B

SELECTING, TYPES, AND FEATURES

The packings in this catalogue are neither designed nor manufactured to the use for medical application.
Please do not use the products in this catalogue for the application physically contacting body fluid or biosystem, or as a transplant material to human body.

Selecting material and the type most suitable for the operating condition is necessary to obtain optimal performance of the packing. In this chapter, we will describe the application range of seals and related products for hydraulic equipment, plus means of selection.

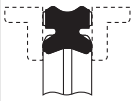
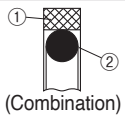
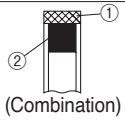
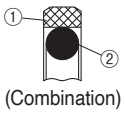
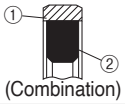
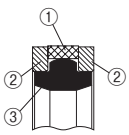
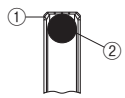
1. Types and Features of Hydraulic Seals for Reciprocating Application

※Pressure
- Without backup ring
- With backup ring

※Temperature
- Nitrile rubber
- Nitrile rubber for low temperature
- Hydrogenated nitrile rubber
- Fluoro rubber
- Iron rubber
- Heat resistant Iron rubber

(1) Special packings for piston seals

〈Table B-1〉 Hydraulic Seals for Reciprocating Motion (Special packings for piston seals)

Type	Classification	NOK Type	Shape	Material		Main applicable fluid	Pressure (MPa) Remark 1) 0 20 40 60	Temperature (°C) Remark 2) −50 −40 −20 0 100 200	Speed (m/s)
Special packings for piston seals	U Packing	ODI		Iron rubber (U801)	U801	·General petroleum hydraulic fluid	35 70	−35 100	0.03～1.0
		OSI		Iron rubber (U801)	U801		30 42	−30 100	
		OUIS		Iron rubber	U801		30 42	−30 100 −10 110	
					U641				
		OUHR		Nitrile rubber	A505	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	14 21	−25 100 −55 80	0.008～1.0
					A567	·Low temperature petroleum hydraulic fluid oil (General petroleum hydraulic fluid oil) Note:When using general petroleum-derived operating oil, we recommend A527.			
		OKH		Nitrile rubber	A566	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	14 21	−25 100 −55 80	0.008～1.0
					A567	·Low temperature petroleum hydraulic fluid oil (General petroleum hydraulic fluid oil) Note:When using general petroleum-derived operating oil, we recommend A527.			
	Combination Seals	SPGO	 (Combination)	①Rareflon (19YF) ②Nitrile rubber Fluoro rubber	A305	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	35	−30 100 −20 160	0.005～1.5
					F201	·General petroleum hydraulic fluid oil ·Phosphate ester type hydraulic fluid oil			
		SPG	 (Combination)	①Rareflon (19YF) ②Nitrile rubber Fluoro rubber	A980	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	35	−40 100 −20 160	
					F201	·General petroleum hydraulic fluid oil ·Phosphate ester type hydraulic fluid oil			
		SPGM	 (Combination)	①Rareflon (55YF) ②Nitrile rubber Fluoro rubber	A305	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	35	−30 100 −20 160	
					F201	·General petroleum hydraulic fluid oil ·Phosphate ester type hydraulic fluid oil			
		SPGN	 (Combination)	①Polyamide resin (21NB) ②Nitrile rubber (A626)		·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	50	−30 110	
		SPGW	 (Combination)	①Rareflon (19YF) ②Polyamide resin (12NM or 80NP) ③Nitrile rubber Fluoro rubber Hydrogenated nitrile rubber	A980	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	50	−40 100 −20 −25 120	
					F201	·General petroleum hydraulic fluid oil ·Phosphate ester type hydraulic fluid oil			
					G928	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil			
		SPGC	 (Combination)	①Rareflon (31BF) ②Nitrile rubber Fluoro rubber	A305	·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	2	−30 100 −20 160	
					F201	·General petroleum hydraulic fluid oil ·Phosphate ester type hydraulic fluid oil			
	C Packing	CPI		Iron rubber (U801)	U801	·General petroleum hydraulic fluid oil	7	−35 100	0.01～0.3
		CPH		Nitrile rubber (A102) (A103) (A104) (A505)		·General petroleum hydraulic fluid oil ·Water-glycol type hydraulic fluid oil ·Oil-water emulsion type hydraulic fluid oil	3.5	−25 100	

Remark 1) Depending on the size of extrusion gap, backup ring might be necessary. Refer to Fig.B-7 on page 25 and dimension table.

Remark 2) Applicable temperature ranges for packings are indicated by colors for each rubber material. (←See the figure to the left.)

Remark 3) When using the packing at a low speed, stick slip may occur depending on the cylinder structure or the using condition. In this case, consult NOK separately.

Remark 4) Some small diameter type cannot be installed with internal groove.

Remark 5) Items with a "—" mark in the dimension table column have unique specifications. Please consult NOK before ordering since there is no dimension description.

Remark 6) When using a special fluid, consult NOK.

In the following case, the combined effect of operating conditions must be carefully considered, therefore, please consult NOK.

(1) In case of minimum pressure exceeding 3MPa at all times

(2) In case of using packing at the border range of applicable temperature and pressure

(3) In case of using packing with extremely short strokes (See examples of using with extremely short strokes on page 260 and 261.)

(4) In case of using packing when speed of extending stroke of rod is greater than that of contracting stroke

Stroke (mm)	Sliding resistance	Installation with integrated groove (Remark 4)	Feature		Dimension table(page)
2,000 or below	Medium	No	·Designed for large section, applicable for wide pressure range	·Iron rubber U801, has excellent wear resistance and sealing ability.	59
	Medium	Yes	·Designed for smaller section, and able to be fitted into integrated groove	·Packings with a smaller section than ODI	67
	Medium	Yes		·Improvement has been made to prevent damages caused by back pressure. ·Material with heat resistance, U641 is also available.	70
	Small	Yes		·Improvement against stick slip has been made. ·The friction resistance is low and an improvement has been made to prevent damages caused by back pressure. ·Nitrile rubber that has excellent low temperature resistance is employed and can be used with special low temperature hydraulic fluid oil (MIL H 5606E).	72
	Small	Yes	·Installation space is saved because of bidirectional sealing ability by single packing.	·Improvement against stick slip has been made. ·Nitrile rubber that has excellent low temperature resistance is employed and can be used with special low temperature hydraulic fluid oil (MIL H 5606E). ·It can be used with combination of Back-Up Ring BRL. (See the page 49)	74
	Very small	Yes	·Rareflon is used for sliding material. This packing has low frictional resistance, eliminating stick slip and assuring high wear resistance. ·Installation space is saved because of bidirectional sealing ability by single packing.	·This is a standard type of combination seal for wide range of application. ·This has the same performance as that of SPG. Installation space is saved because of JIS standard O ring.	77 —
	Very small	Yes		·This has the same performance as SPGO. This is used in case the service range of pressure	81 —
	Very small	Yes		·This has the same performance as SPGO. This is used in case the service range of pressure is wide and sliding speed is high.	86 —
	Small	Yes	·Polyamide resin is used for sliding material. This packing has assuring high durability. ·Installation space is saved because of bidirectional sealing ability by single packing.	·Suppresses venting leaks; provided with slit to allow hydraulic insertion at edge of seal ring. ·Easy to attach using one point step cut on seal ring. ·More compact than SPGW.	88
	Very small	Yes	·Rareflon is used for sliding material. This packing has low friction resistance eliminating stick slip and assuring high wear resistance. ·Installation space is saved because of bi-directional sealing ability by single packing.	·This is a seal for high pressure operation with improved ability of SPG for oil scraping off. ·Backup ring material of polyamide resin to improve the durability.	91 — 91
	Very small	Yes (Remark 4)		·This packing can be fitted on to O ring groove (JIS B 2406 P series). ·This has less sliding friction than O ring to improve the durability. ·This can also be used for pneumatic equipment.	94 —
	Small	No	·This packing is used for relatively low pressure operation.	·Packing material, Iron rubber U801 has excellent wear resistance and sealing ability.	98
	Small	No		·Packing material, nitrile rubber, has excellent oil resistance and reduces sliding friction.	100

1. Types and Features of Hydraulic Seals for Reciprocating Application

(2) Special packings for rod seals

※Pressure
- Without backup ring
- With backup ring

※Temperature
- Nitrile rubber
- Nitrile rubber for low temperature
- Hydrogenated nitrile rubber
- Fluoro rubber
- Iron rubber
- Heat resistant Iron rubber

〈Table B-2〉 Hydraulic Seals for Reciprocating Motion (Special packings for rod seals)

Type	Classification	NOK Type	Shape	Material		Main applicable fluid	Pressure (MPa) Remark 1) 0 20 40 60	Temperature (°C) Remark 2) −50 −40 −20 0 100 200	Speed (m/s)
Special packings for rod seals	U Packing	IDI		Iron rubber (U801)	U801	・General petroleum hydraulic fluid	35 70	−35 100	0.03～1.0
		ISI		Iron rubber	U801 U641		30 42	−30 100 −10 110	
		IUIS		Iron rubber	U801 U641		30 42	−30 100 −10 110	
		IUH		Nitrile rubber	A505	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	14 21	−25 100 −55 80 −25 120	0.008～1.0
					A567	・Low temperature petroleum hydraulic fluid oil (General petroleum hydraulic fluid oil) Note:When using general petroleum-derived operating oil, we recommend A527.			
					G928	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil			
		UNI	① ② (Combination)	①Iron rubber (U801) ②Silicon rubber (S813)	U801	・General petroleum hydraulic fluid ・Low temperature petroleum hydraulic fluid oil	30 42	−45 100	0.03～1.0
	Combination Seals	SPNO	② ① (Combination)	①Rareflon (19YF) ②Nitrile rubber Fluoro rubber	A305	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	35	−30 100 −20 160	0.005～1.5
					F201	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil			
		SPN	② ① (Combination)	①Rareflon (19YF) ②Nitrile rubber Fluoro rubber	A980	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	35	−40 100 −20 160	
					F201	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil			
		SPNS	② ① (Combination)	①Rareflon (55YF) ②Nitrile rubber Fluoro rubber	A305	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	35	−30 100 −20 160	
					F201	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil			
		SPNC	② ① (Combination)	①Rareflon (31BF) ②Nitrile rubber Fluoro rubber	A305	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	2	−30 100 −20 160	
					F201	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil			

Remark 1) Depending on the size of extrusion gap, backup ring might be necessary. Refer to Fig.B-7 on page 25 and dimension table.

Remark 2) Applicable temperature ranges for packings are indicated by colors for each rubber material. (←See the figure to the left.)

Remark 3) When using the packing at a low speed, stick slip may occur depending on the cylinder structure or the using condition. In this case, consult NOK separately.

Remark 4) Some small diameter type cannot be installed with internal groove.

Remark 5) Items with a "—" mark in the dimension table column have unique specifications. Please consult NOK before ordering since there is no dimension description.

Remark 6) When using a special fluid, consult NOK.

In the following case, the combined effect of operating conditions must be carefully considered, therefore, please consult NOK.

(1) In case of minimum pressure exceeding 3MPa at all times

(2) In case of using packing at the border range of applicable temperature and pressure

(3) In case of using packing with extremely short strokes (See examples of using with extremely short strokes on page 260 and 261.)

(4) In case of using packing when speed of extending stroke of rod is greater than that of contracting stroke

Stroke (mm)	Sliding resistance	Installation with integrated groove (Remark 4)	Feature		Dimension table(page)
2,000 or below	Medium	No	·Packings with large section can be used for wide range of pressure.	·Packing material, Iron rubber U801 has excellent wear resistance and sealing ability.	103
	Medium	Yes	·Packings with small section can be fitted in integrated groove.	·Packings with a smaller section of IDI. ·Material with heat resistance, U641 is also available.	111
	Medium	Yes		·Improvement is made to prevent damage caused by back pressure. ·Heat resistant U641 is also available.	114
	Small	Yes (Remark 4)		·Improvement is made to prevent the damages caused by back pressure. ·Material with excellent cold resistance, nitrile rubber A567 is also available. This can be used for special low temperature oil (MIL H 5606E). ·Heat resistant, wear resistant hydrogenated nitrile rubber (H-NBR) G928 material also available.	117
	Medium	No	·This packing is used for low temperature and high pressure operations.	·Iron rubber is used for material and back ring can prevent the lack of interference at low temperature.	120
	Very small	Yes (Remark 4)	·Rareflon is used for sliding material. This packing has low frictional resistance, eliminating stick slip and assuring high wear resistance.	·This is a standard type of combination seal and can be used for wide range of operation.	123 —
	Very small	Yes (Remark 4)		·This has the same performance as SPNO. This is used in case the service range of pressure is wide and sliding speed is high.	126 —
	Very small	Yes (Remark 4)	·Rareflon is used for sliding material. This packing has low friction resistance eliminating stick slip and assuring high wear resistance.	·Compared to SPNO and SPN, the product is excellent in the sealing performance.	129 —
	Very small	No	·Rareflon is used for sliding material. This packing has low friction resistance eliminating stick slip and assuring high wear resistance. ·Installation space is saved because of bi-directional sealing ability by single packing.	·This packing can be fitted on to O ring groove (JIS B 2406 P series). ·This has less sliding friction than O ring to improve the durability. ·This can also be used for pneumatic equipment.	133 —

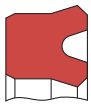
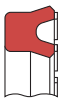
1. Types and Features of Hydraulic Seals for Reciprocating Application

(3) Packings for both piston and rod seals

※Pressure
- Without backup ring
- With backup ring

※Temperature
- Nitrile rubber
- Nitrile rubber for low temperature
- Fluoro rubber
- Iron rubber
- Heat resistant Iron rubber

〈Table B-3〉 Hydraulic Seals for Reciprocating Motion (Packings for both piston and rod seals)

Type	Classification	NOK Type	Shape	Material		Main applicable fluid	Pressure (MPa) Remark 1) 0 20 40 60	Temperature (°C) Remark 2) −50 −40 −20 0 100 200	Speed (m/s)
Packings for both piston and rod seals	U Packing	UPI		Iron rubber (U801)	U801	・General petroleum hydraulic fluid	30 35	−35 100	0.03〜1.0
		USI		Iron rubber (U593)	U593		21	−35 80	
		UPH		Nitrile rubber Fluoro rubber	A505	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	15 32	−25 100 −10 150	0.008〜1.0
					F357	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil			
		USH		Nitrile rubber Fluoro rubber	A505	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil	14 21	−25 100 −55 80 −10 150	
					A567	・Low temperature petroleum hydraulic fluid oil (General petroleum hydraulic fluid oil) Note:When using general petroleum-derived operating oil, we recommend A527.			
					F357	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil			
	V Packing	V99F		Fabric reinforced nitrile rubber	21AG	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil ・Water	4 (3 sheet) 16 (4 sheet) 30 (5 sheet)	−25 100	0.05〜1.0
		V96H		Nitrile rubber Fluoro rubber	A505	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil ・Water	4 (3 sheet) 8 (4 sheet)	−25 100 −10 150	0.05〜0.5
					F357	・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil ・Agricultural chemicals	30 (5 sheet)		

Remark 1) Depending on the size of extrusion gap, backup ring might be necessary. Refer to Fig.B-7 on page 25 and dimension table.

Remark 2) Applicable temperature ranges for packings are indicated by colors for each rubber material. (←See the figure to the left.)

Remark 3) When using the packing at a low speed, stick slip may occur depending on the cylinder structure or the using condition. In this case, consult NOK separately.

Remark 4) Some small diameter type cannot be installed with internal groove.

Remark 5) Items with a "—" mark in the dimension table column have unique specifications. Please consult NOK before ordering since there is no dimension description.

Remark 6) When using a special fluid, consult NOK.

In the following case, the combined effect of operating conditions must be carefully considered, therefore, please consult NOK.

(1) In case of minimum pressure exceeding 3MPa at all times

(2) In case of using packing at the border range of applicable temperature and pressure

(3) In case of using packing with extremely short strokes (See examples of using with extremely short strokes on page 260 and 261.)

(4) In case of using packing when speed of extending stroke of rod is greater than that of contracting stroke

	Stroke (mm)	Sliding resistance	Installation with integrated groove (Remark 4)	Feature		Dimension table (page)
	2,000 or below	Medium	No	・This can be used both for piston and rod seals. ・This packing has large section and can be used for wide range of operations.	・Material, Iron rubber U801, has excellent wear resistance and sealing ability.	137
		Small	Yes (Remark 4)	・This can be used both for piston and rod seals. ・This packing has small section and can be fitted in integrated groove.	・This is a type with smaller section of UPI. ・Improvement has been made to prevent damages caused by back pressure.	143
		Medium	No	・This can be used both for piston and rod seals. ・This packing has large section and can be used for wide range of operations.	・Nitrile rubber and fluoro rubber are available for material to assure wide range of operating temperature. ・Wide variation of size is available.	147
		Small	Yes (Remark 4)	・This can be used both for piston and rod seals. ・This packing has small section and can be fitted in integrated groove.	・This is a type with a smaller section of UPH.	155 — 155
		Large	No	・This can be used for severe operating conditions by plying packings according to the operation pressure. ・Installation width is larger than U packings. Less sealing ability than U packings.	・This is a standard type of V packing.	159
		Large	No		・Compared with V99F, this is selected in case the sealing performance is more important.	165 —

2. Types and Features of Dust Seals

(1) Dust seals for reciprocating motion

The main feature of a dust seal is to seal outside dust. In addition, a sealing system using a dust seal, combined with rod packings and a buffer ring, can prevent oil film being scraped out.

Specific performance will vary depending upon the type of dust seal. Therefore, if maintaining oil film on a cylinder is more important, please consult NOK.

※Temperature
- Nitrile rubber
- Nitrile rubber for low temperature
- Fluoro rubber
- Iron rubber
- Heat resistant Iron rubber

〈Table B-4〉 Dust seals for reciprocating motion

Type	NOK Type	Shape	Material		Main applicable fluid	Pressure (MPa) Remark 1)	Dust proof performance	Oil scraping proof performance
Dust seals	DKI	(Combination)	①Iron rubber (U801) ②Cold rolled steel plate sheet (SPCC)	U801	・Outside dust	−50 −40 −20 0 100 200 −35 100	◎	Medium
	DWI		①Iron rubber (U801) ②Cold rolled steel plate sheet (SPCC)	U801		−55 100	◎	Small
	DWIR		①Iron rubber (U801) ②Cold rolled steel plate sheet (SPCC)	U801		−55 100	○	Very small
	DKBI		①Iron rubber (U801) ②Cold rolled steel plate sheet (SPCC)	U801 U641		−55 100 −10 110	◎	Very small
	DKBI3		①Iron rubber (U801) ②Cold rolled steel plate sheet (SPCC)	U801 U641		−55 100 −10 110	◎	Very small
	DKBZ		①Iron rubber (U801) ②Cold rolled steel plate sheet (SPCC)	U801		−55 100	◎	Very small
	DKB		①Nitrile rubber Fluoro rubber ②Cold rolled steel plate sheet (SPCC)	A795 A980 F975		−55 −20 100 80 −20 150	○	Very small
	DKH		①Nitrile rubber Fluoro rubber ②Cold rolled steel plate sheet (SPCC)	A104 A795 A980 F975		−55 −20 100 80 −20 150	○	Medium
	DSI		Iron rubber (U801)	U801		−35 100	○	Medium
	LBI		Iron rubber (U593)	U593		−35 100	○	Small
	LBH		Nitrile rubber Fluoro rubber	A505 A567 F357		−55 −25 100 80 −10 150	○	Small
	LBHK		Nitrile rubber	A505 A567		−55 −25 100 80	○	Small
	DSPB		①Rareflon (11YF) ②Nitrile rubber Fluoro rubber	A305 F201		−20 −30 100 160	○	Small

Remark 1) Applicable temperature ranges for dust seals are indicated by colors for each rubber material. (←See the figure to the left.)

Remark 2) When using the packing at a low speed, stick slip may occur depending on the cylinder structure or the using condition. In this case, consult NOK separately.

Remark 3) Some small diameter type cannot be installed with internal groove.

Remark 4) Items with a "—" mark in the dimension table column have unique specifications. Please consult NOK before ordering since there is no dimension description.

	Requirement of stopper	Installation with integrated groove	Feature		Dimension table(page)
	No	No	・This is a seal to prevent entry of dust and protect equipment and maintain sealing performance of packings.	・This is a standard type of dust seal of Iron rubber with high dust proof performance.	171
	No	No		・Employing Iron rubber as material, this seal serves under severe dust conditions such as construction equipment.	174
	No	No		・Employing Iron rubber as material, this has the same performance as DWI, excellent in preventing of oil scraping out and in follow-ability to the eccentricity.	176
	No	No		・Employing Iron rubber as material, this is a double-lip dust seal to prevent oil scraping off.	178
	Yes	No		・Small one point hole in DKBI oil lip allows pressure build-up to escape and prevents loss or damage to the dust seal.	180
	Yes	No		・Thanks to the improved dust resistance of the DKBI, the dust seal provides a better balance between dust resistance and oil scraping performance.	182
	Yes	No		・Employing nitrile rubber as material, this is a double-lip dust seal to prevent oil scraping off.	184 — —
	No	No		・Employing nitrile rubber as material, this is a single-lip dust seal. ・Material A795: for diameter ø300 or below A104: for diameter over ø300	186 — —
	—	Yes	・This is a seal to prevent entry of dust and protect equipment and maintain sealing performance of packings. ・This can be fitted into a integrated groove.	・Employing Iron rubber as material, this is a single-lip all rubber dust seal.	189
	—	Yes		・This product uses the iron rubber as the material, and is a double-lip rubber-only dust seal aiming at preventing scrape-out of oil.	192
	—	Yes		・This is a double-lip all rubber dust seal to prevent oil scraping off. ・Nitrile rubber and fluoro rubber are available as material for wide range of operating temperature.	195 — 195
	—	Yes		・This product has a sub-lip in the dust lip, is effective in preventing water from entering, and can be used both indoor and outdoor. ・This product has a notch in the oil lip and lower back of the packing, and is excellent in accumulation pressure prevention characteristics.	198
	—	Yes Remark 3)	・Prevents entry of dust, protects equipment, and maintain, sealing performance of packings.	・Rareflon is used for sliding material. This packing has low frictional resistance, eliminating stick slip.	201 —

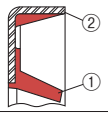
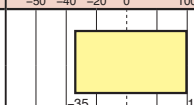
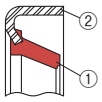
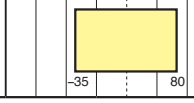
2. Types and Features of Dust Seals

(2) Dust seals for oscillating application

Dust seals for oscillating motion are mainly used for hinge pin and bush parts. In contrast to dust seals for reciprocating motion, the shape of lip is specially designed to reduce torque and have a relief effect by rear-side greasing, this assures good performance in severe dust conditions.

※Temperature
- Nitrile rubber
- Fluoro rubber
- Iron rubber
- Heat resistant Iron rubber
- Heat & cold resistant wide-range iron rubber

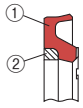
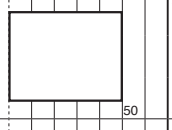
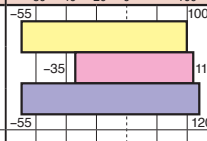
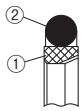
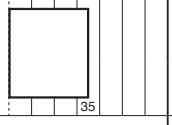
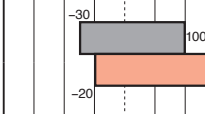
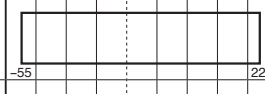
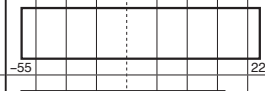
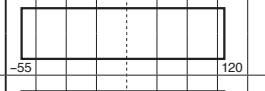
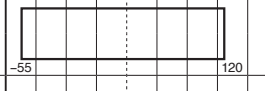
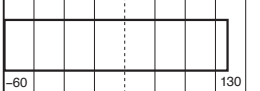
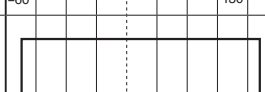
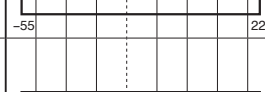
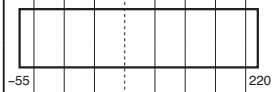
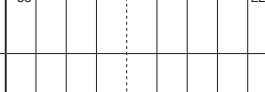
〈Table B-5〉 Dust seals for oscillating and rotating movement

Type	Classification	NOK Type	Shape	Material		Main applicable fluid	Pressure (MPa) Remark 1)	Temperature (°C) Remark 2)
Dust seals for oscillating application	Hinge pin dust seals	DLI		①Iron rubber ②Cold rolled steel plate sheet (SPCC)	U801 U593	・Outside dust	—	
		DLI2		①Iron rubber (U451) ②Cold rolled steel plate sheet (SPCC)	U451		—	

3. Types and Features of Related Products for Hydraulic Equipment

Selecting the right combination of packings and related products for the specific operating conditions will insure proper sealing effectiveness.

〈Table B-6〉 Relating products for reciprocal movement

Type	Classification	NOK Type	Shape	Material		Main applicable fluid	Pressure (MPa) Remark 1)	Temperature (°C) Remark 2)
Special packing for rod seals	Buffer ring	HBY		①Iron rubber ②Polyamide resin (12NM or 80NP)	U801 U641 UH05	・General petroleum hydraulic fluid		
		HBTS		①Rareflon (55YF) ②Nitrile rubber Fluoro rubber	A305 F201	・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil ・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil		
Relating products for reciprocal movement	Wear rings	RYT		Rareflon (05ZF)		・General petroleum hydraulic fluid oil ・Water-glycol type hydraulic fluid oil ・Oil-water emulsion type hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil ・Low temperature petroleum hydraulic fluid oil	—	
		WRT2		Rareflon (08GF)			—	
		WR		Fabric reinforced phenolic resin	12RS 15RS		—	
		WRR		Fabric reinforced phenolic resin	12RS 15RS		—	
		WR		Resin fiber polyester (88RS)			—	
	Contami seals	KZT		Rareflon (05ZF)			—	
	Backup ring	BRT2	 bias-cut	Rareflon (19YF)			—	
		BRT3	 no cut endless type					
		BRN2	 bias-cut	Polyamide resin (80NP)		・General petroleum hydraulic fluid oil ・Phosphate ester type hydraulic fluid oil ・Low temperature petroleum hydraulic fluid oil	—	
		BRN3	 no cut endless type					
		BRL	 Cut type	Polyamide resin (63NP)			—	

Remark 1) Permissible temperature ranges for dust seals are indicated by colors for each rubber material. (←See the figure to the left.)

Remark 2) When using the packing at a low speed, stick slip may occur depending on the cylinder structure or the using condition. In this case, consult NOK separately.

Remark 3) Combination Buckup Ring Part Numbers are listed on each applicable packing's dimension table.

In the following case, the combined effect of operating conditions must be carefully considered, therefore, please consult NOK.

(1) In case of minimum pressure exceeding 3MPa at all times

(2) In case of using packing at the border range of applicable temperature and pressure

(3) In case of using packing with extremely short strokes (See examples of using with extremely short strokes on page 260 and 261.)

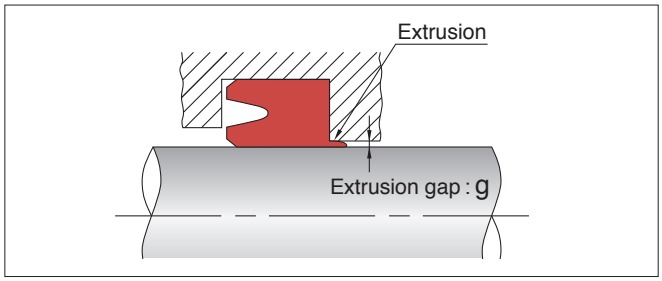
	Speed (m/s)	Feature		Dimension table(page)
	—	·This is a dust seal for oscillating and rotating movement for hinge pin and bush. This can be used under severe dust conditions to improve the durability of the equipment. ·Relief effect makes easy to drain used grease when filling up new grease.	·The product uses the iron rubber as the material, and is the standard type of hinge pin seal excellent in dust resistance.	204
	—		·This is mainly used to the housing diameter exceeding ø160.	206

	Speed (m/s)	Feature		Dimension table(page)
	0.03 ～1.0	·This is used in combination with rod packing to absorb the impact and fluctuating pressure at high load, to isolate high temperature fluid, and to improve the durability of the packing.	·Special shaped slit at the sliding lip that can leak back pressure eliminates the pressure between the rod packing and buffer ring.	208
	0.005 ～1.5		·This has the same function as that of HBY. ·This has small friction resistance and suits for high speed,extremely short stroke operation. ·A slit on the tapered surface (non-sliding surface) can leak back pressure.	211
				—
	0.005 ～1.5	·This is used as bearing of piston to prevent its scoring or eccentricity and to improve the durability of the packings.	·Supplied in hoop (10m/roll) enabling to be cut according to the cylinder diameter. ·Rareflon is used for material. This wear ring has low frictional resistance eliminating stick slip.	214
			·Rareflon is used for sliding material. This packing has low frictional resistance, eliminating stick slip.	—
	0.005 ～1.0		·Excellent compression proof and wear resistance because of its fabric reinforced laminated phenolic resin material. ·One bias-cut is provided on the ring.	217
				—
		·This is used as bearing of rod to prevent its scoring or eccentricity and to improve the durability of the packings.		—
				—
		·This is used as bearing of piston & rod to prevent its scoring or eccentricity and to improve the durability of the packings.	·Resin fiber polyester material is used to boost impact strength and prevent cracking. The excellent compression characteristics of this material also enable a more compact design. ·Resin fiber polyester has low bending strength and is easy to assemble, making it suitable for thin rods.	221
	0.005 ～1.5	·This is used in combination with piston packings and wear rings to prevent damages of packings caused by foreign object in oil within the cylinder and to improve the durability of packings. ·When used in combination with rod packing and metal bush,damages of the rod can be prevented because of the foreign object submerging function of rareflon. ·One point cut is provided and oil pressure bypass slot is also provided to prevent pressure accumulation.		224
	—	·This is used to prevent extrusion of packings and to improve the pressure resistance of the packings.	·Standard cutting shape is bias-cut (BRT2).If there are no problem for installation, no cut endless type (BRT3) can be also used.	— Remark 3)
	—		·Standard cutting shape is bias-cut (BRN2).If there are no problem for installation, no cut endless type (BRN3) can be also used.	— Remark 3)
	—		·This is a backup ring that also serves as a wear ring. It can be used as the OKH type wear ring and as an OKH backup ring.	— Remark 3)

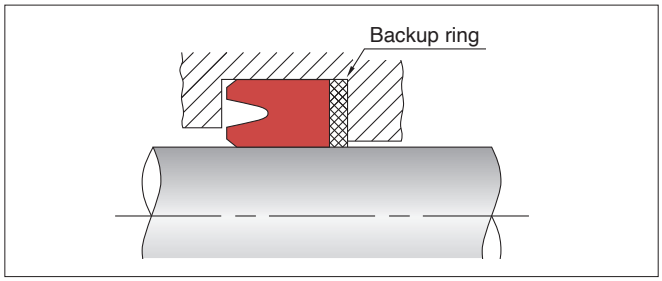
4. Application Range of Backup Ring

(1) The role of backup ring

If the extrusion gap is too large for the operating pressure of the packing, the heels of the packing may be damaged by extrosion (**Fig. B-1**).
In such case, a backup ring is necessary to prevent extrusion of the packing and to improve the durability (**Fig. B-2**).
Fig. B-7 on page **25** shows the relationship between operating pressure and extrusion gap.



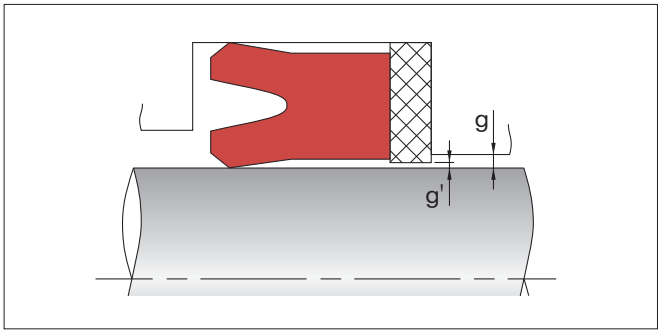
〈Fig. B-1〉



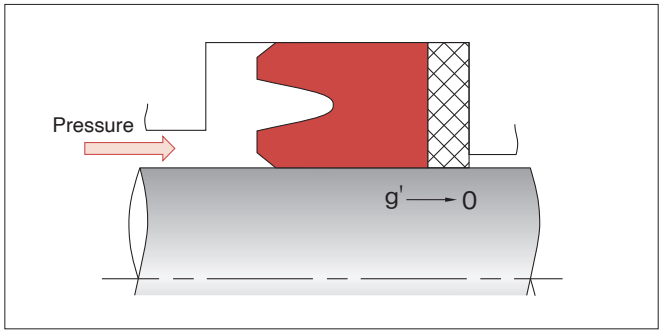
〈Fig. B-2〉

(2) Mechanism preventing extrusion

When the pressure is loaded, the backup ring is compressed and deformed to reduce the gap (**g' → 0**), which prevents the extrusion of the packing heel (**Fig. B-3 and 4**).



〈Fig. B-3〉



〈Fig. B-4〉

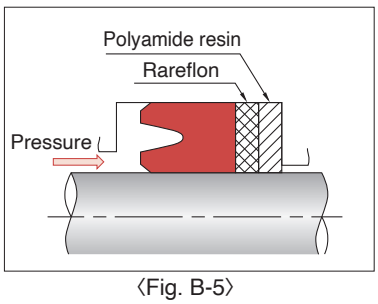
(3) Application Range of Backup Ring

Material characteristics required for a backup ring are easy compression deformation and extrusion resistance under working pressure. Friction resistance and low-friction characteristics are also important because a compressed and deformed backup ring moves in contact with the sliding surface. Considering these requirements, NOK made available two engineered plastic materials; polytetra-fluoro-ethylene (PTFE) resin (NOK rareflon) and polyamide resin. Rareflon is mainly used, while polyamide resin with high rigidity against deformation is used in high pressure conditions. **Table B-7** shows guidelines for material selection and **Table B-8** on page **25** shows the sign and characteristics of these materials and applicable packing type signs.

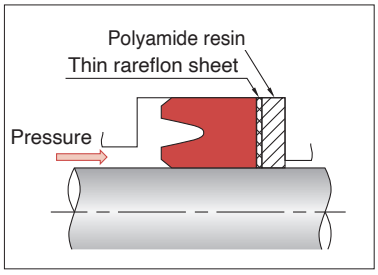
〈Table B-7〉 Guideline for backup ring material selection

Packing material \ Pressure (MPa)	0 – 14	14 – 32	32 – 35	35 – 70
Iron rubber	Rareflon	Rareflon	Polyamide resin	Polyamide resin
Nitrile, fluororubber, etc.	Rareflon	Rareflon	※ Combination of NOK rareflon and polyamide resin (Fig. B-5) ※ Thin rareflon sheet (see Fig. B-6): Effective in adapting to the current groove or as a measure against abrasion (wear) in the heel section.	※ Combination of NOK rareflon and polyamide resin (Fig. B-5) ※ Thin rareflon sheet (see Fig. B-6): Effective in adapting to the current groove or as a measure against abrasion (wear) in the heel section.

Remark 1) This table is a guideline for backup ring material selection. In selecting a packing, conditions other than pressure, such as extrusion gap, temperature, and packing shape, should also be considered.
Remark 2) Some of the packing profiles, especially small sizes, may not fit in the appropriate groove.
Remark 3) The dimensions of the polyamide resin may change due to moisture adsorption. If moisture-proof packaging is necessary, consult NOK.
Remark 4) When using larger diameter (inner diameter (d) exceeding the classification 300mm), consult NOK.



〈Fig. B-5〉



〈Fig. B-6〉 An example of using the Thin rareflon sheet

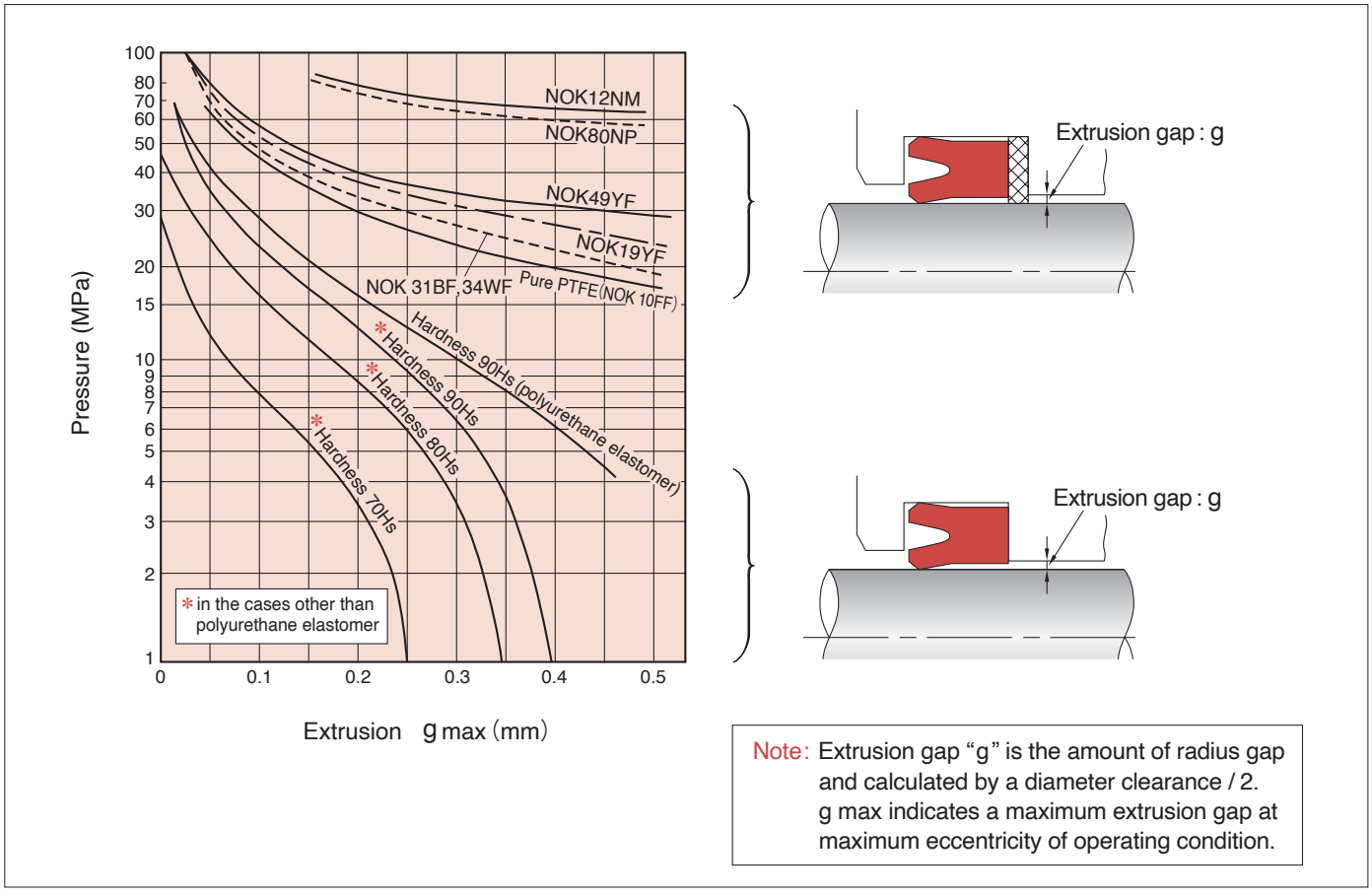
〈Table B-8〉 Material code and characteristics of backup ring

Material	NOK material code	Features	Durability	Applicable packing type sign
Rareflon	10FF	Pure PTFE. This material is excellent in heat resistance, cold resistance, and chemical resistance	Low ↕ High	OUHR UPH、USH IUH
	31BF	Low frictional resistance material with improved frictional and creep resistance against pure PTFE		
	34WF	Material boasts pure PTFE characteristics with enhanced wear resistance and creep resistance.		
	19YF	Standard material with high resistance against extrusion and friction under high pressure operation		
	49YF	Special material with improved extrusion resistance of 19YF		
Polyamide resin	80NP	Material with high resistance against extrusion and friction for high pressure. Its machining manufacturing process makes large diameter seals available		ODI、OSI、OUIS、 UPI、USI IDI、ISI、IUIS、 UNI
	12NM	Material for injection molding having the same performance as 80NP with smaller dimension changes by water absorption		

※ The dimensions of the polyamide resin may change due to moisture adsorption. If the moisture-proof packaging is necessary, consult NOK separately.

(4) Extrusion limit

Fig. B-7 is extrusion limit curves prescribed by JFPS1003 showing extrusions of rubber material for packings. This figure also shows the extrusion limit curves of NOK backup ring materials. The extrusion value of packings and backup rings varies depending on the temperature, pressure, and operating time. Therefore, please refer to the extrusion limit curves on dimension tables of each type for proper application.



〈Fig. B-7〉 Extrusion limit curves

※Extrusion limit may vary depending on the temperature, pressure, and operating time.
Therefore, please consult NOK when using under excessive high temperature and high pressure condition for long term use.

5. Application Range of Wear Ring

(1) The role of wear rings

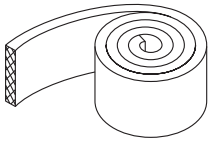
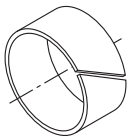
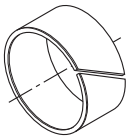
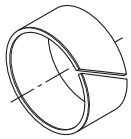
Wear rings are used as bearings on a piston to prevent scuffing the piston and cylinder, minimize the eccentricity, and improve the durability of packings.

(2) Selecting the wear rings

Select the shape and material of a wear ring according to the operating condition. For low speed and heavy load operations such as construction equipment, type WR with fabric reinforced phenolic resin (NOK 12RS·15RS)·resin fiber polyester (NOK 88RS) is recommended.

This material has excellent characteristics against compression load. For high speed and light load operations or operations where stick slip may be possible, type RYT of rareflon (NOK 05ZF) or type WRT (NOK 88RS) is recommended. This material has excellent characteristics against friction and wear. **Table B-9** shows the characteristics and application range of each wear ring type.

〈Table B-9〉 Characteristics and application range of wear ring

Type	RYT	WRT2	WR·WRR	WR
Shape				
Material (NOK sign)	Rareflon (rareflon 05ZF)	Rareflon (rareflon 08GF)	Fabric reinforced phenolic resin (12RS, 15RS)	Resin fiber polyester (NOK 88RS)
Caracteristics	●Low friction and stick slip suppresses wear ring ●Excellent wear resistance under high speed and light load operation ●Supplied in hoop (10m/roll) enabling to be cut according to the cylinder diameter	●Low friction and stick slip suppresses wear ring ●Excellent wear resistance under high speed and light load operation ●Thin rareflon sheet has a bias cut at one location and any required size for diameter and width is available	●NOK standard wear ring having excellent compression resistance characteristics ●Excellent wear resistance under low speed and heavy load operation ●Wide range of diameter and width size are available. Each piece has one point biascut. (Sizes other than those on the dimension table are available.) ●Wear rings of rareflon (WRT) are also available	●Wear ring with high impact strength and lateral load resistance ●Suitable for pistons and rods ●Each piece has one point biascut. (Sizes other than those on the dimension table are available.)
Allowable temperature range	−55～220℃		−55～120℃	−60～130℃

(3) Dimension Set up of Wear Rings

RYT (NOK 05ZF) and WR (NOK 12RS) of various diameter sizes and width sizes are prepared so that the customer can select them according to cylinder diameter and groove size. For details, see the dimension table on pages **214 to 222**. Consult NOK for WRT2 (NOK 08GF) and WR (NOK 15RS) manufacturing. Set width size "h", using the following calculation expression.

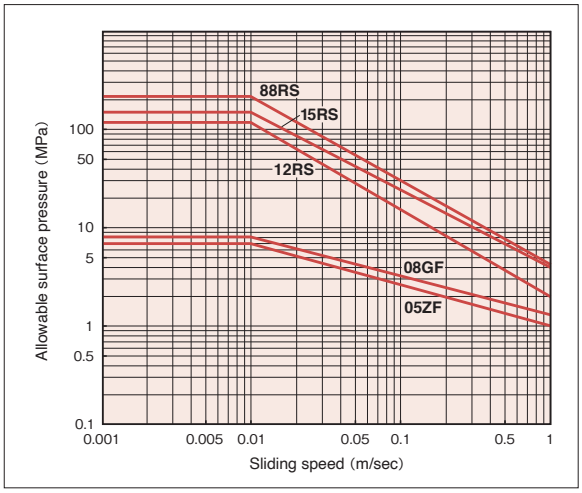
$$h_{min} \geqq \frac{F \cdot S_0}{\sigma \cdot D \cdot \pi \cdot (1/3)} + 2C \quad \cdots\cdots (a)$$

h min : Minimum width size of wear ring (mm)
F : Load charged on wear ring (N)
S_0 : Safety coefficient
σ : Allowable surface pressure of wear ring material (MPa)
D : Inner diameter of cylinder tube (mm)
C : Chamfer width of wear ring (mm)
(12RS·15RS : C=0.8、05ZF·08GF : C=0)

Allowable Surface Pressure of Wear Ring Material : σ

Fig. B-8 shows the allowable surface pressure of wear ring material under the oil lubrication condition.

The allowable surface pressure varies with sliding speed.



〈Fig. B-8〉 Sliding speed and wear ring material's allowable surface pressure

Load that is Applied to Wear Ring : F

The load that is applied to wear rings is based on the principle of leverage and is calculated using the following calculation expression.

① When lateral load exists

〈Piston〉

$$W \times L2 = F1 \times L1$$

$$F1 = W \times \frac{L2}{L1} \quad \cdots\cdots(b)$$

〈Rod〉

$$F2 = F1 + W$$

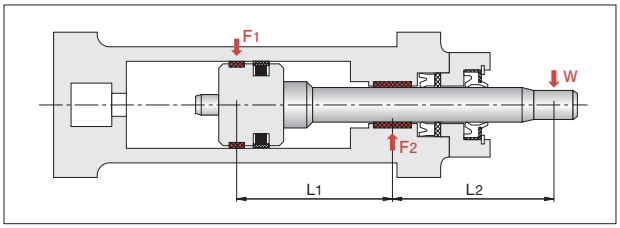
$$F2 = W \times \frac{L1 + L2}{L1} \quad \cdots\cdots(c)$$

② When lateral load does not exist

〈For both piston and rod〉

$$F^{※} = (\text{Piston's weight} + \text{rod's weight}) + \frac{1}{200} \times \frac{\pi \cdot D^2}{4} \times P\,\text{max} \cdots(d)$$

※ F = F1 = F2



〈Fig. B-9〉

W : Lateral load (N)
L1, L2 : Distance (mm)
D : Inner diameter of cylinder tube (mm)
P max : Maximum pressure (MPa)
F1 : Load that is applied to wear ring for piston (N)
F2 : Load that is applied to wear ring for rod (N)

Safety Rate : S0

① When lateral load exists

S0 { When impact lateral load does not exist : 1.5
   { When impact lateral load exists : 4

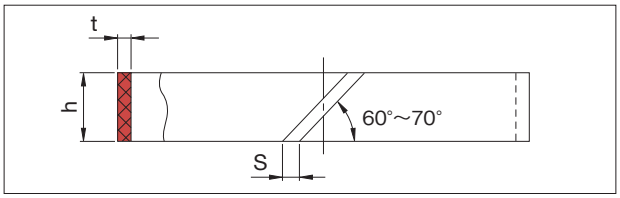
② When lateral load does not exist

S0 = 1

Set width size"h", using the calculation expression described in (3).

$$L = \pi \cdot (D - t) - S$$

Calculate length "L" which is cut according to the inner diameter of the cylinder, using the following calculation expression:



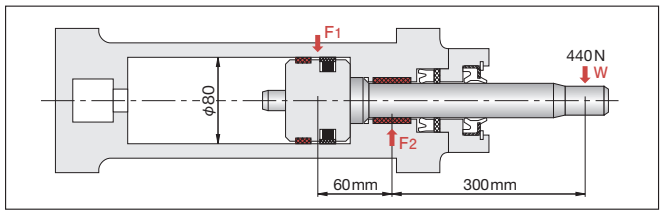
〈Fig. B-10〉

D : Inner diameter of cylinder tube (mm)
t : Thickness of wear ring (mm)
S : Clearance of wear ring (mm)

Note: For t and S, see the dimension table on page 214.

Example Calculation Example of Width Size of Wear Ring

Calculate the width size of wear ring (type: WR, material: 12RS) for the piston, based on the following using condition.



〈Conditions〉

Item	Description
Maximum lateral load (W)	440 N
Maximum rod length (L2)	300 mm
Minimum bearing clearance (L1)	60 mm
Speed (V)	0.3 m/s
Cylinder tube inner diameter (D)	ø80
Impact lateral load	Yes

Step 1 What is the load applied to the wear ring?

First, calculate load F1 for the wear ring.
Since the above condition includes lateral load, calculate the load that is applied to the wear ring, using expression (b).

$$F1 = W \times \frac{L2}{L1} = 440 \times \frac{300}{60} = 2200 \text{ (N)}$$

Step 2 What is the allowable surface pressure of wear ring material?

The line drawing in **Fig. B-8** shows that the allowable surface pressure of 12RS material at V=0.3 m/s is 6 MPa.

Step 3 What is the dimension of wear ring width?

Assign the values obtained in the above steps (1) and (2) to the expression (a) that calculates width size "h" (minimum).
Also, when impact lateral load exists, set the safety rate S0 to 4.

$$h\,\text{min} \geqq \frac{2200 \times 4}{6 \times 80 \times \pi \times (1/3)} + 1.6$$

$$= 19.1 \text{ mm}$$

From the above, 20 mm is obtained for the width size of wear ring for the piston under the above conditions.

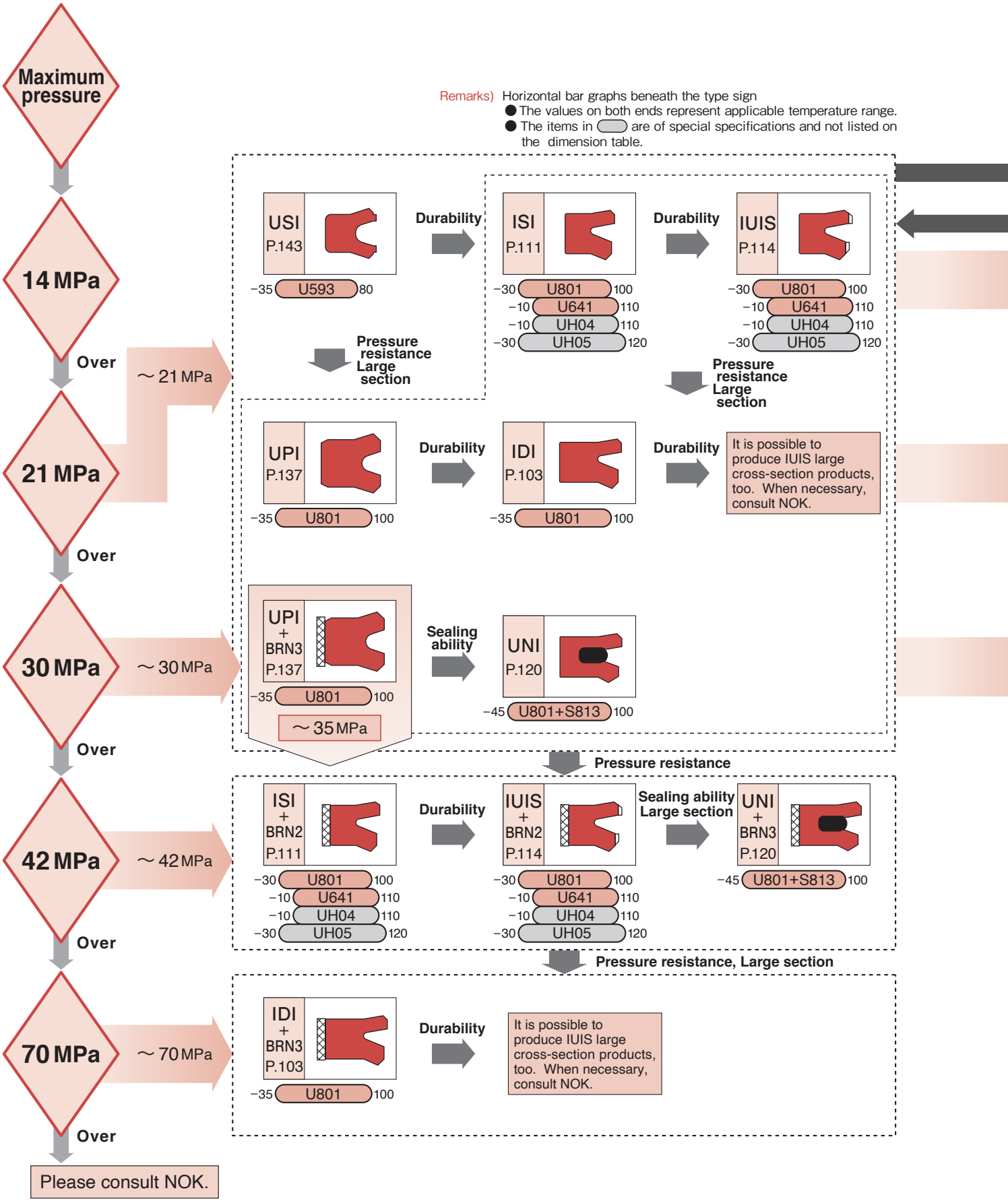
Note: When setting width size, round up the value after the decimal point.

6. Flow Chart for Selecting the Packing Type

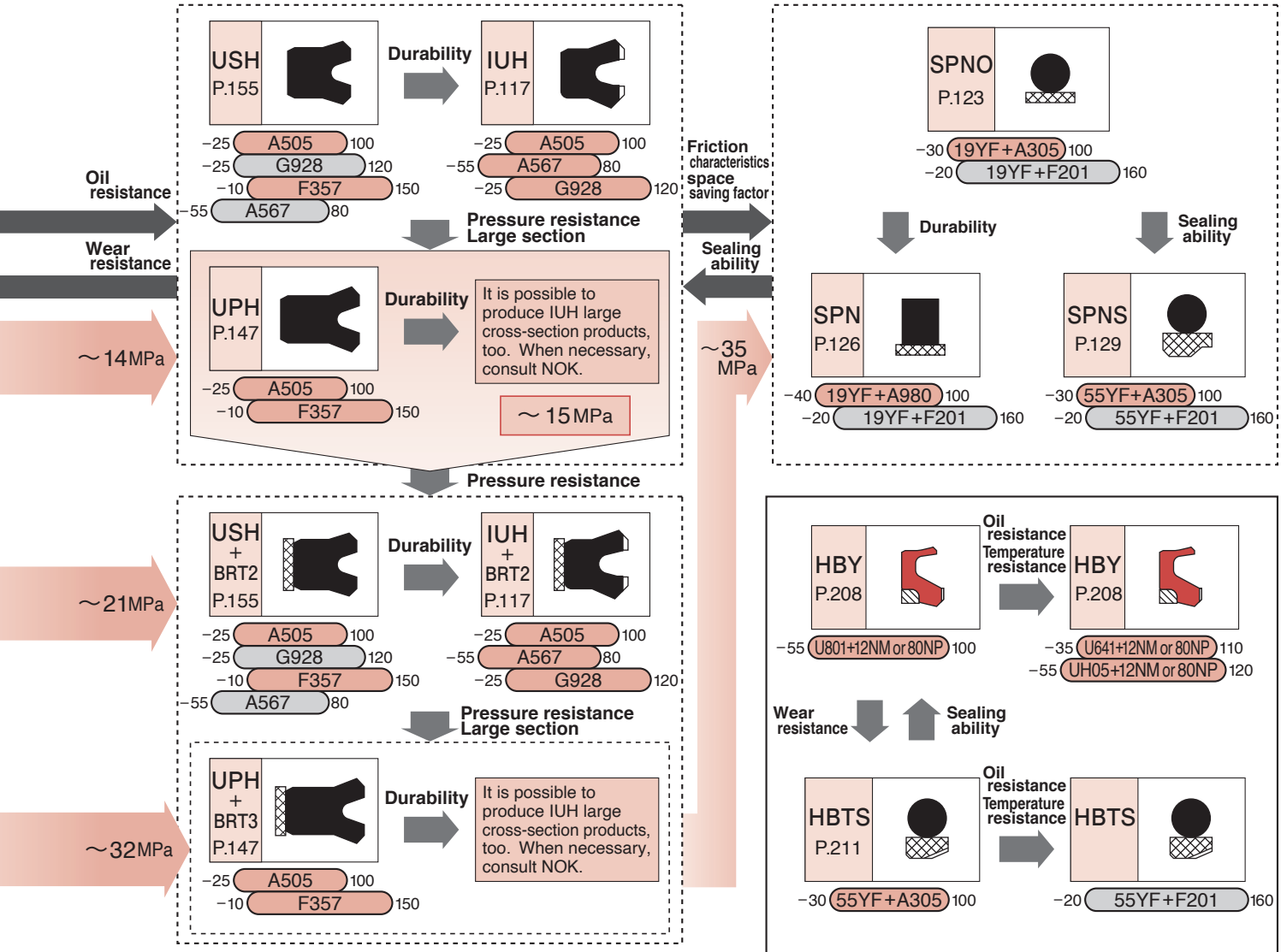
NOK provides a wide range of seals in various conditions. A selection flow chart is shown to determine the optimum seal.

1. After selecting the packing type, check if the working temperature, the speed, and the stroke are in the applicable range for each seal, by referring to pages **14 and 19**.

(1) Rod seals 〈Fig. B-11〉



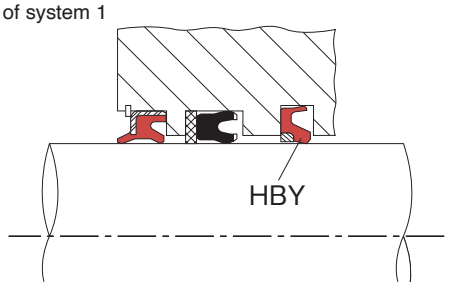
2. Check the affinity between the oil that is used and the seal material, by referring to pages **271 to 292** and to the oil resistance data in **Chapter I**.
3. Check the sealing system of the equipment and model that are used, by referring to page **39** and to the use example in **Chapter D**.
When using a special oil or using the under the condition outside the applicable range, consult NOK separately.



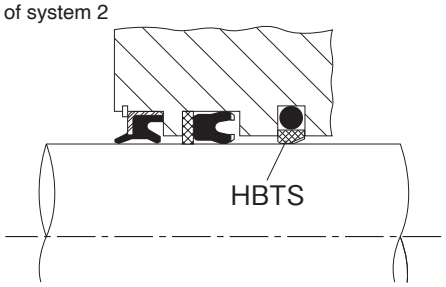
In combination with the buffer ring, the rod seal is effective in buffering the impact pressure, in inhibiting the oil temperature transfer, and in reducing the sliding heat generation, thus being able to improve the durability of the rod seal.
(See “Buffer ring” on page 259.)

Example of sealing system using buffer rings

Example of system 1

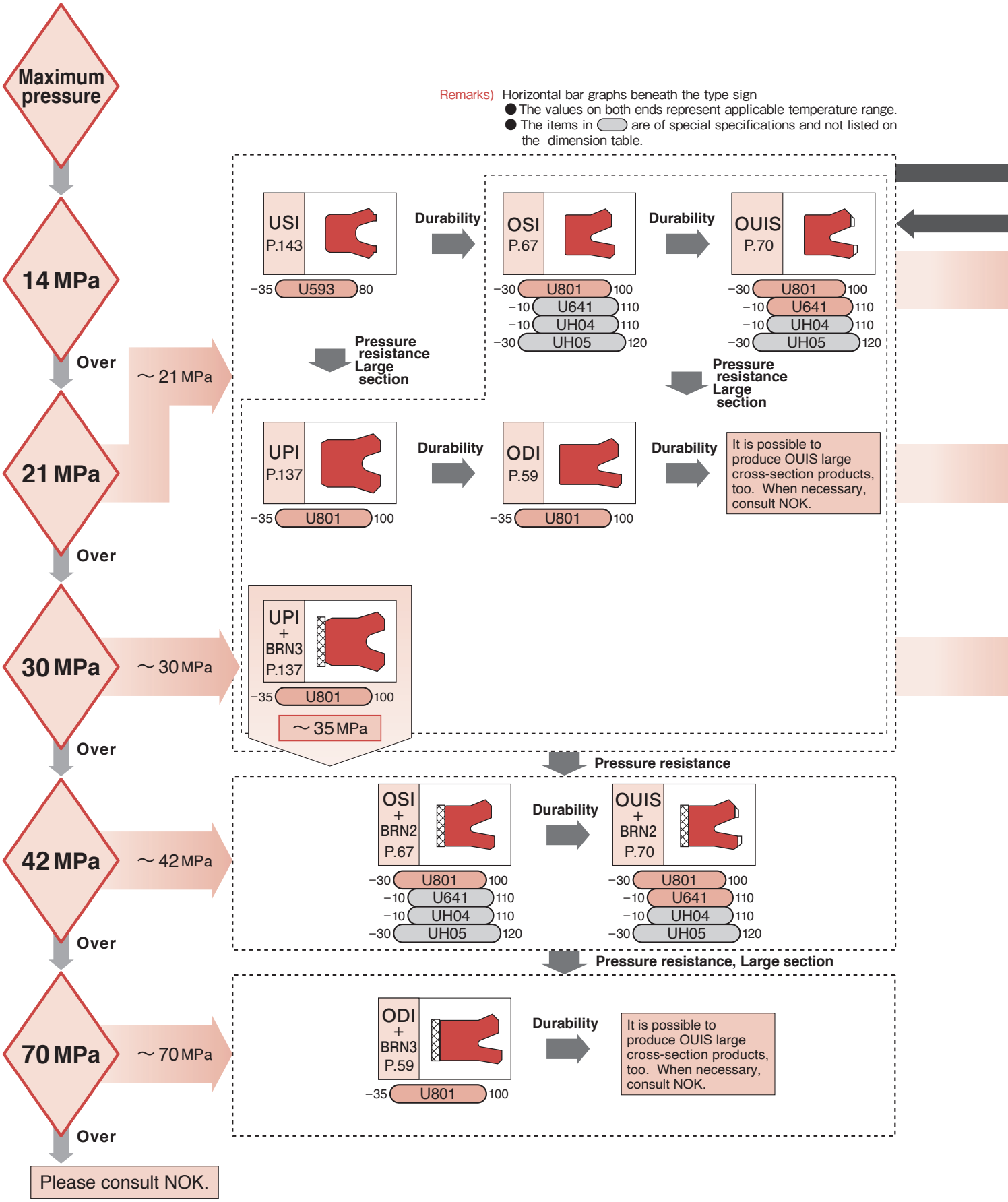


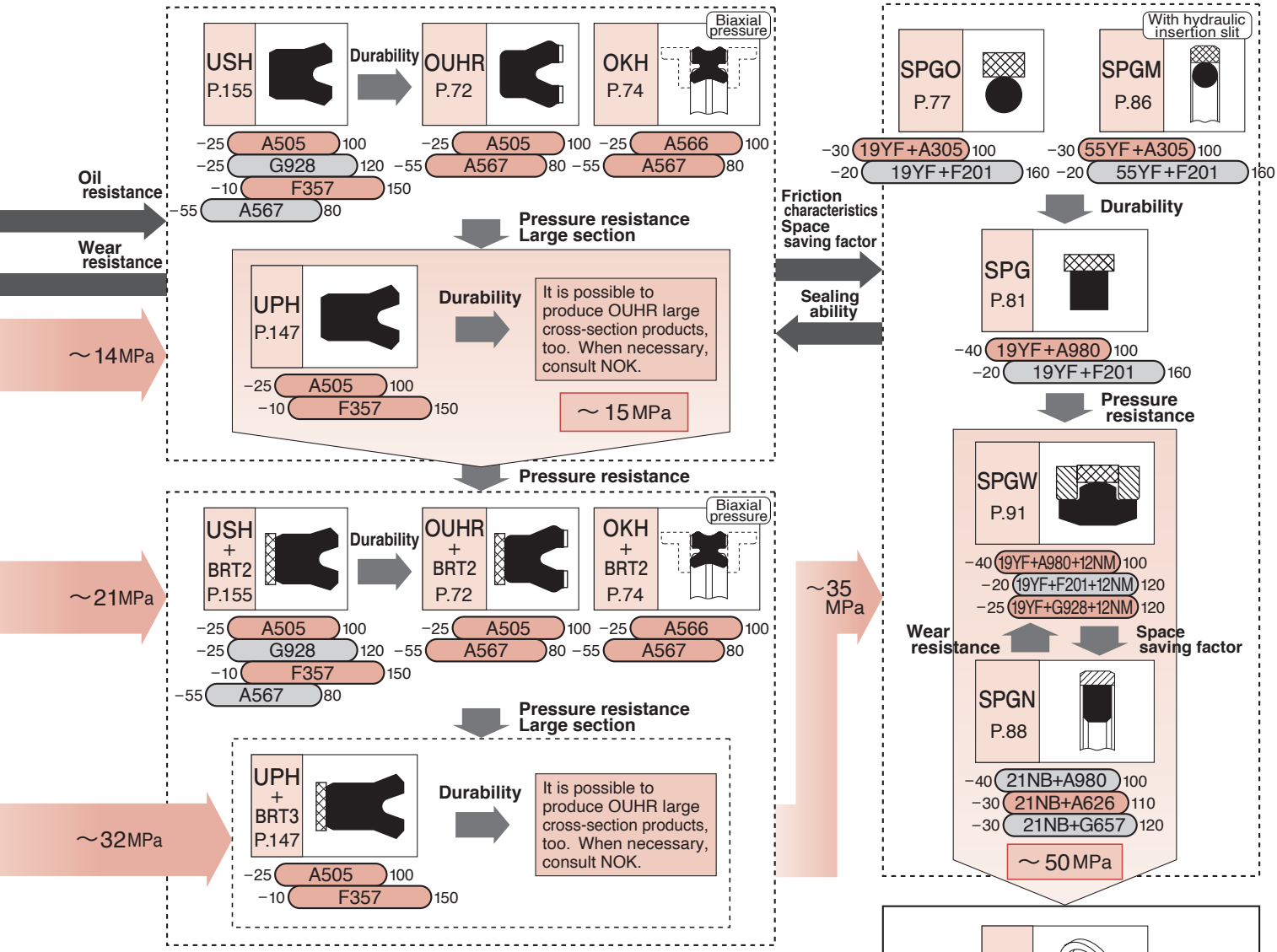
Example of system 2



※1. When the minimum pressure that is applied is usually 3 MPa or larger, the life of the seal is decreased, so we recommend that the customer use the seal in combination with the buffer ring.
※2. In combination with the buffer ring, the customer can use the seal under high pressure.
For example, in the case of IUH type packing, up to 34.3 MPa can be applied (see Hydraulic excavator, rod sealing system on page 47).

(2) Piston seals 〈Fig. B-12〉

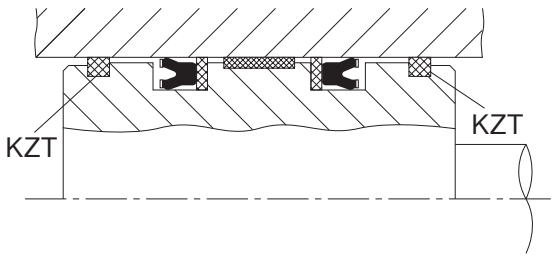




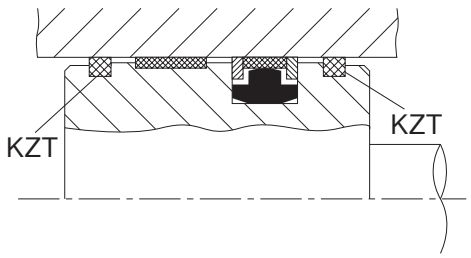
In combination with the contamination seal, the piston seal prevents damage due to foreign objects or adiabatic compression, thus being able to improve the durability of the piston seal. (See “Burnout phenomenon” on page 246.)

Example of sealing system using contami seals

Example of system 1

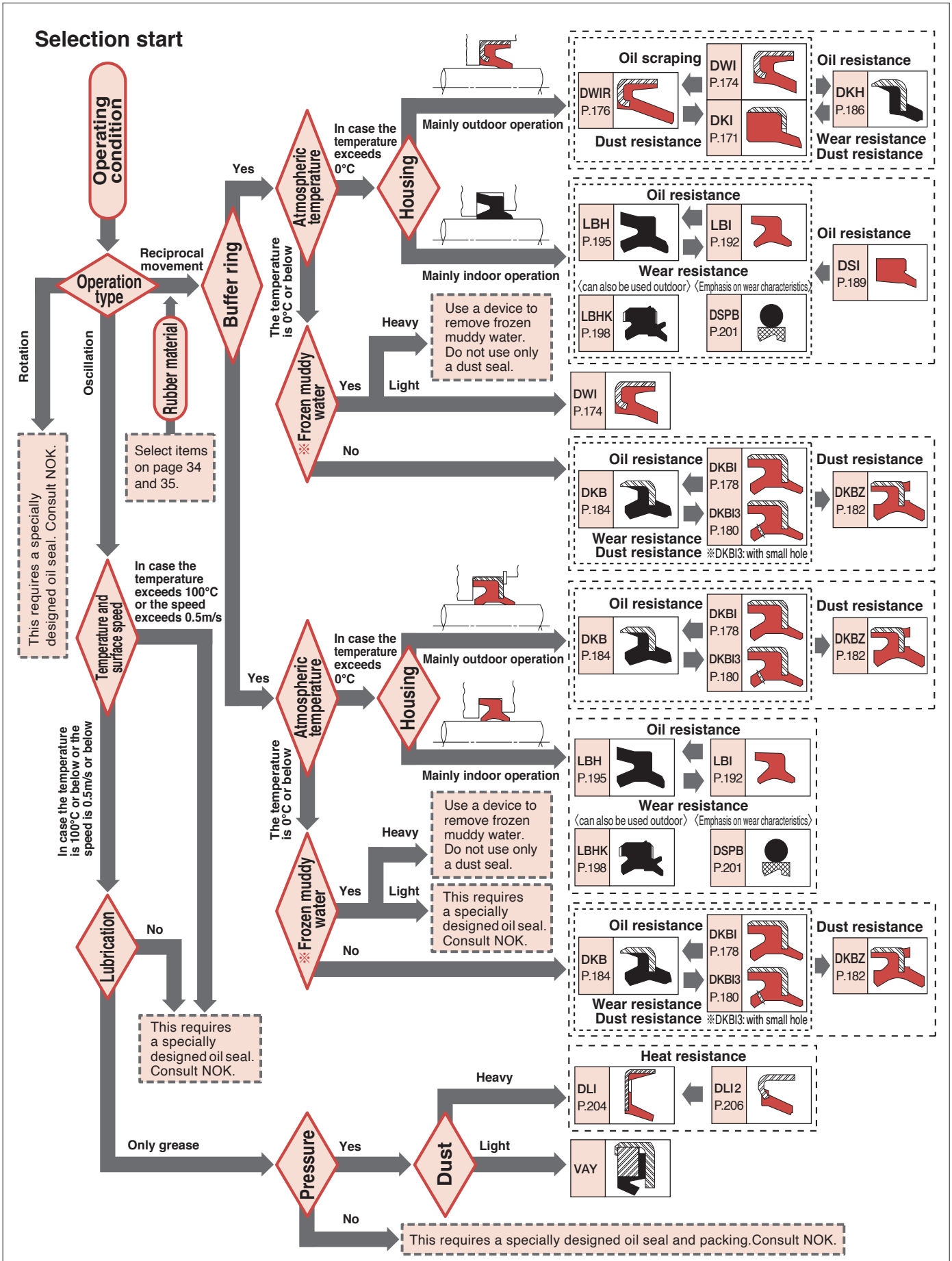


Example of system 2



(3) Dust Seal

〈Fig. B-13〉 Flow chart for selecting dust seal types



※ frozen muddy water : Water on the rod surface during daytime operation tends to be frozen at night time due to low temperature.

If the selection cannot be made by this flow chart because of the operating condition such as within muddy water, sea water, vacuum, or negative pressure, please consult NOK.