Introduction and scope

Housing, Bearing Fit, Staking Procedure and Proof Loading Information and consideration for design

This is designed to be a guide and is a combination of translation of manufacturer's catalogue specifications, recommendations and our own findings during testing and assembly procedures.

It is by no means comprehensive, though should covers the key points needed by both design engineers and assembly operatives alike.

For any help with the recommendations for housing design or any questions relating to either this guide or the staking of spherical bearings, please do not hesitate to contact us.

Considerations

A bearing in the free state is not a functioning bearing. Its performance begins only after it has been installed into its end assembly, and the methods, fits and forces applied in installation will often determine its success or failure in service.

A surprising percentage of early bearing failures can be traced directly to improper mounting conditions.

Some examples of frequently occurring installation errors are:

- Excessive interference fit between housing bore and bearing O.D.
- Improperly designed/used staking tools.
- Excessive staking forces applied.
- Incorrect housing design

*** PLEASE NOTE THE INFORMATION WITHIN RELATES TO STEEL COMPONENT HOUSINGS ONLY***

1 V-Groove

V-groove retention widely used and recommended. The bearing outer race has a small groove machined into each face, which leaves a lip on the race O.D. corners.
With the use of staking tools, these lips are swaged (flared) over the chamfered edges of the housing.

Good V-groove staking requirements;

- ***Correct housing including chamfer profile***
- ***Correct staking tools (per bearing size/type)***
- ***Hydraulic or pneumatic press capable of applying the correct staking force/pressures***

2 AVAILABLE PRESS STAKING TOOLS

For ordering purposes please add suffix "-ST" to the listed Part Number e.g. ABWT3V-ST

Standard Series	Wide Series	High Angle Series
ABT3V	ABWT3V	ABYT3V
ABT4V	ABWT4V	ABYT4V
ABT5V	ABWT5V	ABYT5V
ABT6V	ABWT6V	ABYT6V
ABT7V	ABWT7V	ABYT7V
ABT8V	ABWT8V	ABYT8V
ABT9V	ABWT9V	
ABT10V	ABWT10V	ABYT10V
ABT12V	ABWT12V	ABYT12V
ABT14V	ABWT14V	ABYT14V

3 Housing Design

The housing into which the bearing is mounted must be designed to ensure the structural integrity of the bearing.

Housing Recommendation

T=H

When designing new housings, we suggest creating the housing to be equal width to the outer raceway of the bearing.

I.E. Thickness or width, H, of the Housing is equal to the Width, T, of the Bearing.

Chamfer OD

The catalogue states a chamfer OD of (T-H + 2*E), with a 45 deg. Chamfer angle.
The catalogue spec is in place for modifying housings to suit the acceptance of the bearing.
When designing a housing that is T=H, this allows for correct installation of the bearing into the housing so that it is easier to centre the bearing in the housing.
It also makes it easier during the staking procedure to swage v-groove to conform the (created flange- of the bearing v-groove) to the chamfer of the housing- meaning a stronger stake and reduced possibility misalign the bearing in the housing.

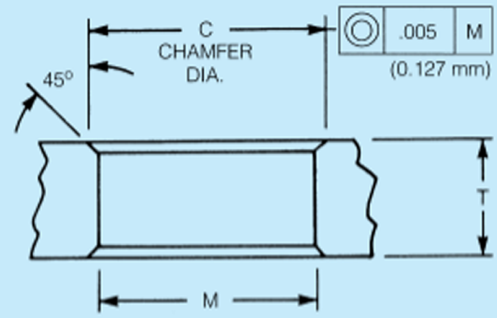
Housing tolerances should be adhered to - to catalogue recommendation.

NMB Minebea Catalogue Specifications

Chamfer Dia.
(C) = M+[T - H + (2 X E)]
(Tolerance + .008/-.007)
T = average housing thickness
H = average outer race thickness
E = average V-groove depth in race, depending on groove.

Chamfered Size Calculation for V-Groove Retention;

V-Groove Size	Avg. Groove Depth (E)
A	.023
B	.033
C	.053
D	.073



CHAMFER DIAMETER
(C) = bearing O.D. + [T-H + (2 × E)]
T = housing thickness
H = outer race thickness
E = V groove depth in race

FIGURE 29 - HOUSING CHAMFER CALCULATION FOR V-GROOVE STAKING.

HOUSING BORE TOLERANCES FOR METAL TO METAL

Table 1

BEARING				HOUSING BORE			
TYPE	STYLE	O.D.		Tolerances		Fit-up	
		INCH	MM	INCH	MM	INCH	MM
METAL TO METAL	Sphericals	Up to 1.750	Up to 44.45	+.0000 -.0005	+0.000 -0.013	Line to line to .0010 tight	Line to line to 0.025 tight
		1.750 and over	44.45 and over	+.0000 -.0008	+0.000 -0.020	Line to line to .0013 tight	Line to line to 0.033 tight
PTFE LINED	Sphericals	All	All	+.0005 -.0000	+0.013 -0.000	Line to line to .0010 loose	Line to line to 0.025 loose
	Plain and Flanged Journal (Sleeve) Bearings	Up to 1.000	Up to 25.40	-.0007 -.0012	-0.018 -0.030	.0002 to .0012 tight	0.005 to 0.030 tight
		1.000 and over	25.40 and over	-.0010 -.0015	-0.025 -0.038	.0005 to .0015 tight	0.013 to 0.038 tight

4 Staking

Installation

Please ensure use of correct ABC specified installation tool

First seat the bearing into the housing using the correct tool.

The installation of a bearing into the housing bore is a simple operation when done properly.

Alignment of the bearing or sleeve to the housing bore is critical to prevent skewing or misalignment during insertion which may damage the bearing and/or housing.

Correct housing tolerances- including diameter, width, roundness and parallelism- should be adhered to.

Hydraulic or pneumatic press capable of applying the correct staking force/pressures.

Correct installation tools and staking tools are required. A guide pin in the tool aligns the ball in a 90° position.

Force should be applied to the outer race face/v-groove **only.**

A lead chamber on either the bearing or housing is required.

Staking

Please ensure use of correct ABC specified staking tool

1. Install bearing into housing and position it symmetrical about housing centre-line within .005.

2. Mount bearing and top anvil over bottom anvil guide pin. (V-groove Staking Method)

3. A trial assembly should be made for each new bearing lot to determine the staking force necessary to meet the axial retention load required. Excessive force should be avoided since this may result in bearing distortion and seriously impair bearing function and life. (See table for recommended Staking Force).

4. Apply the staking force established by trial assembly, rotate assembly 90° and re-apply force.

5. After staking, a slight gap may exist between race lip and housing chamfer as shown in the detail. This gap should not be a cause for rejection providing the bearing meets the thrust load specified.

Staking Force

The force required to stake V-groove bearing is approximately equal to the product of the O.D. and a constant for each groove size.

For example,

A 1.500" (38.10 mm) O.D. bearing having a "B" size groove should require a staking force of approximately 18,000 lbs (80064 N).

Constants shown (below) are based on outer race material having an ultimate tensile strength of 140,000 psi (984.6 N/mm2).

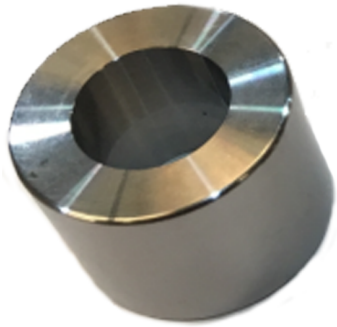
Staking force constants for other materials are proportional to the ultimate tensile of those materials as compared to 140,000 psi (984.6 N/mm2).

Staking forces derived by this formula should be used as a reference guide only to establish a starting point.

Press Insert/Proof Tool and Staking Tool

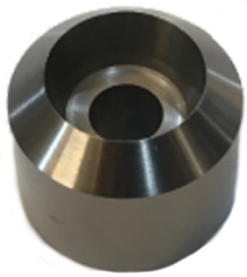
This has 2 orientations
One for press Insert
One of proof load

PRESS INSERT / PROOF LOAD TOOL



One half has a guiding pin
The other a receiving bore

STAKING TOOL IN 2 HALVES



Please note the tool comes in 3 parts

This constuents the tool as a whole, with the Press Insert/ Proof load tool having 2 operations

The fitting and proof load donor can be either circular or D-form shape

5 Procedure for Staking

Step Guide

Step 1

Load the bearing to be staked onto the pin of the staking tool. This uses only the 1/2 of the staking tool with the pin at this stage. Orientation of the ball should be perpendicular to the outer race.

Step 2

Resting the housing on the Press Insert tool, locate the bearing into the housing with the half of the staking tool.

Step 3

Next, either using the press, or by hand if the housing fit allows.

Step 4

Ensure that the bearing is inserted fully into the housing. If the recommendations for housing manufacture have been adhered to (See page 2, section 2 - Housing Recommendation), this should mean that the end face of the bearing is flush with the housing end face.

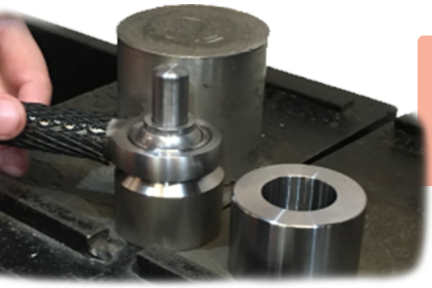
When using the press Insert tool, this will be when the bearing and face meets the tool and the bearing can no longer move axially in the direction it is being pressed.

If the housing is wider than the bearing, it must be located centrally either by measurement or by eye.

Step 5

We next recommend to apply a force of around 1/2-3/4 the staking force. This should deform the v-groove slightly, though only enough to locate the bearing whilst the tool part is changed from the press insert tool to the mating half of the staking tool.

This is not intended as the primary stake.



Step 6

Remove the staking tool from Press Insert tool and check to ensure the bearing is centred in the housing.

Step 7

Assemble mating half of the staking tool, ensuring both halves are correctly seated into the v-grooves ready for the staking force to be applied.

Step 8

Apply the staking force with the press onto the staking tool, ensuring the staking tool is in proper and full contact with the staking grooves.

The staking force can be calculated using the catalogue, or common sizes are listed in the table opposite.

We recommend applying the staking at least twice - Stake once, change orientation through 180 degree axially and stake again.

It is best practice to rotate through 120 degree radial and stake 3 times per side.

6 Common sizes & loads

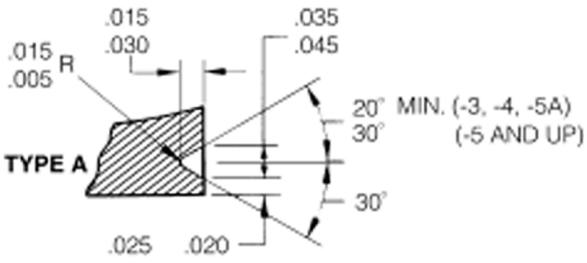
Table 2

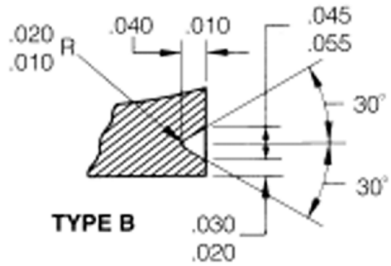
Calculated specific forces per bearing type and size for staking and proof loading

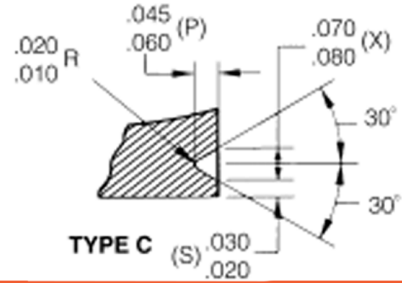
Part No.	OD (in)	Groove Type	Conversion Constant (N)	Staking Force (N)	Conversion load (KG)	Staking Gauge Pressure (Bar)	Proof Load (KG)	Proof Gauge Pressure (Bar)
ABT3V	0.5625	A	34,250	19,266	1,964	50	434	20
ABT4V	0.6562	A	34,250	22,475	2,291	50	506	20
ABT5V	0.75	B	53,376	40,032	4,080	100	711	20
ABT6V	0.8125	B	53,376	43,368	4,421	100	770	20
ABT7V	0.9062	B	53,376	48,369	4,931	125	859	20
ABT8V	1	C	78,730	78,730	8,026	200	1,061	40
ABT9V	1.0937	C	78,730	86,107	8,778	225	1,161	40
ABT10V	1.1875	C	78,730	93,491	9,530	250	1,260	40
ABT12V	1.4375	C	78,730	113,174	11,537	275	1,526	40
ABT14V	1.5625	C	78,730	123,015	12,540	300	1,658	50
ABWT3V	0.625	A	34,250	21,406	2,182	50	482	20
ABWT4V	0.625	A	34,250	21,406	2,182	50	482	20
ABWT5V	0.6875	A	34,250	23,547	2,400	50	530	20
ABWT6V	0.8125	B	53,376	43,368	4,421	100	770	20
ABWT7V	0.9375	B	53,376	50,040	5,101	125	889	20
ABWT8V	1	B	53,376	53,376	5,441	150	948	20
ABWT9V	1.125	B	53,376	60,048	6,121	150	1,067	40
ABWT10V	1.1875	B	53,376	63,384	6,461	175	1,126	40
ABWT12V	1.375	C	78,730	108,254	11,035	275	1,459	40
ABWT14V	1.625	C	78,730	127,936	13,041	325	1,725	50
ABYT3V	0.5625	A	34,250	19,266	1,964	50	434	20
ABYT4V	0.74	A	34,250	25,345	2,584	50	571	20
ABYT5V	0.6875	A	34,250	23,547	2,400	50	530	20
ABYT6V	0.906	A	34,250	31,031	3,163	75	699	20
ABYT7V	1	A	34,250	34,250	3,491	75	771	20
ABYT8V	1.125	A	34,250	38,531	3,928	100	867	20
ABYT10V	1.375	B	53,376	73,392	7,481	200	1,304	40
ABYT12V	1.5625	C	78,730	123,016	12,540	325	1,658	50
ABYT14V	1.75	C	78,730	137,778	14,045	375	1,857	50

Table 3

GROOVE TYPE*	A	B	C
CONSTANT (lbs)	7,700	12,000	17,700
CONSTANT [N]	34,250	53,376	78,730
*SEE BELOW FOR STANDARD GROOVE TYPES & SIZES			







7 Proof Loading

V-Groove type and corresponding staking force

Staked Bearing Proof Testing Method

Proof Load

Using the correct proof load side of the Press Insert/proof load tool (as marked), place the bearing and housing (complete) onto the proof load tool.

Either half of the staking tool or another press tool equal to the OD of the bearing can be used.

Ensure the correct proof load is used.
This can be calculated with use of the catalogue (see table 2)

V-Groove Staking Tool, Installation Tool and Proof Load Tool

Staking tools to include press in guide tool, v-groove staking tool and proof load capability are available from ABC for each type and size range of NMB Minebea bearings – **including both Imperial (inch) and Metric sizes.**

Please ensure use of correct ABC specified proof load tool