ZINCALOY BEARING STOCK DESIGN GUIDELINES

GENERAL RULE

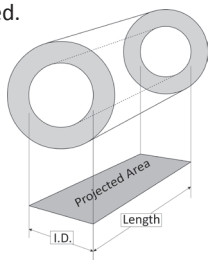
Zincaloy (ZA-12) bearings can be substituted for SAE-660 bronze bearings in most cases without any design changes. Guidelines only differ in relation to press fits and clearances at elevated temperatures.

BEARING PRESSURE

Zincaloy stock is suitable for bearing use under the following operating conditions: Maximum pressure on the bearing at low shaft rotation speed (less than 10 ft/min surface speed) should be kept between 4500 and 6000 psi. As shaft speed increases to 60 ft/min and beyond, the recommended operating pressure decreases to about a 1000 psi. Zincaloy bearings can operate well at very high speeds under low loads as long as the heat generated does not exceed 100°C (212°F) and the bearings are well lubricated.

$$\text{Bearing Pressure, psi} = \frac{\text{Total Load (lb) on Bearing}}{\text{Projected Bearing Area (in}^2\text{)}}$$

$$\text{Shaft Speed, ft/min} = \frac{3.14 \times \text{Shaft Dia. (in.)} \times \text{RPM}}{12}$$



SHAFT MATERIAL AND FINISH

In general, the shaft should be twice as hard as the bearing material. This means in the case of Zincaloy bearings, a mild steel shaft is suitable. Zincaloy works best with a smooth finished shaft in the 7-18 rms range. For non-critical applications 45-50 rms finish is sufficient. The Zincaloy bearing should be fine turned not polished.

BEARING LENGTH

The ratio of bearing length (L) to inside diameter (I.D.) should not exceed 1.5, i.e. L/I.D.=1.5. A larger ratio (a long thin bearing) can work for non-critical applications, but promotes edge loading and alignment problems. A smaller ratio (a short fat bearing) causes high bearing pressure and shortens bearing life.

WALL THICKNESS

Wall thickness should be 5% or more of the inside diameter of the bearing. Minimum wall thickness should be 0.045 x I.D. + 0.02 inches.

BEARING CLEARANCE

Bearing clearance is the gap between the bearing inside diameter and the shaft diameter. This clearance is required for lubrication, expansion and proper running. Minimum bearing clearance should be .0025 inches for every inch of shaft diameter.
However, when bearing temperatures are expected to be greater than 50°C (120°F) clearances should be increased a further 30% to accommodate Zincaloy's greater expansion coefficient. Bearings which are shrink or press fitted into housings should have a further increase in clearance of 80% of the interference fit to accommodate the close-in of the I.D. For critical clearance applications, the I.D. of the bearing should be final sized after fitting.

TEMPERATURE

The maximum recommended running temperature for Zincaloy bearings is 100°C (212°F).

RETENTION METHODS

The standard method of bearing retention is a press or interference fit. In general, 0.001 inch/inch of bearing O.D. is recommended for press fitting Zincaloy bearings into housings. Bearings can be either shrink fitted by cooling the bearing with dry ice or they can be press fitted at room temperature. **NEVER HEAT** the housing in an attempt to expand it or do any welding with the bearing in the housing. This will result in a poorly fitted bearing. Avoid excessive fits which can cause increased close-in. A chamfer on the bearing O.D. lead-end helps to guide in the bearing. Adhesives like Loctite 609 are sometimes used to add greater retention. Other mechanical methods include dowel pin, bolt through washer or set screws.

DRY RUNNING

Most bearings perform best if lubricated, including Zincaloy bearings. However, under extreme conditions of dry running, Zincaloy is superior to bronze under such conditions because a thin film of Zincaloy is smeared over the shaft which protects it from wear and damage.

LUBRICATION

Standard grease grove designs for bronze bearings are suitable for Zincaloy. Small diameter bearings under 3 inches usually require no grooving. Groove edges should be rounded to prevent lubrication from being scraped from the shaft. Standard greases normally used for bronze bearings are compatible with Zincaloy. Acidic, alkaline or sulphur containing lubricants should be avoided to prevent corrosion.

CORROSION

Zincaloy bearings offer good resistance to atmospheric corrosion as well as a variety of plant environments. However, direct exposure to corrosive liquids and gases should be avoided. Contact liquids should have a pH of 6-11.5 to avoid corrosion problems. Zincaloy may experience bimetallic galvanic corrosion if in contact with other metals, however, under atmospheric conditions this is generally small and of no concern. It can be of concern in a constantly wet environment or in sea water. Under these circumstances the material should be tested to determine its suitability.

WEAR RATES

High shaft speed, high load and rough shafts promote the greatest bearing wear. Zincaloy's wear is often considerably lower than bronze under the same conditions. Shaft wear is often reduced with Zincaloy especially compared to aluminum-bronzes and steel bearings.

MACHINING

General recommendations include the generous use of cutting fluid, sharp tools and moderate to high speeds and feeds. All machined comers should have a radius. For details refer to the Zincaloy Machining Guidelines.

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ZINCALOY BEARING STOCK
SPECIFICATION & ENGINEERING INFORMATION

COMPOSITION wt. %	(ASTM B86) ZA-12
Aluminum	10.5 - 11.5
Copper	0.5 - 1.2
Magnesium	0.015 - 0.030
Zinc	Balance

PROPERTIES	As Cast
Tensile Strength (ksi)	61-69
Yield Strength - 0.2% offset (ksi)	45-58
Elongation (%)	1-4
Hardness (BHN @ 250kg load - 5mm ball)	130-150
Density (lb/in.^{3})	0.218

MATERIAL SAFETY DATA SHEET (MSDS)

Zinc alloys in the solid state are not considered as hazardous nor toxic materials. Details can be found in Material Safety Data Sheets (MSDS) which are available upon request.

CON-CAST ZINCALOY BEARING STOCK

Con-cast Zincaloy solid and hollow bearing products are produced by a unique semi-continuous casting process. Due to a continuous, rapid freezing process, the zinc-aluminum con-cast structure is fine grained, homogeneous and porosity free. Therefore, this con-cast Zincaloy structure with its zinc-aluminum metallurgy provides an excellent high load, low speed bearing material.

PERMANENT MOULD CAST (PMC) PRODUCTS

Zincaloy product sizes greater than the con-cast process size capacity are produced by casting the ZA-12 alloy into a permanent mould set-up. This gravity poured, air cooled cast product will not be as porosity free as a con-cast Zincaloy bearing stock. However, the good bearing properties are maintained because of the zinc-aluminum alloy. Note that the machining allowances on the outside and inside diameters are greater than those for the con-cast bearing stock because of the nature of the mould materials and set-up sizing.

WELDING AND JOINING ZINCALOY MATERIALS

Zincaloy materials can only be welded to itself or other zinc-based materials by using the TIG (tungsten inert gas) welding method. The filler rod for TIG welding can be a zinc alloy or aluminum rod. Finish machining of the Zincaloy bearing or part should be done after any welding operation because the welding temperature will cause thermal expansion.

Soldering is difficult and not recommended. However, check with your local welding supplier because they may have products suitable to solder zinc-aluminum alloys together. Welding or soldering Zincaloy to other metals are not recommended.

Adhesives for metals and products such as “Loctite” can be used for lighter duty joining or fastening applications.

NON-SPARKING

Zinc alloy metals generally do not spark when struck by rusted ferrous materials.

ZINC VS BRONZE	ALLOYS		
	ZINC	BRONZE	
PROPERTIES	ZINCALOY	SAE 660	ALLOY 954
Ultimate Tensile Strength (psi)	65,000	35,000	85,000
Yield Strength (psi)	50,000	20,000	32,000
Elongation (%)	2	10	12
Hardness (BHN)	130	60	170
Density (lb/in.^{3})	.218	.322	.269
Melting Range (°F)	710-810	1570-1790	1880-1990
Electrical Conductivity (%IACS)	28	12	13
Thermal Conductivity (BTU/ft-hr-°F)	67	34	35
Coef. of Thermal Expansion (µin/in/°F)	13	10	9

ZINCALOY OFFERS SUPERIOR PROPERTIES COMPARED TO BRONZE

- **RESILIENCE** - Protects bearing housings from deformation due to pounding.
- **BETTER DRY RUNNING PROPERTIES** - Resists damage to shaft if lubrication fails.
- **LOW COEFFICIENT OF FRICTION**
- **BETTER MECHANICAL PROPERTIES** - Especially strength, toughness and hardness.
- **BETTER DAMPENING PROPERTIES** - Absorbs impact energy well to reduce vibration.
- **HIGH TOLERANCE OF FOREIGN SUBSTANCES** - Ability to absorb foreign particles to avoid shaft damage.
- **LIGHTER WEIGHT** - 32% Lighter.
- **FREE MACHINING** - Excellent surface finish.
- **LONGER BEARING LIFE**
- **LEAD FREE**

CHAMPION MOTOR GRADERS FRONT AXLE PROJECT*

DESIGN CONCEPTS - BEARINGS (PINS)

DESIGN ISSUES	CONCEPT #1 Needle Bearings	CONCEPT #2 Steel Bushings	CONCEPT #3 Plastic Bushings	CONCEPT #4 Spherical Steel Bushings	CONCEPT #5 ZA-12 Bushings
1. Sensitivity to Pounding	high	low	high	low	low
2. Sensitivity to Lack of Lubrication	high	high	low	high	low
3. Sensitivity to Contamination	very high	medium	very high	medium	low
4. Sensitivity to Misalignment	high	high	low	very low	medium
5. Cost	high	high	lowest	highest	low
6. Pin Grinding Required	yes	yes	no	no	no
7. Technical Risk	low	low	medium	low	medium
8. Marketing Risk	low	low	medium	low	low
9. OD vs. ID ratio	low	low	low	high	low
10. Grease Retention Ability	good	poor @ $15, good @ $30	good	poor @ $20, good @ $40	good @ $5
11. Lube Interval	long	short	long	short	long
12. Integral Seal?	yes	no	no	yes	no

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