

DP4[®], DP10 and DP11
**METAL-POLYMER SELF-LUBRICATING
LEAD FREE BEARING SOLUTIONS**

GGB began in 1899 as Glacier Antifriction Metal Company, producing plain bearings and introducing many successful new products to the market, including internationally recognized polymer materials. Over the past 120 years, our company has continued forming strategic partnerships, continuously expanding into a global network of manufacturing facilities, increasing production capabilities and resources to become who we are today: world leaders in tribological innovation.

Today, our products can be found everywhere – from scientific vessels at the bottom of the ocean to racecars speeding down the tarmac to jumbo jets slicing through the sky to the Curiosity rover exploring the surface of Mars.

Throughout our history, safety, excellence and respect have formed the foundational values for the entire GGB family. They are of paramount importance as we seek to maximize personal possibility, achieve excellence and establish open, creative work environments with the highest safety standards in the industry.

The Highest Standards in Quality



SAFETY

Our deep-rooted culture of safety places a relentless focus on creating a secure, healthy work environment for all. As one of our core values, safety is essential for us to achieve our goal of having the safest employees in the industry.



EXCELLENCE

Our world-class manufacturing plants in the United States, Brazil, China, Germany, France and Slovakia are certified in quality and excellence according to ISO 9001, IATF 16949, ISO 14001 and ISO 45001. This allows us to access the industry's best practices while aligning our management system with global standards.

For a complete listing of our certifications, please visit our website:

<https://www.ggbearings.com/en/certificates>



RESPECT

Our teams work together with mutual respect regardless of background, nationality, or function, embracing the diversity of people and learning from one another - after all, with respect comes both individual and group growth.

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The GGB Advantage



LOWER SYSTEM COST

GGB bearings reduce shaft costs by eliminating the need for hardening and machining grease paths. Their compact, one-piece construction provides space and weight savings and simplifies assembly.



LOW-FRICTION, HIGH WEAR RESISTANCE

Low coefficients of friction eliminate the need for lubrication, while providing smooth operation, reducing wear and extending service life. Low-friction also eliminates the effects of stick-slip or "stiction" during start up.



MAINTENANCE-FREE

GGB bearings are self-lubricating, making them ideal for applications requiring long bearing life without continuous maintenance, as well as operating conditions with inadequate or no lubrication.



ENVIRONMENTAL

Greaseless, lead-free GGB bearings comply with increasingly stringent environmental regulations such as the EU RoHS directive restricting the use of hazardous substances in certain types of electrical and electronic equipment.



CUSTOMER SUPPORT

GGB's flexible production platform and extensive supply network assure quick turnaround and timely deliveries. In addition, we offer local applications engineering and technical support.



GLOBAL FOOTPRINT

Our global presence and local logistics networks ensure our customers receive only the highest quality bearing solutions, in a timely manner and with extensive engineering support.

We don't just make products, we build partnerships. That's the GGB Advantage.

1 Introduction

This brochure describes the range of selflubricated PTFE based metal-polymer plain bearings specifically developed by GGB for use in dry applications. PTFE based metal-polymer plain bearings are used extensively in a diverse range of industrial and automotive applications, where potentially they can:

- offer environmentally friendly dry running operation (as opposed to grease or oil lubricated)
- improve friction and wear performance (relative to conventional bronze, steel and bimetal bearings)
- reduce equipment / operating costs and improve performance (when replacing rolling element bearings)

These GGB plain bearing materials give excellent performance in a wide range of loads, speeds and temperatures; with or without external lubrication.

GGB's longest serving product, DU®, was developed as a self-lubricated dry bearing more than 50 years ago, when it quickly became established as a worldwide industry standard.

However, due to the lead content in the DU® overlay, GGB has developed a new range of lead free self-lubricated materials capable of meeting the most stringent performance requirements.

Each new material complies with the following European Parliament legislation:

- End of Life vehicles directive 2000/53/EC concerning the elimination of hazardous materials in the construction of passenger vehicles and light trucks (the EVL directive).
- Directive 2002/95/EC concerning the restriction of the use of certain hazardous substances in electrical and electronic equipment (the RoHS regulations).

Although designed for dry operation, these PTFE based materials can also perform exceptionally well in fluid lubricated conditions. For example, both DP4® and DP10 are particularly suited to marginally lubricated conditions, and DP4® performs well in oil lubricated heavy duty hydraulic applications.

2 Structure and Composition

GGB's PTFE based metal-polymer materials are composed of three bonded layers: a steel backing and a porous bronze interlayer, impregnated and overlaid with a bearing surface consisting of PTFE (polytetrafluoroethylene) and fillers.

The steel backing provides mechanical strength while the bronze sinter layer provides a strong mechanical bond for the filled PTFE bearing lining.

The PTFE-based bearing surface exhibits very low friction properties, and the different filler packages (indicated below) give each product its unique set of physical characteristics, for example, superior wear resistance.

DP4® can also be supplied with a bronze backing, (referred to as DP4-B) when improved corrosion resistance or antimagnetic properties are required.

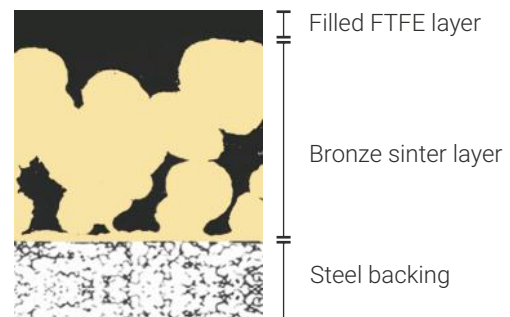


Figure 1: DP4 microsection

2.1 MATERIAL BEARING LAYER COMPOSITION

MATERIAL	DP4®	DP10	DP11
Bearing Lining Composition	PTFE + Fillers	PTFE + Solid lubricant	PTFE + Solid lubricant + Fillers

Table 1: Material bearing layer composition

2.2 BASIC FORMS

Standard Components

Standard products are manufactured according to international, national and internal standards. Standard products are produced in the following forms:

- Cylindrical Bushes
- Flanged Bushes
- Thrust Washers
- Flanged Washers
- Strip Material



Figure 2: Standard stock products

Availability

- | | | |
|--------------|---|-------------------------------|
| DP4® | Cylindrical, flanged bushes, thrust and flanged washers and strip | — ex stock |
| DP4-B | Cylindrical, flanged bushes and strip
Thrust and flanged washers | — ex stock
— made to order |
| DP10 | All forms | — made to order |
| DP11 | All forms | — made to order |

Non-Standard Components

Non-Standard products are manufactured to requirements and may for example include the following forms:

- Modified standard parts (notches, oil grooves, etc.)
- Stampings and deep drawn parts
- Special shapes



Figure 3: Non-Standard products made to order

3 Properties

3.1 PHYSICAL AND MECHANICAL PROPERTIES

BEARING PROPERTIES		UNITS	DP4®	DP4-B	DP10	DP11
Physical Properties						
Coefficient of linear thermal expansion	Parallel to the surface	10 ⁻⁶ /K	11	18	11	11
	Normal to the surface	10 ⁻⁶ /K	30	36	30	30
Operating temperature	Min	°C	- 200	- 200	- 200	- 200
	Max	°C	280	280	280	280
Mechanical Properties						
Compressive yield strength		N/mm ²	350	300	350	350
Maximum load, p	Static	N/mm ²	250	140	250	250
	Dynamic	N/mm ²	140	140	140	140
Bearing Properties - Dry						
Maximum sliding speed, U		m/s	2,5	2,5	2,5	2,5
Maximum pU factor		N/mm ² x m/s	1,0	1,0	1,0	1,0
Recommended mating surface hardness		HB	> 200	> 200	> 200	> 200
Recommended mating surface finish R _a		mm	0,4 ± 0,1	0,4 ± 0,1	0,4 ± 0,1	0,4 ± 0,1

Table 2: Physical and Mechanical Properties

4 Bearing Performance

Each application, depending on the equipment design, usage and operating conditions (load, speed, type of movement, temperature, etc.), places individual demands on the bearing.

GGB undertook an extensive test program in order to determine each material's dry wear performance, while operating with different types of movement.

The three different types of movement are: – Continuous rotation – Low frequency oscillation – High frequency oscillation

Additionally, friction values for each material were measured under low and high speed dry running conditions. Finally, the material's resistance to bore burnishing (bore calibration) was also validated.

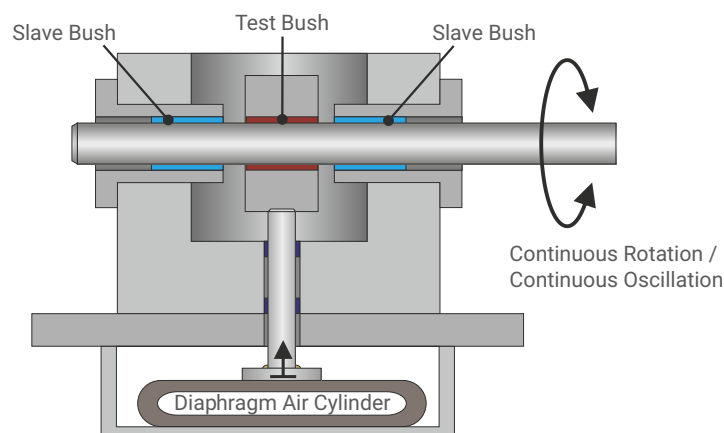


Figure 4: GGB Jupiter test rig

4.1 CONTINUOUS ROTATION

Under continuous rotation according to the GGB test conditions, the relative dry wear performance of each material see Fig.5.

Typical applications include:

Pulleys, sheaves, sprockets, wheels, axles, gears & gear shafts, crank shafts, office equipment, bank note handling machinery, packaging machinery, special purpose machinery, cranes & hoists, agricultural machinery, etc.

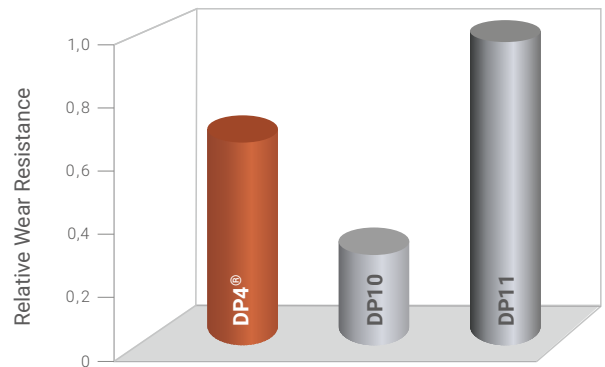


Figure 5: Relative wear resistance

Test Conditions:

- Specific load = 25 N/mm²
- Rotation speed = 0,04 m/s
- Life test

4.2 OSCILLATING MOVEMENT LOW FREQUENCY / HIGH AMPLITUDE

Under low frequency and high amplitude oscillating movement, according to the GGB test conditions, the relative dry wear performance of each material see Fig.6.

Typical applications include:

Pulleys, sheaves, sprockets, wheels, axles, gears & gear shafts, crank shafts, office equipment, bank note handling machinery, packaging machinery, special purpose machinery, cranes & hoists, agricultural machinery, etc.

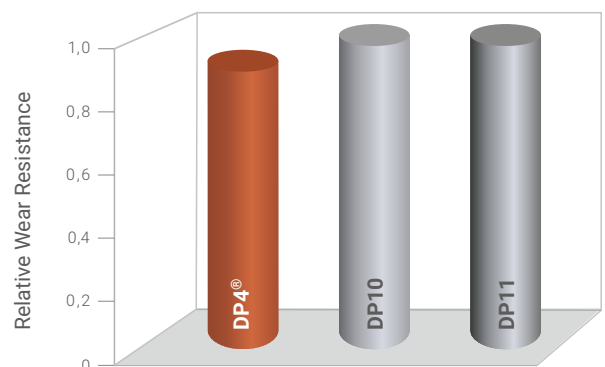


Figure 6: Relative wear resistance

Test Conditions:

- Specific load = 5 N/mm²
- Frequency = 1 Hz
- Angle = ±60°
- 40 Hours Operation

4.3 OSCILLATING MOVEMENT HIGH FREQUENCY / LOW AMPLITUDE

Under high frequency and low amplitude oscillating movement according to the GGB test conditions, the relative dry wear performance of each material see Fig.7.

Typical applications include:

Pulley dampers, belt tensioners, chain tensioners, twin mass flywheels, clutches, solenoids, textile machines, etc.

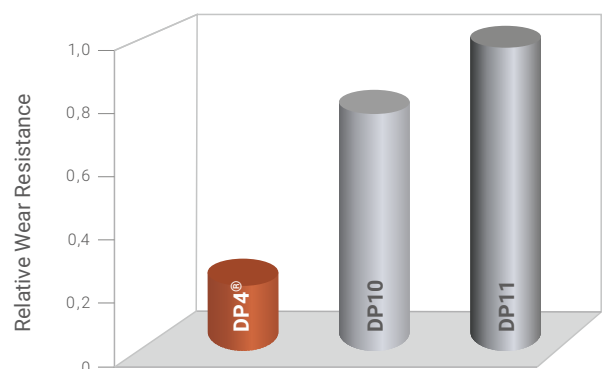


Figure 7: Relative wear resistance

Test Conditions:

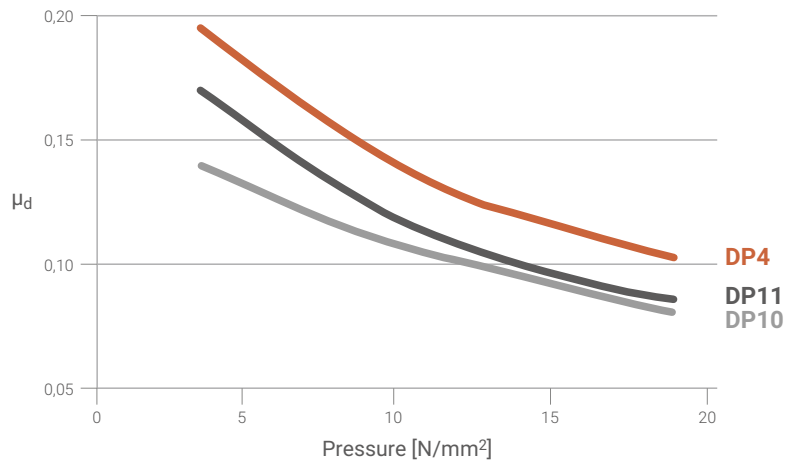
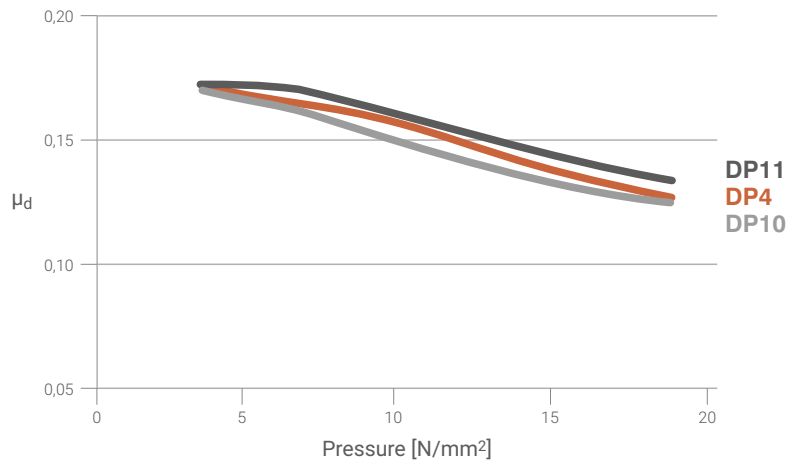
- Specific load = 5 N/mm²
- Frequency = 30 Hz
- Angle = ±3°
- Life test

4 Bearing Performance

4.4 DRY FRICTION

A low level of friction is generally desirable in most dry bearing applications. An indication of dynamic friction coefficient under low and high speed dry conditions is indicated in the graphs below. None of the materials exhibited stick-slip effects.

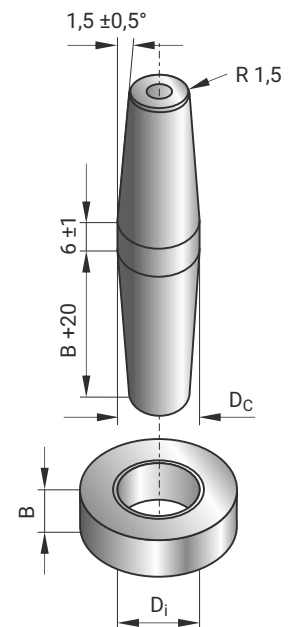
Note that actual friction values in the final application will depend upon many design and operating factors. Consequently, if frictional characteristics are critical to an application, the actual values should be determined by testing.



4.5 BUSH BURNISHING

Burnishing the bore of an assembled bush (calibration) reduces the variation of the inner diameter of the bush, which leads to a reduction in the clearance variation between the bush and the shaft (less play, lower noise, etc). The recommended burnishing tool design is shown in the illustration opposite.

GGB trials demonstrated that all three materials exhibited no removal of the bearing layer for diametric burnish interferences up to 0,15 mm. However the impact of burnishing on the bearing and on the assembly should be validated by trials.



5 Selection Guide

5.1 PRODUCT PERFORMANCE COMPARISON

Product selection may be simplified by using the following table which compares the relative strengths of each material.

For specific applications where bearing performance is of major importance, or where environmental or unusual operating conditions are present, prototype testing or test rig simulations are recommended, to confirm satisfactory bearing design and performance.

MATERIAL	CONTINUOUS ROTATION	LOW FREQUENCY OSCILLATION	HIGH FREQUENCY OSCILLATION	DRY FRICTION	BURNISH-ABILITY
DP4®	●	●	●	●	●
DP10	●	●	●	●	●
DP11	●	●	●	●	●

● Recommended ● Good ● Fair

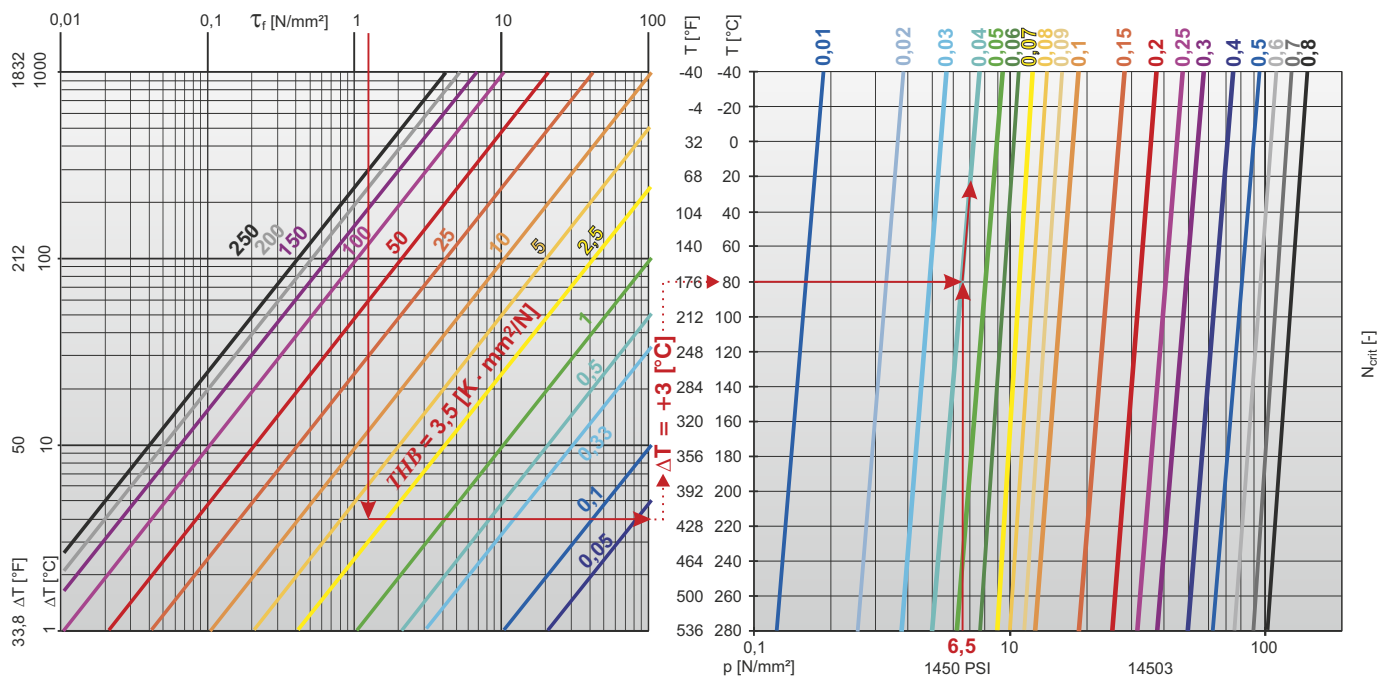
5.2 CALCULATION OF GGB BEARING PERFORMANCE

For many years, GGB has carried out extensive plain bearing material testing on a variety of test rigs running under a range of different, but controlled operating conditions.

Using the data from these tests, in addition to the various graphs and guides shown above and published for its other materials,

GGB has been able to develop advanced programs that enable GGB engineers to undertake more detailed predictions of bearing performance and bearing material selection according to the unique operating conditions of each specific application.

This service is available by completing the enclosed Data Sheet for Bearing Design and by contacting your local GGB representative.



6 Bearing Application Data Sheet

Not sure which GGB part fits your application requirements?

Please complete the form below and share it with your GGB sales person or distributor representative.

DATA FOR BEARING DESIGN CALCULATION

Application: _____

Project/No.: _____ Quantity: _____ New Design Existing Design

Steady load Rotating load Rotational movement Oscillating movement Linear movement

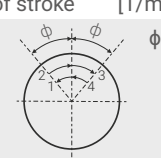
DIMENSIONS [MM]

Inside diameter	D_i	
Outside diameter	D_o	
Length	B	
Flange Diameter	D_{fl}	
Flange thickness	B_{fl}	
Wall thickness	S_T	
Length of slideplate	L	
Width of slideplate	W	
Thickness of slideplate	S_S	

LOAD

<input type="checkbox"/> Static load	
<input type="checkbox"/> Dynamic load	
Axial load F	[N]
Radial load F	[N]

MOVEMENT

Rotational speed	N [1/min]	
Speed	U [m/s]	
Length of stroke	L_s [mm]	
Frequency of stroke	[1/min]	
Oscillating cycle		ϕ [°]
Osc. frequency	N_{osz} [1/min]	

MATING SURFACE

Material	
Hardness	HB/HRC
Surface finish	Ra [µm]

CUSTOMER INFORMATION

Company _____

Street _____

City / State / Province / Post Code _____

Telephone _____ Fax _____

Name _____

Email Address _____ Date _____

FITS & TOLERANCES

Shaft	D_J	
Bearing housing	D_H	

OPERATING ENVIRONMENT

Ambient temperature	T_{amb} [°]	
Bearing housing material		
<input type="checkbox"/> Housing with good heating transfer properties		
<input type="checkbox"/> Light pressing or insulated housing with poor heat transfer properties		
<input type="checkbox"/> Non metal housing with poor heat transfer properties		
<input type="checkbox"/> Alternate operation in water and dry		

LUBRICATION

<input type="checkbox"/> Dry	
<input type="checkbox"/> Continuous lubrication	
<input type="checkbox"/> Process fluid lubrication	
<input type="checkbox"/> Initial lubrication only	
<input type="checkbox"/> Hydrodynamic conditions	
Process fluid	
Lubricant	
Dynamic viscosity	η [mPas]

SERVICE HOURS PER DAY

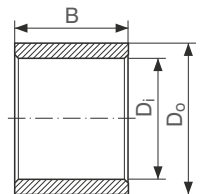
Continuous operation	
Intermittent operation	
Operating time	
Days per year	

SERVICE LIFE

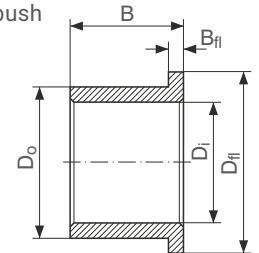
Required service life	L_H [h]
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BEARING TYPE

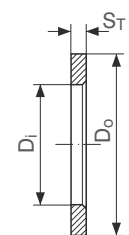
Cylindrical bush



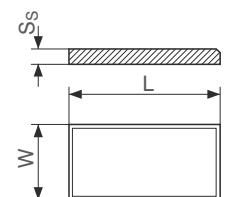
Flanged bush



Thrust washer



Slideplate



Special parts (sketch)

7 Product Information

GGB assures the products described in this document have no manufacturing errors or material deficiencies.

The details set out in this document are registered to assist in assessing material suitability for intended use. They have been developed from our own investigations as well as generally accessible publications. They do not represent any assurance for the properties themselves.

Unless expressly declared in writing, GGB gives no warranty that the products described are suited for any particular purpose or specific operating circumstances. GGB accepts no liability for any losses, damages, or costs however they may arise through direct or indirect use of these products.

GGB's sales and delivery terms and conditions, included as an integral part of quotations, stock and price lists, apply absolutely to all business conducted by GGB. Copies can be made available on request.

Products are subject to continual development. GGB retains the right to make specification amendments or improvements to technical data without prior announcement. Edition 2023 (this edition replaces earlier editions which hereby lose their validity).

STATEMENT REGARDING LEAD CONTENT IN GGB PRODUCTS & EU DIRECTIVE COMPLIANCE

GGB is committed to adhering to all U.S., European, and international standards and regulations with regard to lead content. We have established internal processes that monitor any changes to existing standards and regulations, and we work collaboratively with customers and distributors to ensure all requirements are strictly followed. This includes RoHS and REACH guidelines.

GGB makes it a top priority to operate in an environmentally conscious and safe manner. We follow numerous industry best practices and are committed to meeting or exceeding a variety of internationally recognized standards for emissions control and workplace safety.

Each of our global locations has management systems in place that adhere to IATF 16949, ISO 9001, ISO 14001, ISO 45001, and AS9100D/EN9100 quality regulations.

All of our certificates can be found here: <https://www.ggbearings.com/en/certificates>. A detailed explanation of our commitment to REACH and RoHS directives can be found at:

<https://www.ggbearings.com/en/who-we-are/quality-and-environment>.

HEALTH HAZARD - WARNING

Fabrication

At temperatures up to 250 °C the polytetrafluoroethylene (PTFE) present in the lining material is completely inert so that even on the rare occasions in which DP4®, DP4-B, DP10 or DP11 bushes are drilled or sized after assembly there is no danger in boring or burnishing.

At higher temperatures however, small quantities of toxic fumes can be produced and the direct inhalation of these can cause an influenza type of illness which may not appear for some hours but which subsides without after-effects in 24-48 hours.

Such fumes can arise from PTFE particles picked up on the end of a cigarette. Therefore smoking should be prohibited where DP4®, DP4-B, DP10 or DP11 are being machined.

DU®, DU-B, DP4®, DP4-B, DP10 and DP11 are trademarks of GGB

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PUSHING BOUNDARIES TO CO-CREATE A HIGHER QUALITY OF LIFE



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