□	U-6900-H-S8MO	U-6900-H-S4PB	U-6900-H-S4AG
	6000	10	26	8	6000-H-□□	6000-H-□□	6000-H-T36	6000-H-S□T36	U-6000-H-S8PF	U-6000-H-S□S8PF	6000-H-T□	6000S□T□	6000-H-□□	U-6000-H-S8MO	U-6000-H-S4PB	U-6000-H-S4AG
	6200	10	30	9	6200-H-□□	6200-H-□□	6200-H-T36	6200-H-S□T36	U-6200-H-S8PF	U-6200-H-S□S8PF	6200-H-T□	6200S□T□	6200-H-□□	U-6200-H-S8MO	U-6200-H-S4PB	U-6200-H-S4AG
12	6801	12	21	5	6801-H-□□	6801-H-□□	6801-H-T36	6801-H-S□T36	U-6801-H-S8PF	U-6801-H-S□S8PF	6801-H-T□	6801S□T□	6801-H-□□	U-6801-H-S8MO	U-6801-H-S4PB	U-6801-H-S4AG
	6901	12	24	6	6901-H-□□	6901-H-□□	6901-H-T36	6901-H-S□T36	U-6901-H-S8PF	U-6901-H-S□S8PF	6901-H-T□	6901S□T□	6901-H-□□	U-6901-H-S8MO	U-6901-H-S4PB	U-6901-H-S4AG
	6001	12	28	8	6001-H-□□	6001-H-□□	6001-H-T36	6001-H-S□T36	U-6001-H-S8PF	U-6001-H-S□S8PF	6001-H-T□	6001S□T□	6001-H-□□	U-6001-H-S8MO	U-6001-H-S4PB	U-6001-H-S4AG
	6201	12	32	10	6201-H-□□	6201-H-□□	6201-H-T36	6201-H-S□T36	U-6201-H-S8PF	U-6201-H-S□S8PF	6201-H-T□	6201S□T□	6201-H-□□	U-6201-H-S8MO	U-6201-H-S4PB	U-6201-H-S4AG
15	6802	15	24	5	6802-H-□□	6802-H-□□	6802-H-T36	6802-H-S□T36	U-6802-H-S8PF	U-6802-H-S□S8PF	6802-H-T□	6802S□T□	6802-H-□□	U-6802-H-S8MO	U-6802-H-S4PB	U-6802-H-S4AG
	6902	15	28	7	6902-H-□□	6902-H-□□	6902-H-T36	6902-H-S□T36	U-6902-H-S8PF	U-6902-H-S□S8PF	6902-H-T□	6902S□T□	6902-H-□□	U-6902-H-S8MO	U-6902-H-S4PB	U-6902-H-S4AG
	6002	15	32	9	6002-H-□□	6002-H-□□	6002-H-T36	6002-H-S□T36	U-6002-H-S8PF	U-6002-H-S□S8PF	6002-H-T□	6002S□T□	6002-H-□□	U-6002-H-S8MO	U-6002-H-S4PB	U-6002-H-S4AG
	6202	15	35	11	6202-H-□□	6202-H-□□	6202-H-T36	6202-H-S□T36	U-6202-H-S8PF	U-6202-H-S□S8PF	6202-H-T□	6202S□T□	6202-H-□□	U-6202-H-S8MO	U-6202-H-S4PB	U-6202-H-S4AG
17	6803	17	26	5	6803-H-□□	6803-H-□□	6803-H-T36	6803-H-S□T36	U-6803-H-S8PF	U-6803-H-S□S8PF	6803-H-T□	6803S□T□	6803-H-□□	U-6803-H-S8MO	U-6803-H-S4PB	U-6803-H-S4AG
	6903	17	30	7	6903-H-□□	6903-H-□□	6903-H-T36	6903-H-S□T36	U-6903-H-S8PF	U-6903-H-S□S8PF	6903-H-T□	6903S□T□	6903-H-□□	U-6903-H-S8MO	U-6903-H-S4PB	U-6903-H-S4AG
	6003	17	35	10	6003-H-□□	6003-H-□□	6003-H-T36	6003-H-S□T36	U-6003-H-S8PF	U-6003-H-S□S8PF	6003-H-T□	6003S□T□	6003-H-□□	U-6003-H-S8MO	U-6003-H-S4PB	U-6003-H-S4AG
	6203	17	40	12	6203-H-□□	6203-H-□□	6203-H-T36	6203-H-S□T36	U-6203-H-S8PF	U-6203-H-S□S8PF	6203-H-T□	6203S□T□	6203-H-□□	U-6203-H-S8MO	U-6203-H-S4PB	U-6203-H-S4AG
20	6804	20	32	7	6804-H-□□	6804-H-□□	6804-H-T36	6804-H-S□T36	U-6804-H-S8PF	U-6804-H-S□S8PF	6804-H-T□	6804S□T□	6804-H-□□	U-6804-H-S8MO	U-6804-H-S4PB	U-6804-H-S4AG
	6904	20	37	9	6904-H-□□	6904-H-□□	6904-H-T36	6904-H-S□T36	U-6904-H-S8PF	U-6904-H-S□S8PF	6904-H-T□	6904S□T□	6904-H-□□	U-6904-H-S8MO	U-6904-H-S4PB	U-6904-H-S4AG
	6004	20	42	12	6004-H-□□	6004-H-□□	6004-H-T36	6004-H-S□T36	U-6004-H-S8PF	U-6004-H-S□S8PF	6004-H-T□	6004S□T□	6004-H-□□	U-6004-H-S8MO	U-6004-H-S4PB	U-6004-H-S4AG
	6204	20	47	14	6204-H-□□	6204-H-□□	6204-H-T36	6204-H-S□T36	U-6204-H-S8PF	U-6204-H-S□S8PF	6204-H-T□	6204S□T□	6204-H-□□	U-6204-H-S8MO	U-6204-H-S4PB	U-6204-H-S4AG
25	6805	25	37	7	6805-H-□□	6805-H-□□	6805-H-T36	6805-H-S□T36	U-6805-H-S8PF	U-6805-H-S□S8PF	6805-H-T□	6805S□T□	6805-H-□□	U-6805-H-S8MO	U-6805-H-S4PB	U-6805-H-S4AG
	6905	25	42	9	6905-H-□□	6905-H-□□	6905-H-T36	6905-H-S□T36	U-6905-H-S8PF	U-6905-H-S□S8PF	6905-H-T□	6905S□T□	6905-H-□□	U-6905-H-S8MO	U-6905-H-S4PB	U-6905-H-S4AG
	6005	25	47	12	6005-H-□□	6005-H-□□	6005-H-T36	6005-H-S□T36	U-6005-H-S8PF	U-6005-H-S□S8PF	6005-H-T□	6005S□T□	6005-H-□□	U-6005-H-S8MO	U-6005-H-S4PB	U-6005-H-S4AG
	6205	25	52	15	6205-H-□□	6205-H-□□	6205-H-T36	6205-H-S□T36	U-6205-H-S8PF	U-6205-H-S□S8PF	6205-H-T□	6205S□T□	6205-H-□□	U-6205-H-S8MO	U-6205-H-S4PB	U-6205-H-S4AG
30	6006	30	55	13	6006-H-□□	6006-H-□□	6006-H-T36	6006-H-S□T36	U-6006-H-S8PF	U-6006-H-S□S8PF	6006-H-T□	6006S□T□	6006-H-□□	U-6006-H-S8MO	U-6006-H-S4PB	U-6006-H-S4AG
	6206	30	62	16	6206-H-□□	6206-H-□□	6206-H-T36	6206-H-S□T36	U-6206-H-S8PF	U-6206-H-S□S8PF	6206-H-T□	6206S□T□	6206-H-□□	U-6206-H-S8MO	U-6206-H-S4PB	U-6206-H-S4AG
35	6007	35	62	14	6007-H-□□	6007-H-□□	6007-H-T36	6007-H-S□T36	U-6007-H-S8PF	U-6007-H-S□S8PF	6007-H-T□	6007S□T□	6007-H-□□	U-6007-H-S8MO	U-6007-H-S4PB	U-6007-H-S4AG
	6207	35	72	17	6207-H-□□	6207-H-□□	6207-H-T36	6207-H-S□T36	U-6207-H-S8PF	U-6207-H-S□S8PF	6207-H-T□	6207S□T□	6207-H-□□	U-6207-H-S8MO	U-6207-H-S4PB	U-6207-H-S4AG
40	6008	40	68	15	6008-H-□□	6008-H-□□	6008-H-T36	6008-H-S□T36	U-6008-H-S8PF	U-6008-H-S□S8PF	6008-H-T□	6008S□T□	6008-H-□□	U-6008-H-S8MO	U-6008-H-S4PB	U-6008-H-S4AG
	6208	40	80	18	6208-H-□□	6208-H-□□	6208-H-T36	6208-H-S□T36	U-6208-H-S8PF	U-6208-H-S□S8PF	6208-H-T□	6208S□T□	6208-H-□□	U-6208-H-S8MO	U-6208-H-S4PB	U-6208-H-S4AG

Dimensions of SPACEA Series Bearings

Operating conditions					Bearings for corrosive environments				Bearings for high temperatures					Non-magnetic bearings	
					Room temperature	Room temperature	up to 200°C	up to 200°C	up to 200°C	up to 200°C	up to 400°C Air	up to 400°C Air	up to 500°C Air	Room temperature Air-vacuum	up to 200°C Air-vacuum
				Inner & outer rings	Stainless steel	Stainless steel	Stainless steel + corrosion resistant coating	Stainless steel + corrosion resistant coating	Precipitation hardened stainless steel	Ceramics	Stainless steel	Stainless steel	Ceramics	Non-magnetic material	Ceramics
				Balls	Stainless steel	Ceramics	Stainless steel + corrosion resistant coating	Ceramics	Ceramics	Ceramics	Stainless steel	Ceramics	Ceramics	Ceramics	Ceramics
				Cage	Fluororesin	Fluororesin	Fluororesin	Fluororesin	Fluororesin	Fluororesin	Graphite	Graphite	Graphite	Fluororesin	Fluororesin
				Grease	Waterproof grease	Waterproof grease	–	–	–	–	–	–	–	Fluorine grease	–
Shaft diameter	Basic bearing number	Boundary dimensions, mm Bore diameter *d*	Outside diameter *D*	Width *B*	■■■-H-T36	■■■-H-S□T36 depends on ceramic material	U-■■■-H-SNWT36	U-■■■-H-S□S5NWT36 depends on ceramic material	■■■-H-□S□T36 depends on ceramic material depends on stainless steel material	■■■S□T36 depends on ceramic material	U-■■■-H-□ depends on cage material	U-■■■-H-S□□ depends on cage material depends on ceramic material	U-■■■S□□ depends on cage material depends on ceramic material	■■■□S□T36 depends on ceramic material depends on non-magnetic material	■■■S□T36 depends on ceramic material
4	604	4	12	4	604-H-T36	604-H-S□T36	U-604-H-SNWT36	U-604-H-S□S5NWT36	604-H-□S□T36	604S□T36	U-604-H-□	U-604-H-S□□	U-604S□□	604□S□T36	604S□T36
	624	4	13	5	624-H-T36	624-H-S□T36	U-624-H-SNWT36	U-624-H-S□S5NWT36	624-H-□S□T36	624S□T36	U-624-H-□	U-624-H-S□□	U-624S□□	624□S□T36	624S□T36
5	605	5	14	5	605-H-T36	605-H-S□T36	U-605-H-SNWT36	U-605-H-S□S5NWT36	605-H-□S□T36	605S□T36	U-605-H-□	U-605-H-S□□	U-605S□□	605□S□T36	605S□T36
	625	5	16	5	625-H-T36	625-H-S□T36	U-625-H-SNWT36	U-625-H-S□S5NWT36	625-H-□S□T36	625S□T36	U-625-H-□	U-625-H-S□□	U-625S□□	625□S□T36	625S□T36
6	686	6	13	5	686-H-T36	686-H-S□T36	U-686-H-SNWT36	U-686-H-S□S5NWT36	686-H-□S□T36	686S□T36	U-686-H-□	U-686-H-S□□	U-686S□□	686□S□T36	686S□T36
	696	6	15	5	696-H-T36	696-H-S□T36	U-696-H-SNWT36	U-696-H-S□S5NWT36	696-H-□S□T36	696S□T36	U-696-H-□	U-696-H-S□□	U-696S□□	696□S□T36	696S□T36
	606	6	17	6	606-H-T36	606-H-S□T36	U-606-H-SNWT36	U-606-H-S□S5NWT36	606-H-□S□T36	606S□T36	U-606-H-□	U-606-H-S□□	U-606S□□	606□S□T36	606S□T36
	626	6	19	6	626-H-T36	626-H-S□T36	U-626-H-SNWT36	U-626-H-S□S5NWT36	626-H-□S□T36	626S□T36	U-626-H-□	U-626-H-S□□	U-626S□□	626□S□T36	626S□T36
7	687	7	14	5	687-H-T36	687-H-S□T36	U-687-H-SNWT36	U-687-H-S□S5NWT36	687-H-□S□T36	687S□T36	U-687-H-□	U-687-H-S□□	U-687S□□	687□S□T36	687S□T36
	697	7	17	5	697-H-T36	697-H-S□T36	U-697-H-SNWT36	U-697-H-S□S5NWT36	697-H-□S□T36	697S□T36	U-697-H-□	U-697-H-S□□	U-697S□□	697□S□T36	697S□T36
	607	7	19	6	607-H-T36	607-H-S□T36	U-607-H-SNWT36	U-607-H-S□S5NWT36	607-H-□S□T36	607S□T36	U-607-H-□	U-607-H-S□□	U-607S□□	607□S□T36	607S□T36
	627	7	22	7	627-H-T36	627-H-S□T36	U-627-H-SNWT36	U-627-H-S□S5NWT36	627-H-□S□T36	627S□T36	U-627-H-□	U-627-H-S□□	U-627S□□	627□S□T36	627S□T36
8	688	8	16	5	688-H-T36	688-H-S□T36	U-688-H-SNWT36	U-688-H-S□S5NWT36	688-H-□S□T36	688S□T36	U-688-H-□	U-688-H-S□□	U-688S□□	688□S□T36	688S□T36
	698	8	19	6	698-H-T36	698-H-S□T36	U-698-H-SNWT36	U-698-H-S□S5NWT36	698-H-□S□T36	698S□T36	U-698-H-□	U-698-H-S□□	U-698S□□	698□S□T36	698S□T36
	608	8	22	7	608-H-T36	608-H-S□T36	U-608-H-SNWT36	U-608-H-S□S5NWT36	608-H-□S□T36	608S□T36	U-608-H-□	U-608-H-S□□	U-608S□□	608□S□T36	608S□T36
	628	8	24	8	628-H-T36	628-H-S□T36	U-628-H-SNWT36	U-628-H-S□S5NWT36	628-H-□S□T36	628S□T36	U-628-H-□	U-628-H-S□□	U-628S□□	628□S□T36	628S□T36
9	689	9	17	5	689-H-T36	689-H-S□T36	U-689-H-SNWT36	U-689-H-S□S5NWT36	689-H-□S□T36	689S□T36	U-689-H-□	U-689-H-S□□	U-689S□□	689□S□T36	689S□T36
	699	9	20	6	699-H-T36	699-H-S□T36	U-699-H-SNWT36	U-699-H-S□S5NWT36	699-H-□S□T36	699S□T36	U-699-H-□	U-699-H-S□□	U-699S□□	699□S□T36	699S□T36
	609	9	24	7	609-H-T36	609-H-S□T36	U-609-H-SNWT36	U-609-H-S□S5NWT36	609-H-□S□T36	609S□T36	U-609-H-□	U-609-H-S□□	U-609S□□	609□S□T36	609S□T36
	629	9	26	8	629-H-T36	629-H-S□T36	U-629-H-SNWT36	U-629-H-S□S5NWT36	629-H-□S□T36	629S□T36	U-629-H-□	U-629-H-S□□	U-629S□□	629□S□T36	629S□T36
9.525	R6	9.525	22.225	7.142	SR6T36	SR6S□T36	U-SR6SNWT36	U-SR6S□S5NWT36	SR6-H-□S□T36	R6S□T36	U-SR6□	U-SR6S□□	U-R6S□□	R6□S□T36	R6S□T36
10	6800	10	19	5	6800-H-T36	6800-H-S□T36	U-6800-H-SNWT36	U-6800-H-S□S5NWT36	6800-H-□S□T36	6800S□T36	U-6800-H-□	U-6800-H-S□□	U-6800S□□	6800□S□T36	6800S□T36
	6900	10	22	6	6900-H-T36	6900-H-S□T36	U-6900-H-SNWT36	U-6900-H-S□S5NWT36	6900-H-□S□T36	6900S□T36	U-6900-H-□	U-6900-H-S□□	U-6900S□□	6900□S□T36	6900S□T36
	6000	10	26	8	6000-H-T36	6000-H-S□T36	U-6000-H-SNWT36	U-6000-H-S□S5NWT36	6000-H-□S□T36	6000S□T36	U-6000-H-□	U-6000-H-S□□	U-6000S□□	6000□S□T36	6000S□T36
	6200	10	30	9	6200-H-T36	6200-H-S□T36	U-6200-H-SNWT36	U-6200-H-S□S5NWT36	6200-H-□S□T36	6200S□T36	U-6200-H-□	U-6200-H-S□□	U-6200S□□	6200□S□T36	6200S□T36
12	6801	12	21	5	6801-H-T36	6801-H-S□T36	U-6801-H-SNWT36	U-6801-H-S□S5NWT36	6801-H-□S□T36	6801S□T36	U-6801-H-□	U-6801-H-S□□	U-6801S□□	6801□S□T36	6801S□T36
	6901	12	24	6	6901-H-T36	6901-H-S□T36	U-6901-H-SNWT36	U-6901-H-S□S5NWT36	6901-H-□S□T36	6901S□T36	U-6901-H-□	U-6901-H-S□□	U-6901S□□	6901□S□T36	6901S□T36
	6001	12	28	8	6001-H-T36	6001-H-S□T36	U-6001-H-SNWT36	U-6001-H-S□S5NWT36	6001-H-□S□T36	6001S□T36	U-6001-H-□	U-6001-H-S□□	U-6001S□□	6001□S□T36	6001S□T36
	6201	12	32	10	6201-H-T36	6201-H-S□T36	U-6201-H-SNWT36	U-6201-H-S□S5NWT36	6201-H-□S□T36	6201S□T36	U-6201-H-□	U-6201-H-S□□	U-6201S□□	6201□S□T36	6201S□T36
15	6802	15	24	5	6802-H-T36	6802-H-S□T36	U-6802-H-SNWT36	U-6802-H-S□S5NWT36	6802-H-□S□T36	6802S□T36	U-6802-H-□	U-6802-H-S□□	U-6802S□□	6802□S□T36	6802S□T36
	6902	15	28	7	6902-H-T36	6902-H-S□T36	U-6902-H-SNWT36	U-6902-H-S□S5NWT36	6902-H-□S□T36	6902S□T36	U-6902-H-□	U-6902-H-S□□	U-6902S□□	6902□S□T36	6902S□T36
	6002	15	32	9	6002-H-T36	6002-H-S□T36	U-6002-H-SNWT36	U-6002-H-S□S5NWT36	6002-H-□S□T36	6002S□T36	U-6002-H-□	U-6002-H-S□□	U-6002S□□	6002□S□T36	6002S□T36
	6202	15	35	11	6202-H-T36	6202-H-S□T36	U-6202-H-SNWT36	U-6202-H-S□S5NWT36	6202-H-□S□T36	6202S□T36	U-6202-H-□	U-6202-H-S□□	U-6202S□□	6202□S□T36	6202S□T36
17	6803	17	26	5	6803-H-T36	6803-H-S□T36	U-6803-H-SNWT36	U-6803-H-S□S5NWT36	6803-H-□S□T36	6803S□T36	U-6803-H-□	U-6803-H-S□□	U-6803S□□	6803□S□T36	6803S□T36
	6903	17	30	7	6903-H-T36	6903-H-S□T36	U-6903-H-SNWT36	U-6903-H-S□S5NWT36	6903-H-□S□T36	6903S□T36	U-6903-H-□	U-6903-H-S□□	U-6903S□□	6903□S□T36	6903S□T36
	6003	17	35	10	6003-H-T36	6003-H-S□T36	U-6003-H-SNWT36	U-6003-H-S□S5NWT36	6003-H-□S□T36	6003S□T36	U-6003-H-□	U-6003-H-S□□	U-6003S□□	6003□S□T36	6003S□T36
	6203	17	40	12	6203-H-T36	6203-H-S□T36	U-6203-H-SNWT36	U-6203-H-S□S5NWT36	6203-H-□S□T36	6203S□T36	U-6203-H-□	U-6203-H-S□□	U-6203S□□	6203□S□T36	6203S□T36
20	6804	20	32	7	6804-H-T36	6804-H-S□T36	U-6804-H-SNWT36	U-6804-H-S□S5NWT36	6804-H-□S□T36	6804S□T36	U-6804-H-□	U-6804-H-S□□	U-6804S□□	6804□S□T36	6804S□T36
	6904	20	37	9	6904-H-T36	6904-H-S□T36	U-6904-H-SNWT36	U-6904-H-S□S5NWT36	6904-H-□S□T36	6904S□T36	U-6904-H-□	U-6904-H-S□□	U-6904S□□	6904□S□T36	6904S□T36
	6004	20	42	12	6004-H-T36	6004-H-S□T36	U-6004-H-SNWT36	U-6004-H-S□S5NWT36	6004-H-□S□T36	6004S□T36	U-6004-H-□	U-6004-H-S□□	U-6004S□□	6004□S□T36	6004S□T36
	6204	20	47	14	6204-H-T36	6204-H-S□T36	U-6204-H-SNWT36	U-6204-H-S□S5NWT36	6204-H-□S□T36	6204S□T36	U-6204-H-□	U-6204-H-S□□	U-6204S□□	6204□S□T36	6204S□T36
25	6805	25	37	7	6805-H-T36	6805-H-S□T36	U-6805-H-SNWT36	U-6805-H-S□S5NWT36	6805-H-□S□T36	6805S□T36	U-6805-H-□	U-6805-H-S□□	U-6805S□□	6805□S□T36	6805S□T36
	6905	25	42	9	6905-H-T36	6905-H-S□T36	U-6905-H-SNWT36	U-6905-H-S□S5NWT36	6905-H-□S□T36	6905S□T36	U-6905-H-□	U-6905-H-S□□	U-6905S□□	6905□S□T36	6905S□T36
	6005	25	47	12	6005-H-T36	6005-H-S□T36	U-6005-H-SNWT36	U-6005-H-S□S5NWT36	6005-H-□S□T36	6005S□T36	U-6005-H-□	U-6005-H-S□□	U-6005S□□	6005□S□T36	6005S□T36
	6205	25	52	15	6205-H-T36	6205-H-S□T36	U-6205-H-SNWT36	U-6205-H-S□S5NWT36	6205-H-□S□T36	6205S□T36	U-6205-H-□	U-6205-H-S□□	U-6205S□□	6205□S□T36	6205S□T36
30	6006	30	55	13	6006-H-T36	6006-H-S□T36	U-6006-H-SNWT36	U-6006-H-S□S5NWT36	6006-H-□S□T36	6006S□T36	U-6006-H-□	U-6006-H-S□□	U-6006S□□	6006□S□T36	6006S□T36
	6206	30	62	16	6206-H-T36	6206-H-S□T36	U-6206-H-SNWT36	U-6206-H-S□S5NWT36	6206-H-□S□T36	6206S□T36	U-6206-H-□	U-6206-H-S□□	U-6206S□□	6206□S□T36	6206S□T36
35	6007	35	62	14	6007-H-T36	6007-H-S□T36	U-6007-H-SNWT36	U-6007-H-S□S5NWT36	6007-H-□S□T36	6007S□T36	U-6007-H-□	U-6007-H-S□□	U-6007S□□	6007□S□T36	6007S□T36
	6207	35	72	17	6207-H-T36	6207-H-S□T36	U-6207-H-SNWT36	U-6207-H-S□S5NWT36	6207-H-□S□T36	6207S□T36	U-6207-H-□	U-6207-H-S□□	U-6207S□□	6207□S□T36	6207S□T36
40	6008	40	68	15	6008-H-T36	6008-H-S□T36	U-6008-H-SNWT36	U-6008-H-S□S5NWT36	6008-H-□S□T36	6008S□T36	U-6008-H-□	U-6008-H-S□□	U-6009S□□	6008□S□T36	6008S□T36
	6208	40	80	18	6208-H-T36	6208-H-S□T36	U-6208-H-SNWT36	U-6208-H-S□S5NWT36	6208-H-□S□T36	6208S□T36	U-6208-H-□	U-6208-H-S□□	U-6209S□□	6208□S□T36	6208S□T36

Applications and performance of SPACEA Series bearings

Bearings for clean rooms (clean conditions, air)

Bearings that are to be used in clean rooms in factories producing LCDs, semiconductors or pharmaceuticals must be able to function for long periods without affecting the cleanliness of the air in the room.

• Operating conditions

Speed: 10~500 rpm
Bearing temperature: room temperature~60˚C
Atmosphere: air

• Performance requirements

Low dust generation
High durability

• Bearing specifications

Type: deep-groove ball bearing with cage
Lubrication: Clean Grease LG2
Material: martensite stainless steel

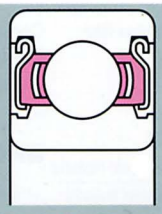


Fig. 14 Bearing for clean environment

Fig. 15 Silicon wafer transporter robot

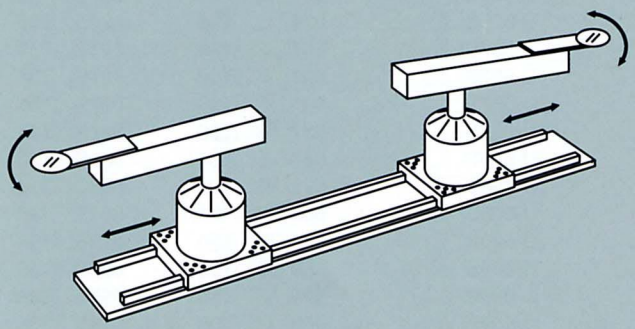
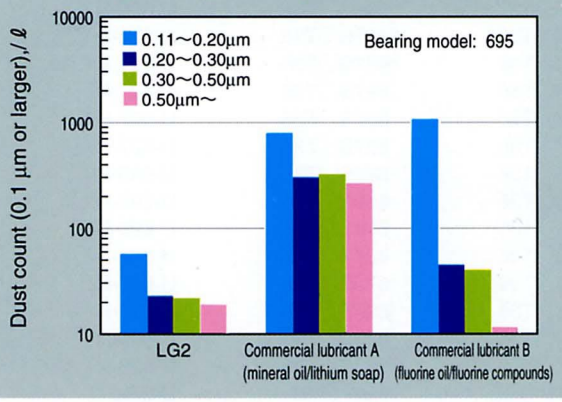


Fig. 16 Distribution of dust particles generated by bearings using three types of lubricant



Bearings for LCD, semiconductor and hard disk production machinery (clean conditions, air-vacuum)

Bearings for sputtering, CVD, ion implantation and other devices used in semiconductor manufacturing must not only function in high vacuums, high temperatures and clean conditions, but are frequently exposed to atmospheric air. They are also subject to the adhesion of chemical reactants in the film coating process. Under these conditions, it is essential that they be extremely durable.

• Operating conditions

Speed: 10~500 rpm
Bearing temperature: room temperature~200˚C
Vacuum: 10^{-6} Pa~atmospheric pressure

• Performance requirements

Lubricity in both air and vacuum
Low dust generation

• Bearing specifications

Type: deep-groove ball bearing with cage
Lubrication: Special Fluororesin Coating
Material: martensite stainless steel

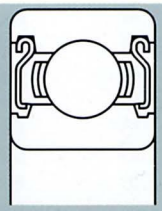


Fig. 17 Bearing for clean environment

Fig. 18 Sputtering transporter device

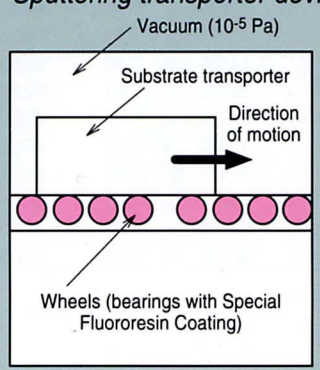
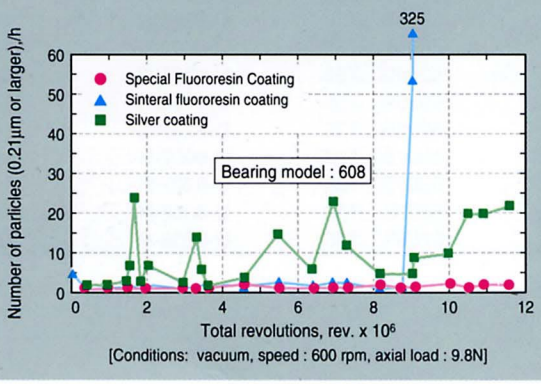


Fig. 19 Change in dust count of bearings over time



Bearings for cleaning devices (strong acids, etc.)

Bearings that are to be used in cleaning devices are likely to be exposed to corrosive gases or liquids and must have high corrosion resistance.

• Operating conditions

Speed:	10~500 rpm
Bearing temperature:	room temperature~60˚C
Atmosphere:	corrosive gases or liquids

• Bearing specifications

Type:	deep-groove ball bearing with cage
Lubrication:	fluororesin
Material:	high corrosion resistance ceramics

• Performance requirements

Strong resistance to corrosive atmospheres

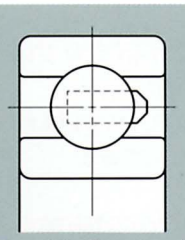


Fig. 20 Bearing for corrosive environment

Fig. 21 Cleaning device

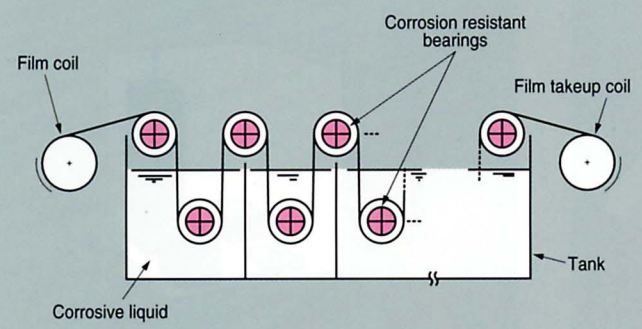
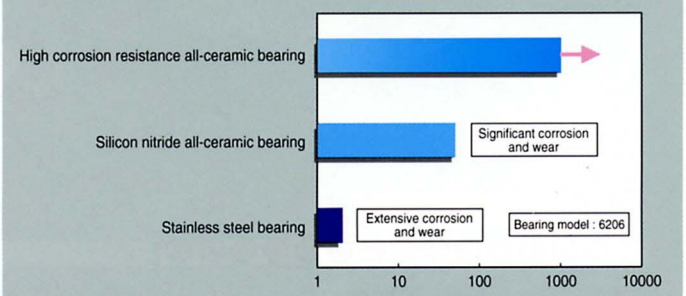


Fig. 22 Endurance life of high corrosion resistance ceramic bearings



Bearings for cleaning devices (weak acids, etc.)

Bearings that are to be used in cleaning devices for LCD and semiconductor production will be exposed to corrosive liquids and vapors such as weak acids or weak alkalis. They must therefore have enduring resistance to corrosion.

• Operating conditions

Speed:	10~500 rpm
Bearing temperature:	room temperature~100˚C
Atmosphere:	corrosive gases or liquids (weak acids, alkalis, etc.)

• Bearing specifications

Type:	deep-groove ball bearing with cage
Lubrication:	fluororesin
Material:	ceramics

• Performance requirements

Long-lasting resistance to corrosive atmospheres

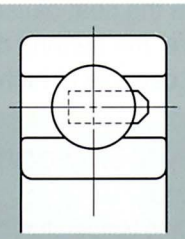


Fig. 23 Bearing for corrosive environment

Fig. 24 Semiconductor production device (polishing process)

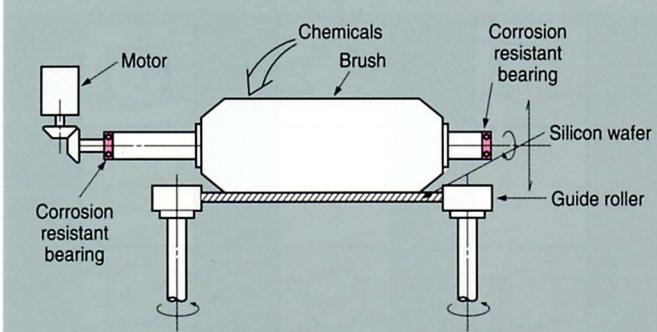
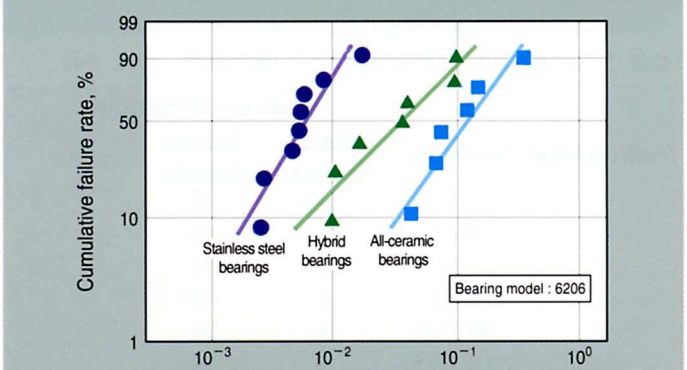


Fig. 25 Endurance life of corrosion resistant bearings in water



Applications and performance of SPACEA Series bearings

Bearings for food processing machinery (water)

Bearings that are to be used in food processing and washing machinery will be exposed to water and must have enduring resistance to corrosion.

• Operating conditions

Speed:	10~1,000 rpm
Bearing temperature:	room temperature~80°C
Atmosphere:	water droplets or submersion in water

• Performance requirements

Corrosion resistance

• Bearing specifications

Type:	deep-groove ball bearing
Lubrication:	waterproof grease
Material:	inner & outer rings - martensite stainless steel balls - ceramics

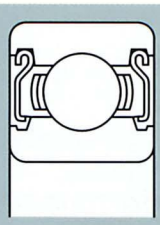


Fig. 26 Bearing for corrosive environment

Fig. 27 Raw material preparation device (food processing)

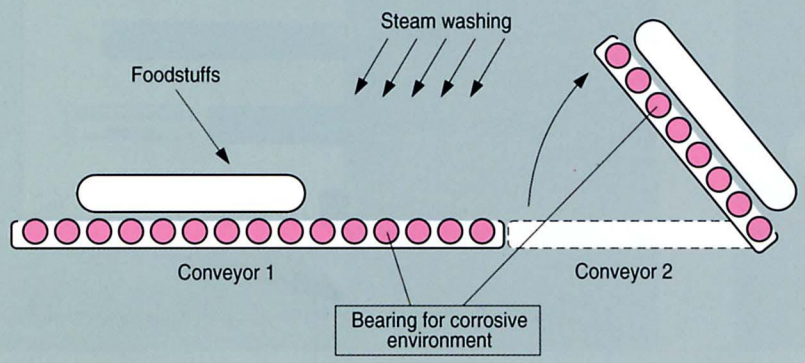
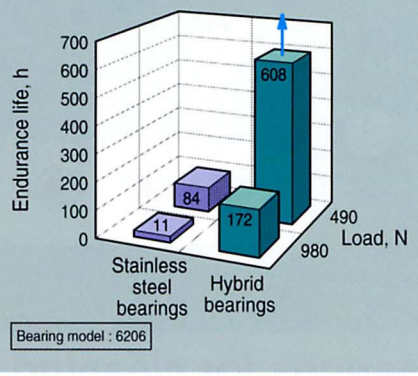


Fig. 28 Endurance life of hybrid bearings



Bearings for X-ray tubes and X-ray bearing units (vacuums, high temperatures, high speeds)

X-ray tubes with rotating anodes are constructed as shown in Fig. 29. The anode rotates at high speed to disperse the heat caused by the impact of electrons, therefore, the bearing that supports the anode must not only be capable of high speeds but also have high load capacity. Especially for X-ray tubes which must be capable of high output, the SPACEA Series includes integrated bearing units in which the inner ring and axis are made in one section for additional mounting accuracy and rigidity.

• Operating conditions

Speed:	3,000~10,000 rpm
Bearing temperature:	250~500°C
Vacuum:	10^{-4}~10^{-5} Pa

• Performance requirements

High rotational speed
High load capacity

• Bearing specifications

Lubrication:	lead coating, silver coating
Material:	high speed tool steel

Fig. 29 Corrosion resistant bearing

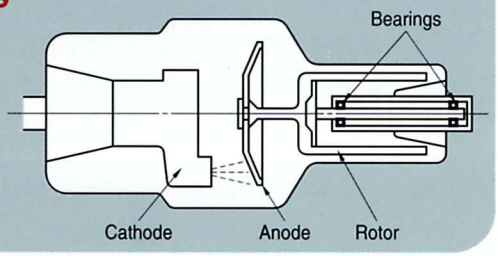


Table 5 Dimensions of bearings for X-ray tubes (Unit: mm)

Shaft diameter	Model No.	Boundary dimensions		
		Bore diameter *d*	Outside diameter *D*	Width *B*
6	626-F	6	19	6
6	B6-54-F	6	19	6
8	608-F	8	22	7
8	B8-10-F	8	22	7
10	B10-36-F	10	22	6

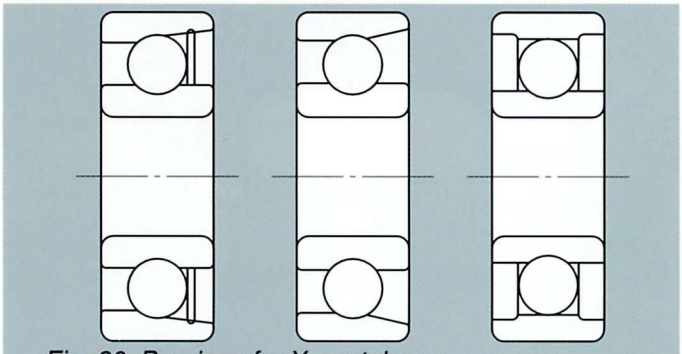


Fig. 30 Bearings for X-ray tubes

Fig. 31 X-ray tube bearing unit

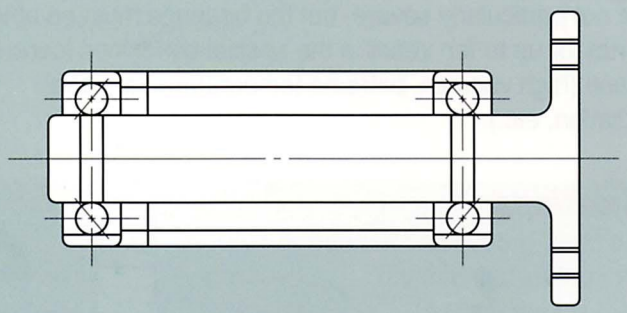
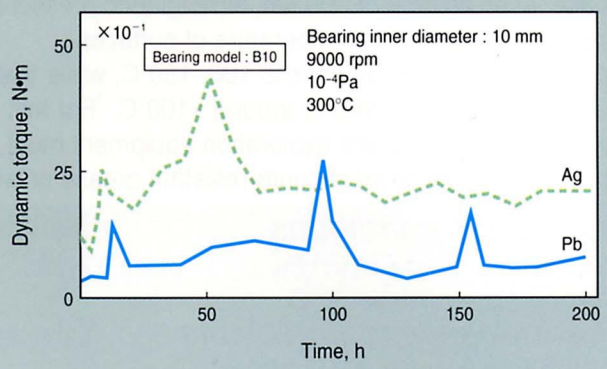


Fig. 32 Endurance life of X-ray tube bearing



Touchdown bearings for turbo molecular pumps (vacuums, high speeds)

In turbo molecular pumps with magnetic bearings, power cuts cause the magnetic bearings to lose their load-bearing capacity and the resulting contact between rotating and non-rotating parts leads to blade damage. To prevent such damage, it is best to use touchdown bearings. In the event of a power cut, the rotor which is turning at high speed immediately comes into contact with the touchdown bearing and remains supported by it until the pump comes to a standstill.

- ***Operating conditions***

  Speed: 20,000~50,000 rpm (d_mn value 2~3 million)

  Vacuum: 10^{-1} Pa

- ***Performance requirements***

  Rapid follow-up

- ***Bearing specifications***

  Type: full-type deep-groove ball bearing, angular contact ball bearing

Lubrication: lead or molybdenum disulfide coating

Material: inner & outer rings, balls-bearing steel or martensite stainless steel (balls - ceramics)

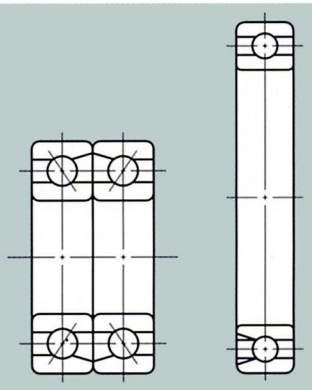


Fig. 33 Touchdown bearings

Fig. 34 Structure of turbo molecular pump

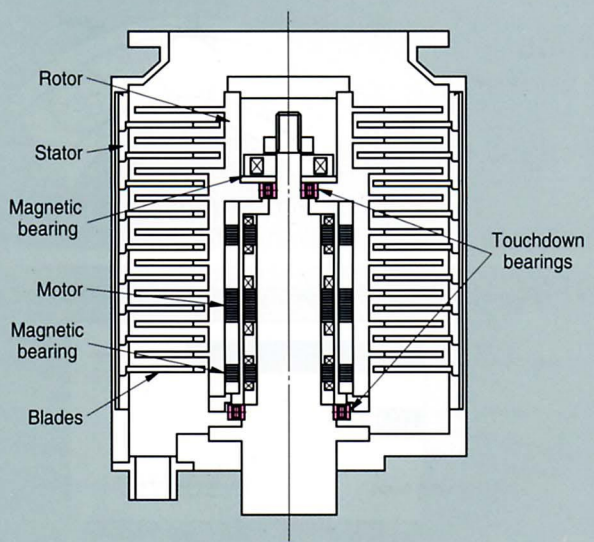
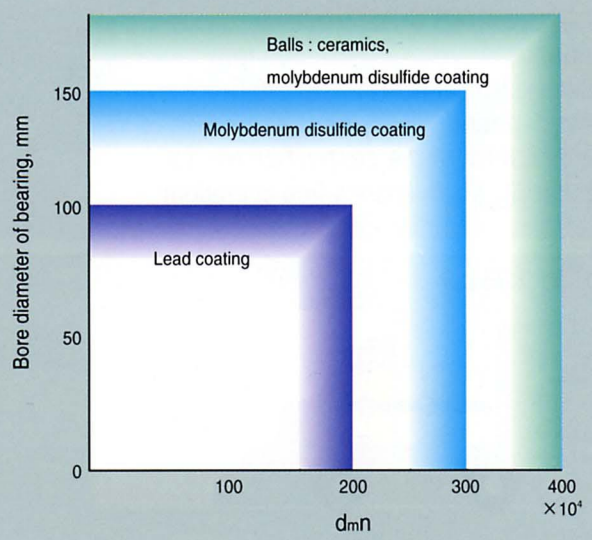


Fig. 35 Solid lubricant specifications for touchdown bearings



Applications and performance of SPACEA Series bearings

Bearings for space exploration equipment

In space, at an altitude of 300 km, atmospheric pressure drops to 10^{-5} Pa and the temperature of surfaces exposed to direct sunlight rises to 100~150˚C, while that of surfaces unexposed falls to around –100˚C. For this reason, bearings for space exploration equipment must be lubricated with special vacuum-resistant grease or with solid lubricants. The load and speed conditions in space are not particularly severe, but the bearings must be able to run for up to ten years in the special conditions found in space (high vacuum, extreme temperature variation, radiation, etc.).

• Operating conditions

Vacuum: 10^{-7} ~10^{-4} Pa
Temperature: –100~150˚C

• Performance requirements

Lubricity in vacuum and at high and low temperatures
Heat resistance of bearing material (owing to high-temperature baking)

• Bearing specifications

Type: full-type deep-groove ball bearing, angular contact ball bearing
Lubrication: (1) high vacuum grease
(2) lead, silver or molybdenum disulfide coating
Material: inner & outer rings, balls - martensite stainless steel
retainer - austenite stainless steel, fluororesin

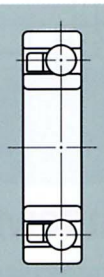


Fig. 36 Bearing for manipulator

Fig. 37 Space station experiment module

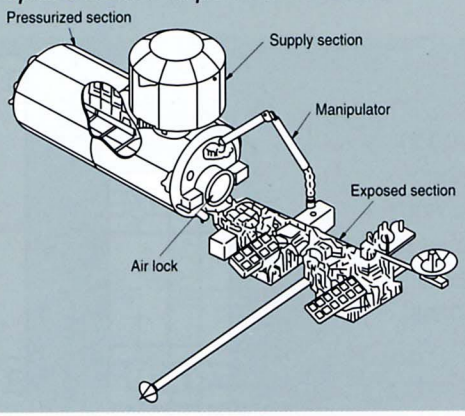
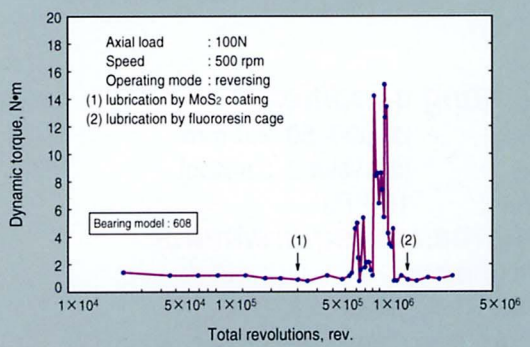


Fig. 38 Lubrication performance of bearing with MoS_2 coating and fluororesin cage



Bearings for kiln cars (high temperatures)

Bearings for the cars and conveyors used in heat treatment furnaces and kilns in the ceramics industry are difficult to replace owing to the high temperatures in which they are used and must, as far as possible, be maintenance-free.

• Operating conditions

Speed: 10~500 rpm
Bearing temperature: up to 500˚C
Atmosphere: air

• Performance requirements

Durability (maintenance-free operation)

• Bearing specifications

Type: deep-groove ball bearing
Lubrication: graphite
Material: martensite stainless steel, ceramics

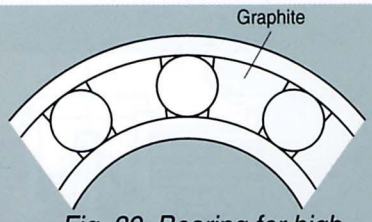


Fig. 39 Bearing for high temperature

Fig. 40 Kiln car

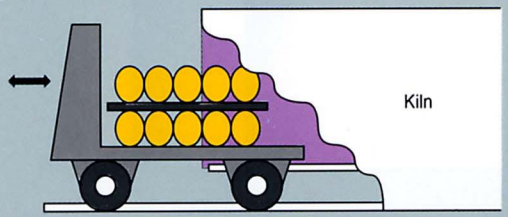
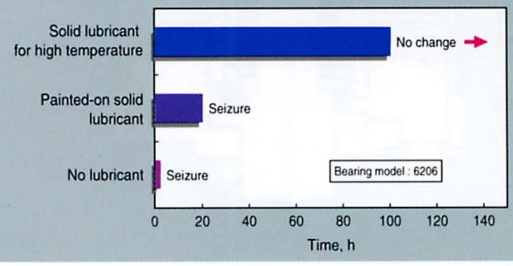


Fig. 41 Endurance life of high temperature bearings with solid lubricants



Bearings for liquid gas submerged pumps (low temperatures)

Bearings for LNG submerged pumps must operate at a temperature of –162°C. Lubrication of the bearings must be provided by the low-viscosity liquid that is being pumped and the bearings must have high durability.

• Operating conditions

Speed: 1,160~3,600 rpm
Temperature of liquid pumped: –196~0°C

• Performance requirements

Capable of lubrication by the low-viscosity liquid pumped
Rust resistant

• Bearing specifications

Type: deep-groove ball bearing
Lubrication: self-lubricating resin
Material: inner & outer rings - martensite stainless steel
balls - martensite stainless steel or AISI M50

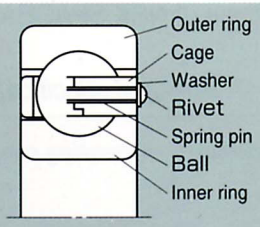


Fig. 42 Bearing for submerged pump

Fig. 43 Submerged pump

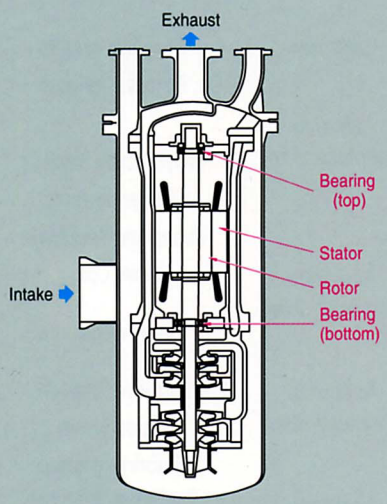
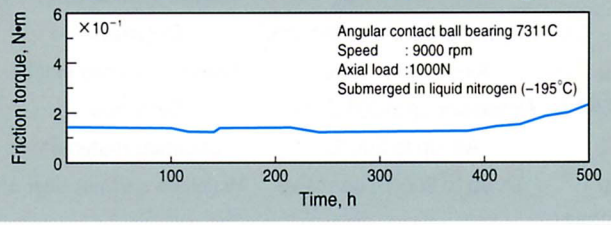


Table 6 Dimensions of submerged pump bearing (Unit: mm)

Shaft diameter	Model No.	Bore diameter	Outside diameter	Width
30	6206-H-T35D	30	62	16
35	6207-H-T35D	35	72	17
55	6211-H-T35D	55	100	21
40	6308-H-T35D	40	90	23
55	6311-H-T35D	55	120	29
70	6314-H-T35D	70	150	35
90	6318-H-T35D	90	190	43
100	6320-H-T35D	100	215	47

Note: Please contact NSK for other dimensions.

Fig. 44 Endurance life of low temperature bearing



Bearings for machine tool spindles (high speeds)

Bearings for machine tool spindles are used at high rotational speeds (high d_mn). The use of ceramic materials reduces the rise in temperature of the bearing, increases its rigidity and enhances its resistance to seizure.

• Operating conditions

Speed: 4,000~15,000 rpm
Temperature: room temperature~50°C
Atmosphere: air

• Performance requirements

Small temperature rise
High rigidity
High resistance to seizure

• Bearing specifications

Type: angular contact ball bearing, cylindrical roller bearing
Lubrication: grease or oil
Material: inner & outer rings - bearing steel
balls - ceramics

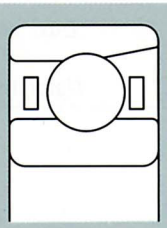


Fig. 45 Bearing for machine tool spindle

Fig. 46 Spindle

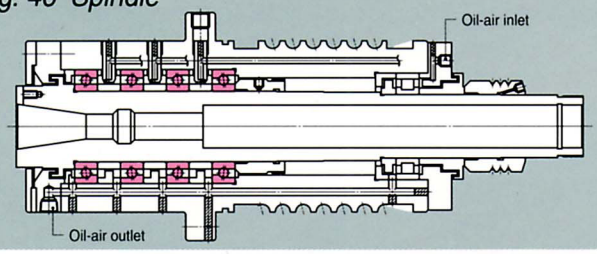
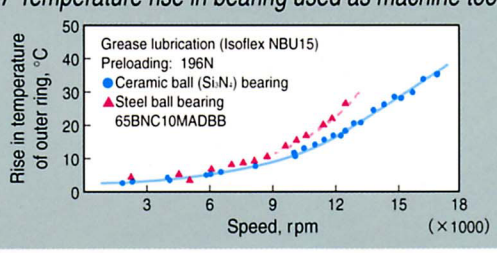


Fig. 47 Temperature rise in bearing used as machine tool spindle



Note: For more information on bearings for machine tool spindles, see Precision Ceramic Angular Contact Ball Bearings and Neo-Brid ™ Angular Contact Ball Bearings.

SPACEA Series Ball Screws

Specifications and operating conditions

NSK's SPACEA Series ball screws are suitable for a wide range of special operating environments. The table on this page shows the principal specifications and operating conditions of NSK SPACEA Series ball screws.

Table 7 Principal specifications of SPACEA Series ball screws

Environment	Operating conditions	Ball screw specifications				For more technical data see page(s) ...
		Shaft / Nut	Balls	Recirculation components	Lubricant / Surface treatment	
Clean	Air, room temperature	Standard material	Standard material	Standard material	Clean Grease LG2, solid oil	3, 23, 24
		Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Clean Grease LG2, solid oil Fluoride Low-Temperature Chrome Coating	3, 23, 24
	Air-vacuum, room temperature				Fluorine grease	
	Air-vacuum, up to 200°C					
	Air-vacuum, up to 200°C, corrosive	Ceramics	Ceramics	Ceramics	Fluorine grease	
Vacuum	Air-vacuum, room temperature	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Fluorine grease	
	Air-vacuum, up to 200°C					
	Air-vacuum, up to 300°C				Molybdenum disulfide	
	High vacuum, up to 500°C				Silver coating	25
Corrosive	Acid, alkaline, clean	Standard material	Standard material	Austenite stainless steel	Fluoride Low-Temperature	5, 31, 32
		Martensite stainless steel	Martensite stainless steel		Chrome Coating	5
		Precipitation hardened stainless steel	Precipitation hardened stainless steel		Fluorine grease	
	Strong acid, high alkaline, clean, non-magnetic	Ceramics	Ceramics			
Non-Magnetic	Air-vacuum, clean	Special austenite steel	Ceramics	Austenite stainless steel	Fluorine grease	
	Air-vacuum, up to 200°C, clean	Ceramics			Fluororesin	
High-Temperature	Air, up to 200°C	Standard material	Standard material	Austenite stainless steel	Fluorine grease	
	Air, up to 200°C, corrosive	Martensite stainless steel	Martensite stainless steel		Fluoride Low-Temperature Chrome Coating	31, 32
	Air, up to 500°C, corrosive	Ceramics	Ceramics		Fluoride Low-Temperature Chrome Coating Fluorine grease	31, 32
Low-Temperature	down to –270°C	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Solid lubricant	
Radioactive	Air	Standard material	Standard material	Standard material	Radiation resistant grease	
		Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		
Foreign particle contaminated	Dust, wood chips	Standard material	Standard material	Standard material	Solid oil	
	Water, under water	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		

Dimensions and operating environments

The table on this page shows the principal dimensions of NSK SPACEA Series ball screws and their suitability for various operating environments.

Fig. 48 Key to ball screw dimensions

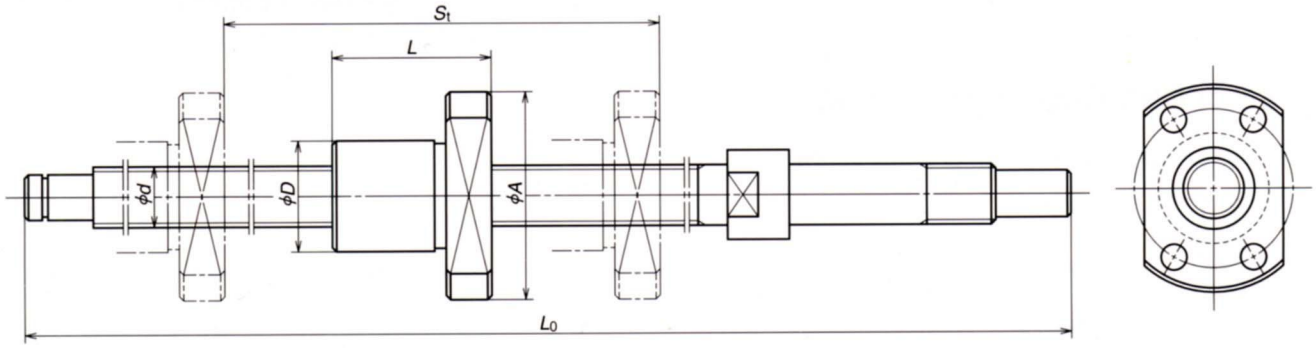


Table 8 Dimensions and operating environments of SPACEA Series ball screws

Series	Shaft diameter	Lead	Dimension (mm) Nut outer diameter D	Flange outer diameter A	Nut length L	Max. threaded length of shaft L0max	St	Basic Load rating (Dynamic) (N)	{kgf}	Suitability for special environments Clean	Vacuum	Corrosive	High temperature	Foreign particle contaminated
KA	6	1	12	24	21	174	100	470	48	○	○	○		
	8	1	14	27	21	248	150	545	55	○	○	○		
	8	2	16	29	28	248	150	1080	110	○	○	○		
	10	2	18	35	29	308	200	1210	125	○	○	○		
	10	4	26	46	34	430	300	2250	230	○	○	○		
	12	2	20	37	29	380	250	1360	140	○	○	○		
	12	5	30	50	40	580	450	3070	315	○	○	○		
	12	10	30	50	50	580	450	3070	315	○	○	○		
	15	10	34	57	51	1161	1000	5780	590	○	○	○		
	15	20	34	55	45	1161	1000	4150	425	○	○	○		
	16	2	25	44	40	461	300	2870	295	○	○	○		
	20	20	46	74	63	1208	1000	5760	585	○	○	○		
Made to order	10	2	22	39	29	308		1210	125	○	○	○	○	○
	10	4	26	46	34	430		2250	230	○	○	○	○	○
	12	2	24	41	29	380		1360	140	○	○	○	○	○
	12	5	30	50	40	580		3070	315	○	○	○	○	○
	12	10	30	50	50	580		3070	315	○	○	○	○	○
	15	10	34	57	51	1161		5780	590	○	○	○	○	○
	15	20	34	55	45	1161		4150	425	○	○	○	○	○
	16	2	30	49	40	461		2870	295	○	○	○	○	○
	20	20	46	74	63	1208		5760	585	○	○	○	○	○
	25	5	50	73	55	1800		13600	1380	○	○	○	○	○
	25	25	44	71	90	1800		8280	845	○	○	○	○	○
	32	5	58	85	106	2400		15100	1540	○	○	○	○	○
	32	32	51	85	109	2400		9450	965	○	○	○	○	○
	40	10	82	124	193	3000		42500	4340	○	○	○	○	○
	40	40	64	106	133	3000		15100	1530	○	○	○	○	○
	50	10	93	135	163	3500		47200	4820	○	○	○	○	○
	50	50	80	126	161	3500		22500	2290	○	○	○	○	○
	63	10	108	154	107	5000		51700	5270	○	○	○	○	○

SPACEA Series Ball Screws

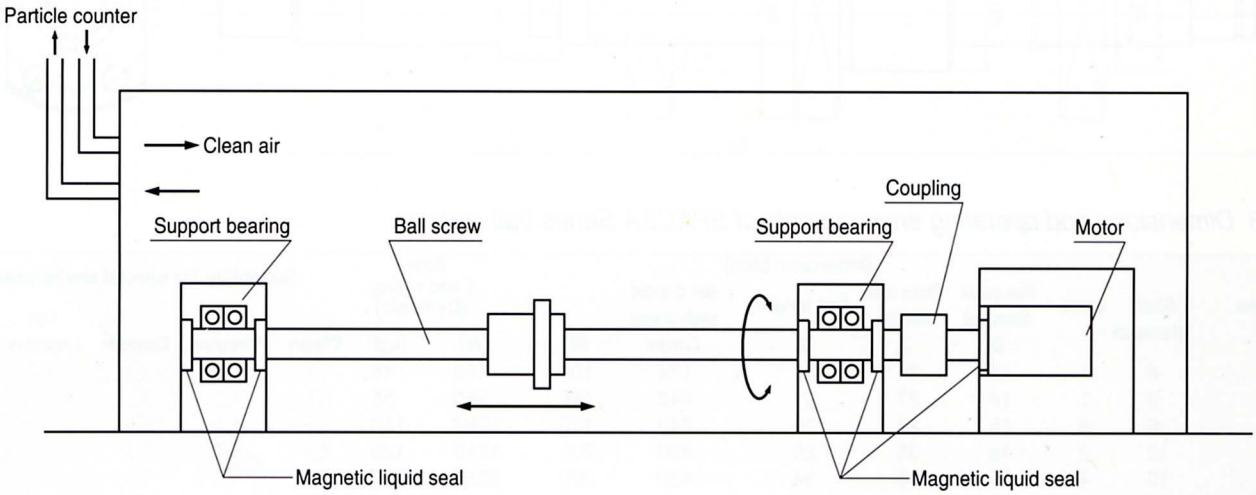
Lubrication technology in SPACEA Series ball screws

NSK Clean Grease LG2

NSK Clean Grease LG2 is used in NSK's Linear Guides, Ball Screws, Monocarriers, Robot Modules, Megathrust Motors, XY tables and a host of other products designed to low-dust specifications for use in clean rooms. Its outstanding performance has won widespread trust and praise among makers of semiconductor manufacturing equipment. In many areas, it outperforms the fluorine greases conventionally used in clean rooms.

Features of NSK Clean Grease LG2

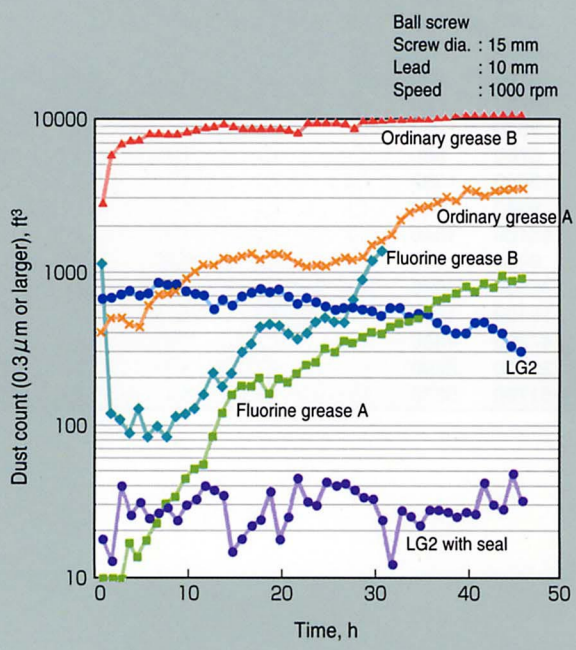
Fig. 49 Measuring the dust count of a ball screw



Feature 1: Outstanding low dust characteristics

LG2 offers stable dust characteristics for even longer than fluorine greases.

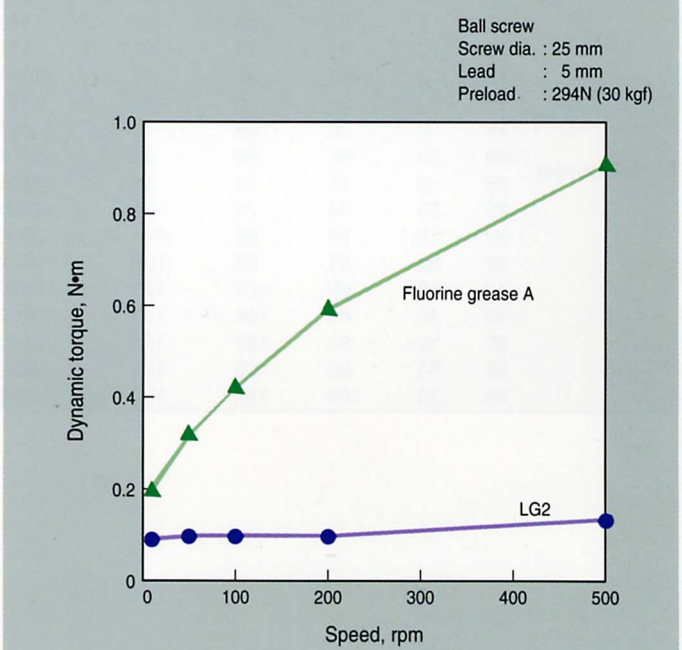
Fig. 50 Comparison of dust characteristics



Feature 2: Stable torque characteristics

LG2 greatly reduces the burden on motors running at high speeds: less than 20% of that of fluorine greases (ball screw at 500 rpm).

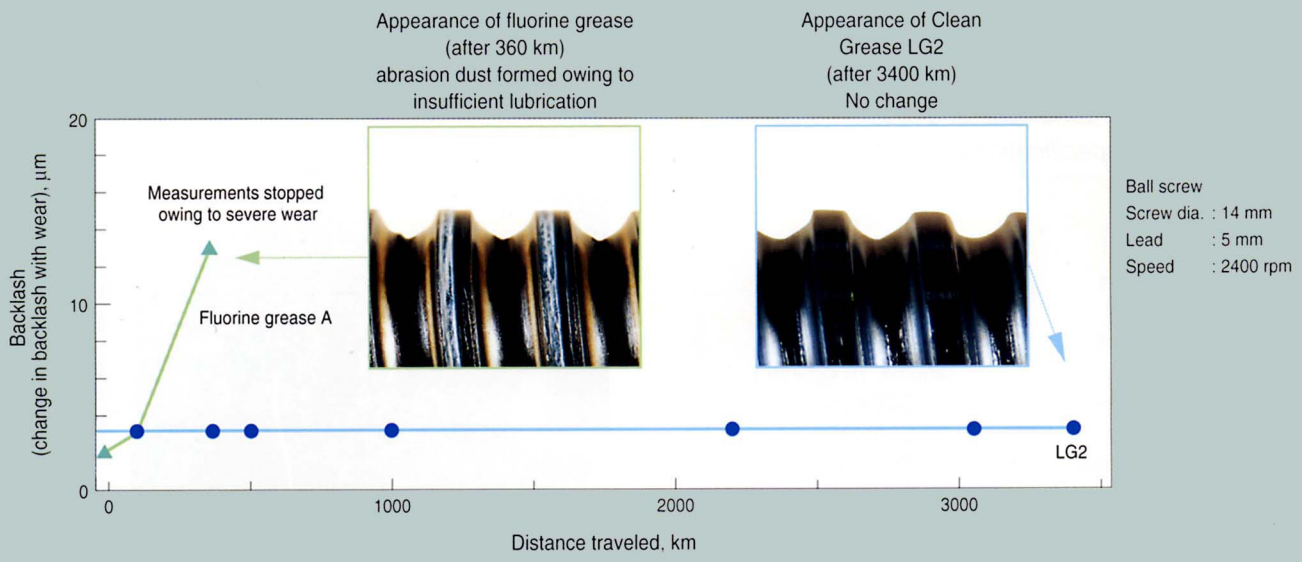
Fig. 51 Comparison of torque characteristics



Feature 3: Long life

LG2 lasts over 10 times longer than fluorine greases and has a service life equivalent to that of ordinary greases, allowing longer maintenance intervals.

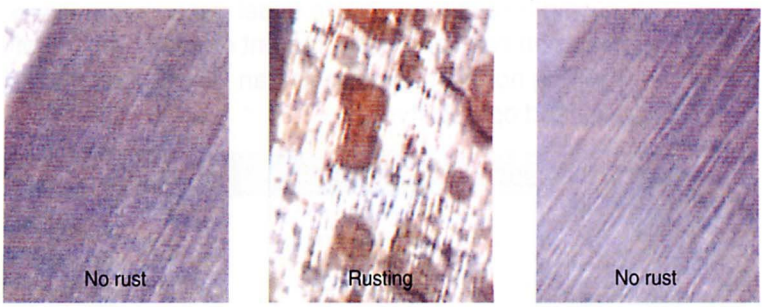
Fig. 52 Durability test of ball screw



Feature 4: Superior rust prevention

LG2 has the rust prevention capability of conventional greases which is far higher than that of fluorocarbon greases.

Fig. 53 Ball screw rust prevention test
(test conditions: 96 hours at humidity 95%, temperature 70°C)



Clean Grease LG2 | Fluorine grease A | Ordinary grease B

Table 9 Bearing rust prevention test

Type	Rust level after 7 days
NSK Clean Grease LG2 LG2	No rust
Fluorine grease B	Rusting
Test conditions	• 19 mg injected into 695 bearing • temperature 90°C, humidity 60%
Evaluation method:	microscope observation

Overall evaluation of Clean Grease LG2

NSK Clean Grease LG2 clearly outperforms conventional greases in many areas. The table below shows an overall evaluation of its performance.

Table 10 Evaluation of Clean Grease LG2

Characteristic	LG2	Fluorine grease	Ordinary grease
Dust count	A	B	D
Torque	A	C	B
Durability	A	D	A
Rust prevention	A	D	A

Note: A: Good B: Good-Poor
C: Poor-Very Poor D: Very Poor

SPACEA Series Ball Screws

Ball screws with silver coating

SPACEA Series ball screws can be coated with soft metal as a solid lubricant (silver coating). These products are designed for use in semiconductor manufacturing equipment, surface improvement devices and other machinery used under vacuum conditions.

Durability tests under vacuum conditions

Testing devices and conditions

The two tables below describe the specifications of the ball screw and the test conditions of a recent durability test of SPACEA Series ball screws.

Table 11 Ball screw specifications

Shaft diameter		2mm
Lead		4mm
Ball diameter		2.381mm
No. of turns x circuits		2.5 x 1
Axial load (Preload)		29.4N{3kgf}
Max. contact pressure (Max. preload)		approx. 690 Pa (approx. 70 kgf/mm^2)
Material	Screw	SUS630
	Nut	SUS440C
	Ball tube	SUS304
	Balls	SUS440C
Solid lubricant		Special silver coating

Table 12 Test conditions

Speed	300rpm
Vacuum	1.3×10^{-5}~1.3×10^{-6}Pa (10^{-7}~10^{-8}torr)
Stroke	160mm

Fig. 54 Vacuum testing device

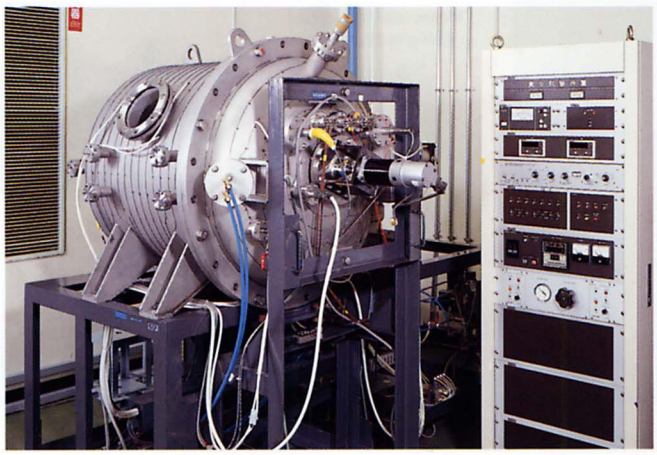


Fig. 55 Schematic drawing of test rig

Method of evaluation

A bearing using a solid lubricant is considered to have reached the end of its service life when the deterioration of the solid lubricant leads to a sharp rise in friction. For this reason, the evaluation of the torque and life of a ball screw using a solid lubricant life under vacuum conditions was based on constant measurement of torque in the ball screw during normal operation and an investigation of its durability and operability.

Results of tests

The results of the torque test are shown in Fig. 56, those of the durability test in Table. 13.

Fig. 56 Result of torque test

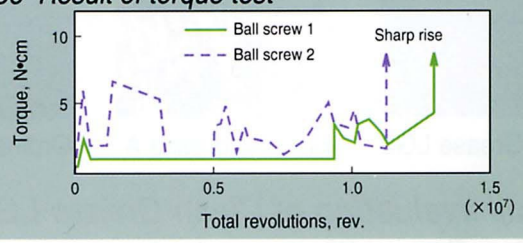


Table 13 Durability of ball screw

		Ball screw 1	Ball screw 2
Service life	Total revolutions, rev.	1.35×10^7	1.13×10^7
	Total distance traveled, km	54.0	45.2
	Total running time, h	750	628

Note: Total running time assumes steady running at 300 rpm.

• Ball screw 1 results

The torque remained fairly stable until around 1 x 10^7 rev but thereafter the characteristics deteriorated somewhat and at approximately 1.35 x 10^7 rev torque rose sharply, suggesting that the service life of the ball screw was at an end.

• Ball screw 2 results

The torque was slightly higher than with ball screw 1, and slightly less stable. During the test, the torque momentarily rose sharply several times (to several N•cm). This is probably due to the soft metal of the coating (silver) shifting repeatedly. Finally, the torque rose sharply at 1.13 x 10^7 rev, and the service life was judged to be at an end.

Overall evaluation

The above test results indicate that if the load on the ball screw is of the order of 29.4 N {3 kgf}, service life will be at least 1 x 10^7 rev. Since the soft metal coating tends to shift several times leading to momentary sharp rises in torque before the ball screw reaches the end of its service life, it seems advisable to select a drive motor with ample spare torque capacity.

SPACEA Series NSK Linear Guides

The SPACEA Series includes a range of NSK linear guides adapted to a wide variety of special operating conditions.

The table on this page shows the principal specifications and operating conditions of NSK Linear Guides in the SPACEA Series.

Table. 14 Specifications and operating conditions of SPACEA Series NSK Linear Guides

Environment	Operating conditions	NSK Linear Guide specifications				For more technical data see page(s)...
		Rail / Ball slides	Balls	Recirculation components	Lubricant / Surface treatment	
Clean	Air, room temperature	Standard material	Standard material	Standard material	Clean Grease LG2, K1 Seal	3, 4, 23, 24, 29,30
		Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Clean Grease LG2, K1 Seal Fluoride Low-Temperature Chrome Coating	3, 4, 23, 24, 29, 30, 31, 32
	Air-vacuum, room temperature				Fluorine grease	
	Air-vacuum, up to 200°C					
Vacuum	Air-vacuum, room temperature	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Fluorine grease	
	Air-vacuum, up to 200°C					
	Air-vacuum, up to 300°C				Molybdenum disulfide	
	High vacuum, up to 500°C				Silver coating	25
Corrosive	Water vapor, water	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		
	Acids, alkalis	Standard material	Standard material	Standard material	Fluoride Low-Temperature Chrome Coating	5, 31, 32
	Acids, alkalis, clean conditions	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Fluoride Low-Temperature Chrome Coating Clean Grease LG2	3, 5, 23, 24, 31, 32
	Strong acids, strong alkalis				Fluoride Low-Temperature Chrome Coating Fluorine grease	5, 31, 32
	Organic solvents				Fluorine grease	
High-Temperature	Air, up to 150°C	Standard material	Standard material	Austenite stainless steel	ET 150 grease	
	Air, up to 200°C	Martensite stainless steel	Martensite stainless steel		Fluorine grease	
	Air, up to 200°C, corrosive				Fluoride Low-Temperature Chrome Coating Fluorine grease	5, 31 32
Low-Temperature	down to –270°C	Martensite stainless steel	Martensite stainless steel	Austenite stainless steel	Solid lubricant	
Radioactive	Air	Standard material	Standard material	Standard material	Radiation resistant grease	
		Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		
Foreign particle contaminated	Dust, wood chips	Standard material	Standard material	Standard material	K1 Seal	3, 4, 29, 30
		Martensite stainless steel	Martensite stainless steel	Austenite stainless steel		
	Water, under water		Standard material	Standard material		
			Martensite stainless steel	Austenite stainless steel		

SPACEA Series NSK Linear Guides

Dimensions and operating environments

The tables on these two pages show the principal dimensions of SPACEA Series NSK Linear Guides and their suitability for various operating environments.

Fig. 57.1 Models LS-AL, LS-CL

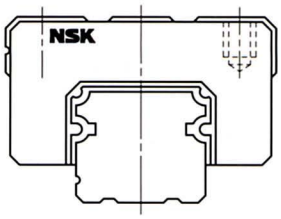


Fig. 57.2 Models LH-AN, LH-BN

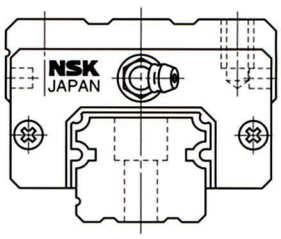


Fig. 57.3 Models LS-EL, LH-EL, LH-GL

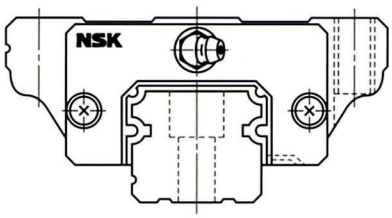
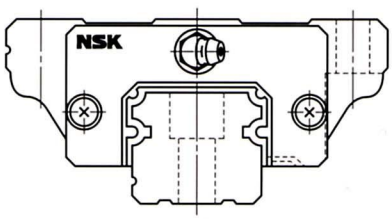


Fig. 57.4 Models LS-FL, LS-KL, LH-FL, LH-HL



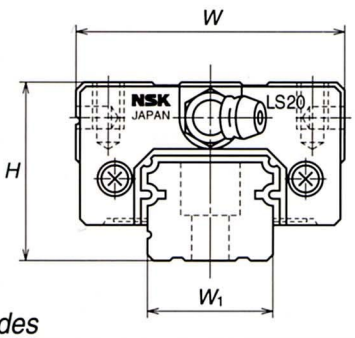


Table 15.1 Dimensions and operating environments of SPACEA Series NSK Linear Guides

Series	Model No.	Height	Overall width	Dimension (mm) Ball slide length L		Rail width	Maximum rail length	Basic load rating (Dynamic)		Suitability for special environments				
		H	W	standard	with K1 Seal	W_1	L_0max	(N)	{kgf}	Clean	Vacuum	Corrosive	High-temperature	Foreign particle contaminated
LU	LU09AR	10	20	30	36.4	9	275	1470	150	○	○	○	○	○
	LU09TR	10	20	30	36.4	9	275	1470	150	○	○	○	○	○
	LU12AR	13	27	35.2	42.2	12	470	2160	220	○	○	○	○	○
	LU12TR	13	27	35.2	42.2	12	470	2160	220	○	○	○	○	○
	LU15AL	16	32	43.6	51.8	15	670	4300	440	○	○	○	○	○
LE	LE09AR	12	30	39.8	46.8	18	400	2450	250	○	○	○		○
	LE09TR	12	30	39.8	46.8	18	400	2450	250	○	○	○		○
	LE12AR	14	40	45	53	24	800	3550	360	○	○	○	○	○
	LE15AR	16	60	56.6	66.2	42	1000	6200	630	○	○	○	○	○
LW	LW17EL	17	60	51.4	61.6	33	1000	4200	430				○	○
	LW21EL	21	68	58.8	71.4	37	1600	4700	480				○	○
	LW27EL	27	80	74	86.6	42	2000	9800	1000					○
	LW35EL	35	120	108	123	69	2400	25700	2620					○
LS	LS15CL	24	34	40.4	50	15	1000	4550	465	○	○	○	○	○
	LS15AL	24	34	56.8	66.4	15	1000	6700	685	○	○	○	○	○
	LS15KL	24	52	40.4	50	15	1000	4550	465	○	○	○	○	○
	LS15FL	24	52	56.8	66.4	15	1000	6700	685	○	○	○	○	○
	LS15EL	24	52	56.8	66.4	15	1000	6700	685	○	○	○	○	○
	LS20CL	28	42	47.2	57.8	20	3500	6550	670	○	○	○	○	○
	LS20AL	28	42	65.2	75.8	20	3500	8900	910	○	○	○	○	○
	LS20KL	28	59	47.2	57.8	20	3500	6550	670	○	○	○	○	○
	LS20FL	28	59	65.2	75.8	20	3500	8900	910	○	○	○	○	○
	LS20EL	28	59	65.2	75.8	20	3500	8900	910	○	○	○	○	○
	LS25CL	33	48	59.4	70	23	3500	10600	1080	○	○	○	○	○
	LS25AL	33	48	81.4	92	23	3500	14400	1470	○	○	○	○	○
	LS25KL	33	73	59.4	70	23	3500	10600	1080	○	○	○	○	○
	LS25FL	33	73	81.4	92	23	3500	14400	1470	○	○	○	○	○
	LS25EL	33	73	81.4	92	23	3500	14400	1470	○	○	○	○	○
	LS30CL	42	60	67.4	79.4	28	3500	15900	1620	○	○	○	○	○
	LS30AL	42	60	96.4	108.4	28	3500	23400	2390	○	○	○	○	○
	LS30KL	42	90	67.4	79.4	28	3500	15900	1620	○	○	○	○	○
	LS30FL	42	90	96.4	108.4	28	3500	23400	2390	○	○	○	○	○
	LS30EL	42	90	96.4	108.4	28	3500	23400	2390	○	○	○	○	○
	LS35CL	48	70	77	90	34	3500	22100	2250					○
	LS35AL	48	70	108	121	34	3500	32500	3320					○
	LS35KL	48	100	77	90	34	3500	22100	2250					○
	LS35FL	48	100	108	121	34	3500	32500	3320					○
	LS35EL	48	100	108	121	34	3500	32500	3320					○

Fig. 57.5 Models LU-AR, LU-TR, LU-AL

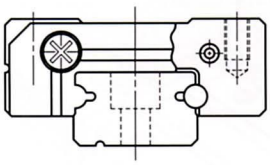


Fig. 57.6 Models LE-AR, LE-TR

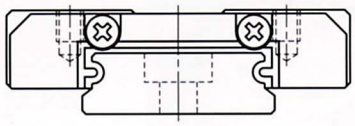
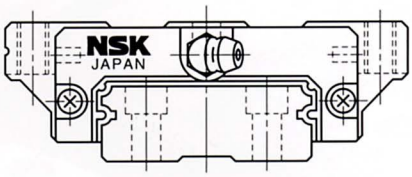


Fig. 57.7 Models LW-EL



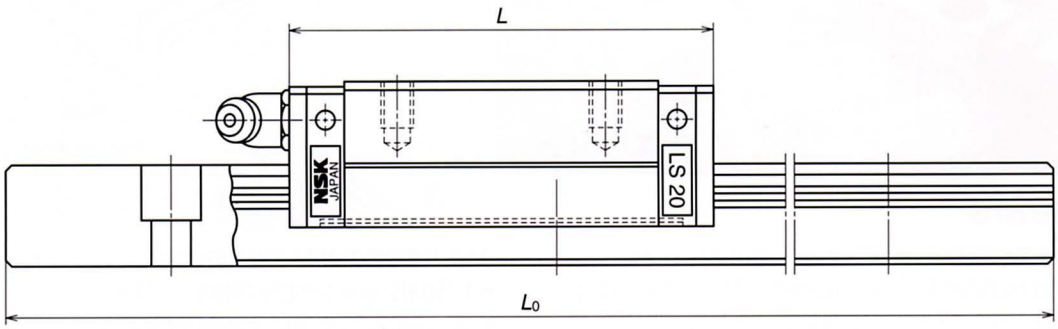


Table 15.2 Dimensions and operating environments of SPACEA Series NSK Linear Guides

Series	Model No.	Height	Overall width	Dimension (mm) Ball slide length L		Rail width	Maximum rail length	Basic load rating (Dynamic)		Suitability for special environments				
		H	W	standard	with K1 Seal	W_1	L_0max	(N)	{kgf}	Clean	Vacuum	Corrosive	High-temperature	Foreign particle contaminated
LH	LH20AN	30	44	69.8	80.4	20	3500	14200	1450	○	○	○	○	○
	LH20BN	30	44	91.8	102.4	20	3500	18200	1860	○	○	○	○	○
	LH20FL	30	63	69.8	80.4	20	3500	14200	1450	○	○	○	○	○
	LH20HL	30	63	91.8	102.4	20	3500	18200	1860	○	○	○	○	○
	LH20EL	30	63	69.8	80.4	20	3500	14200	1450	○	○	○	○	○
	LH20GL	30	63	91.8	102.4	20	3500	18200	1860	○	○	○	○	○
	LH25AN	40	48	79	90.6	23	3500	21000	2140	○	○	○	○	○
	LH25BN	40	48	107	118.6	23	3500	26900	2740	○	○	○	○	○
	LH25FL	36	70	79	90.6	23	3500	21000	2140	○	○	○	○	○
	LH25HL	36	70	107	118.6	23	3500	26900	2740	○	○	○	○	○
	LH25EL	36	70	79	90.6	23	3500	21000	2140	○	○	○	○	○
	LH25GL	36	70	107	118.6	23	3500	26900	2740	○	○	○	○	○
	LH30AN	45	60	85.6	97.6	28	3500	25700	2620	○	○	○	○	○
	LH30BN	45	60	124.6	136.6	28	3500	37500	3800	○	○	○	○	○
	LH30FL	42	90	98.6	110.6	28	3500	25700	2620	○	○	○	○	○
	LH30HL	42	90	124.6	136.6	28	3500	37500	3800	○	○	○	○	○
	LH30EL	42	90	98.6	110.6	28	3500	25700	2620	○	○	○	○	○
	LH30GL	42	90	124.6	136.6	28	3500	37500	3800	○	○	○	○	○
	LH35AN	55	70	109	122	34	4000	39000	3960				○	○
	LH35BN	55	70	143	156	34	4000	49500	5060				○	○
	LH35FL	48	100	109	122	34	4000	39000	3960				○	○
	LH35HL	48	100	143	156	34	4000	49500	5060				○	○
	LH35EL	48	100	109	122	34	4000	39000	3960				○	○
	LH35GL	48	100	143	156	34	4000	49500	5060				○	○
	LH45AN	70	86	139	154	45	3990	66000	6740				○	○
	LH45BN	70	86	171	186	45	3990	79500	8130				○	○
	LH45FL	60	120	139	154	45	3990	66000	6740				○	○
	LH45HL	60	120	171	186	45	3990	79500	8130				○	○
	LH45EL	60	120	139	154	45	3990	66000	6740				○	○
	LH45GL	60	120	171	186	45	3990	79500	8130				○	○
	LH55AN	80	100	163	178	53	3960	97500	9940				○	○
	LH55BN	80	100	201	216	53	3960	118000	12000				○	○
	LH55FL	70	140	163	178	53	3960	97500	9940				○	○
	LH55HL	70	140	201	216	53	3960	118000	12000				○	○
	LH55EL	70	140	163	178	53	3960	97500	9940				○	○
	LH55GL	70	140	201	216	53	3960	118000	12000				○	○

SPACEA Series NSK Linear Guides

Lubrication and surface treatment of SPACEA Series NSK Linear Guides

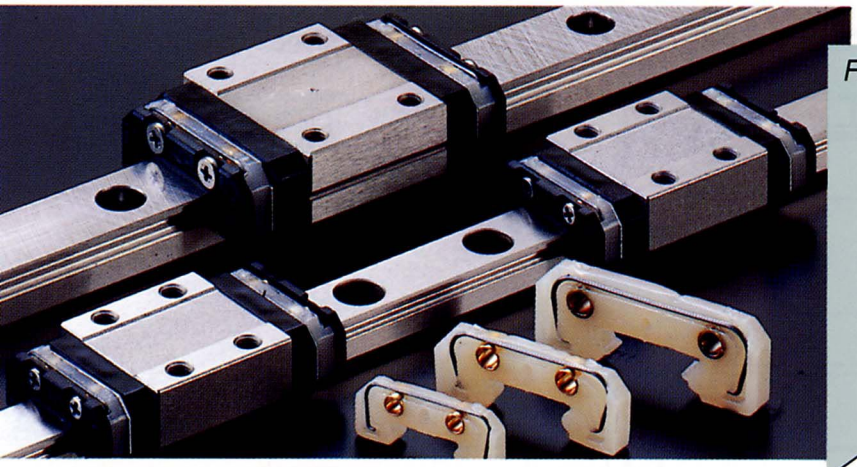
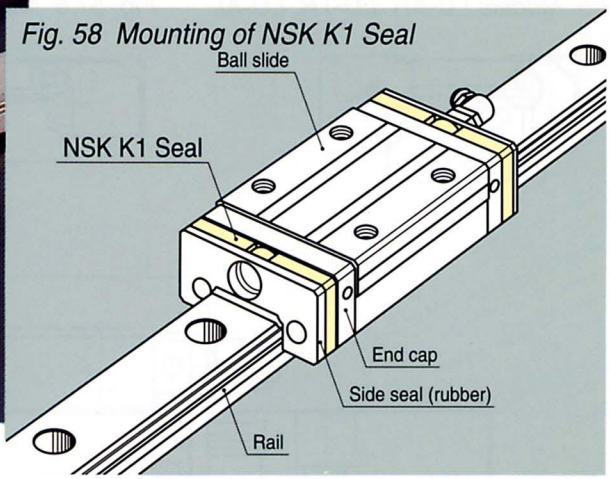


Fig. 58 Mounting of NSK K1 Seal



NSK K1 Seals

NSK K1 Seals are seals made of a revolutionary new material, and fitted to NSK Linear Guides. The material is a "porous synthetic resin" which contains a high proportion of lubricating oil. This oil is gradually exuded and supplements the lubrication of the linear guide. NSK K1 Seals are simply fitted on the inside of the standard side seal which are made of rubber.

Characteristics

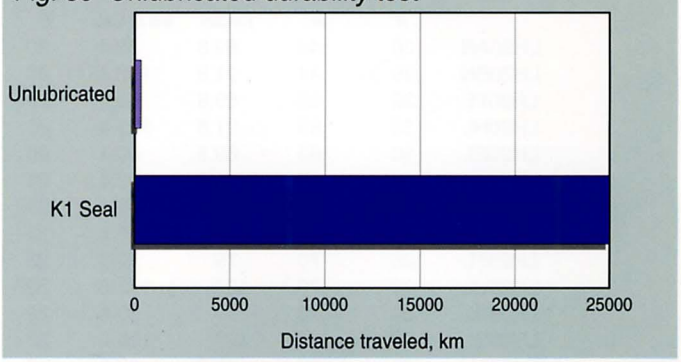
• High-speed unlubricated durability test

Fig. 59 shows the results of a test of linear guide durability at high speeds with no lubrication at all and with a K1 Seal. The unlubricated linear guide became unusable (damaged) in a short space of time, but the linear guide with the K1 Seal covered a distance of 25,000 km without mishap.

Conditions:

Linear guide:	LH30AN (preload Z1)
Speed:	200m/min.
Stroke:	1800 mm
Unlubricated:	fully degreased, no lubricant added
K1 Seal:	fully degreased, K1 Seal fitted

Fig. 59 Unlubricated durability test

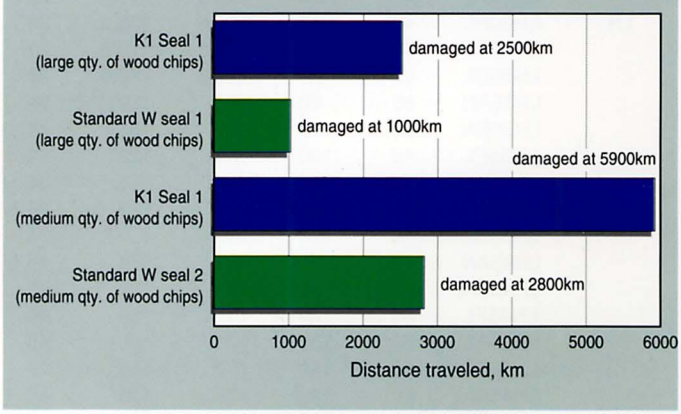


Wood chips durability test

Wood chips absorbs lubricating oil and is therefore a particularly difficult environmental condition (Fig. 60), but as is clear from Fig. 61 a linear guide with K1 Seals will have a service life twice as long as that of a linear guide fitted with double conventional seals.

Fig. 60 Durability test of linear guide exposed to wood chips

Fig. 61 Wood chips durability test



Conditions:

Linear guide:	LH30AN (preload Z1)
Speed:	24 m/min.
Stroke:	490 mm
Load:	490 N / bearing

Seal specifications/lubrication

Standard W seal: standard W seal + AV2 grease

K1 Seal: K1 Seal + standard seal + AV2 grease

Wood chips: 1 - large qty. of wood chips 2 - medium qty. of wood chips

Water immersion test

Once a week, NSK's research laboratories conduct a test in which an NSK Linear Guide is made to run continuously for 24 hours, totally immersed in water. The results of these tests are shown in Fig. 62. When the Linear Guide is not fitted with K1 Seals, the ball groove quickly becomes worn and the bearing fails, but when K1 Seals are fitted, wear is reduced to approximately 1/3 (see Table. 16) confirming that the seals provide a significant lubricating effect.

Conditions:

Linear guide:	LS30 stainless steel (preload Z1)
Speed:	24m/min.
Stroke:	400 mm
Load:	4700 N/bearing
Lubrication:	full pack of food processing machinery grease
(US made; typical characteristics:	
	consistency 280/basic oil viscosity: 580 (cSt)
Water immersion:	run once a week for 24 hours,
	fully immersed in water

Dust characteristics

Fig. 63 compares the dust characteristics of linear guides under various forms of lubrication. It reveals that the combination of K1 Seals with NSK Clean Grease LG2 has a dust-reducing effect equivalent to using vacuum grease.

Conditions:

Linear guide:	LS20
Speed:	36m/min.

Oil and chemical resistance

Table. 17 records the results of a test in which K1 Seals were immersed in chemicals and oils at 40°C. K1 Seals were found to be stable when in contact with grease and cutting lubricants, and use in combination with these substances presents no problems. However exposure to chemicals with degreasing properties (white kerosene, hexane, etc.) caused the surface of the seals to suffer a sharp loss of oil content suggesting that their lubricating effect may deteriorate under these conditions.

Fig. 62 Water immersion test

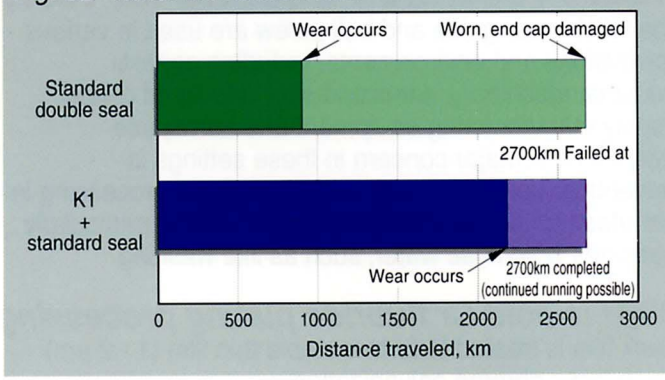


Table 16 Comparison of wear to ball grooves and balls (Unit: μm)

Lubrication	Ball slide groove	Rail groove	Balls
K1 Seal fitted	16~18	2~3	6~8
K1 Seal not fitted	30~45	9~11	17~25

Fig. 63 Comparison of dust characteristics

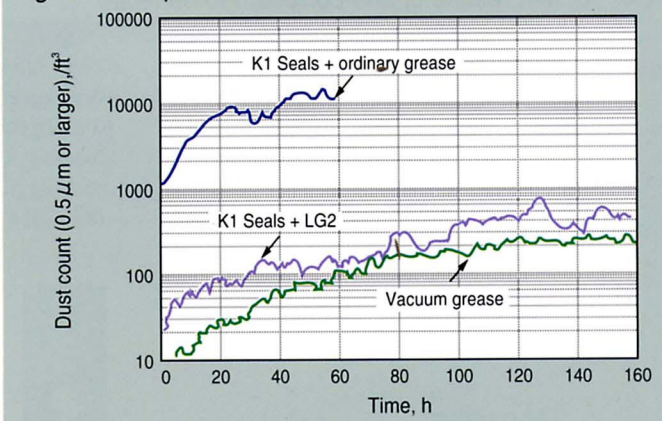


Table 17 Compatibility of K1 Seals with oils and chemicals

Chemical/oil	Compatibility
Cutting lubricants (water based, oil based)	A
Grease (mineral oil based, ester based)	A
Rust preventatives (without solvents)	A
Rust preventatives (with solvents)	B
White kerosene	B
Hexane	C

A: compatible
B: proceed with caution
(no problem if for short periods only)
C: incompatible

SPACEA Series NSK Linear Guides

Rust Prevention Coating for NSK Linear Guides® and Ball Screws

The NSK linear guide and ball screw are used in various applications and environments, including general industrial machinery, semiconductor and liquid crystal display manufacturing equipment and aerospace equipment. A major concern in these settings is preventing rust which may occur during wet processing in manufacturing equipment utilizing chemicals, particularly machines which use water, such as like washing machines and in various manufacturing stages of semiconductors and liquid crystal display. NSK applies a fluororesin coating as a surface treatment on electrolytic rustproofing black film (cold Cr fluoride plating) as the optimal rust prevention coating for linear guide and ball screws in such machines and equipment, with successful results. Experimental data supporting these findings is provided below.

What is cold Cr fluoride plating processing?

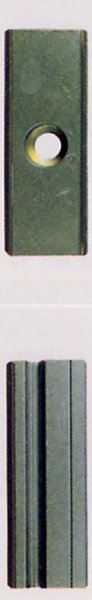
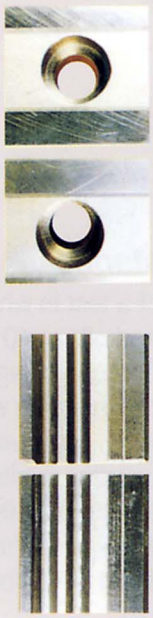
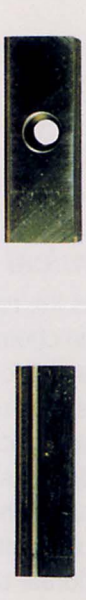
Black film is treated to form a stable thin film (1 - 2 μm) which lacks chrome galvanization.
In addition, a fluororesin coating is applied to this film to increase corrosion resistance.

- This low-temperature treatment with no hydrogen brittleness enables stable, accurate control.
- The thin film and resistance to corrosion reduces factors which might adversely affect the accuracy of parts.
- Very high durability on rolling surfaces compared with other surface treatments.
- Lower in price compared with other surface treatments and stainless products.

Review of experimental data

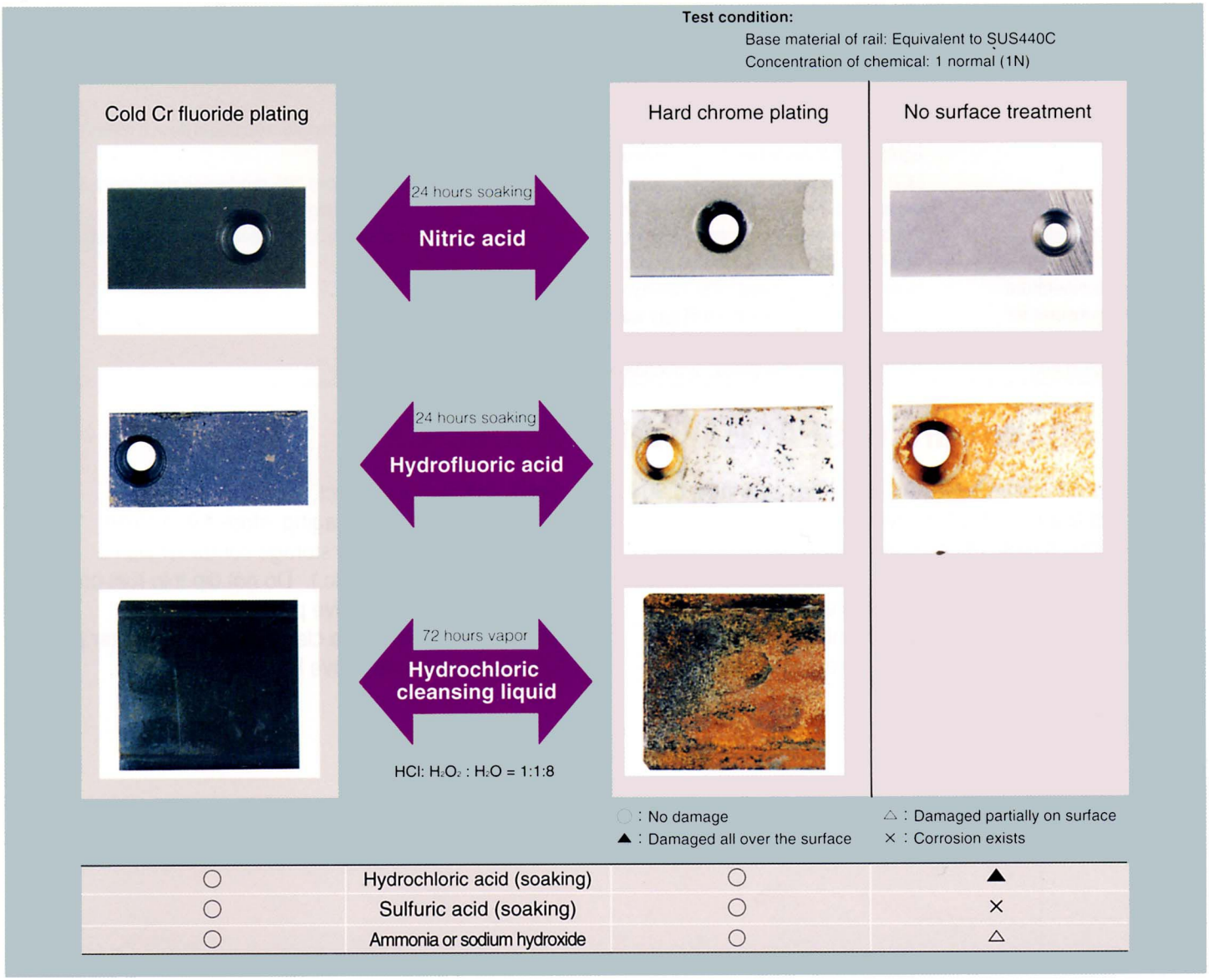
Table 18 test results of anti-corrosion to humidity

Rust condition — A: No rust, B: Discoloration, but no rust, C: Spot rust, D: Light rust, E: Totally rusted

Characteristic	Sample	Cold Cr fluoride plating	Hard chrome plating	Electrolysis nickel plating	Equivalent material to SUS440C	Standard product
Rust condition	Upper face	(Grinding) B	(Grinding) B	(Grinding) A	(Grinding) C	(Grinding) D
	Side face	(Grinding) A	(Grinding) A	(Grinding) A	(Grinding) C	(Grinding) E
	Bottom face	(Grinding) A	(Grinding) A	(Grinding) A	(Grinding) C	(Grinding) E
	End face	(Cutting) A	(Cutting) C	(Cutting) A	(Cutting) C	(Cutting) E
	Chamfer, Grinding off	(Drawing) A	(Drawing) D	(Drawing) A	(Drawing) C	(Drawing) E
Rustproofing capability	<Test condition> • Testing machine: Dabaiespeck High temperature and high humidity vessel • Temperature: 70°C • Relative humidity: 95% • Time: 96 hours To/from the setting condition of temperature and humidity Rise time: 5 hours Fall time: 2 hours					
	Film thickness	5 μm	0.5 – 7 μm	10 μm	—	—

Test results of anti-corrosion to chemical exposure

Fig. 64 test results anti-corrosion to chemical exposure



○	Hydrochloric acid (soaking)	○	▲
○	Sulfuric acid (soaking)	○	×
○	Ammonia or sodium hydroxide	○	△

Fig. 65 Test results of durability to surface treatment

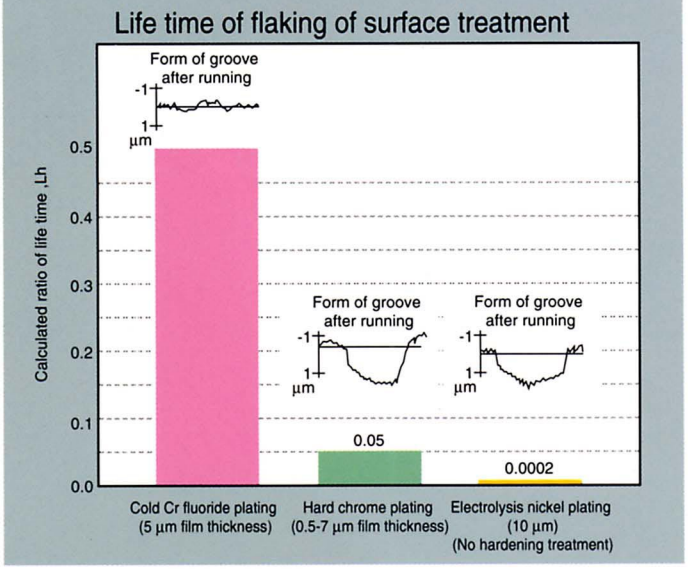


Table 19 Total evaluation

	Available length	Rustproofing capability	Stability of quality	Durability	Cost
Cold Cr fluoride plating	◎ (4m)	◎	○	◎	◎
Hard chrome plating	△ (2m)	○	×	△	△
Electrolysis nickel plating	◎ (4m)	◎	△	×	△
Equivalent material to SUS440C	○ (3.5m)	○	◎	◎	△

◎: Superior
○: No problem for use
△: Not as good
×: Problem réstricting use

Applications of SPACEA Series products

The table below lists some of the major applications of SPACEA Series products.

Applications of the SPACEA Series

Series	Applications
Clean	LCD panel production machinery, semiconductor production machinery, hard disk production machinery, food processing machinery, pharmaceutical production machinery
Vacuum	Space exploration equipment, vacuum devices, stepping motors for vacuum use, electronic device manufacturing equipment, X-ray tubes, turbo molecular drag pumps
Corrosion resistant	LCD panel production machinery, semiconductor production machinery, hard disk production machinery, food processing machinery, hot dipping tanks, film production machinery, cleaning equipment
K1 Seals	Food processing machinery, wood working machinery, cleaning machinery, iron & steel processing machinery
Non-magnetic	Semiconductor production equipment, medical diagnostic equipment
High temperature	Heat treatment furnace roller conveyors, kiln cars
Low temperature	Liquid fuel turbo pumps, liquid gas submerged pumps
Radiation resistant	Nuclear reactors, fusion reactors, accelerators
High speed	Machine tools, jet engines, turbochargers

Notes on the care of SPACEA Series products

To get the most from your SPACEA Series bearings, ball screws and linear guides for special operating environments, please observe the following precautions:

- The product is fully degreased before being wrapped in humidity-resistant packaging. To limit the risk of corrosion, etc. do not open the packaging until you are ready to use the product.
- After opening the packaging, store it in a clean dessicator or other dry storage container with a desiccant (silica gel, etc.). Do not dip it in rust preventor or wrap it in anticorrosive paper.
- Handle the product in a clean location and wear plastic gloves or other protective handwear.

System requirements form

In preparation for ordering NSK SPACEA Series bearings, you may wish to note your system requirements on this form. All the information you give us will help to ensure that the components selected provide the optimum performance for your needs. If you would like more detailed information, please contact your NSK representative at one of our worldwide offices listed on the back cover.
Please contact NSK for assistance in selecting SPACEA Series ball screws and linear guides.

Your name _____

Department _____

Company _____

Address _____

Phone _____

Fax _____

Model number /dimensions	Basic model number			If model ordered is special size (d x D x B)		
				Ø x Ø x		
Equipment for which bearing will be used	1. New equipment	2. Experience of use with similar equipment		3. Replacement purposes		
	Type (model No.)	Capacity		Number used per machine		
Location used		1. Free side	2. Fixed side	3. Horizontal axis	4. Vertical axis	5. Diagonal axis
Operating conditions	Rotation mode	1. Inner ring turns 2. Outer ring turns 3. Inner and outer rings turn 4. Continuous 5. Intermittent 6. Fluctuating 7. Reversing 8. Sudden acceleration 9. Vibration 10. Other ( ):				
	Speed (rpm)	Minimum	Normal (continious)	Maximum		
	Loading (N)		Maximum load	Normal load (continious)		
	Radial					
	Axial					
	Type of load	1. Vibration 2. Shock 3. Fluctuation 4. Moment 5. Other ( ):				
	Temperature (°C)	Bearing, ball screw or NSK linear Guide		Ambient		
	Environment	1. Air 2. Air- vacuum 3. Vacuum 4. Other ( ):				
		Cleanliness				
		Pressure: Pa				
		Corrosive gases	F-based	Cl-based	Br-based	Other ( ):
		Corrosive liquids	Acid	Alkaline	Other ( ):	
Current specifications	Material	Inner ring:	Outer ring:	Balls:	Cage:	
	Lubricant:					
	Other:					
	Frequency of replacement:					
Diagram of installation site or other appropriate information						