AMPEP INDUSTRIAL BEARINGS CATALOGUE

1.1 THE COMPANY

AMPEP plc is situated in Clevedon, near Bristol, England. The company was formed in 1963 and for many years was a privately owned British company. In September 1988, AMPEP became a subsidiary of SARMA, an SKF company, and thus has the backing of this "World Class" Engineering Group, working at the forefront of bearing technology.

AMPEP self-lubricating plain bearings incorporate the unique Fiberslip AMPEP X1 liner and AMPEP XL system and should not be confused with other self-lubricating bearing types. Our products are all manufactured in Clevedon from high quality materials using the most up to date machines and techniques. Considerable investment continues to be made by the company in advanced technology machine tools, computer aided design and in research and development, in order to maintain the company's leading position in the European self-lubricating plain bearing industry.

Our design department prepares schemes for many of the leading companies in Europe. This design work is regarded as confidential. Every effort is made to ensure the accuracy of this free design advice which is given without prejudice.

AMPEP is approved to ISO 9002. The majority of our bearings are used in aerospace applications and this is reflected in product quality. AMPEP has been audited by many UK and European companies including SNCF (approval AQF 2), GEC Alsthom, and the British Railways Board.

1.2 SELF LUBRICATING BEARINGS

AMPEP bearings are manufactured from high quality carbon and corrosion resistant steels. Counterfaces to the self-lubricating liner employ super finished through hardened steel, hard chrome or tungsten carbide as appropriate to the application and performance required.

There are two bearing laminates used in AMPEP bearings, Fiberslip and AMPEP X1. Fiberslip is the original successful bearing material based on the American technology of the 1960s, incorporated in the standard range of AMPEP bearings and is a registered trade name. This composite material has a bearing surface of woven PTFE (polytetrafluoroethylene) which provides a low coefficient of friction and a high degree of chemical inertness. Because of its unique method of construction the poor mechanical properties inherent in bulk PTFE polymers have been overcome.

AMPEP X1 is AMPEP's own development of the successful Fiberslip material differing only in textile design but with improved wear characteristics.

AMPEP XL extended life bearings are the result of an extensive development programme. Test data indicates an improvement of 5-10 times the endurance life over standard Fiberslip and AMPEP X1 bearings when operated at 6 Hz and bearing stresses up to ±35 MPa (±5000 lbf/in^2) (caused by sinusoidal reversing loads).

AMPEP lined bearings have many distinct and valuable advantages which provide solutions to a variety of difficult applications.

These advantages are as follows:

- Operation without lubrication whilst tolerating many lubricating and non-lubricating fluids.
- A low coefficient of friction.
- A very high bearing stress to mass ratio.
- A high resistance to fatigue and impulse loadings.
- Operational over a temperature range outside the scope of most lubricants.
- A high resistance to wear.
- Long life without maintenance.
- High reliability.
- Freedom from stick-slip, fretting and brinelling.
- High tolerance to ingested solid and liquid contaminants.
- Controlled pre-load in self-aligning types.

1.3 APPLICATIONS

In general industry, AMPEP self-lubricating bearings are used in a wide range of applications, on railway vehicles, high performance racing cars, fighting vehicles, fork lift trucks, marine equipment, valves and power generation equipment particularly where oscillatory motions and/or high loadings are prevalent.

AMPEP self-lubricating bearings have been used in rail bogie suspension systems over the past 25 years. Applications include torsion bars (anti-roll bars), damper attachment points, swing links, brake mechanisms, steering linkages, valve linkages and couplings (tailpins and auto couplers).

As an example in a typical rail bogie suspension system where extended lives are required, bearing pressures of 3.5 MPa (500 lbf/in^2) to 20 MPa (3000 lbf/in^2) are encountered together with angles of oscillation of ± 1° at 30 Hz to ± 5° at 0.1 Hz. Under these demanding conditions lives in excess of 2.2 x 10^6 km (approximately 1.5 x 10^6 miles) of travel are obtained.

SELF LUBRICATING BEARINGS

SECTION 2.0

TECHNICAL INFORMATION

INDEX

SELF-LUBRICATING BEARINGS - TECHNICAL INFORMATION

2.0.1 PRODUCT RANGE

The AMPEP product range which contains an AMPEP self-lubricating liner is as follows:

Spherical Bearings
These are manufactured from high quality carbon and corrosion resistant steels containing Fiberslip or AMPEP X 1 liners or utilising the AMPEP XL system. Outer races are either chamfered or contain Grumman grooves in their outer faces for use in staking retention. Plated outer races are available. Details of these metric and imperial dimensioned products can be found in Section 2.1.0.

Rod End Bearings
Rod ends are constructed from high quality carbon and corrosion resistant steels, and contain Grumman grooved cartridge spherical bearings as described above. Details of these products can be found in Section 2.2.0.

Journal Bearings
These are manufactured in corrosion resistant steels or light alloy backings, lined in their bores with Fiberslip or AMPEP X1. Flanged types are also available on which the front face of the flange is lined with Fiberslip or AMPEP X1. Light alloy components are anodised. Details of these metric and imperial dimensioned products can be found in Section 2.3.0.

Special Products
In addition to the standard range of products, many bearing assemblies have been designed for specific applications. A high proportion of AMPEP production capacity is employed on the manufacture of such products.
Special bearings can be simple variants of standard parts or sophisticated assemblies especially designed to utilise the unique properties of AMPEP materials and the expertise of its design and production engineers, for particularly rigorous applications. Considerable design expertise has been built up over the past three decades which is freely available on request.
AMPEP also provides a lining only service for situations when complete manufacture is not feasible for economic or technical reasons.

2.0.2 MATERIALS

2.0.2/1 SELF-LUBRICATING LINERS

There are two bearing laminates used in AMPEP bearings. These are Fiberslip and AMPEP X1. Both of these are based upon a woven PTFE/GLASS fabric laminated under heat and pressure with a phenolic resin glass cloth to form a bearing laminate.
There are at present two forms of Fiberslip and two forms of AMPEP X1. Fiberslip is denoted by a letter 'B' and AMPEP X1 by 'X1'. Suffixing the 'B' or 'X1' are two digits giving the type of laminate, the differences generally taking the form of varying glass and PTFE fabric thickness selected to give optimum performance in applications.

2.0.2/2 BEARING MATERIAL CHARACTERISTICS

Ideal applications are found where bearing pressures are high, movement is slow and maintenance is difficult or impossible.
Some important characteristics are:

- Withstands high bearing pressures - failure occurs at approximately 1030 MPa (150000 lbf/in^2), i.e. stronger in compression than many steels. This has been achieved by the woven, resin filled structure, since bulk PTFE yields at 14 MPa.
- Mean dynamic operating pressure between 3.5 to 35 MPa (500 to 5000 lbf/in^2).
- Surface velocity up to 0,1 m/s (20 ft/min).
- Ideal in oscillatory applications.
- No lubrication required.
- Virtually impervious to chemical attack.
- Minimum stick-slip.
- Relatively low coefficient of friction.
- Low wear rate.
- Will tolerate solid contamination.
- Young's Modulus, E, between 5200 and 6700 MPa (0.75 and 1 x 10^6 lbf/in^2).

2.0.3 DESIGN

2.0.3/1 IMPORTANT DESIGN FACTORS

The ultimate stress level of AMPEP lining materials in compression is in the order of 1030 MPa (150000 lbf/in^2). This is in excess of the yield stress of the more common corrosion resistant steels and light alloys normally used as the outer race materials in the standard bearing assemblies.
Therefore the ultimate permissible bearing loads are largely determined by the strength of the metal details employed in the bearing races and not by the bearing laminates. The following ultimate and static limit values are based on bearings having AMS5643 corrosion resistant steel outer races.
Where alternative materials are employed, suitable cautionary notes are included within this manual, drawing the attention of the design teams to the limitations imposed on the bearings as a result. These reservations apply also to rod end bearings where the threaded rod and eye end become the limiting factors in the bearing assembly.

Ultimate Load Definition
This is the highest stress level which the bearing assembly can accept and still be capable of operation with no detail fractured or broken.

Static Load Definition
This limit load is defined as two thirds of the ultimate load with an additional requirement that the permanent set following one application of the load shall not exceed 0.3% of the bearing outside diameter.

Determination of Limiting Loads
The static limit and ultimate load carrying capacity of the corrosion resistant steel outer races of the bearings in this manual have been determined from tests performed under strictly controlled laboratory conditions for a single carefully applied load. Their inclusion enables design teams to assess the safety margins of bearings in particular applications.

Radial and axial static limit loads of the corrosion resistant steel outer races of the bearings in this manual are calculated on stress levels of 430 MPa (62500 lb/in^2) and 215 MPa (31250 lb/in^2) respectively.

Radial and axial static limit loads of the medium carbon steel outer races of the bearings in this manual are calculated on stress levels of 280 MPa (40000 lb/in^2) and 140 MPa (20000 lb/in^2) respectively.

Static load limits are based on stress levels of 430 MPa (62500 lb/in^2) for corrosion resistant steel journal bearings and 206 MPa (30000 lb/in^2) for aluminium alloy journal bearings.

For bearing series 11B----- conforming to American Military Specifications the following criteria apply:

Radial Static Load Definition
After the radial load listed on the relevant specification sheet has been applied, the total deflection of the bearing and fixture shall be less than 0.010 inch for bearings with a bore of 0.375 inch or less, 0.015 inch for 0.4375 inch and 0.500 inch bores, 0.017 inch for 0.5625 bores and 0.020 inch for 0.750 inch bores and up. In all instances, the permanent set shall be less than 0.003 inch.

Axial Static Load Definition
After the axial load listed on the relevant specification sheet has been applied, the permanent set shall be less than 0.005 inch.

Ultimate Load Definition
No fracture of the race or ball or push out of the ball shall occur when 1.5 times the radial or axial limit load is applied.

Determination of Limiting Loads
The AMPEP static limit loads for this range are based on two thirds of the 0.1% proof stress of the outer race material. Radial and axial static limit loads are calculated on stress levels of 70000 lb/in^2 and 35000 lb/in^2 respectively.

2.0.4 PROJECTED AREAS AND LOADINGS

2.0.4/1 CALCULATING BEARING PROJECTED AREAS AND STRESS LEVELS

(a) Stress

$P = \frac{W}{A}$ Where P = stress or pressure

W = load

A = projected area

(b) Projected Area 'A'

Spherical Bearings: Area = (H-4t) x ∅

Where H = minimum outer race width

4t = 1,6 mm or 0.064 in (t = liner thickness)

∅ = ball spherical diameter

Plain journal bearings: Area = (W-4t) x B

Where W = minimum journal length

4t = 1,6 mm or 0.064 in

B = inside diameter

Flanged journal bearings: Use formula as for plain journal bearings but reduce W by width of the flange and assume the latter carries no radial load.

Thrust faces: $\text{Area} = \frac{\pi}{4}[(A-2t) + (B+2G)]\ [(A-2t) - (B+2G)]$

Where A = minimum flange outside diameter

G = internal recess width

B = inside diameter of journal bearing

t = 0,4 mm or 0.016 in

't' in the above formulae refers to the liner thickness. 4t is used on bushes and spherical bearings, to allow 2t on each side of the bearing, to take account of liner recess and edge effects.

2.0.4 PROJECTED AREAS AND LOADING

The radial and axial static limit loads are given in the standard bearing specification sheets.

Spherical Bearing Tables

Whilst spherical bearings are not primarily designed to carry axial loads, they do in fact possess an axial load capacity. The bearing tables show axial bearing areas and these should be used in conjunction with the axial bearing pressures which are in all cases half the radial bearing pressures due to the increased shear content of the load on the liner.

Rod End Bearing Tables

The loads quoted in the tables for rod ends are those at which yield of the rod end eye is anticipated when the force is applied axially along the thread. As the yield strength of the rod end eye is almost invariably lower than the strength of the spherical bearings, designers should ensure that the capacity of the rod end is adequate.

The area of a rod end eye may be calculated from the following formula:

$$[0.0349r^2\varnothing + \frac{(HX)}{2}] - [HB + 2C^2]$$

where $\varnothing$ is in degrees

$$\sin \varnothing = \frac{H}{2r}$$

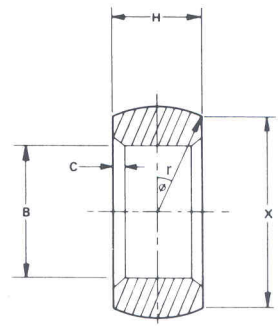
$$X = \sqrt{((2r)^2 - H^2)}$$

H = rod end head width

r = half rod end head diameter

B = rod end bore

c = rod end bore chamfer



SECTION THROUGH ROD END EYE

When a rod end is subjected to fatigue, 10% of the ultimate tensile stress should be considered as a maximum stress level unless the Design Authority decrees otherwise. Rod end bearings are not considered suitable for axially applied loads. Applications which induce bending moments in the threaded sections of the rods must be given special design consideration.

Journal Bearing Tables

The static limit loads are not given for individual bearings in the table but can be calculated from the information shown on the standard series data sheets in Section 2.3.1.

2.0.5 BEARING CHARACTERISTICS

2.0.5/1 INTERFACIAL VELOCITY

AMPEP PTFE bearings were originally intended for applications at high bearing stress levels associated with periodic oscillatory movement where rubbing speeds in excess of 0.02 m/s (4 feet per minute) were seldom encountered, however, the increasing use of this type of bearing in the rotating assemblies of helicopters has demonstrated that dry rubbing speeds up to 0.23 m/s (45 feet per minute) are possible in certain special circumstances consistent with acceptable life.
The PTFE bearing layer is an effective thermal and electrical insulating medium and under dry sliding conditions a PV factor (a useful measure of the suitability of AMPEP bearing materials for a particular application) of 700 kPa m/s (2000 lbf/in^2 ft/min) should not normally be exceeded. The PV factor is obtained by multiplying the average bearing pressure by the mean velocity.
In applications where splash or total immersion in mineral oils, silicone fluids, fuels and non-polar fluids prevail then the PV factors may be substantially increased.
The use of polar fluids such as water, alcohols, glycols and the more sophisticated phosphate esters as heat transfer fluid media, although effective, can result in higher rates of wear and advice should be sought from our Technical Sales Department.
The use of grease in AMPEP bearings is not recommended as this tends to form a viscous film at the bearing interface which promotes stick-slip and also entraps solid contamination in the immediate bearing environment.

2.0.5/2 TEMPERATURE EXTREMES

While exposure to temperatures of 523 K (250°C) results in gradual thermal degradation and carbonisation of the resin binder system the PTFE surface is largely unaffected and tests have demonstrated the ability to operate in such an environment at a bearing pressure of 70 MPa (10000 lbf/in^2) for over 250 hours. Excursions up to 573 K (300°C) are possible although backlash will develop fairly rapidly under loads sufficient to cause permanent deformations of the PTFE surface at this high temperature.
Prolonged exposures of 10000 hours at 393 K (120°C) were carried out by British Aircraft Corporation and the effects on elastic deformation and rate of wear at room temperature were studied. No unacceptable deterioration was reported. The maximum recommended operating temperature for AMPEP X1 and Fiberslip is 523 K (250°C) and the minimum known operating temperature is 223 K (-50°C), although the immersion of bearings in liquid nitrogen at 80 K (-193°C) for freeze fitting is an established practice and no detrimental effect to the liner systems and bonding has been reported to date.

2.0.5/3 COEFFICIENT OF THERMAL EXPANSION

For practical purposes the coefficient of thermal expansion of the liner may be regarded as being identical to that of the metal backing due to the relatively thin bearing layer. However, changes in the preloads and torques of larger bearings are noticeable with wide temperature fluctuations due to entrapment of the PTFE layer between two highly conforming steel surfaces. As a result preloads and torques tend to increase at high temperatures and decrease at low temperatures. This is also combined with changes in the coefficient of friction at the interfaces making assessments of the degree of change somewhat speculative.
At elevated temperatures the increased preload also planishes the PTFE bearing surface making it very smooth and reflective and on return to room temperature a loss of original preload and torque is frequently observed, although this is not necessarily accompanied by any measurable loss in stiffness.

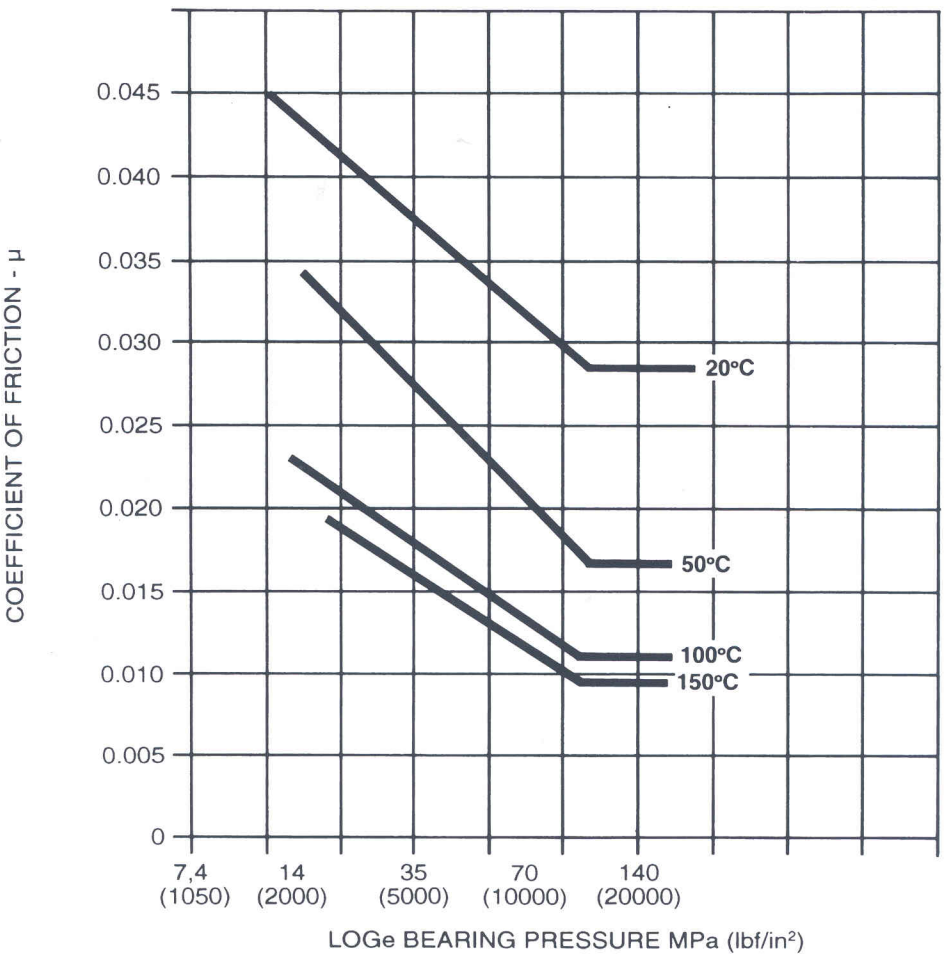
2.0.5/4 FRICTIONAL PROPERTIES

The frictional characteristics of bearing assemblies are principally as follows:

- The coefficient of friction decreases at fixed sliding speeds with increasing bearing pressure reaching a minimum at 70 MPa (10000 lbf/in^2).
- Coefficient of friction increases with decreasing temperature.
- Coefficient of friction increases with increased sliding velocity.

Actual values for drysliding obtained by experiment are illustrated on the next page showing the effects of temperature and pressure, unfortunately no comprehensive data exists for changes in velocity. The frictional properties of PTFE are considerably modified by the introduction of contaminant fluids and these are further discussed in the relative section on the subject.

2.0.5 BEARING CHARACTERISTICS



Cautionary Note

These graphs were prepared from surfaces sliding at 0,0006 m/s (1/8 feet per minute) and values of m are lower than would normally be expected. Approximately 0,008 m/s (1 to 2 feet per minute) is considered appropriate for most design applications and the order of friction values under these conditions at room temperature is as follows:

34,5 MPa (5000 psi) μ = 0.08
69 MPa (10000 psi) μ = 0.065
138 MPa (20000 psi) μ = 0.055

Static frictional values are slightly higher than dynamic values at temperatures up to 323 K (+ 50°C) but thereafter are almost undetectable.

As a result stick-slip phenomena, as exemplified by judder, audible noise, erratic operation, etc. are almost eliminated with the use of AMPEP bearings.

Bearings which have been unused for some time or which have been standing in a completely static state sometimes exhibit noticeable stiction at the first movement but thereafter display normal characteristics. Stick-slip is also displayed on occasions when the sliding direction has changed such as in a spherical bearing altering from rotation to misalignment, but neither of these examples have proved to be any technical obstacle in practice.

2.0.5 BEARING CHARACTERISTICS

2.0.5/5 WEAR CHARACTERISTICS

During use the self-lubricating liner wears, the PTFE gradually being depleted. Backlash gradually develops and ultimately the bearing will need to be replaced when the backlash limit for the application has been reached.
Wear of the liner is primarily a function of bearing pressure, surface velocity and sliding distance at a given temperature. Other factors have an effect on life, these are:

- Surface finish of liner counterface - life increases with improved surface finish - surface should be hard and corrosion resistant.
- Hardness of liner and counterface - generally the harder the surface the longer the life of the bearing.
- Good conformity (contact area) between liner and counterface is essential to maximise bearing life.
- Presence of contaminants - these increase wear particularly the ingress of water. If appreciable water contamination is likely the bearing should be sealed.

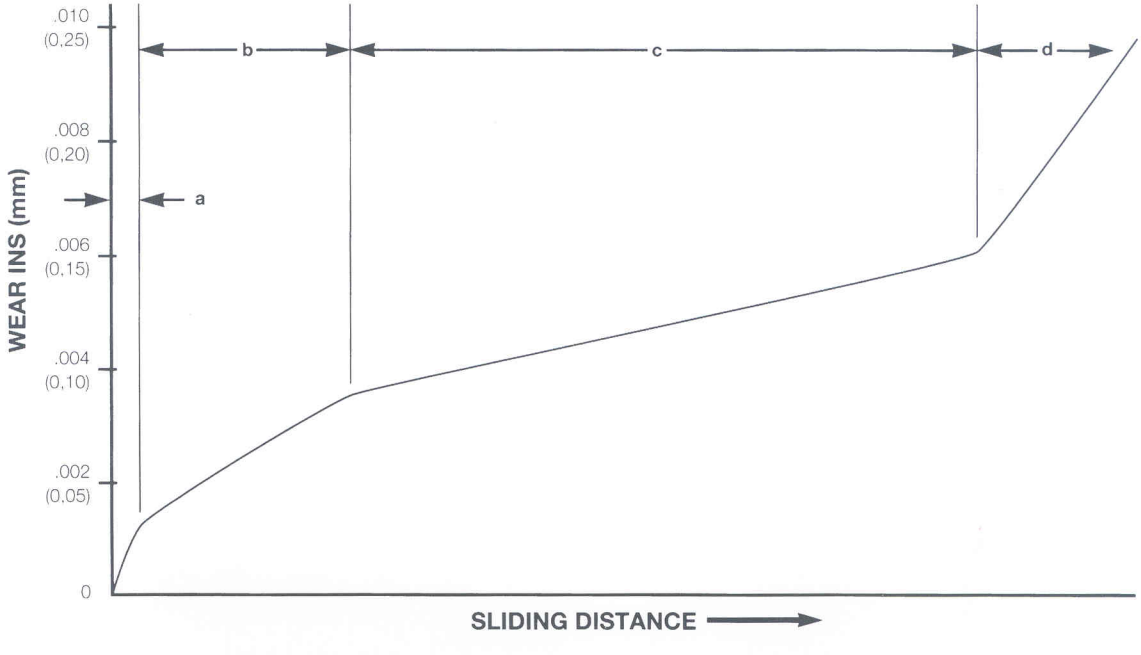
Wear takes place in AMPEP bearings at high pressure circa 170 MPa (25000 lbf/in^2) in four phases:

a) A fairly rapid bedding-down phase during which the crests and troughs at the woven surface are levelled and coated by a smooth PTFE film. Wear values up to 0,025 mm (0.001 in) may be recorded during this phase depending upon the grade of material being employed.

b) A reduced wear rate between bedding-in and achieving a more stable plateau in phase 3 which can be attained between 0,075/0,125 mm (0.003/0.005 in).

c) A lengthy period during which wear values attain 0,15/0,20 mm (0.006/0.008 in) at a very low rate of wear.

d) The final phase when wear rate accelerates again and metal to metal contact is a possibility at 0,20/0,40 mm (0.008/0.016 in) depending on the type of material employed.



A typical diagrammatic representation for Fiberslip is shown above and the variations in wear rate are due entirely to the composite nature of the bearing layer and the sequence in which the composition of the actual sliding interface changes in composition as wear progresses.

2.0.5 BEARING CHARACTERISTICS

2.0.5/6 IMPULSE LOADING

In this catalogue the term 'static load' implies a steadily applied force with no rotation of the sliding surfaces with respect to each other, whereas 'dynamic load' refers to steady loads with movement at the bearing interface. Impulse, or live loads with no appreciable movement at the bearing surface do not usually cause wear.
A test to assess the effect of vibration on bearing backlash under the following conditions produced no detectable increase in bearing play or wear of the Fiberslip liner:
Bearing pressure 163 MPa ± 9,82 MPa (23700 lbf/in^2 ± 1425 lbf/in^2) 20 x 10^6 cycles with an applied frequency of 30 Hz.
Bearing pressure 163 MPa ± 19,64 MPa (23700 lbf/in^2 ± 2850 lbf/in^2) 0,5 x 10^6 cycles with an applied frequency of 30 Hz.
In these conditions only a light planish of the bearing liner and a reduction in torque is to be expected.

2.0.5/7 SPHERICAL BEARING TORQUE

The torque to oscillate the inner ball within its outer race in the unloaded condition can be varied to suit the application if required. However, when loaded bearing torque is a function of load, coefficient of friction and the internal ball radius, the fit of the bearing in its housing will also influence torque. An interference of 0,05 mm (0.002 in) can result in a torque of at least 10 times the torque prior to assembly.

2.0.5/8 BEARING PRESSURE LIMITS

AMPEP Fiberslip flat pads adhered to high strength steel have been subjected to laboratory compression test at pressures in excess of 700 MPa (100000 lbf/in^2) before structural failure occurred. These values were obtained for a single, steadily applied force. Most common metallic materials will undergo compressive yield prior to failure of AMPEP bearing liners. For general guidance the following apply:

Maximum static bearing pressure
280 MPa (40000 lbf/in^2)

Maximum static operating pressure
140 MPa (20000 lbf/in^2)

Maximum dynamic operating pressure
70 MPa (10000 lbf/in^2)

2.0.5 BEARING CHARACTERISTICS

2.0.5/9 CONTAMINANTS

These may be both liquid or solid and their effect on the bearing materials and performance can differ widely.

Dealing first with solid contamination, this is potentially damaging to the performance characteristics and increased wear rate may occur by the scoring of counterfaces. In practice the embedability of the woven PTFE surface has demonstrated an inherent high tolerance of solid contaminant particles by ingestion into the surface and neutralising their destructive capacity by coating the particles with the PTFE film.

Fine particles appear to be tolerated fairly readily and in some cases have even led to reduced wear rates while very sharp, hard particles measuring 0,25/0,50 mm (0.010/0.020 in) have caused counterface damage and reduced performance. Much depends on the volume, size and physical characteristics of the contaminant in question. Experience to date indicates that AMPEP PTFE bearings have a much greater tolerance to ingested solids than would be expected of conventional rolling element bearings.

Liquid contaminants come in two main groups, aqueous and organic, and are potentially capable of affecting both bearing materials and performance. The former most frequently occur as rain or sea water but battery fluids, human body fluids, condensation, wash down, and chemical toilet fluids may also be encountered. Laboratory tests and field experience have shown that the majority have an almost negligible effect, with the exception of the highly dissociated acids and alkalis, viz. nitric or sulphuric acids and particularly caustic soda or potash solutions. All these attack the resin binder and adhesive system in concentrations of 10% or more and must be excluded from the operating environment or from attacking the bearings in any processing operations which the user may wish to carry out following bearing installation but prior to assembly, i.e. pre-painting or plating operations.

Organic fluids are encountered both during assembly sequences as chlorinated compounds or ketones used in degreasing and cleaning, and again in service as fuels, lubricants, de-icing and hydraulic fluids. As many AMPEP bearings are employed in power control systems, it is essential that they are compatible with such fluids, as some degree of contamination during assembly, service and maintenance is unavoidable. Hydrocarbon fuels and mineral oils of similar molecular construction have no deleterious effect and may even improve life. Friction is reduced, as with most fluids including water, but certain oil additives do promote stick-slip and some care is required with bearings fitted to manual control systems and torque sensitive servo mechanisms. Cleaning fluids of the organic type previously mentioned have not been found detrimental and are frequently used during the manufacture of the bearings at Clevedon.

De-icing fluids of the glycol-methanol types and hydraulic fluids of the phosphate ester type tend to cause increased wear but the test results have a fairly wide scatter band. Silicone based hydraulic fluids appear to have negligible effect.

Greases are not recommended in conjunction with AMPEP bearings as the oil segregates at the PTFE bearing face leaving a soap film mixed with PTFE debris which is highly viscous, causing stick-slip and erratic friction characteristics. Greases containing molybdenum disulphide or graphite are, if anything, worse than those without.

The chemically inert character of PTFE renders it resistant to attack by all fluids except those specially designed for etching PTFE to improve adhesion. The increase in wear rates observed with some de-icing and hydraulic fluids can only be accounted for by assuming their continuing disruption of the PTFE shear film at the sliding interface which more rapidly depletes the reservoir of PTFE available for film regeneration than when such fluids are absent.

Appropriate sealed types are recommended for applications where the operating environment is highly contaminated or subjected to forced liquid pressure.

2.0.5 BEARING CHARACTERISTICS

2.0.5/10 ELECTRICAL AND THERMAL PROPERTIES

Both PTFE and glass resin impregnated laminates are excellent thermal and electrical insulators. Resistance to heat dissipation should be borne in mind in the higher velocity applications. Electrical conductivity between adjoining structures may need to be provided by jumpers when lightning strikes are being considered.

2.0.5/11 BEARING HANDLING AND STORAGE

AMPEP products remain unchanged over long periods provided storage conditions are maintained at a reasonable standard. All catalogue items are individually sealed in polythene bags and provided these remain unopened and stores are controlled between 15-25°C and 50-75% R.H. then users are assured of at least 15 years life without detriment.

Care should be taken not to contaminate bearings removed for inspection with grease, oil, water, etc. Users are reminded that these bearings are high quality precision products and should be treated accordingly. Bearings should be kept sealed in their packs at all times until the instant of installation and maintained

2.0.6 BEARING SELECTION GUIDE

2.0.6/1
BEARING TYPES

SPHERICAL BEARINGS

Advantages
Maximum predictable capacity and life for a given bearing area.
Accepts up to 24° misalignment.
Preload and stiffness predictable and consistent with each assembly.
Least prone to damage on assembly

Disadvantages
Heavier than journal bearing of equivalent area and larger in diameter causing housings to be larger.
Additional skills and special tooling required for assembly and replacement.
Outer races in corrosion resistant steel necessitate use of wet assembly or sacrificial sleeves if used in light alloy structures.

ROD ENDS

Advantages
Convenience of installation and replacement.

Disadvantages
Rod eye end limits capacity of the installed spherical bearing.
Limited number of applications where it can be used.
Restricted use in bending due to stresses in threaded lengths.

JOURNAL BEARINGS

Advantages
Light weight and compact housing requirement.
Ease of fitting.
Choice of compatible shell materials.

Disadvantages
½° maximum incidental misalignment capacity.
Somewhat lower life than equivalent spherical bearing.
Some free play in a proportion of assemblies.
Possibility of assembly damage greater than with spherical bearings.

Although some of the disadvantages in the various types of bearing can be mitigated with procedures described in this manual, the recommendation must be for spherical bearings in the most critical areas where performance and stiffness are the primary features and for journal bearings in the less critical areas unless a misaligning feature is required.

Rod ends are a convenient way in which a spherical bearing can be readily adapted but applications tend to be confined to the ends of rods or tubes.

Applications having a primary axial thrust requirement should be dealt with on an individual consultative basis with AMPEP Technical Sales Department.

2.0.6 BEARING SELECTION GUIDE

2.0.6/2 ESTIMATING BEARING LIFE

Wear or backlash in a bearing assembly is normally used to determine the end of useful life. A graph of wear rates for the Fiberslip and X1 liners and the XL system is shown below. This depicts typical results at 293K (+20°C).

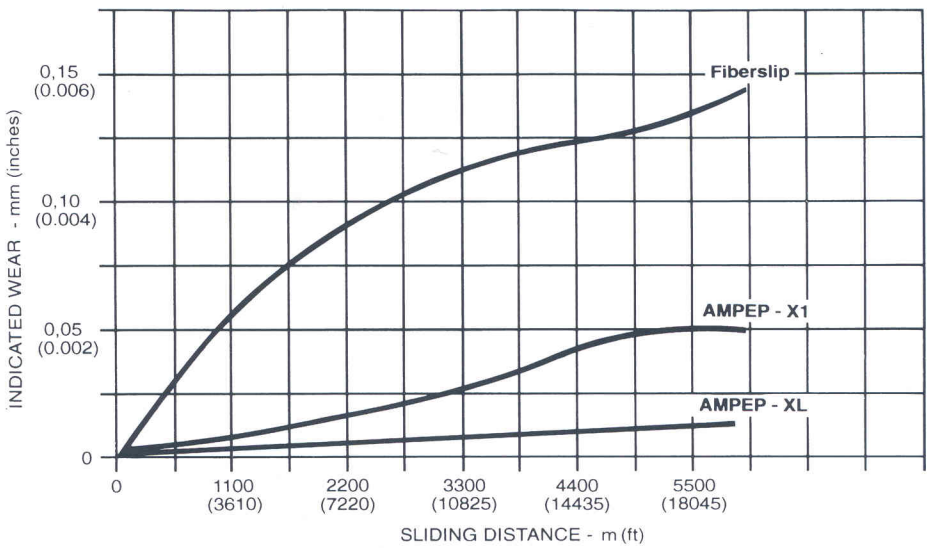


Figure 4: Wear Characteristics of Fiberslip, X1 liner and XL System

Test Details:

Temperature:	Ambient
Sliding Velocity:	0,005 m/s (0.984 feet per minute)
Bearing Pressure:	120 MPa (17400 lbf/in²)
Loading:	Unidirectional constant

Appropriate allowances should be made for factors such as temperature, sliding velocity, surface finish, etc. which can decrease the bearing life. Also the life of a bearing is in approximate ratio to the inverse square of the pressure, i.e. halving the stress level or doubling the bearing area for a given load increases the life by a factor of 4.

Extreme Temperature Factors

When operating between temperatures of 223/253 K (-50°C/-20°C) and 353/423 K (+80°C/+150°C), the predicted life should be reduced by a factor of two. If the proportion of the life at these extremes does not exceed 10% of the total life then this factor can be ignored. If it occurs over a greater proportion than 10% then the appropriate allowance should be made. At a temperature between 423/523 K (+150°C/+250°C) a life reduction of 4 should be applied.

Sliding Velocity

The majority of applications involve oscillatory motion and the sliding velocity is normally expressed as an arithmetic mean. Wear remains fairly constant up to 0,03 m/s (6 feet per minute) but above this rubbing speed it tends to increase as a result of localised heating of the friction surfaces. Thus, between 0,03 m/s - 0,06 m/s (6 - 12 feet per minute) the predicted life should be reduced by a factor of 2, from 0,066 - 0,120 m/s (13 - 24 feet per minute) by a factor of 3 and 0,127 - 0,254 m/s (25 - 50 feet per minute) by a factor of 4.

Counterface Surface Finish

Bearing life is dependent upon the roughness of the counterface surface finish. AMPEP standard spherical bearing counterfaces are finished to better than 0,05µm (2 micro inch) RA.

2.0.6 BEARING SELECTION GUIDE

Contaminants

As previously discussed in Section 2.0.5/9 certain fluid contaminants in service such as mineral oils, silicone oils and kerosene fuels are not detrimental and if continuously applied, may be positively beneficial in reducing friction and removing heat from the sliding interface.

Very fine solid dust contamination has not proved to have a detrimental effect on bearing life but much will depend on the degree of environmental hostility, particle size and abrasiveness of the contaminants involved. In high risk applications consideration should be given to fitting spherical bearings with high preloads to exclude large particles or, in the last resort, some form of external sealing.

Liquid water, aqueous fluids, alcohol/glycol de-icing fluids and the more sophisticated phosphate ester hydraulic fluids have been observed to cause varying degrees of increased wear in PTFE bearings and predicted lives should be reduced by a factor of 4 where frequent or massive contamination is considered unavoidable.

Water vapour between relative humidities of 5-95% has been demonstrated by test as having no significant effect on wear rate. However the inherent hygroscopic nature of fibre reinforced laminates promotes very small changes in volume of the bearing layer. These are normally almost undetectable by normal measuring techniques but can, on occasion, manifest themselves as changes on no-load rotational characteristics of spherical bearings where the ball is an interference fit in the outer race in order to eliminate any undesirable free play in these assemblies as supplied. Frictional torque under load remains virtually unchanged in the above circumstances as the dimensional changes due to humidity variations are extremely small compared with the elastic deflection of the liner system when loaded.

Angular and Directional Movement

Oscillatory motions of small amplitude and relatively high frequency occurring with vibrations and "fidgeting" motions can be largely discounted in the assessment of total linear sliding distances for life predictions, provided the angular movement does not exceed ½° per cycle. Experience has shown that at these very small angles the bearing material is really at its best and wear is virtually absent although some loss in preload will be observed. All angular motions in excess of ½° must be integrated into the total sliding distance.

In journal bearings used in axial sliding applications or planar sliding motions the rate of wear is known to be increased by a factor of approximately 2.5 and the predicted life should be reduced appropriately. This increased wear rate is due to the almost instantaneous loss of PTFE shear film and the debris at every cycle by transference from the loaded zone by the moving counterface.

Choice of Bearing Material

Predicted bearing lives can be improved by factors of 2-3 if AMPEP X1 is employed within the temperature band of 0 to 80°C. Outside this zone very little improvement over the standard Fiberslip is exhibited.

At bearing pressures up to ± 35 MPa (± 5000 lbf/in^2) AMPEP XL provides increasingly extended lives of 5 to 10 times those obtained from Fiberslip and AMPEP X1.

A standard range of AMPEP XL bearings does not exist at present. However all standard spherical bearings can be supplied in XL form also many special bearings exist. Please note, bushes are not available in XL form. Contact the Technical Sales Department for further information.

General notes

Designers applying the life prediction data and the attendant factors are reminded that this is intended as a guide in selecting a bearing considered appropriate for a particular application. The results should indicate the order of life expectancy for any particular bearing application. If doubt exists concerning any critical application then AMPEP Technical Sales Department will give the necessary advice on request. The advice proffered in this section is for guidance only and is not a substitute for sound engineering and design practice. This selection advice cannot be allowed to dominate the design function where previous experience or in-service feed-back indicates that such a choice would later be demonstrated to be in error.

2.0.7 BEARING INSTALLATION & RETENTION

2.0.7/1 SPHERICAL BEARING FITTING INFORMATION

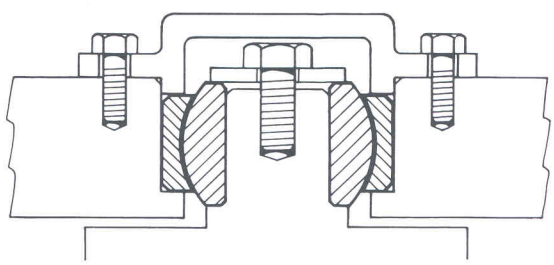
AMPEP bearings are supplied finished and no attempt should be made to machine either the metal components nor the woven PTFE liner, in the interests of minimising risk of damage to a high quality, precision engineered component.

The limits for the bearings and the recommended housing and shaft sizes are as follows:

	Inch Series	Metric Series
Bearing Outside Diameter	h7	h7
Housing Inside Diameter	J7	J7
Shaft Outside Diameter	j7	h7
Bearing Inside Diameter	H7	J8

Cylindricity should be controlled within the bore tolerance. These are transition fits and are known to operate satisfactorily.

However AMPEP bearings have relatively high coefficients of friction (approximately 0,05 - 0,1) at the bearing pressures encountered in actual applications. Thus to prevent bearings rotating in their housings or on their pins it is necessary to use an adhesive such as Loctite or to clamp the bearing, shown below. When using an adhesive it is important to seek guidance from the adhesive manufacturer since the preparation and cleanliness of mating surfaces are essential.



It is sometimes desired to use interference fits. AMPEP bearings are manufactured with a preload and closely controlled conformance between the mating surfaces of the inner and outer races. Consequently an interference of 0,05 mm (0.002 in) between the race outside diameter and housing bore can result in a torque of at least 10 times the torque prior to assembly. The recommended method for fitting bearings into high interference housings is to freeze the bearing in liquid nitrogen.

2.0.7/2 PRELOADED SPHERICAL BEARINGS

Where bearing stiffness is of particular importance, especially in power control circuits and structural joints consideration should be given to the use of preloaded spherical bearings. Originally interference fitted bearings were employed, but, due to the variation in interference fit resulting from the tolerances of housing bore and bearing outside diameter, considerable torque variations between assembled bearings were encountered.

AMPEP preloaded spherical bearings are specially constructed to provide increased stiffness and whilst there must be a corresponding torque increase, this is predetermined and maintained within reasonable limits. Generally the reduction in diameteral deflection of a preloaded bearing is of the order of 0,05 mm (0.002 in). Naturally the mating housing and shaft tolerances must be maintained at a low level as must be the clearance between shaft and bearing bore and spherical bearing outside diameter and housing bore. Otherwise the advantages of a preloaded bearing will be lost. Since interference is not required, the assembly problems with these products are much less than with the interference fitted bearings. For further details of these products refer to the AMPEP Technical Sales Department.

2.0.7 BEARING INSTALLATION & RETENTION

2.0.7/3 CLEARANCE FITTED SPHERICAL BEARINGS

This technique is usually employed where torque control and backlash are of primary importance. These conditions tend to prevail in low torque bearings for manual control systems and in certain special applications where bearings are supplied with high preloads and controlled stiffness values which must be preserved even after installation in their housings.

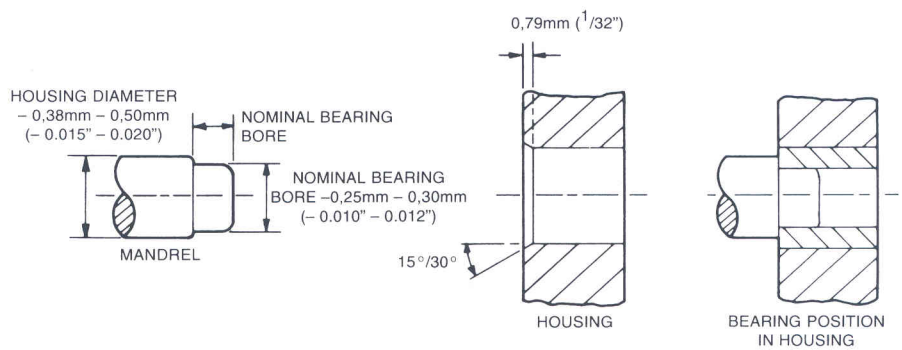
Retention is effected solely by an adhesive system which should be selected and tested to suit the user's requirement. Clearances of 0,05/0,10 mm (0.002/0.004 in) have been employed with Loctite grades and also an epoxy system ECCOBOND 104. No problems have been reported using steel housings but the elevated curing temperatures have been known to cause torque fluctuations with light alloy housings owing to the differences in thermal contraction of the dissimilar metals after the adhesive system has hardened. The latter problem is stated to have been overcome by use of a lower temperature curing adhesive system, namely Loctite 270 to DTD 900/6003.

2.0.7/4 INSTALLATION AND RETENTION OF JOURNAL BEARINGS

Journal bearings are normally interference fitted into their housings and the technique is illustrated below using a mandrel press with which production personnel are well acquainted. The table in Section 2.3.2 gives the recommended housing and shaft sizes for clearance and transition fits of shafts selected for particular applications.

Where the accumulation of tolerances results in an unacceptably high range of shaft clearance the range can be reduced by adhesive bonding the bearings into clearance fit housings.

The table in Section 2.3.2 also includes these recommended housing sizes and two ranges of appropriate shafts to give clearance and transition fits but with reduced band widths.



2.0.7/5 PIN AND SHAFT INSTALLATION

For spherical bearings, the recommended pin sizes are given in Section 2.1.3. These sizes give light transition fits with not more than 0,005 mm (0.0002 in) interference. For those designers wishing to reduce free play still further, it is known that interference fits of pin can be employed but care must be taken to ensure that "pick up" does not occur between the ball bore and the pin on assembly. Potential users of this process must take care to ensure that force fitting end loads on the pins are reacted within the spherical inner race or ball of the bearing and never transmitted from the ball to the outer race and housing.

For journal bearings the shafts or pins can usually be assembled quite readily by hand but it is important to provide lead-in chamfers to shafts to prevent damage to the bearings. The normally accepted 45° chamfers so widely used in engineering are not suitable for use with the Fiberslip type of bearing and need modifying to a much improved standard.

To locate spherical bearings centrally on their pins, most users employ some form of end clamping device on the end faces of the balls.

With journal bearings, the end float is taken on the thrust faces of flanged bearings mounted in fork ends or central lugs of the mechanisms.

SPHERICAL BEARINGS - SELF LUBRICATING NARROW - CHAMFERED OUTER RACE NORMAL TORQUE

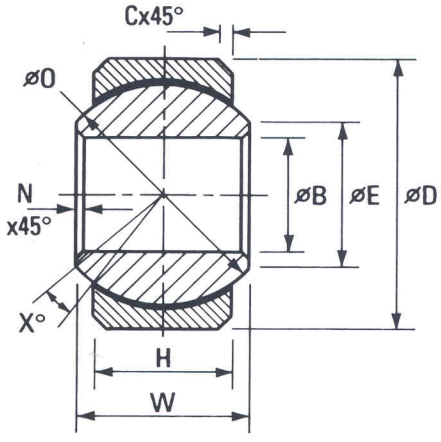
21CNZ -- INCH SERIES

MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Corrosion resistant steel

Ball
Through hardened corrosion resistant steel



DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number 21CNZ --	B Bore Dia + 0.0000 − 0.0005	W Ball Width + 0.000 − 0.002	D Race O/Dia + 0.000 − 0.0005	H Race Width + 0.000 − 0.010	C Race Chamf + 0.000 − 0.010	X° Min	O Ball Dia Ref	E Ball Face Min	No Load Breakout Torque Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	in						in		lbf.in	in²		lbf		ft	lb
04	0.2500	0.343	0.6562	0.255	0.020	10	0.500	0.364	5.0	0.091	0.010	5430	291	0.00036	0.02
05	0.3125	0.375	0.7560	0.286	0.020	10	0.593	0.419	5.0	0.126	0.016	7545	485	0.00043	0.03
06	0.3750	0.406	0.8125	0.317	0.030	9	0.625	0.475	5.0	0.152	0.027	9100	815	0.00045	0.04
07	0.4375	0.437	0.9062	0.348	0.030	8	0.687	0.530	8.0	0.188	0.038	11300	1146	0.00050	0.05
08	0.5000	0.500	1.0000	0.395	0.030	9	0.781	0.600	8.0	0.251	0.058	15050	1734	0.00057	0.07
081	0.5005	0.437	0.8750	0.380	0.030	6	0.718	0.560	8.0	0.216	0.053	12970	1585	0.00053	0.05
10	0.6250	0.625	1.1875	0.505	0.030	9	1.000	0.739	8.0	0.431	0.117	25860	3519	0.00072	0.12
12	0.7500	0.750	1.4375	0.598	0.040	9	1.250	0.920	8.0	0.655	0.179	39300	5375	0.00091	0.21
16	1.0000	1.000	1.7500	0.802	0.040	9	1.569	1.118	8.0	1.138	0.377	68270	11300	0.00110	0.39
												⚠1	⚠1		

NOTES

⚠1 Radial and Axial Limit Loads are based on stress levels of 62500 lbf/in² and 31250 lbf/in² respectively.
These values do not exceed ²/₃ of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3 /1a for recommended Housing and Shaft dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	21	C	N	Z	05	1
Spherical						
Specification Ident						
Narrow						
Chamfered Outer Race						
Ball bore dia code in multiples of 1/16 inch						
Special size version code						

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be suppled on request

ampep

AMPEP DATA SHEET
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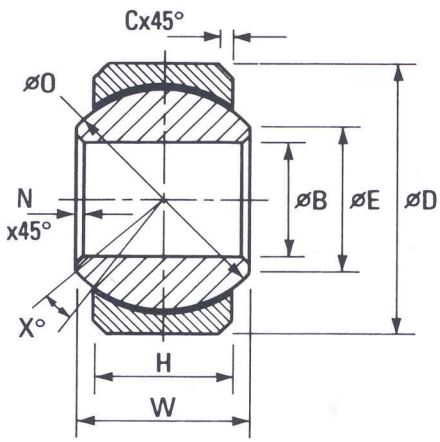
21CWZ -- INCH SERIES

SPHERICAL BEARINGS - SELF LUBRICATING WIDE - CHAMFERED OUTER RACE NORMAL TORQUE



MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Corrosion resistant steel

Ball
Through hardened corrosion resistant steel

DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number 21CWZ --	B Bore Dia + 0.0000 − 0.0005	W Ball Width + 0.000 − 0.005	D Race O/Dia + 0.000 − 0.0005	H Race Width + 0.000 − 0.010	C Race Chamf + 0.000 − 0.010	X° Min	O Ball Dia Ref	E Ball Face Min	No Load Breakout Torque Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	in						in		lbf.in	in²		lbf		ft	lb
04	0.2500	0.437	0.6250	0.332	0.025	15	0.531	0.300	5.0	0.137	0.039	8220	1157	0.00038	0.03
05	0.3125	0.437	0.6875	0.322	0.025	14	0.594	0.360	5.0	0.147	0.031	8840	927	0.00043	0.03
06	0.3750	0.500	0.8125	0.411	0.030	9	0.687	0.470	5.0	0.232	0.072	13890	2148	0.00050	0.06
07	0.4375	0.562	0.9375	0.447	0.030	10	0.781	0.537	8.0	0.292	0.089	17480	2663	0.00056	0.08
08	0.5000	0.625	1.0000	0.510	0.030	9	0.875	0.607	8.0	0.382	0.127	22890	3817	0.00063	0.10
10	0.6250	0.750	1.1875	0.572	0.030	12	1.062	0.747	8.0	0.529	0.166	31730	4993	0.00077	0.16
101	0.6255	0.875	1.3750	0.630	0.040	14	1.218	0.849	8.0	0.677	0.210	40630	6286	0.00090	0.20
12	0.7500	0.875	1.3750	0.635	0.040	13	1.250	0.845	8.0	0.701	0.213	42070	6376	0.00091	0.24
16	1.0000	1.375	2.1250	1.010	0.040	12	1.937	1.269	8.0	1.813	0.639	108780	19175	0.00140	0.97
												△1	△1		

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	21	C	W	Z	06	1
Spherical						
Specification Ident						
Wide						
Chamfered Outer Race						
Ball bore dia code in multiples of 1/16 inch						
Special size version code						

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

△ NOTES

△1 Radial and Axial Limit Loads are based on stress levels of 62500 lbf/in² and 31250 lbf/in² respectively.
These values do not exceed 2/3 of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/1a for recommended Housing and Shaft dimensions

SPHERICAL BEARINGS - SELF LUBRICATING NARROW - CHAMFERED OUTER RACE NORMAL TORQUE

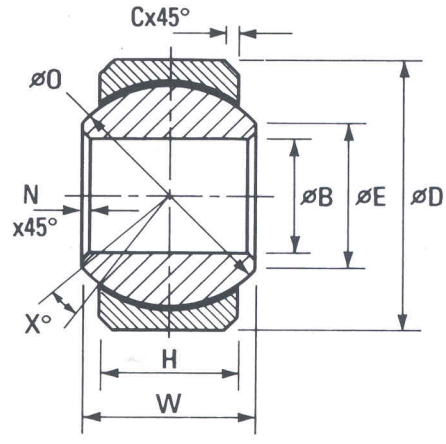
NZS --
INCH SERIES

MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, phosphated bore and faces



DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number NZS --	B Bore Dia —	W Ball Width —	D Race O/Dia —	H Race Width —	C Race Chamf —	X° Min	O Ball Dia Ref	E Ball Face Min	No Load Breakout Torque Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	**in**						**in**		**lb in**	**in²**		**lbf**		**ft**	**lb**
20	1.2500 1.2510	1.098 1.091	2.0000 1.9990	0.942 0.932	0.030 0.045	6	1.781	1.405	30	1.546	0.547	61840	10935	0.0155	0.50
24	1.5000 1.5010	1.317 1.310	2.4375 2.4363	1.130 1.120	0.030 0.045	6	2.254	1.832	30	2.380	0.819	95210	16380	0.0197	0.93
32	2.0000 2.0012	1.755 1.748	3.1875 3.1864	1.505 1.495	0.030 0.045	5	3.004	2.441	40	4.299	1.533	171950	30650	0.0262	2.09
40	2.5000 2.5012	2.187 2.180	3.9375 3.9361	1.880 1.870	0.040 0.060	6	3.656	2.933	60	6.603	2.470	264110	49390	0.0319	3.90
48	3.0000 3.0012	2.625 2.618	4.7500 4.7484	2.255 2.245	0.040 0.060	5	4.468	3.618	90	9.745	3.623	389790	72470	0.0390	6.95
												△1	△1		

△ NOTES

△1 Radial and Axial Limit Loads are based on stress levels of 40000 lbf/in² and 20000 lbf/in² respectively.
These values do not exceed ²/₃ of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/1b for recommended Housing and Shaft dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number — N Z S 20
Narrow — N
Chamfered Outer Race — Z
Spherical — S
Ball bore dia code in multiples of 1/16 inch — 20

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

ampep

AMPEP DATA SHEET
2.1.1/2a
ISSUE - 0301

SPHERICAL BEARINGS - SELF LUBRICATING NARROW - CHAMFERED OUTER RACE NORMAL TORQUE

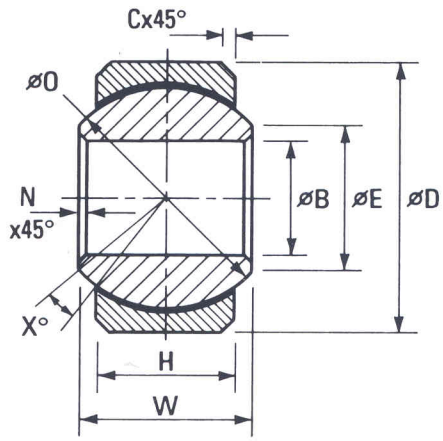
11BNZ -- INCH SERIES

MATERIALS

Liner
Ampep X1

Outer Race
Corrosion resistant steel

Ball
Corrosion resistant steel



DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number 11BNZ --		B Bore Dia + 0.0000 − 0.0005	W Ball Width + 0.000 − 0.002	D Race O/Dia + 0.0000 − 0.0005	H Race Width + 0.000 − 0.010	C Race Chamf + 0.000 − 0.010	X° Min	O Ball Dia Ref	E Ball Face Min	No load breakout torque Min/Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	**Size**	**in**						**in**		**lbf.in**	**in²**		**lbf**		**ft**	**lb**
03	3/16	0.1900	0.281	0.5625	0.223	0.020	10	0.437	0.293	0.25 5.0	0.071	0.016	4970	560	0.00031	0.02
04	1/4	0.2500	0.343	0.6562	0.255	0.020	10	0.500	0.364	0.25 5.0	0.098	0.025	6860	875	0.00036	0.02
05	5/16	0.3125	0.375	0.7500	0.286	0.020	10	0.593	0.419	0.25 5.0	0.135	0.033	9450	1155	0.00043	0.03
06	3/8	0.3750	0.406	0.8125	0.317	0.030	9	0.625	0.475	0.25 5.0	0.162	0.046	11340	1610	0.00045	0.04
07	7/16	0.4375	0.437	0.9062	0.348	0.030	8	0.687	0.530	0.50 8.0	0.199	0.060	13930	2100	0.00050	0.05
08	1/2	0.5000	0.500	1.0000	0.395	0.030	8	0.781	0.600	0.50 8.0	0.272	0.090	19040	3150	0.00057	0.07
09	9/16	0.5625	0.562	1.0937	0.442	0.030	8	0.875	0.670	0.50 8.0	0.346	0.116	24220	4060	0.00063	0.09
10	5/8	0.6250	0.625	1.1875	0.505	0.030	8	1.000	0.739	1.0 8.0	0.459	0.158	32130	5530	0.00072	0.12
12	3/4	0.7500	0.750	1.4375	0.598	0.040	8	1.250	0.920	1.0 8.0	0.690	0.230	48300	8050	0.00091	0.21
14	7/8	0.8750	0.875	1.5625	0.708	0.040	8	1.375	0.980	1.0 8.0	0.850	0.263	59500	9205	0.00100	0.27
16	1	1.0000	1.000	1.7500	0.802	0.040	9	1.562	1.118	1.0 8.0	1.112	0.356	77840	12460	0.00113	0.39
20	1 1/4	1.2500	1.093	2.0000	0.947	0.040	6	1.812	1.445	2.0 20.0	1.553	0.533	108710	18655	0.00132	0.53
24	1 1/2	1.5000	1.312	2.4375	1.135	0.040	6	2.250	1.827	2.0 20.0	2.351	0.800	164570	28000	0.00163	0.96
28	1 3/4	1.7500	1.531	2.8125	1.322	0.040	6	2.625	2.14	10.0 35.0	3.234	1.125	226380	39375	0.00191	1.48
32	2	2.0000	1.750	3.1875	1.510	0.040	6	3.000	2.44	10.0 35.0	4.260	1.483	298200	51905	0.00218	2.10
													⚠1	⚠1		

△ NOTES

⚠1 Radial and Axial Limit Loads are based on stress levels of 70000 lbf/in² and 35000 lbf/in² respectively.
These values do not exceed 2/3 of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/2a for recommended Housing and Shaft dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	11	B	N	Z	06
Spherical					
Specification Ident					
Narrow					
Chamfered Outer Race					
Ball bore dia code in multiples of 1/16 inch					

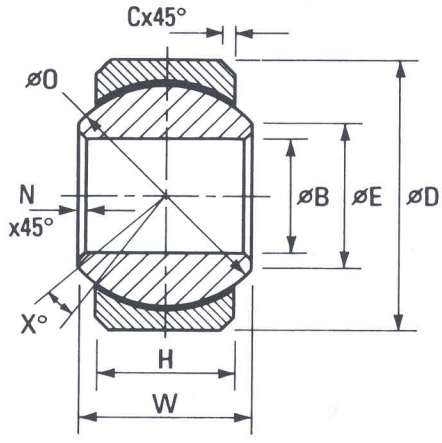
SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

ampep

11BWZ -- INCH SERIES

SPHERICAL BEARINGS - SELF LUBRICATING WIDE - CHAMFERED OUTER RACE NORMAL TORQUE



MATERIALS

Liner
Ampep X1

Outer Race
Corrosion resistant steel

Ball
Corrosion resistant steel

DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number 11BWZ --		B Bore Dia + 0.0000 − 0.0005	W Ball Width + 0.000 − 0.002	D Race O/Dia + 0.0000 − 0.0005	H Race Width + 0.000 − 0.010	C Race Chamf + 0.000 − 0.010	X° Min	O Ball Dia Ref	E Ball Face Min	No load breakout torque Min/Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	Size	in						in		lbf.in	in²		lbf		ft	lb
03	3/16	0.1900	0.437	0.6250	0.332	0.020	15	0.531	0.300	0.25 5.0	0.145	0.056	10150	1960	0.00038	0.031
04	1/4	0.2500	0.437	0.6250	0.332	0.020	15	0.531	0.300	0.25 5.0	0.145	0.056	10150	1960	0.00038	0.031
05	5/16	0.3125	0.437	0.6875	0.322	0.020	14	0.593	0.360	0.25 5.0	0.156	0.050	10920	1750	0.00043	0.035
06	3/8	0.3750	0.500	0.8125	0.411	0.030	8	0.687	0.466	0.25 5.0	0.243	0.093	17010	3255	0.00050	0.060
07	7/16	0.4375	0.562	0.9375	0.447	0.030	10	0.781	0.537	0.50 8.0	0.304	0.113	21280	3955	0.00056	0.080
08	1/2	0.5000	0.625	1.0000	0.510	0.030	9	0.875	0.607	0.50 8.0	0.406	0.166	28420	5810	0.00063	0.100
09	9/16	0.5625	0.687	1.1250	0.541	0.030	10	1.000	0.721	0.50 8.0	0.495	0.186	34650	6510	0.00072	0.135
10	5/8	0.6250	0.750	1.1875	0.572	0.030	12	1.062	0.747	1.0 8.0	0.558	0.210	39060	7350	0.00077	0.160
12	3/4	0.7500	0.875	1.3750	0.635	0.040	13	1.250	0.845	1.0 8.0	0.681	0.200	47670	7000	0.00091	0.240
14	7/8	0.8750	0.875	1.6250	0.760	0.040	6	1.375	0.995	1.0 8.0	0.921	0.320	64470	11200	0.00100	0.350
16	1	1.0000	1.375	2.1250	1.010	0.040	12	1.937	1.269	2.0 12.0	1.782	0.616	124740	21560	0.00140	0.970
20	1 1/4	1.2500	1.500	2.3750	1.135	0.050	12	2.156	1.548	2.0 20.0	2.253	0.805	157710	28175	0.00156	1.100
24	1 1/2	1.5000	1.687	2.6875	1.228	0.050	12	2.437	1.758	2.0 20.0	2.772	0.953	194040	33355	0.00177	1.450
28	1 3/4	1.7500	1.812	3.0000	1.322	0.050	12	2.750	2.06	10.0 35.0	3.388	1.116	237160	39060	0.00199	1.850
32	2	2.0000	1.937	3.2500	1.385	0.050	12	3.000	2.20	10.0 35.0	3.885	1.233	271950	43155	0.00218	2.150
													△1	△1		

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number — 11 B W Z 06
Spherical
Specification Ident
Wide
Chamfered Outer Race
Ball bore dia code in multiples of 1/16 inch

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

△ NOTES

△1 Radial and Axial Limit Loads are based on stress levels of 70000 lbf/in² and 35000 lbf/in² respectively.
These values do not exceed 2/3 of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/2a for recommended Housing and Shaft dimensions

SPHERICAL BEARINGS - SELF LUBRICATING HIGH MISALIGNMENT - CHAMFERED OUTER RACE NORMAL TORQUE

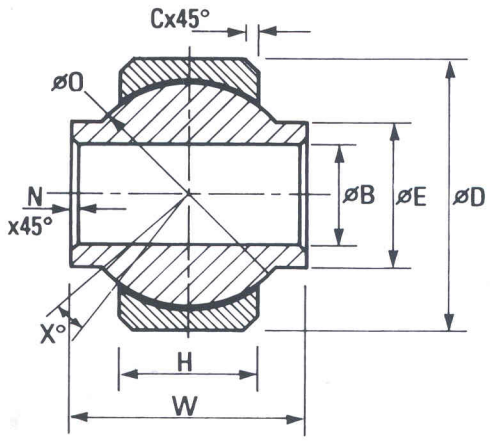
11BHZ -- INCH SERIES

MATERIALS

Liner
Ampep X1

Outer Race
Corrosion resistant steel

Ball
Corrosion resistant steel



DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015
C = 0.025/0.035

Part Number 11BHZ --		B Bore Dia + 0.0000 − 0.0005	W Ball Width + 0.000 − 0.002	D Race O/Dia + 0.0000 − 0.0005	H Race Width + 0.000 − 0.010	X° Min	O Ball Dia Ref	E Collar Dia Min	No load breakout torque Min/Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	**Size**	**in**					**in**		**lbf.in**	**in²**		**lbf**		**ft**	**lb**
03	3/16	0.1900	0.500	0.5625	0.215	15	0.437	0.312	0.25 5.0	0.071	0.009	4 970	315	0.00031	0.02
031	3/16	0.1900	0.560	0.6250	0.332	15	0.531	0.280	0.25 5.0	0.150	0.051	10500	1785	0.00038	0.03
04	1/4	0.2500	0.593	0.7400	0.260	24	0.593	0.350	0.25 5.0	0.116	0.020	8120	700	0.00043	0.04
05	5/16	0.3125	0.813	0.9060	0.350	22	0.781	0.480	0.25 5.0	0.233	0.053	16310	1855	0.00056	0.07
051	5/16	0.3125	0.625	0.6875	0.245	20	0.593	0.420	0.25 5.0	0.113	0.015	7910	525	0.00043	0.025
06	3/8	0.3750	0.813	0.9060	0.350	22	0.781	0.480	0.25 5.0	0.233	0.053	16310	1855	0.00056	0.07
07	7/16	0.4375	0.875	1.0000	0.350	22	0.875	0.570	0.50 8.0	0.250	0.056	17500	1960	0.00063	0.10
08	1/2	0.5000	0.937	1.1250	0.406	20	1.000	0.680	0.50 8.0	0.333	0.083	23310	2905	0.00072	0.16
10	5/8	0.6250	1.200	1.1375	0.572	20	1.250	0.810	1.0 8.0	0.616	0.180	43120	6600	0.00091	0.25
12	3/4	0.7500	1.280	1.5625	0.625	19	1.375	0.920	1.0 8.0	0.758	0.220	53060	7700	0.00100	0.32
14	7/8	0.8750	1.400	1.7500	0.630	19	1.531	1.080	1.0 8.0	0.833	0.220	58310	7700	0.00111	0.43
16	1	1.0000	1.875	2.1250	0.840	21	1.875	1.220	2.0 12.0	1.416	0.440	99120	15400	0.00136	0.81
20	1 1/4	1.2500	1.875	2.5000	1.010	21	2.250	1.500	2.0 20.0	2.066	0.660	144620	23100	0.00163	1.11
24	1 1/2	1.5000	2.250	3.0000	1.180	21	2.672	1.802	2.0 20.0	3.019	0.798	211330	27930	0.00194	2.22

△1 △1

△ NOTES

△1 Radial and Axial Limit Loads are based on stress levels of 70000 lbf/in² and 35000 lbf/in² respectively.
These values do not exceed ²/₃ of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/2b for recommended Housing and Shaft dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	11	B	H	Z	03
Spherical					
Specification Ident					
High Misalignment					
Chamfered Outer Race					
Ball bore dia code in multiples of 1/16 inch					

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

ampep

SPHERICAL BEARINGS - SELF LUBRICATING NARROW - CHAMFERED OUTER RACE NORMAL TORQUE

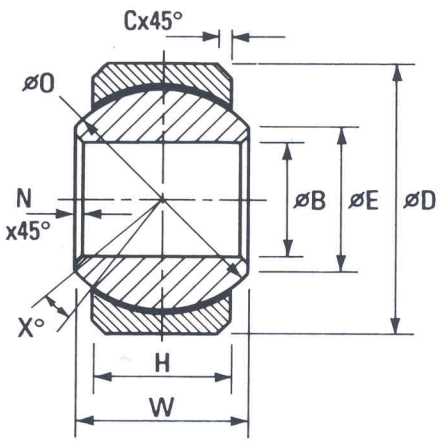
21C -- NZ
METRIC SERIES

MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Corrosion resistant steel

Ball
Through hardened corrosion resistant steel



DIMENSIONS, TOLERANCES, LOADS

N = 0.10/0.40

Part Number 21C -- NZ	B Bore Dia –	W Ball Width +0.10 −0.10	D Race O/Dia –	H Race Width +0.10 −0.10	C Race Chamf –	X° Min	O Ball Dia Ref	E Ball Face Min	No Load Breakout Torque Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	mm						mm		Nm	mm²		kN		mm	g
10	9.988 10.015	10.5	21.000 20.979	8	0.50 0.80	11	15.87	11.9	0.80	107.60	28.11	49.50	6.47	0.13849	20
12	11.988 12.015	10.0	22.000 21.979	7	0.50 0.80	11	17.45	14.3	0.80	100.86	15.90	46.40	3.66	0.15228	17
15	14.988 15.015	12.0	26.000 25.979	9	0.50 0.80	9	22.21	18.7	0.80	172.80	34.77	79.50	8.00	0.19302	32
17	16.988 17.015	14.0	30.000 29.975	10	0.50 0.80	10	25.41	21.2	0.80	223.10	46.00	102.63	10.58	0.22174	49
20	19.987 20.020	16.0	35.000 34.975	12	0.60 1.50	9	29.73	24.9	0.80	320.49	74.03	147.43	17.03	0.25944	65
25	24.987 25.020	20.0	42.000 41.975	16	0.60 1.50	7	36.05	30.0	1.00	515.52	133.49	221.67	28.70	0.31560	115
												①	①		

NOTES

① Radial and Axial limit loads are based on stress levels of 430 MPa and 215 MPa respectively.
These values do not exceed ²/₃ of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/3a for recommended Housing and Shaft dimensions and Staking Tools

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

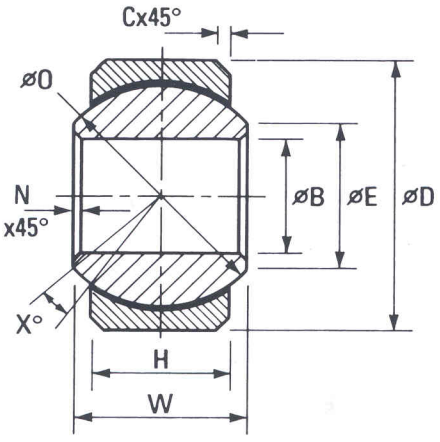
Basic Series Part Number	21	C	05	N	Z
Spherical					
Specification Ident					
Ball bore dia code in multiples of 1/16 inch					
Narrow					
Chamfered Outer Race					

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

21C -- WZ
METRIC SERIES

SPHERICAL BEARINGS - SELF LUBRICATING WIDE - CHAMFERED OUTER RACE NORMAL TORQUE



MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Corrosion resistant steel

Ball
Through hardened corrosion resistant steel

DIMENSIONS, TOLERANCES, LOADS

N = 0.10/0.40

Part Number 21C -- WZ	B Bore Dia –	W Ball Width +0.10 −0.10	D Race O/Dia –	H Race Width +0.10 −0.10	C Race Chamf –	X° Min	O Ball Dia Ref	E Ball Face Min	No Load Breakout Torque Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	mm						mm		Nm	mm²		kN		mm	g
08	7.990 8.012	11.0	18.000 17.979	8.0	0.50 0.80	14	15.07	10.3	0.50	102.17	28.80	47.00	6.62	0.13157	17
10	9.988 10.015	12.5	21.000 20.979	10.0	0.50 0.80	10	17.47	12.2	0.80	153.39	52.96	70.56	12.18	0.15245	27
12	11.988 12.015	16.0	26.000 25.979	13.0	0.50 0.80	9	22.28	15.5	0.80	262.46	99.74	120.73	22.94	0.19443	49
15	14.988 15.015	17.0	29.000 28.979	13.5	0.50 0.80	9	25.42	18.9	0.80	312.16	106.71	143.59	24.54	0.22133	62
17	16.988 17.015	18.0	30.000 29.975	14.5	0.50 0.80	8	27.31	20.1	0.80	362.68	126.20	166.83	29.03	0.23832	69
20	19.987 20.020	20.0	35.000 34.975	16.0	0.50 0.80	8	31.78	24.7	0.80	469.71	156.63	216.06	36.03	0.27733	104
22	21.987 22.020	22.0	40.000 39.975	18.0	0.60 1.00	9	34.90	27.1	1.00	585.62	206.72	269.83	47.54	0.30456	126
25	24.987 25.020	32.0	54.000 53.970	26.0	0.60 1.00	8	47.63	35.3	1.00	1157.40	434.33	497.68	93.38	0.41565	445
												⚠1	⚠1		

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	21	C	06	W	Z
Spherical					
Specification Ident					
Ball bore dia code in multiples of 1/16 inch					
Wide					
Chamfered Outer Race					

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

NOTES

⚠1 Radial and Axial limit loads are based on stress levels of 430 MPa and 215 MPa respectively.
These values do not exceed 2/3 of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/3a for recommended Housing and Shaft dimensions and Staking Tools

SPHERICAL BEARINGS - SELF LUBRICATING NARROW - CHAMFERED OUTER RACE NORMAL TORQUE

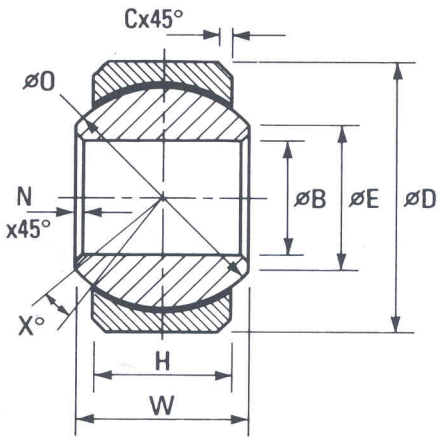
-- NZS
METRIC SERIES

MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, phosphated bore and faces



DIMENSIONS, TOLERANCES, LOADS

N = 0.10/1.00

Part Number -- NZS	B Bore Dia	W Ball Width	D Race O/Dia	H Race Width	C Race Chamf	X° Min	O Ball Dia	E Ball Face	No Load Breakout Torque	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
	–	+ 0.10 – 0.10	–	+ 0.10 – 0.10	–		Ref	Min	Max						
Code	**mm**						**mm**		**Nm**	**mm²**		**kN**		**mm**	**g**
50	49.985 50.010	35.0	75.000 74.979	28.0	0.9 1.1	7	66.0	55.9	3.39	1735	502	486.0	69.2	0.576	549
60	59.981 60.010	44.0	90.000 89.965	36.0	1.4 1.6	7	80.0	66.8	10.17	2744	874	762.4	120.6	0.698	1011
70	69.981 70.010	49.0	105.000 104.965	40.0	1.4 1.6	6	92.0	77.8	10.17	3524	1094	986.6	151.0	0.803	1533
80	79.981 80.010	55.0	120.000 119.965	45.0	1.4 1.6	6	105.0	89.4	10.17	4546	1406	1273.0	194.1	0.916	2260
												①	①		

NOTES

① Radial and Axial limit loads are based on stress levels of 280MPa and MPa and 140 MPa respectively.
These values do not exceed ²/₃ of 0.1% Proof Stress of Outer Race material.

BEARING INSTALLATION

Refer to following section 2.1.3/3b for recommended Housing and Shaft dimensions and Staking Tools

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number ____ 50 N Z S
* Ball bore dia code in multiples of 1/16 inch
Narrow
Chamfered Outer Race
Spherical

SPECIAL TYPES

Bearings based on the above specification with non-standard features may be supplied on request

SPHERICAL BEARINGS - SELF LUBRICATING SEALED NORMAL TORQUE

21-_____P
METRIC SERIES

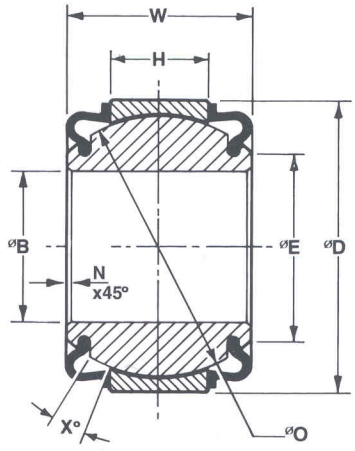
MATERIALS

Liner
Ampep X1

Outer Race
Medium carbon steel phosphated

Ball
Corrosion resistant steel

Seal
Neoprene rubber



DIMENSIONS, TOLERANCES, LOADS

N = 0.28/0.48

Part Number 21-____P	B Bore Dia —	W Ball Width + 0.10 − 0.10	D Race O/Dia —	H Race Width + 0.10 − 0.10	X° Min	O Ball Dia Ref	E Ball Face Min	No Load Breakout Torque Max	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
Code	mm					mm		Nm	mm²		kN		mm	g
8783	19.987 20.008	26.0	42.000 41.975	13.0	10	37.0	25.76	0.90	418.1	76.9	117.07	10.61	0.32289	146
8785	29.987 30.008	36.0	55.000 54.970	19.0	7	51.0	36.09	3.39	882.3	202.9	247.04	28.00	0.44506	329
10311	19.987 20.008	26.0	44.425 44.400	13.0	10	37.0	25.76	0.90	418.1	76.9	117.07	10.61	0.32289	161
10312	29.987 30.008	36.0	58.700 58.670	18.5	7	51.0	36.09	3.39	856.8	189.5	239.90	26.15	0.44506	372
											△1	△1		

△ NOTES

△1 Radial and Axial limit loads are based on stress levels of 280 MPa and 140 MPa respectively.
These values do not exceed ⅔ of 0.1% Proof Stress of Outer Race material.

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification
No standard series exists for sealed spherical bearings. Other sealed bearings based on the above specification may be supplied on request

BEARING INSTALLATION

Refer to following section 2.1.3/4a for recommended Housing and Shaft dimensions

SEALED - SELF LUBRICATING BALL PIN ASSEMBLIES

SPECIALS METRIC SERIES

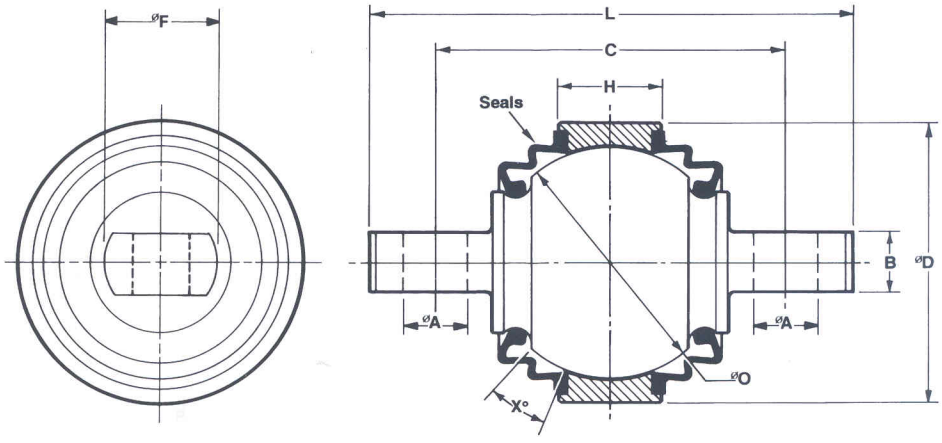
MATERIALS

Liner
Ampep X1

Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface

Seal
Neoprene rubber



DIMENSIONS, TOLERANCES, LOADS

Part Number 21-_____P	D Race O/Dia	H Race Width	B Pin Width	C Distance Between Holes	L Length	A Hole Dia	X° Min	O Ball Dia	F Pin Dia	No load breakout torque	Radial proj Area	Axial proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
	–	–	–	–	–	–		Ref	Max	Max						
Code	**mm**							**mm**		**Nm**	**mm²**		**kN**		**mm**	**g**
4442	56.000 55.981	30.1 29.9	22.4 22.0	84.5 84.0	118.0 117.0	19.00 19.50	12	49.2	32.0	20.0	1299	615	117	86	0.430	820
8484	62.000 61.970	23.1 22.9	16.5 15.5	88.2 87.8	116.0 114.0	13.00 13.20	22	53.0	32.0	22.6	975	314	66	44	0.463	875
10031	62.000 61.970	21.1 20.9	16.5 15.5	88.2 87.8	121.0 116.0	17.50 17.77	15	53.0	35.0	22.6	922	283	81	40	0.463	935
10700	62.000 61.970	35.1 34.9	16.2 15.8	88.2 87.8	121.0 116.0	13.00 13.20	12	53.0	35.0	50.0	1611	803	68	112	0.463	1140
7955	61.988 61.975	25.1 24.9	16.2 15.8	88.2 87.8	116.0 114.0	13.00 13.27	23	53.0	32.0	50.0	1081	380	64	53	0.463	995
9130	75.000 74.970	28.1 27.9	26.2 25.8	130.2 129.8	174.0 172.0	19.00 19.33	18	62.0	43.0	27.0	1451	490	149	69	0.541	2180
8032	74.988 74.970	28.1 27.9	26.2 25.8	130.2 129.8	175.0 173.0	19.00 19.33	18	62.0	43.0	50.0	1451	490	149	69	0.541	2180
7933	74.988 74.970	28.1 27.9	16.2 15.8	98.2 97.8	130.0 125.0	17.50 17.77	18	62.0	38.0	50.0	1451	490	71	69	0.541	1570
7983	74.988 74.970	28.1 27.9	16.2 15.8	94.2 93.8	130.0 125.0	17.50 17.80	18	62.0	38.0	50.0	1451	490	71	69	0.541	1570
8876	80.041 80.011	35.5 34.5	20.5 19.5	96.5 95.5	130.0 129.5	16.80 17.20	17	66.675	38.0	3.5	2027	803	102	112	0.582	1975
3 **10300**	90.000 89.965	34.1 33.9	34.1 33.9	130.2 129.8	171.0 169.0	M20x 2.5 thread	12	80.0	38.1	50.0	2352	754	250	105	0.698	3170
													1	2		

NOTES

1. Radial static limit loads are based on bending failure of suitably clamped bearing assemblies, using 2/3 Ball Pin Yield Stress (433 MPa)
2. Axial static limit loads are based on a stress level of 140 MPa
3. Rectangular end profile

BEARING INSTALLATION

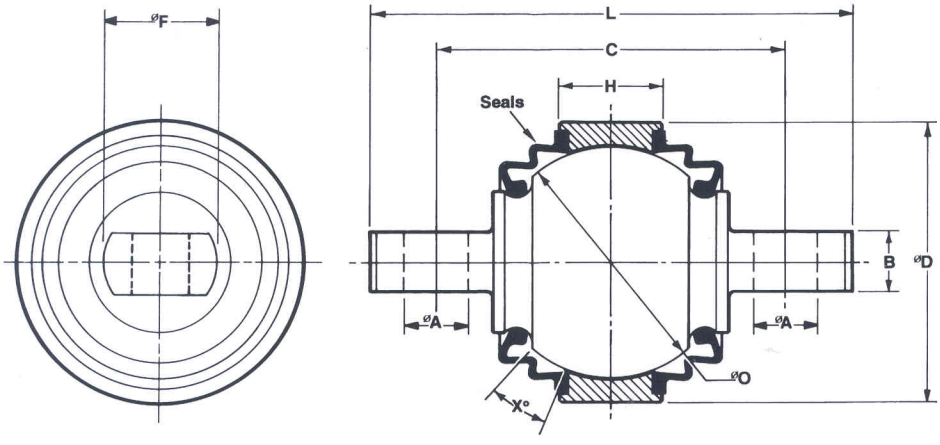
Refer to following section 2.1.3/4b for recommended Housing dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification
No standard series exists for ball pin assemblies. Other ball pin assemblies based on the above specification may be supplied on request

SPECIALS
METRIC SERIES

SEALED - SELF LUBRICATING BALL PIN ASSEMBLIES



MATERIALS

Liner/Counterface
Ampep XL System

Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, phosphated bore and faces

Seal
Neoprene rubber

DIMENSIONS, TOLERANCES, LOADS

Part Number 21-____P	D Race O/Dia	H Race Width	B Pin Width	C Distance Between Holes	L Length	A Hole Dia	X° Min	O Ball Dia	F Pin Dia	No load breakout torque	Radial proj Area	Axial proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
	–	–	–	–	–	–		Ref	Max	Max						
Code	**mm**							**mm**		**Nm**	**mm²**		**kN**		**mm**	**g**
9267	62.000 61.970	25.1 24.9	22.5 21.5	100.2 99.8	140.0 139.8	16.40 16.60	23	53.0	32.0	27.0	1081	380	110	53	0.463	1120
9159	62.000 61.970	25.1 24.9	16.5 15.5	88.2 87.8	116.0 114.0	13.00 13.20	23	53.0	32.0	22.6	1081	380	64	53	0.463	995
7075	61.988 61.975	25.1 24.9	16.2 15.8	88.2 87.8	116.0 114.0	13.00 13.27	23	53.0	32.0	50.0	1081	380	64	53	0.463	995
8904	66.645 66.615	25.1 24.9	16.5 15.5	96.2 95.8	135.0 134.8	17.40 17.60	23	53.0	32.0	23.0	1081	380	65	53	0.463	1110
7113	74.988 74.970	28.1 27.9	16.2 15.8	94.2 93.8	130.0 125.0	17.50 17.77	18	62.0	38.0	50.0	1451	490	79	69	0.541	1570
10293	81.870 81.835	35.1 34.9	20.2 19.8	120.3 119.7	152.0 148.0	17.80 18.20	12	62.0	38.3	7.0	1885	803	84	112	0.541	2095
													△1	△2		

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

No standard series exists for ball pin assemblies. Other ball pin assemblies based on the above specification may be supplied on request

△ NOTES

△1 Radial static limit loads are based on bending failure of suitably clamped bearing assemblies, using ²/₃ Ball Pin Yield Stress (433 MPa)

△2 Axial static limit loads are based on a stress level of 140 MPa

BEARING INSTALLATION

Refer to following section 2.1.3/4b for recommended Housing dimensions

SELF LUBRICATING BALL PIN ASSEMBLY

21-____ P
METRIC SERIES

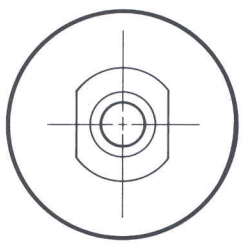
MATERIALS

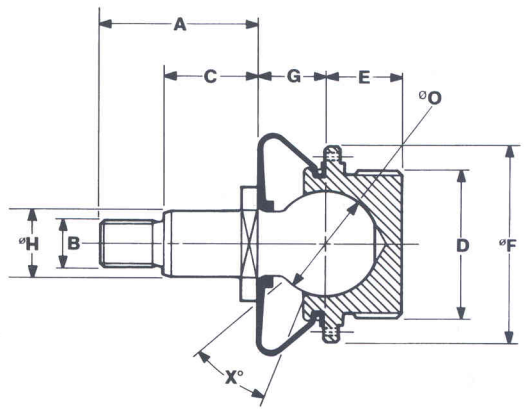
Liner
Ampep XL

Socket
Corrosion resistant steel

Ball Pin
Corrosion resistant steel. Hard chrome plated on spherical surface

Seal
Neoprene rubber





DIMENSIONS, TOLERANCES, LOADS

Part Number 21-___P	A	B	C	D	E	F	G	H	O
	Pin Length	Ball Pin Thread	Shank Length	Housing Thread	Depth	Flange Dia		Shank Dia	Ball Dia Ref
	mm	–	mm	–	mm				
9629	42.0	M12 x 1.25-6g RH	25.0	M39 x 1.5-6g RH	20.0	52.051 52.032	18.0	17.039 17.028	28.0

Part Number 21-___P	X° Misalignment Angle	No Load Breakout Torque	Radial Proj Area	Axial Proj Area	Static Radial Limit Load	Static Axial Limit Load	Distance Travelled per Degree	Approx Mass
	Min	Max						
	–	Nm	mm^2		kN		mm	g
9629	27.5	2.26	463	66.5 ③	15.2 ①	14.3 ②	0.244	325

NOTES

① Radial limit loads are based on bending failure of Ball Pin compnent at a stress level of 851 MPa

② Axial limit loads are based on a stress level of 215 MPa with Ball Pin Socket assembly fixed in housing

③ Axial projected area of bearing assembly when viewed from horizontal centre line towards Ball Pin flange

BEARING INSTALLATION

Refer to following section 2.1.3/5a for recommended Housing dimensions

SPHERICAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

21CNZ --
21CWZ --
INCH SERIES

SERIES: 21CNZ --

Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	in		in	
04	0.2497	0.2491	0.6569	0.6562
05	0.3122	0.3116	0.7508	0.7500
06	0.3747	0.3741	0.8133	0.8125
07	0.4372	0.4365	0.9070	0.9062
08	0.4997	0.4990	1.0008	1.0000
081	0.5002	0.4994	0.8758	0.8750
10	0.6247	0.6240	1.1883	1.1875
12	0.7497	0.7489	1.4385	1.4375
16	0.9997	0.9989	1.7510	1.7500

SERIES: 21CWZ --

Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	in		in	
04	0.2497	0.2491	0.6257	0.6250
05	0.3122	0.3116	0.6882	0.6875
06	0.3747	0.3741	0.8133	0.8125
07	0.4372	0.4365	0.9383	0.9375
08	0.4997	0.4990	1.0008	1.0000
10	0.6247	0.6240	1.1883	1.1875
101	0.6252	0.6245	1.3760	1.3750
12	0.7497	0.7490	1.3760	1.3750
16	0.9997	0.9989	2.1260	2.1250

NZS --
INCH SERIES

SPHERICAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

SERIES: NZS --				
Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	**in**		**in**	
20	1.2506	1.2496	2.0008	1.9996
24	1.5006	1.4996	2.4383	2.4371
32	2.0007	1.9995	3.1884	3.1870
40	2.5007	2.4995	3.9384	3.9370
48	3.0007	2.9995	4.7510	4.7494

SPHERICAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

11BNZ -- 11BWZ-- INCH SERIES

SERIES: 11BNZ --

Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	in		in	
03	0.1897	0.1892	0.5628	0.5623
04	0.2497	0.2492	0.6565	0.6560
05	0.3122	0.3117	0.7503	0.7498
051	0.3122	0.3117	0.7503	0.7498
06	0.3747	0.3742	0.8128	0.8123
07	0.4372	0.4367	0.9065	0.9060
08	0.4997	0.4992	1.0003	0.9998
09	0.5622	0.5617	1.0940	1.0935
10	0.6247	0.6242	1.1878	1.1873
12	0.7497	0.7492	1.4378	1.4373
14	0.8747	0.8742	1.5628	1.5623
16	0.9997	0.9992	1.7503	1.7498
20	1.2497	1.2492	2.0003	1.9998
24	1.4997	1.4992	2.4378	2.4373
28	1.7497	1.7492	2.8128	2.8123
32	1.9997	1.9992	3.1878	3.1873

SERIES: 11BWZ --

Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	in		in	
03	0.1897	0.1892	0.6253	0.6248
04	0.2497	0.2492	0.6253	0.6248
05	0.3122	0.3117	0.6878	0.6873
06	0.3747	0.3742	0.8128	0.8123
07	0.4372	0.4367	0.9378	0.9373
071	0.4372	0.4367	0.9065	0.9060
08	0.4997	0.4992	1.0003	0.9998
09	0.5622	0.5617	1.1253	1.1248
10	0.6247	0.6242	1.1878	1.1873
12	0.7497	0.7492	1.3753	1.3748
14	0.8747	0.8742	1.6253	1.6248
16	0.9997	0.9992	2.1253	2.1248
20	1.2497	1.2492	2.3753	2.3748
24	1.4997	1.4992	2.6878	2.6873
28	1.7497	1.7492	3.0003	2.9998
32	1.9997	1.9992	3.2503	3.2498

11BHZ --
INCH SERIES

SPHERICAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

SERIES: 11BHZ --				
Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	in		in	
03	0.1897	0.1892	0.5628	0.5623
031	0.1897	0.1892	0.6253	0.6248
04	0.2497	0.2492	0.7403	0.7398
05	0.3122	0.3117	0.9063	0.9058
051	0.3122	0.3117	0.6878	0.6873
06	0.3747	0.3742	0.9063	0.9058
07	0.4372	0.4367	1.0003	0.9998
08	0.4997	0.4992	1.1253	1.1248
10	0.6247	0.6242	1.3753	1.3748
12	0.7497	0.7492	1.5628	1.5623
14	0.8747	0.8742	1.7503	1.7498
16	0.9997	0.9992	2.1253	2.1248
20	1.2497	1.2492	2.5003	2.4998
24	1.4997	1.4992	3.0003	2.9998

SPHERICAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

SERIES: 21C--NZ				
Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	mm		mm	
10	10.000	9.982	21.012	20.991
12	12.000	11.982	22.012	21.991
15	15.000	14.982	26.012	25.991
17	17.000	16.982	30.014	29.989
20	20.000	19.982	35.014	34.989
25	25.000	24.982	42.014	41.989

SERIES: 21C--WZ				
Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	mm		mm	
08	8.000	7.985	18.012	17.991
10	10.000	9.982	21.012	20.991
12	12.000	11.982	26.012	25.991
15	15.000	14.982	29.012	28.991
17	17.000	16.982	30.014	29.989
20	20.000	19.979	35.014	34.989
22	22.000	21.979	40.014	39.989
25	25.000	24.979	54.018	53.988

--NZS
METRIC SERIES

SPHERICAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

SERIES: --NZS				
Nominal Bore	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	**mm**		**mm**	
50	50.000	49.975	75.018	74.988
60	60.000	59.970	90.022	89.987
70	70.000	69.970	105.022	104.987
80	80.000	79.970	120.022	119.987

SPHERICAL BEARINGS - SELF LUBRICATING SEALED - SHAFT & HOUSING DIMENSIONS

SERIES: 21-____P				
Part Number	Recommended Shaft Dia		Recommended Housing Dia	
	Max	Min	Max	Min
Code	mm		mm	
8783	20.000	19.979	42.014	41.989
8785	30.000	29.975	55.018	54.988
10311	20.000	19.979	44.439	44.414
10312	30.000	29.975	58.718	58.688

BALL PIN ASSEMBLIES - SELF LUBRICATING HOUSING DIMENSIONS

SERIES: SPECIALS 21-____P		
Part Number	Recommended Housing Dia	
	Max	Min
Code	mm	
4442	56.018	55.988
8484	62.018	61.988
10031	62.018	61.988
10700	62.018	61.988
7955	62.018	61.988
9130	75.018	74.988
8032	75.018	74.988
7933	75.018	74.988
7983	75.018	74.988
8876	80.071	80.036
10300	90.022	89.987
9267	62.018	61.988
9159	62.018	61.988
7075	62.018	61.988
8904	66.660	66.630
7113	75.028	74.982
10293	81.890	81.860

BALL PIN BEARINGS - SELF LUBRICATING HOUSING DIMENSIONS

21-____ P
METRIC SERIES

SERIES: SPECIALS 21-____P				
Part Number	Pin Housing		Socket Housing	
	Max	Min	Max	Min
	mm		mm	
9629	17.047	17.027	52.060	52.030

ROD END BEARINGS- SELF LUBRICATING MALE

22CML ----
22CMR ----
INCH SERIES

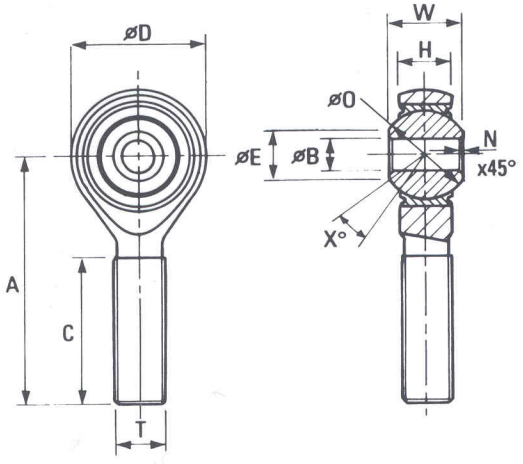
MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Corrosion resistant steel

Ball
Through hardened corrosion resistant steelp

Rod End Body
Corrosion resistant steel



DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.005

Part Number	B	W	D	H	A	T	C	X°	O	E	Ultimate Static Load	Distance Travelled per Degree	Approx Mass
	Bore Dia	Ball Width	Head Dia	Head Width	Length	Thread	Full Thread Length	Min	Ball Dia	Ball Face			
22CML ---- 22CMR ----	+ 0.0002 – 0.0005	+ 0.000 – 0.005	± 0.010	+ 0.000 – 0.010	± 0.015	UNF-3A	Min		Ref	Min			
Code	in								in		lbf	ft	lb
04U1	0.2500	0.437	0.806	0.337	1.560	5/16 - 24	0.940	17	0.531	0.300	6750	0.00039	0.07
04U2	0.2500	0.375	0.806	0.337	1.560	5/16 - 24	0.940	5	0.531	0.300	6750	0.00039	0.07
05U1	0.3125	0.437	0.900	0.327	1.875	5/16 - 24	1.160	14	0.594	0.400	8150	0.00043	0.09
05U2	0.3125	0.437	0.900	0.327	1.875	3/8 - 24	1.160	14	0.594	0.400	8150	0.00043	0.10
06U1	0.3750	0.500	1.025	0.416	1.940	3/8 - 24	1.160	9	0.687	0.470	10300	0.00050	0.14
06U2	0.3750	0.500	1.025	0.416	1.940	7/16 - 20	1.160	9	0.687	0.470	10300	0.00050	0.14
07U1	0.4375	0.562	1.150	0.452	2.125	7/16 - 20	1.250	10	0.781	0.540	12900	0.00057	0.22
07U2	0.4375	0.562	1.150	0.452	2.125	1/2 - 20	1.250	10	0.781	0.540	12900	0.00057	0.19
08U1	0.5000	0.625	1.337	0.515	2.440	1/2 - 20	1.440	9	0.875	0.610	21250	0.00064	0.26
08U2	0.5000	0.625	1.337	0.515	2.440	5/8 - 18	1.440	9	0.875	0.610	21250	0.00064	0.28
10U1	0.6250	0.750	1.525	0.577	2.625	5/8 - 18	1.530	12	1.062	0.750	23900	0.00077	0.42
10U2	0.6250	0.750	1.525	0.577	2.625	3/4 - 16	1.530	12	1.062	0.750	23900	0.00077	0.46

(1)

NOTES

(1) Ultimate radial static loads are based on 0.2% proof stress of the rod end body material

(2) Fatigue Limit – In applications where a large number of compression/tension loads are expected to accumulate, it is recommended that applied loads do not exceed 10% of the ultimate radial static loads stated

(3) Axial push out load capacity exceeds strength of threaded portion in bending. The use of rod ends in axial modes is not recommended. If, however, this is unavoidable, consultation with Ampep Technical Sales Department is advised regarding the specific application

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	22	C	M	R	04	U	1
Rod End				L			

- Specification Ident
- Male
- Thread (right hand R, left hand L)
- Ball bore dia code in multiples of 1/16 inch
- Unified Thread Form
- Thread Size Code

BEARING INSTALLATION

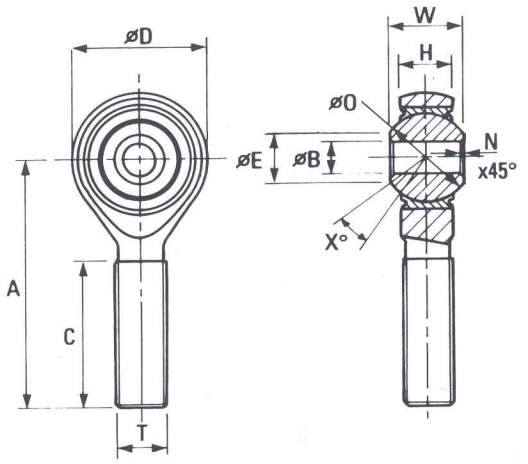
Refer to following section 2.2.2/3a for recommended Shaft dimensions

ampep

AMPEP DATA SHEET
2.2.1/1a
ISSUE - 0301

22AML ----
22AMR ----
INCH SERIES

ROD END BEARINGS - SELF LUBRICATING MALE



MATERIALS

Liner
Ampep X1

Outer Race
Corrosion resistant steel

Ball
Corrosion resistant steel

Rod End Body
Nickel-chromium-molybdenum (high carbon) steel, electroplated (gold colour)

DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number	B	W	D	H	A	T	C	X°	O	E	Ultimate Static Radial Load	Distance Travelled per Degree	Approx Mass
	Bore Dia	Ball Width	Head Dia	Head Width	Length	Thread	Full Thread Length	Min	Ball Dia	Ball Face			
21AML ---- 21AMR ----	+ 0.0000 − 0.0005	+ 0.000 − 0.002	+ 0.010 − 0.010	+ 0.000 − 0.010	+ 0.040 − 0.010	UNF-3A	+ 0.060 − 0.030		Ref	Min			
Code	**in**								**in**		**lbf**	**ft**	**lb**
04U1	0.2500	0.437	0.806	0.337	1.562	5/16 - 24	0.908	15	0.531	0.300	7200	0.00039	0.066
05U1	0.3125	0.437	0.875	0.327	1.875	5/16 - 24	1.250	14	0.593	0.360	8400	0.00043	0.087
05U2	0.3125	0.437	0.875	0.327	1.875	3/8 - 24	1.250	14	0.593	0.360	9200	0.00043	0.093
06U1	0.3750	0.500	1.030	0.415	1.938	3/8 - 24	1.218	8	0.687	0.466	11200	0.00050	0.138
06U2	0.3750	0.500	1.030	0.415	1.938	7/16 - 20	1.218	8	0.687	0.466	11200	0.00050	0.140
06U3	0.3750	0.500	1.030	0.415	1.938	1/2 - 20	1.218	8	0.687	0.466	11200	0.00050	0.142
07U1	0.4375	0.562	1.250	0.400	2.437	7/16 - 20	1.593	15	0.781	0.537	13800	0.00056	0.200
07U2	0.4375	0.562	1.250	0.452	2.125	1/2 - 20	1.281	10	0.781	0.537	18200	0.00056	0.190
08U1	0.5000	0.625	1.337	0.515	2.437	1/2 - 20	1.500	9	0.875	0.607	22700	0.00063	0.278
08U2	0.5000	0.625	1.375	0.515	2.437	5/8 - 18	1.500	9	0.875	0.607	24300	0.00063	0.280
10U1	0.6250	0.750	1.560	0.577	2.625	5/8 - 18	1.562	12	1.062	0.747	30000	0.00077	0.424
10U2	0.6250	0.750	1.560	0.577	2.625	3/4 - 16	1.562	12	1.062	0.747	30000	0.00077	0.460

△1

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	22	A	M	R	05	U	1
Rod End				L			
Specification Ident							
Male							
Thread (right hand R, left hand L)							
Ball bore dia code in multiples of 1/16 inch							
Unified Thread Form							
Thread Size Code							

△ NOTES

△1 Ultimate static load based on 0.2% proof stress of the rod end body material

△2 Fatigue Limit – in applications where a large number of compression/tension loads are expected to accumulate, it is recommended that applied loads do not exceed 10% of the ultimate radial static loads stated

△3 Axial push out load capacity exceeds strength of threaded portion in bending. The use of rod ends in axial modes is not recommended. If, however, this is unavoidable, consultation with Ampep Technical Sales Department is advised regarding the specific application

BEARING INSTALLATION

Refer to following section 2.2.2/3b for recommended Shaft dimensions

ROD END BEARINGS - SELF LUBRICATING MALE

22HML ----
22HMR ----
INCH SERIES

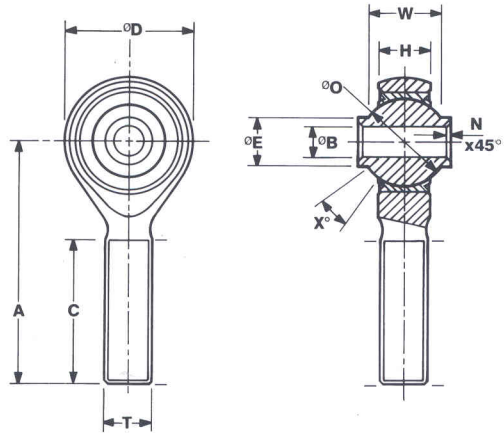
MATERIALS

Liner
Ampep X1

Outer Race
Corrosion resistant steel

Ball
Corrosion resistant steel

Rod End Body
Nickel-chromium-molybdenum (high carbon) steel, electroplated (gold colour)



DIMENSIONS, TOLERANCES, LOADS

N = 0.005/0.015

Part Number	B	W	D	H	A	T	C	X°	O	E	Ultimate Static Radial Load	Distance Travelled per Degree	Approx Mass
	Bore Dia	Ball Width	Head Dia	Head Width	Length	Thread	Thread Length		Ball Dia	Collar Dia			
21HML ---- 21HMR ----	+ 0.0000 − 0.0005	+ 0.000 − 0.002	+ 0.010 − 0.010	+ 0.000 − 0.010	+ 0.040 − 0.010	UNF-3A	+ 0.060 − 0.030	Min	Ref	Min			
Code	in								in		lbf	ft	lb
03U2	0.1900	0.500	0.750	0.220	1.500	5/16 - 24	1.000	15	0.437	0.312	5120	0.00031	0.670
04U2	0.2500	0.593	1.000	0.265	1.938	3/8 - 24	1.250	24	0.593	0.350	8960	0.00043	0.108
05U2	0.3125	0.813	1.125	0.355	2.125	7/16 - 20	1.375	22	0.781	0.480	9740	0.00056	0.156
06U2	0.3750	0.813	1.125	0.355	2.125	7/16 - 20	1.375	22	0.781	0.480	9740	0.00056	0.160
07U2	0.4375	0.875	1.312	0.355	2.438	1/2 - 20	1.500	22	0.875	0.570	14460	0.00063	0.252
08U2	0.5000	0.937	1.500	0.411	2.625	5/8 - 18	1.625	20	1.000	0.680	20240	0.00072	0.395
10U2	0.6250	1.200	1.750	0.577	2.875	3/4 - 16	1.750	20	1.250	0.810	27080	0.00091	0.630
12U2	0.7500	1.280	2.000	0.630	3.375	7/8 - 14	1.875	19	1.375	0.920	35030	0.00100	0.910

△1

NOTES

△1 Ultimate static load based on 0.2% proof stress of the rod end body material

△2 Fatigue Limit – in applications where a large number of compression/tension loads are expected to accumulate, it is recommended that applied loads do not exceed 10% of the ultimate radial static loads stated

△3 Axial push out load capacity exceeds strength of threaded portion in bending. The use of rod ends in axial modes is not recommended. If, however, this is unavoidable, consultation with Ampep Technical Sales Department is advised regarding the specific application

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	22	H	M	R	05	U	2
Rod End				L			

- Specification Ident
- Male
- Thread (right hand R, left hand L)
- Ball bore dia code in multiples of 1/16 inch
- Unified Thread Form
- Thread Size Code

BEARING INSTALLATION

Refer to following section 2.2.2/4a for recommended Shaft dimensions

ampep

ROD END BEARINGS - SELF LUBRICATING MALE

---- ML
---- MR
METRIC SERIES

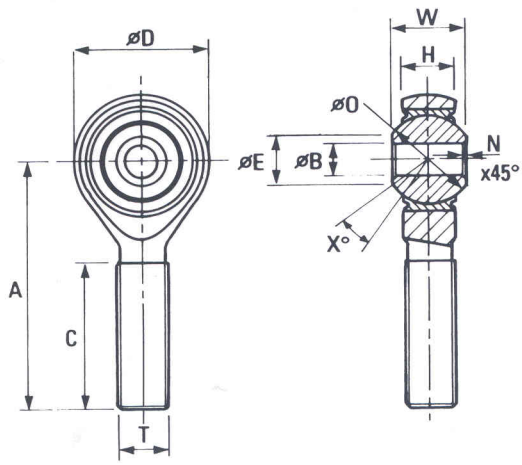
MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, phosphated bore and faces

Rod End Body
Medium carbon low alloy steel phosphated



DIMENSIONS, TOLERANCES, LOADS

N = 0.30/0.50

Part Number ---- ML ---- MR	B Bore Dia –	W Ball Width ± 0.1	D Head Dia + 1.0 - 0.2	H Head Width ± 0.1	A Length + 1.0 - 0.2	T Thread –	C Thread Length –	X° Min	O Ball Dia Ref	E Ball Face Min	Ultimate Static Radial Load	Distance Travelled per Degree	Approx Mass
	mm								mm		kN	mm	g
0808	7.989 8.007	8.0	24.0	5.1	42.0	M8 x 1.25	24.0	18	13.0	10.25	19	0.113	26
1010	9.989 10.007	9.0	28.0	6.1	48.0	M10 x 1.5	29.0	12	16.0	13.20	27	0.140	42
1212	11.989 12.007	10.0	32.0	7.1	54.0	M12 x 1.75	33.0	11	18.0	15.00	35	0.157	72
1514	14.989 15.007	12.0	38.0	9.1	60.0	M14 x 2.0	36.0	9	22.0	18.40	54	0.192	119
1716	16.989 17.007	14.0	44.0	10.1	66.0	M16 x 1.5	40.0	10	25.0	20.70	70	0.218	170
2020	19.987 20.008	16.0	51.0	12.1	78.0	M20 x 1.5	47.0	9	30.0	25.40	95	0.253	294
2524	24.987 25.008	20.0	62.0	16.1	94.0	M24 x 2.0	57.0	8	35.0	28.80	160	0.310	480

(1)

NOTES

(1) Ultimate static load based on 0.2% proof stress of the rod end body material

(2) Fatigue limit – in applications where a large number of compression/tension loads are expected to accumulate, it is recommended that applied loads do not exceed 10% of the ultimate radial static loads stated

(3) Axial push out load capacity exceeds strength of threaded portion in bending. The use of rod ends in axial modes is not recommended. If, however, this is unavoidable, consultation with Ampep Technical Sales Department is advised regarding the specific application

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	08	08	M	R
Ball bore dia in mm				L
Thread size code				
Male				
Thread (right hand R, left hand L)				

SPECIAL TYPES

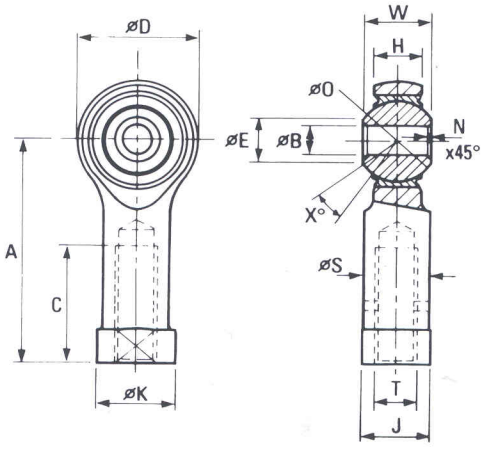
Bearings based on the above specification with non-standard features may be supplied on request

BEARING INSTALLATION

Refer to following section 2.2.2/5a for recommended Shaft dimensions

---- FL
---- FR
METRIC SERIES

ROD END BEARINGS - SELF LUBRICATING FEMALE



MATERIALS

Liner
Ampep Fiberslip®

Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, phosphated bore and faces

Rod End Body
Medium carbon low alloy steel phosphated

DIMENSIONS, TOLERANCES, LOADS

N = 0.30/0.50

Part Number ---- FL ---- FR	B Bore Dia –	W Ball Width ± 0.1	D Head Dia +1.0 – 0.2	H Head Width ± 0.1	A Length +1.0 – 0.2	T Thread –	C Full Thread Length Min	X° Min	O Ball Dia Ref	E Ball Face Min	J Across Flats	K Flat Dia	S Shank Dia	Ultimate Static Radial Load	Distance Travelled per Degree	Approx Mass
	mm								mm					kN	mm	g
0808	7.989 8.007	8.0	24.0	5.1	36.0	M8 x 1.25	17.0	18	13.0	10.25	14.0	16.0	12.5	19	0.113	36
1010	9.989 10.007	9.0	28.0	6.1	43.0	M10 x 1.5	21.0	12	16.0	13.20	17.0	19.0	15.0	27	0.140	58
1212	11.989 12.007	10.0	32.0	7.1	50.0	M12 x 1.75	24.0	11	18.0	15.00	19.0	22.0	17.5	35	0.157	88
1514	14.989 15.007	12.0	38.0	9.1	61.0	M14 x 2.0	30.0	9	22.0	18.40	22.0	26.0	21.0	54	0.192	156
1716	16.989 17.007	14.0	44.0	10.1	67.0	M16 x 1.5	34.0	10	25.0	20.70	27.0	29.0	24.0	70	0.218	225
2020	19.987 20.008	16.0	51.0	12.1	77.0	M20 x 1.5	40.0	9	30.0	25.40	32.0	34.0	27.5	95	0.253	323
2524	24.987 25.008	20.0	62.0	16.1	94.0	M24 x 2.0	48.0	8	35.0	28.80	36.0	42.0	33.5	160	0.310	624

△1

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	08	08	F	R
Ball bore dia in mm				L
Thread size code				
Female				
Thread (right hand R, left hand L)				

△ NOTES

△1 Ultimate static load based on 0.2% proof stress of the rod end body material

△2 Fatigue Limit – in applications where a large number of compression/tension loads are expected to accumulate, it is recommended that applied loads do not exceed 10% of the ultimate radial static loads stated

△3 Axial push out load capacity exceeds strength of threaded portion in bending. The use of rod ends in axial modes is not recommended. If, however, this is unavoidable, consultation with Ampep Technical Sales Department is advised regarding the specific application

BEARING INSTALLATION

Refer to following section 2.2.2/5b for recommended Shaft dimensions

SPHERICAL BEARINGS - SELF LUBRICATING BALL PIN ROD END ASSEMBLIES

SPECIALS
METRIC SERIES

MATERIALS

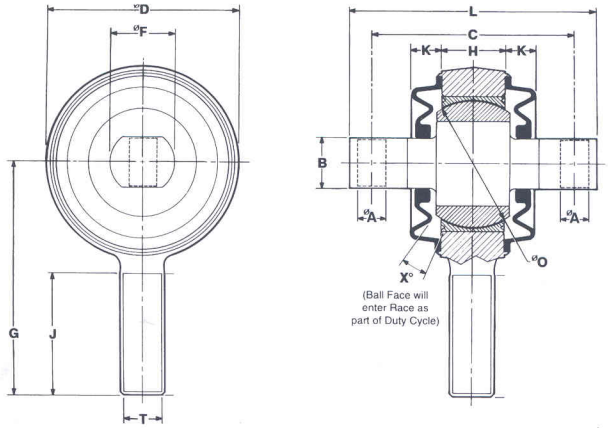
Liner
Ampep Fiberslip®
except where designated △1

Outer Race
Medium carbon steel phosphated

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, except where designated △1

Rod End Body
Medium carbon low alloy steel phosphated

Seal
Neoprene rubber



DIMENSIONS, TOLERANCES, LOADS

	Part Number	D	H	B	C	L	A	X°	O	F	G	T	J	K	No Load Breakout Torque	Radial Proj Area	Static Radial Limit Load	Distance Travelled per Degree	Approx Mass
		Head Dia	Head Width	Pin Width	Distance Between Holes	Pin Dia	Hole Dia	Min	Ball Dia	Pin Dia	Length	Thread	Full Thread Length	Seal Width					
	22-___P	–	Ref			–	Ref		Ref			–	Min	Ref	Max				
		mm							mm						Nm	mm²	kN	mm	g
	6726	116.5 115.0	38.35	30.0	123.0	150.5 149.5	17.0	12	76.2	40.0	141.2 138.2	R/Hand M27 x 3-6g	73.0	19.0	8.00	2801	174	0.665	4300
	8050	116.5 115.0	38.35	30.0	123.0	150.5 149.5	17.0	12	76.2	40.0	141.2 138.2	L/Hand M27 x 3-6g	73.0	19.0	8.00	2801	174	0.665	4300
△1	8228	116.5 115.0	38.35	30.0	123.0	150.5 149.5	17.0	12	76.2	40.0	141.2 138.2	R/Hand M27 x 3-6g	73.0	19.0	8.00	2801	174	0.665	4300
△1	8229	116.5 115.0	38.35	30.0	123.0	150.5 149.5	17.0	12	76.2	40.0	141.2 138.2	L/Hand M27 x 3-6g	73.0	19.0	8.00	2801	174	0.665	4300

△2

△ NOTES

△1 Liner/Counterface Ampep XL system

△2 Radial static limit loads are based on bending failure of suitably clamped bearing assemblies, using ²/₃ Ball Pin Yield Stress (433 MPa)

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codifcation
No standard series exists for Ball Pin Rod End Assemblies.

Other Ball Pin Rod End Assemblies based on the above specification may be supplied on request.

SPHERICAL BEARINGS - SELF LUBRICATING DOUBLE ENDED BALL PIN LINK

SPECIALS
METRIC SERIES

MATERIALS

Liner
Ampep X1

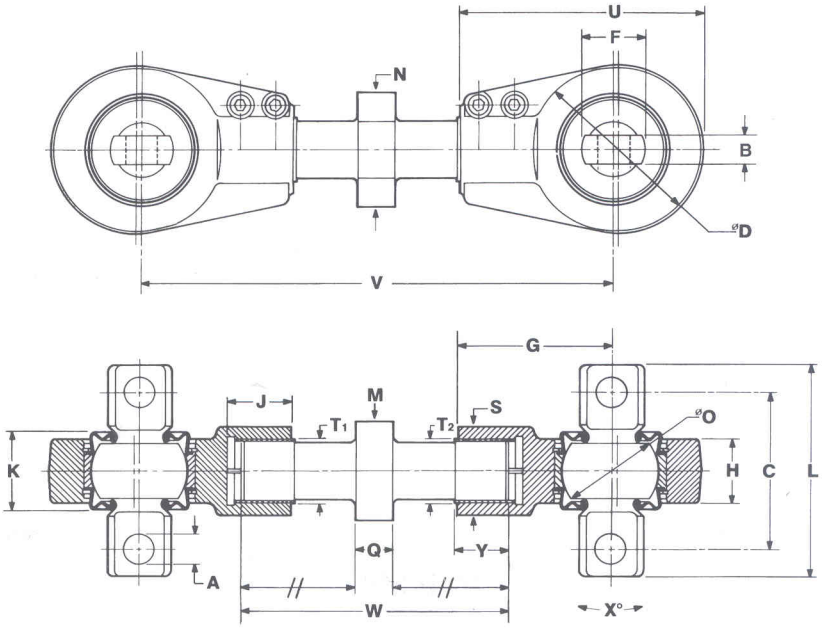
Outer Race
Medium carbon steel

Ball
Medium carbon low alloy steel, hard chrome plated on spherical surface, phosphated bore and faces

Rod End Body
Medium carbon low alloy steel phosphated

Seal
Neoprene rubber

Turn Buckle Pin
Medium carbon low alloy steel phosphated and sealed



DIMENSIONS, TOLERANCES, LOADS

Part Number 25-____P	D Head Dia	H Head Width	B Pin Width	C Distance Between Holes	L Pin Length	A Hole Dia	X° Min	O Ball Dia	F Pin Dia	G Length	T1 T2 Thread	J Thread Length with Run-out	W Turnbuckle Pin Length	Y Turnbuckle Pin Thread Length
	Ref		–		–	–		Ref	–	Ref	L/H R/H	Ref		
	mm							mm			–	mm		
10659	94	35	16.5 15.5	88.2 87.8	121.0 116.0	17.77 17.50	15	53	35.0 34.5	85	M35 x 1.5	36	95.25	22
10967	94	35	16.5 15.5	88.2 87.8	121.0 116.0	17.77 17.50	15	53	35.0 34.5	85	M35 x 1.5	36	150.00	30

Part Number 25-____P	S Shank Dia	U Head Length	V Pitch	Q Width of Flats	M Distance Across Flats	N Distance Across Corners	K Overall Seal Width	Shank Pinch Bolt Spec	No Load Breakout Torque	Radial Proj Area	Static Radial Limit Load	Distance Travelled per Degree	Approx Mass
	Ref		±10	Ref			Max		Max				
	mm								Nm	mm	kN	mm	g
10659	49	135	210	8	54.99 53.80	63.5	43	4 off M8 x 30	22.6	922	81	0.463	6060
10967	49	135	265	20	54.99 53.80	63.5	43	4 off M8 x 30	22.6	922	81	0.463	6570

△1

NOTES

△1 Radial static limit loads are based on bending failure of suitably clamped bearing assemblies, using ⅔ Ball Pin Yield Stress (433 MPa)

△2 Maximum pinch bolt torque 25Nm

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification
No standard series exists for Double Ended Ball Pin Links. Other Double Ended Ball Pin Link Assemblies based on the above specification may be supplied on request.

ROD ENDS - SELF LUBRICATING SHAFT DIMENSIONS

22CML ----
22CMR ----
INCH SERIES

SERIES: 22CML ---- , 22CMR ----		
Part Number	Recommended Shaft Dia	
	Max	Min
Code	**mm**	
04U1	0.2497	0.2491
04U2	0.2497	0.2491
05U1	0.3122	0.3116
05U2	0.3122	0.3116
06U1	0.3747	0.3741
06U2	0.3747	0.3741
07U1	0.4372	0.4365
07U2	0.4372	0.4365
08U1	0.4997	0.4990
08U2	0.4997	0.4990
10U1	0.6247	0.6240
10U2	0.6247	0.6240

22AML ----
22AMR ----
INCH SERIES

ROD ENDS - SELF LUBRICATING SHAFT DIMENSIONS

SERIES: 22AML ---- , 22AMR ----		
Part Number	Recommended Shaft Dia	
	Max	Min
Code	mm	
04U1	0.2497	0.2491
05U1	0.3122	0.3116
05U2	0.3122	0.3116
06U1	0.3747	0.3741
06U2	0.3747	0.3741
06U3	0.3747	0.3741
07U1	0.4372	0.4365
07U2	0.4372	0.4365
08U1	0.4997	0.4990
08U2	0.4997	0.4990
10U1	0.6247	0.6240
10U2	0.6247	0.6240

ROD ENDS - SELF LUBRICATING SHAFT DIMENSIONS

22HML ----
22HMR ----
INCH SERIES

SERIES: 22HML ---- , 22HMR ----		
Part Number	Recommended Shaft Dia	
	Max	Min
Code	**mm**	
03U2	0.1897	0.1892
04U2	0.2497	0.2492
05U2	0.3122	0.3117
06U2	0.3747	0.3742
07U2	0.4372	0.4367
08U2	0.4997	0.4992
10U2	0.6247	0.6242
12U2	0.7497	0.7492

ROD ENDS - SELF LUBRICATING
SHAFT DIMENSIONS

---- ML
---- MR
METRIC SERIES

SERIES: ---- ML , ---- MR		
Part Number	Recommended Shaft Dia	
	Max	Min
Code	**mm**	
0808	8.000	7.985
1010	10.000	9.985
1212	12.000	11.982
1514	15.000	14.982
1716	17.000	16.982
2020	20.000	19.979
2524	25.000	24.979

JOURNAL BEARINGS - SELF LUBRICATING PLAIN - AL. ALLOY & STEEL BACKED

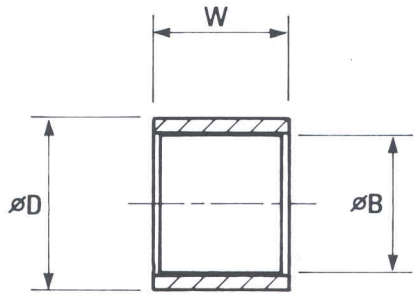
13AAZ --
13ASZ --
INCH SERIES

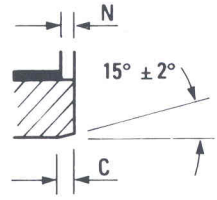
MATERIALS

Liner
Ampep X1

Shell
For 13AAZ -- Series:
Aluminium alloy

For 13ASZ -- Series:
Corrosion resistant steel





N= 0.010 For sizes 04 to 12 incl.
0.020 For sizes 14 to 32 incl.
C= 0.020/0.030

DIMENSIONS AND TOLERANCES

All Dimensions in inches

Nominal Bore		B	D	W												Distance Travelled Per Degree
		Bore Dia	O/Dia	-0.005 Overall Width -0.015												
Code	Size	–	–	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	2	ft
04	1/4	0.2503 0.2512	0.3760 0.3755	03	04												0.00018
05	5/16	0.3130 0.3139	0.4386 0.4381	03	04	05											0.00022
06	3/8	0.3756 0.3765	0.5011 0.5006	03	04	05	06	07									0.00026
08	1/2	0.5006 0.5016	0.6888 0.6883	03	04	05	06	07	08								0.00036
10	5/8	0.6257 0.6267	0.8139 0.8134		04	05	06	07	08	10							0.00045
12	3/4	0.7508 0.7520	0.9389 0.9384		04	05	06	07	08	10	12	14					0.00054
14	7/8	0.8759 0.8771	1.0640 1.0635			05	06	07	08	10	12	14					0.00063
16	1	1.0010 1.0022	1.1890 1.1885			05	06	07	08	10	12	14	16				0.00072
18	1 1/8	1.1263 1.1275	1.3143 1.3137				06	07	08	10	12	14	16				0.00081
20	1 1/4	1.2512 1.2528	1.5019 1.5013						08	10	12	14	16	20			0.00090
22	1 3/8	1.3763 1.3779	1.6269 1.6263						08	10	12	14	16	20			0.00100
24	1 1/2	1.5013 1.5029	1.7519 1.7513						08	10	12	14	16	20	24		0.00109
28	1 3/4	1.7517 1.7533	2.0023 2.0016								12	14	16	20	24		0.00127
32	2	2.0017 2.0035	2.2523 2.2516								12	14	16	20	24	32	0.00145

MASS

Per Inch Width Al. Alloy	Per Inch Width Steel
lb (Max)	
0.007	0.012
0.008	0.020
0.009	0.024
0.019	0.050
0.023	0.060
0.027	0.070
0.030	0.075
0.034	0.084
0.038	0.093
0.058	0.146
0.063	0.160
0.068	0.173
0.078	0.200
0.089	0.225

LOADS

For 13AAZ -- Series:
Static limit load = 30000 x B x (W-0.06) lbf

For 13ASZ -- Series:
Static limit load = 62500 x B x (W-0.06) lbf

BEARING INSTALLATION

Refer to following section 2.3.2/1a for recommended Housing and Shaft dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	13	A	A	Z	04	03
Journal Bearing			S			

Specification Ident
Backing Matl. (A-Al.Alloy, S-Steel)
Plain
Bore dia code in multiples of 1/16 inch
Width code in multiples of 1/16 inch

SPECIAL TYPES

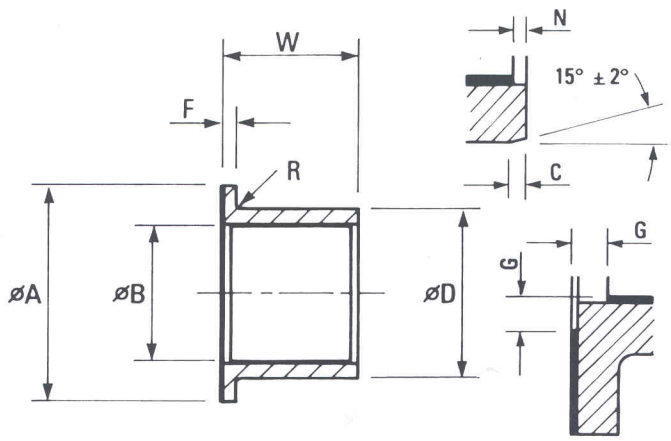
Bearings based on the above specifications with non-standard features may be supplied on request

ampep

AMPEP DATA SHEET
2.3.1/1a
ISSUE - 0301

13AAF -- 13ASF -- INCH SERIES

JOURNAL BEARINGS - SELF LUBRICATING FLANGED - AL. ALLOY & STEEL BACKED



N= 0.010 For sizes 04 to 12 incl.
0.020 For sizes 14 to 32 incl.
G= 0.020 For sizes 04 to 12 incl.
0.040 For sizes 14 to 32 incl.
R= 0.020/0.030
C= 0.020/0.030

MATERIALS

Liner
Ampep X1

Shell
For 13AAF -- Series:
Aluminium alloy

For 13ASF -- Series:
Corrosion resistant steel

DIMENSIONS AND TOLERANCES

All Dimensions in inches

Nominal Bore		B	D	F	A	W												Distance Travelled Per Degree
		Bore Dia	O/Dia	Flange Thickness	Flange Dia	-0.005 Overall Width -0.015												
Code	Size	–	–	+ 0.000 – 0.005	+ 0.000 – 0.010	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	2	ft
04	1/4	0.2503 0.2512	0.3760 0.3755	0.062	0.500	04	05											0.00018
05	5/16	0.3130 0.3139	0.4386 0.4381	0.062	0.562	04	05	06	07									0.00022
06	3/8	0.3756 0.3765	0.5011 0.5006	0.062	0.625	04	05	06	07									0.00026
08	1/2	0.5006 0.5016	0.6888 0.6883	0.062	0.875	04	05	06	07	08								0.00036
10	5/8	0.6257 0.6267	0.8139 0.8134	0.062	1.000	04	05	06	07	08	10							0.00045
12	3/4	0.7508 0.7520	0.9389 0.9384	0.062	1.125	04	05	06	07	08	10	12	14					0.00054
14	7/8	0.8759 0.8771	1.0640 1.0635	0.062	1.250		05	06	07	08	10	12	14					0.00063
16	1	1.0010 1.0022	1.1890 1.1885	0.062	1.375		05	06	07	08	10	12	14	16				0.00072
18	1 1/8	1.1263 1.1275	1.3143 1.3137	0.094	1.625			06	07	08	10	12	14	16				0.00081
20	1 1/4	1.2512 1.2528	1.5019 1.5013	0.094	1.750					08	10	12	14	16	20			0.00090
22	1 3/8	1.3763 1.3779	1.6269 1.6263	0.094	1.875					08	10	12	14	16	20			0.00100
24	1 1/2	1.5013 1.5029	1.7519 1.7513	0.094	2.000					08	10	12	14	16	20	24		0.00109
28	1 3/4	1.7517 1.7533	2.0023 2.0016	0.094	2.250							12	14	16	20	24		0.00127
32	2	2.0017 2.0035	2.2523 2.2516	0.094	2.500							12	14	16	20	24	32	0.00145

MASS

Per Inch Width Al. Alloy	Per Inch Width Steel
lb (Max)	
0.0077	0.0132
0.0088	0.0220
0.0099	0.0264
0.0209	0.0550
0.0263	0.0660
0.0297	0.0770
0.0330	0.0825
0.0374	0.0924
0.0418	0.1023
0.0638	0.1606
0.0693	0.1760
0.0748	0.1903
0.0858	0.2200
0.0979	0.2475

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	13	A	A	F	04	04
Journal Bearing			S			
Specification Ident						
Backing Matl. (A-Al.Alloy, S-Steel)						
Flanged						
Bore dia code in multiples of 1/16 inch						
Width code in multiples of 1/16 inch						

SPECIAL TYPES

Bearings based on the above specifications with non-standard features may be supplied on request

LOADS

For 13AAF -- Series:
Static limit load = 30000 x B x (W-0.06) lbf

For 13ASF -- Series:
Static limit load = 62500 x B x (W-0.06) lbf

BEARING INSTALLATION

Refer to following section 2.3.2/1a for recommended Housing and Shaft dimensions

JOURNAL BEARINGS - SELF LUBRICATING PLAIN - AL. ALLOY & STEEL BACKED

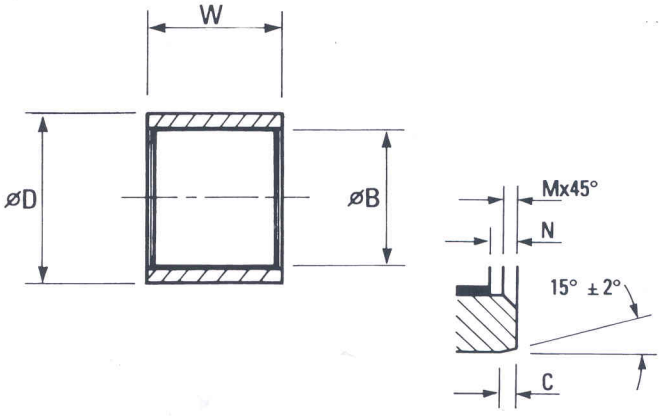
13C -- AZ
13C -- SZ
METRIC SERIES

MATERIALS

Liner
Ampep X1

Shell
For 13C -- AZ Series:
Aluminium alloy

For 13C -- SZ Series:
Corrosion resistant steel



N= 0.8 Max
C= 0.50/0.75
M= 0.2 Max

DIMENSIONS AND TOLERANCES

All Dimensions in millimetres

Nominal Bore	B	D	W																
	Bore Dia	O/Dia	-0.1 Overall Length -0.4																
Code	–	–	06	08	10	12	15	16	18	20	22	25	28	30	32	35	40	45	50
06	6.004 6.022	10.024 10.015	**06**																
08	8.005 8.027	12.029 12.018	**06**	**08**															
10	10.005 10.027	14.029 14.018	**06**	**08**	**10**														
12	12.006 12.033	16.029 16.018	**06**	**08**	**10**	**12**													
15	15.006 15.033	19.035 19.022		**08**	**10**	**12**	**15**												
16	16.006 16.033	20.035 20.022		**08**	**10**	**12**	**15**	**16**											
18	18.006 18.033	22.035 22.022			**10**	**12**	**15**		**18**										
20	20.007 20.040	25.035 25.022			**10**	**12**	**15**			**20**									
22	22.007 22.040	26.035 26.022				**12**	**15**			**20**	**22**								
25	25.007 25.040	30.035 30.022				**12**	**15**			**20**	**22**	**25**							
28	28.007 28.040	34.042 34.026					**15**			**20**	**22**	**25**	**28**						
30	30.007 30.040	36.042 36.026					**15**			**20**	**22**	**25**		**30**					
32	32.009 32.048	38.042 38.026					**15**			**20**	**22**	**25**		**30**	**32**				
35	35.009 35.048	42.042 42.026								**20**	**22**	**25**		**30**		**35**			
40	40.009 40.048	48.042 48.026								**20**		**25**		**30**		**35**	**40**		
45	45.009 45.048	52.051 52.032										**25**		**30**		**35**	**40**	**45**	
50	50.009 50.048	58.051 58.032										**25**		**30**		**35**	**40**	**45**	**50**

MASS

Per mm Length Al. Alloy	Per mm Length Steel
g (Approx)	
0.15	0.39
0.18	0.48
0.22	0.58
0.26	0.68
0.31	0.82
0.32	0.87
0.37	0.97
0.51	1.36
0.44	1.16
0.63	1.66
0.85	2.25
0.91	2.40
0.96	2.54
1.23	3.26
1.61	4.25
1.55	4.11
1.98	5.22

LOADS

For 13C -- AZ Series:
Static limit load = 206 x B x (W-1.5) Newtons

For 13C -- SZ Series:
Static limit load = 430 x B x (W-1.5) Newtons

BEARING INSTALLATION

Refer to following section 2.3.2/1b for recommended Housing and Shaft dimensions

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	13	C	08	08	A	Z
Journal Bearing					S	
Specification Ident						
Bore dia code in mm						
Length code in mm						
Backing Matl. (A-Al.Alloy, S-Steel)						
Plain						

SPECIAL TYPES

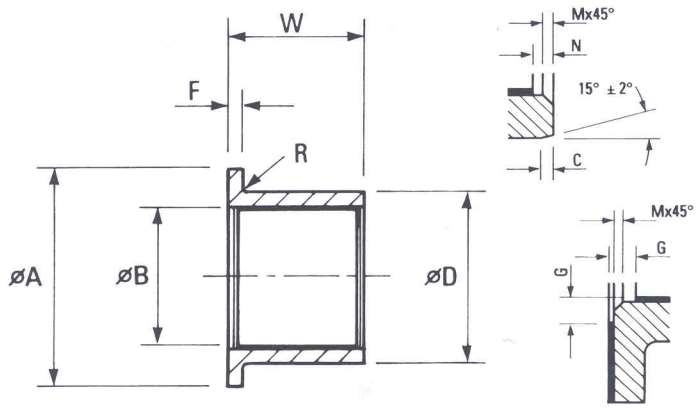
Bearings based on the above specifications with non-standard features may be supplied on request

ampep

AMPEP DATA SHEET
2.3.1/2a
ISSUE - 0301

13C -- AF
13C -- SF
METRIC SERIES

JOURNAL BEARINGS - SELF LUBRICATING FLANGED - AL. ALLOY & STEEL BACKED



G= 0.5 for sizes 06 to 18 incl.
1.0 for sizes 20 to 50 incl.
R= 0.1/0.4 for sizes 06 to 10 incl.
0.5/0.8 for sizes 12 to 50 incl.
N= 0.8 Max
C= 0.50/0.75
M= 0.2 Max

MATERIALS

Liner
Ampep X1

Shell
For 13C -- AF Series:
Aluminium alloy

For 13C -- SF Series:
Corrosion resistant steel

DIMENSIONS AND TOLERANCES

All Dimensions in millimetres

Nominal Bore	B	D	F	A	W															
	Bore Dia	O/Dia	Flange Thickness	Flange Dia	-0.1 Overall Length -0.4															
Code	–	–	+ 0.00 – 0.15	+ 0.00 – 0.25	06	08	10	12	15	16	18	20	22	25	28	30	32	35	40	45	50
06	6.004 6.022	10.024 10.015	1.5	12.0	06																
08	8.005 8.027	12.029 12.018	1.5	14.0	06	08															
10	10.005 10.027	14.029 14.018	1.5	16.0	06	08	10														
12	12.006 12.033	16.029 16.018	1.5	22.0	06	08	10	12													
15	15.006 15.033	19.035 19.022	1.5	25.0		08	10	12	15												
16	16.006 16.033	20.035 20.022	1.5	26.0		08	10	12	15	16											
18	18.006 18.033	22.035 22.022	1.5	28.0			10	12	15		18										
20	20.007 20.040	25.035 25.022	1.5	30.0			10	12	15			20									
22	22.007 22.040	26.035 26.022	1.5	32.0				12	15			20	22								
25	25.007 25.040	30.035 30.022	1.5	35.0				12	15			20	22	25							
28	28.007 28.040	34.042 34.026	2.5	40.0					15			20	22	25	28						
30	30.007 30.040	36.042 36.026	2.5	42.0					15			20	22	25		30					
32	32.009 32.048	38.042 38.026	2.5	44.0					15			20	22	25		30	32				
35	35.009 35.048	42.042 42.026	2.5	47.0								20	22	25		30		35			
40	40.009 40.048	48.042 48.026	2.5	52.0								20		25		30		35	40		
45	45.009 45.048	52.051 52.032	2.5	57.0										25		30		35	40	45	
50	50.009 50.048	58.051 58.032	2.5	62.0										25		30		35	40	45	50

MASS

Per mm Length Al. Alloy	Per mm Length Steel
g (Approx)	
0.18	0.46
0.21	0.55
0.24	0.65
0.35	0.91
0.39	1.03
0.40	1.08
0.44	1.16
0.57	1.53
0.51	1.34
0.69	1.82
0.97	2.56
1.03	2.77
1.08	2.85
1.32	3.50
1.69	4.45
1.64	4.34
2.05	5.41

PART NUMBERS AND SERIES VERSIONS

Series Part Number Codification

Basic Series Part Number	13	C	08	08	A	F
Journal Bearing						
Specification Ident					S	
Bore dia code in mm						
Length code in mm						
Backing Matl. (A-AL.Alloy, S-Steel)						
Flanged						

SPECIAL TYPES

Bearings based on the above specifications with non-standard features may be supplied on request

LOADS

For 13C -- AF Series:
Static limit load
= 206 x B x (W-F-1.5) Newtons
Static axial limit load
= 180 x π/4 x [(A-0.75)² - (B+2.75)²] Newtons

For 13C -- SF Series:
Static limit load
= 430 x B x (W-F-1.5) Newtons
Static axial limit load
= 340 x π/4 x [(A-0.75)² - (B+2.75)²] Newtons

BEARING INSTALLATION

Refer to following section 2.3.2/1b for recommended Housing and Shaft dimensions

JOURNAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

13A -- INCH SERIES

SERIES: 13AAZ --, 13ASZ --, 13AAF --, 13ASF --

Nominal Bore		Housing Dia.		Shaft Dia.				Housing Dia.		Shaft Dia.			
Code	Size	Interference Fit		Transition Running Fit		Clearance Running Fit		Adhesive Bonded		Transition Running Fit		Clearance Running Fit	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
04	1/4	0.3754	0.3750	0.2500	0.2496	0.2495	0.2491	0.3800	0.3780	0.2511	0.2507	0.2503	0.2499
05	5/16	0.4380	0.4375	0.3125	0.3121	0.3120	0.3116	0.4426	0.4406	0.3138	0.3134	0.3130	0.3126
06	3/8	0.5005	0.5000	0.3750	0.3746	0.3745	0.3741	0.5051	0.5031	0.3764	0.3760	0.3756	0.3752
08	1/2	0.6882	0.6875	0.5000	0.4996	0.4994	0.4990	0.6928	0.6908	0.5014	0.5010	0.5006	0.5002
10	5/8	0.8133	0.8125	0.6250	0.6246	0.6244	0.6240	0.8179	0.8159	0.6265	0.6261	0.6257	0.6253
12	3/4	0.9383	0.9375	0.7500	0.7495	0.7492	0.7487	0.9429	0.9409	0.7516	0.7511	0.7508	0.7503
14	7/8	1.0633	1.0625	0.8750	0.8745	0.8742	0.8737	1.0680	1.0660	0.8767	0.8762	0.8759	0.8754
16	1	1.1883	1.1875	1.0000	0.9995	0.9992	0.9987	1.1930	1.1910	1.0018	1.0013	1.0010	1.0005
18	1 1/8	1.3135	1.3125	1.1250	1.1245	1.1242	1.1237	1.3183	1.3163	1.1271	1.1266	1.1263	1.1258
20	1 1/4	1.5010	1.5000	1.2500	1.2494	1.2490	1.2484	1.5059	1.5039	1.2520	1.2514	1.2512	1.2506
22	1 3/8	1.6260	1.6250	1.3750	1.3744	1.3740	1.3734	1.6309	1.6289	1.3771	1.3765	1.3763	1.3757
24	1 1/2	1.7510	1.7500	1.5000	1.4994	1.4990	1.4984	1.7539	1.7519	1.5021	1.5015	1.5013	1.5007
28	1 3/4	2.0012	2.0000	1.7500	1.7494	1.7490	1.7484	2.0063	2.0043	1.7525	1.7519	1.7517	1.7511
32	2	2.2512	2.2500	2.0000	1.9993	1.9988	1.9981	2.2563	2.2543	2.0025	2.0018	2.0017	2.0010

13C -- METRIC SERIES

JOURNAL BEARINGS - SELF LUBRICATING SHAFT & HOUSING DIMENSIONS

SERIES: 13C -- AZ, 13C -- SZ, 13C -- AF, 13C -- SF

Nominal Bore Code	Housing Dia.		Shaft Dia.			
	Interference Fit		Transition Running Fit		Clearance Running Fit	
	Max	Min	Max	Min	Max	Min
06	10.015	10.000	6.007	5.999	5.990	5.982
08	12.018	12.000	8.007	7.998	7.987	7.978
10	14.018	14.000	10.007	9.998	9.987	9.978
12	16.018	16.000	12.008	11.997	11.984	11.973
15	19.021	19.000	15.008	14.997	14.984	14.973
16	20.021	20.000	16.008	15.997	15.984	15.973
18	22.021	22.000	18.008	17.997	17.984	17.973
20	25.021	25.000	20.009	19.996	19.980	19.967
22	26.021	26.000	22.009	21.996	21.980	21.967
25	30.021	30.000	25.009	24.996	24.980	24.967
28	34.025	34.000	28.009	27.996	27.980	27.967
30	36.025	36.000	30.009	29.996	29.980	29.967
32	38.025	38.000	32.011	31.995	31.975	31.959
35	42.025	42.000	35.011	34.995	34.975	34.959
40	48.025	48.000	40.011	39.995	39.975	39.959
45	52.030	52.000	45.011	44.995	44.975	44.959
50	58.030	58.000	50.011	49.995	49.975	49.959

Housing Dia.		Shaft Dia.			
Adhesive Bonded		Transition Running Fit		Clearance Running Fit	
Max	Min	Max	Min	Max	Min
10.124	10.074	6.024	6.016	6.004	5.996
12.129	12.079	8.025	8.016	8.005	7.996
14.129	14.079	10.025	10.016	10.005	9.996
16.129	16.079	12.026	12.015	12.006	11.995
19.135	19.085	15.026	15.015	15.006	14.995
20.135	20.085	16.026	16.015	16.006	15.995
22.135	22.085	18.026	18.015	18.006	17.995
25.135	25.085	20.027	20.014	20.007	19.994
26.135	26.085	22.027	22.014	22.007	21.994
30.135	30.085	25.027	25.014	25.007	24.994
34.142	34.092	28.027	28.014	28.007	27.994
36.142	36.092	30.027	30.014	30.007	29.994
38.142	38.092	32.029	32.013	32.009	31.993
42.142	42.092	35.029	35.013	35.009	34.993
48.142	48.092	40.029	40.013	40.009	39.993
52.151	52.101	45.029	45.013	45.009	44.993
58.151	58.101	50.029	50.013	50.009	49.993