

# AIR BEARING SPINDLE

# NRAF-5080

## OPERATION MANUAL

OM-K0592E 002

Thank you for purchasing the air bearing spindle, NRAF-5080. NRAF-5080 is an air bearing spindle designed for use with 80,000min<sup>-1</sup> E3000 System. It fits perfectly to internal grinding of small bore that requires micro precision grinding. The motor, the air line kit, and the control unit are required to drive this spindle. Read this operation manuals carefully before use.

### 1. CAUTIONS FOR HANDLING AND OPERATION

- Read these warnings and cautions carefully and only use in the manner intended.
- These warnings and cautions are intended to avoid potential hazards that could result in personal injury to the operator or damage to the device. These are classified as follows in accordance with the seriousness of the risk.

Class	Degree of Risk
⚠ <b>WARNING</b>	<b>A safety hazard could result in bodily injury or damage to the device if the safety instructions are not properly followed.</b>
⚠ <b>CAUTION</b>	<b>A hazard that could result in light or moderate bodily injury or damage to the device if the safety instructions are not followed.</b>

#### ⚠ **WARNING**

- ① This Air Bearing Turbine Spindle is not a hand tool. It is designed to be used on CNC machines or special purpose machines.
- ② Do not touch the cutting tool while it is running. It is very dangerous.
- ③ Wear safety glasses, dust mask and use a protective cover around the Air Bearing Turbine Spindle whenever the Air Bearing Turbine Spindle is rotating.
- ④ Never operate or handle the Air Bearing Turbine Spindle until you have thoroughly read the Operation Manuals and safe operation has been confirmed.
  - 1) To prevent injuries / damages, check the Air Bearing Turbine Spindle and cutting tool for proper installation, before operating the Air Bearing Turbine Spindle.
  - 2) Before disconnecting the Air Bearing Turbine Spindle, always turn the compressed air supply OFF to the Air Line Kit. Then it is safe to remove the Air Bearing Turbine Spindle.
- ⑤ Whenever installing an Air Bearing Turbine Spindle to a metal fixed base, ensure that the fixed base is grounded in order to avoid risk of an electric shock.
- ⑥ When installing a tool, tighten the collet correctly and check again the collet and collet nut before use. Do not over-tighten the collet. This may cause damage to the spindle.
- ⑦ Do not use bent, broken, chipped, out of round or sub-standard tools, as this may cause them to shatter or explode. Tools with fractures or a bent shank will cause injury to the operator. When using a new tool, rotate it in a low speed and increase speed gradually for safety.
- ⑧ Do not exceed the recommended maximum allowable speed of the tool. For your safety, use speeds below the maximum allowable speed.

## **⚠ WARNING**

- ⑨ Do not apply excessive force. This may cause injury to the operator by slippage or damage of the tool, or loss of concentricity and precision of the Air Bearing Turbine Spindle.

## **⚠ CAUTION**

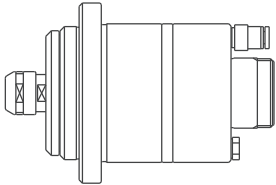
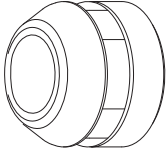

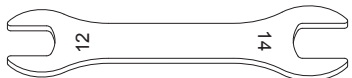

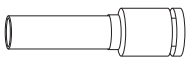
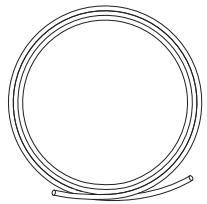

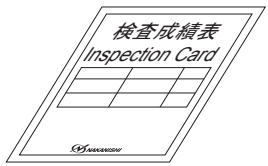
- ① Do not drop or hit this Air Bearing Turbine Spindle, as shock can damage to the internal components.
- ② Use the our recommended Air Line Kit (AL - A0611 / AL - A1205) or oil mist filterequiped similar product when operating the Air Bearing Turbine Spindle.
- ③ Before use, carefully read " Air Line Kit Operation Manual " regarding the correct connection, operation and cautions when using the Air Line Kit.
- ④ Be sure to clean the collet and collet nut, the inside of the spindle before replacing the tool. If ground particles or metal chips stick to the inside of spindle or the collet, damage to the collet or spindle can occur due to the loss of precision.
- ⑤ When cleaning a Air Bearing Turbine Spindle, stop the Air Bearing Turbine Spindle and remove debris with a soft brush or a cloth. Do not blow compressed air into the end of spindle area (refer to section " 6 - 2 Outside View ") as foreign particles or cutting debris may get into the Air Bearing.
- ⑥ Always clean the tool shank before installing the tool in the spindle.
- ⑦ When sizing the correct collet size to the tool shank diameter, a tolerance of +0 ~ -0.01mm is strongly recommended.  
A tool shank within the +0 ~ -0.1mm range is mountable, however, this may cause poor concentricity and or insufficient tool shank gripping force.
- ⑧ Be sure to drain moisture and condensation from the Air Line Kit (oi mist filter or mist separator and micro mist separator) regularly to avoid moisture being carried to the Air Bearing Turbine Spindle. This may cause damage to the Air Bearing Turbine Spindle.
- ⑨ Select suitable products or tools for all applications. Do not exceed the capabilities of the Air Bearing Turbine Spindle or cutting tools.
- ⑩ Do not stop the supplied cooling air to the Air Bearing Turbine Spindle while it is rotating. Removing the air pressure from the Air Bearing Turbine Spindle will cause a loss of purging, allowing the Air Bearing Turbine Spindle to ingest coolant and debris.This will cause damage to the Air Bearing Turbine Spindle.
- ⑪ Carefully direct coolant spray directly on the tool. Do not spray directly on the Air Bearing Turbine Spindle and collet nut. Large amounts of coolant sprayed directly on the Air Bearing Turbine Spindle may cause excess load of the Air Bearing Turbine Spindle causing a loss of durability and longevity of the Air Bearing Turbine Spindle.
- ⑫ Stop working immediately when abnormal rotation or unusual vibration are observed. Immediately, please check the content of section " 15. TROUBLESHOOTING ".
- ⑬ Always check if the tool, collet, collet nut, connection hose and supply air hose for signs of wear or damage before and after operating.
- ⑭ If the collet or collet nut show signs of wear or damage, replace them before a malfunction or additional damage occurs.
- ⑮ After installation, repair, initial operation, or long periods of non operation, please carry out break-in as follow.  
Start rotating slowly and over a short period of 15 - 20 minutes, increase speed gradually until Maximum Allowable Motor Rotation Speed.
- ⑯ Do not disassemble, modify or attempt to repair this Air Bearing / Air Turbine Spindle. Additional damage will occur to the internal components. Service must be performed by NSK NAKANISHI or an authorized service center.
- ⑰ When using this Air Bearing Turbine Spindle for mass production, please consider the purchase of an additional Air Bearing Turbine Spindle to be used as a back-up in case of emergency.
- ⑱ Securely connect the compressor supply connection hose to the Air Line Kit. Then connect the supply air hoses from the Air Line Kit to the Air Bearing and Air Turbine Spindle to avoid accidental disconnection during operation.

## 2. BASIC PACKAGE

When opening the package, check if it includes all items listed in " Table. 1 Packing List Contents ".

In the event of any shortage, please contact either NAKANISHI (see the " 4. CONTACT US " section) or your local dealer.

Table 1. Packing List Contents

<p>Air Bearing Spindle · · 1pc.</p> 	<p>Collet Nut (K-265A) · · 1pc.*</p> 	<p>Collet <math>\phi</math> 3.0 (CHK-3.0) or <math>\phi</math> 3.175 (CHK-3.175) · · 1pc.*</p> 
<p>Wrench (12 × 14) · · 2pcs.</p> 	<p>Bar Wrench (K-236) · · 1pc.</p> 	<p>Reducer (<math>\phi</math> 6/<math>\phi</math> 4Fitting) · · 1pc.</p> 
<p>Air Hose (<math>\phi</math> 4mm × 4m) · · 1pc.</p> 	<p>Operation Manual · · 1set.</p> 	<p>Inspection Card · · 1pc.</p> 

\* The Collet and Collet Nut is attached to the air bearing spindle.

## 3. WARRANTY

We provide a limited warranty for our products. We will repair or replace the products if the cause of failure is due to the following manufactures defects. Please contact us or your local distributor for details.

- (1) Defect in manufacturing.
- (2) Any shortage of components in the package.
- (3) Where damaged components are found when initially opening the package.  
(This shall not apply if the damage was caused by the negligence of a customer)

## 4. CONTACT US

For your safety and convenience when purchasing our products, we welcome your questions.

If you have any questions about operation, maintenance and repair of the product, please contact us.

### Contact Us

#### ● For U.S. Market

Company Name : **NSK America Corp.**  
Industrial Div.  
Business Hours : 8:00 to 17:00 (CST)  
(closed Saturday, Sunday and Public Holidays)  
U.S. Toll Free No. : +1 800 585 4675  
Telephone No. : +1 847 843 7664  
Fax No. : +1 847 843 7622  
Website : www.nskamericacorp.com

#### ● For Other Markets

Company Name : **NAKANISHI INC.**   
Business Hours : 8:00 to 17:00 (JST)  
(closed Saturday, Sunday and Public Holidays)  
Telephone No. : +81 289 64 3520  
e-mail : webmaster-ie@nsk-nakanishi.co.jp

## 5. FEATURES

- ① Adoption of the air bearing and turbine drive is suited for small diameter drilling and grinding of finely shaped parts which require high precision machining.
- ② The spindle housing is made from precision ground, hardened, stainless steel.
- ③ It is designed for use with 80,000min<sup>-1</sup> spindle.
- ④ For the air bearing, a rotating shaft is floated without contact by supplying dry compressed air from which oil is removed to the bearing gap. This prevents the bearing from being worn.
- ⑤ Use the high performance material to enhance the durability and the cooling.

## 6. SPECIFICATIONS AND DIMENSIONS

### 6 - 1 Specifications

Model	NRAF-5080
Maximum Motor Rotation Speed	80,000min <sup>-1</sup>
Spindle Accuracy	within 1 μm
Air Bearing Required Air Pressure	0.5MPa
Weight	810g
Noise Level	Less than 80dB(A) (When connecting to the motor)

<Option>

Collet (CHK- □□ )	φ 0.5mm- φ 6.0mm in 0.1mm increments and φ 2.35mm, φ 3.175mm, φ 4.76mm, φ 6.35mm
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## 6 - 2 Outside View

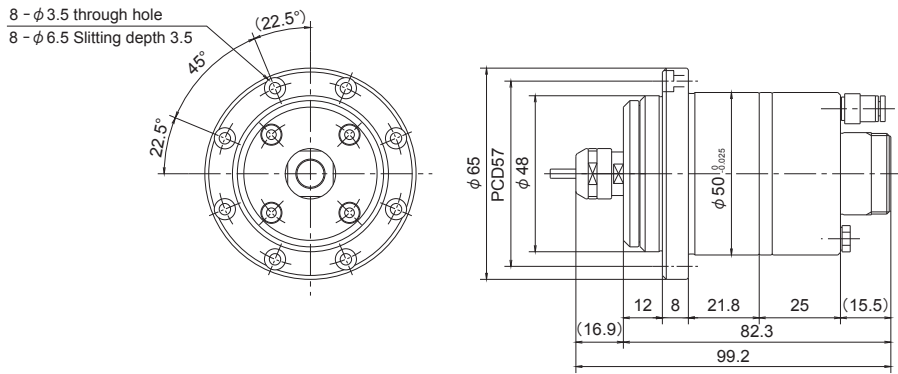


Fig. 1

## 7. CONNECTING TO MOTOR (EM-3080J)

Connect to Brushless Motor refer Fig.2 by following procedure.

- ① Align the threads on the front end of the brushless motor and the rear end of the spindle NRAF-5080. Then check if insert it smoothly.
- ② Align the threads, and turn the spindle clockwise. When the transmission clutch is not engaged, turn the thread of the motor and stop it by first turn.  
NEVER tighten it. Return the thread back slightly, and turn the bar by hand.  
Engage the transmission clutch, and tighten it.
- ③ Then insert the provided bar wrench into the spindle insertion hole and tighten it.

### ⚠ CAUTION

- ① Clean the hands and the connecting parts, before connecting the spindle to the motor, to prevent entry of debris into the motor and spindle.
- ② When connecting the motor to the spindle, never force to insert it. Be sure to connect them carefully, checking if the motor rotates smoothly by connecting to the spindle.

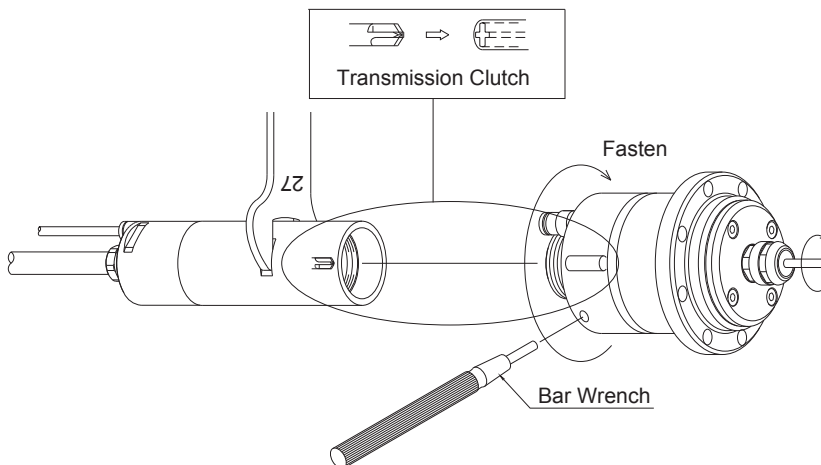


Fig. 2

## 8. REPLACING TOOLS

Replace cutting tools refer to Fig.3 by the following procedures.

- ① Supply the pressure (0.5MPa) to the air bearing.
- ② Set the provided spanner 12mm on the spindle shaft to fix.
- ③ Set the provided spanner 14mm on the collet nut, turn it counterclockwise to loosen the collet nut and pull out the end tool. When the collet nut is turned by approximately one turn, it is tightened, and when further turned, the collet is opened.
- ④ Insert another cutting tool into the collet, and turn the collet nut clockwise to fix. (Collet nut recommended tightening torque: 7Nm)

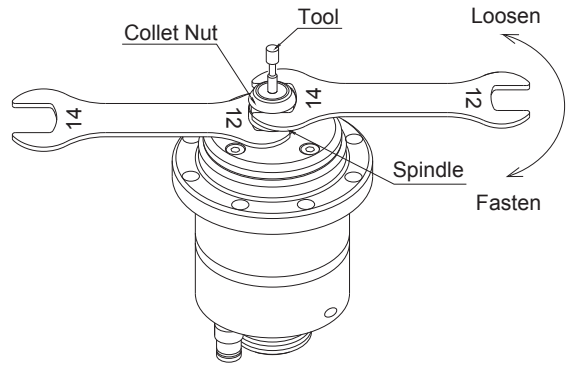


Fig. 3

### ⚠ CAUTION

- ① Never replace the cutting tool and collet without supplying air to the air bearing. If replacement operation is performed with no air supplied, since the spindle shaft contacts the bearing, the contact parts of both are damaged, which may cause improper functioning.
- ② When tightening the collet nut, make sure to insert the cutting tool into the collet. If the collet nut is tightened without inserting the collet nut, the collet has been tightened more than necessary and the collet may be internally disengaged from the latch of the collet nut. When the latch is disengaged, the collet remains in the spindle even if the collet nut is loosened and the collet may not be removed.
- ③ When tightening the collet nut, runout accuracy of cutting tool will deteriorate by tightening more than necessary and the collet may be damaged.
- ④ After installing the cutting tool, measure the runout accuracy at the outside diameter section and check that there is no abnormality.

## 9. REPLACING COLLET

Replace the collet refers to Figs.4 and 5 by the following procedures.

- ① Supply the pressure (0.5MPa) to the air bearing.
- ② Loosen the collet nut with the cutting tool installed according to the "8.Replacing Tools" described above, and turn until the collet nut is removed from the spindle shaft, then pull it together with the end tool from the spindle shaft. After that, pull out the cutting tool from the collet. (Fig.4)
- ③ The collet and collet nut are held together by a groove in the collet and a flange in the collet nut. To remove the collet hold the collet nut in one hand and push diagonally down on the collet. The collet should pop out. (Fig.5)
- ④ Install the new collet in the collet nut by positioning the collet in the collet nut and pressing down on a flat surface. (Fig.5)

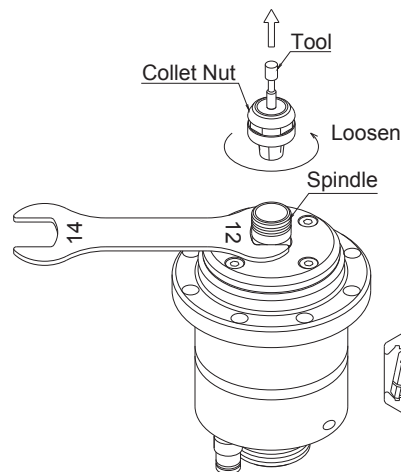


Fig. 4

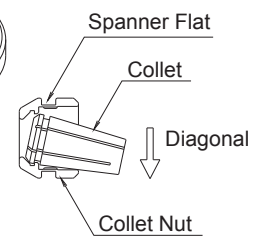


Fig. 5

## 10. INSTALLING SPINDLE

In the case of installation of NRAF-5080 to the holder, adopting a flange fixing method minimizes make damage to the mounting method. The advanced characteristics incorporated in the spindle are fully utilized and observing the precautions shown below and proper installation can realize high precision machining.

Insert the spindle housing diameter  $\phi$  50 section into a holder (prepared by customer), and fix the spindle to the countersink holes (8 locations) on the flange using M3 bolts as shown in Fig.1

### ⚠ CAUTION

- ① If the spindle is tightened and fixed with bolts and slits, the main body will be geometrically deformed and assembly accuracy will be affected, and troubles such as rotation failure and heat generation may result. Absolutely NEVER fix it with bolt and slits. (Fig.6, Fig.7, Fig.8)
- ② Since the spindle housing section has been assembled by stacking some components with high precision, some troubles may result by giving shock or causing damage when installing to the holder. Therefore, carefully perform installation work.

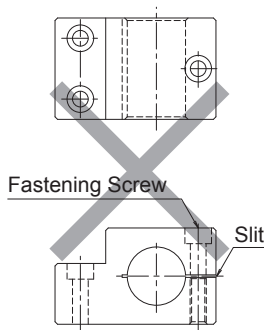


Fig. 6

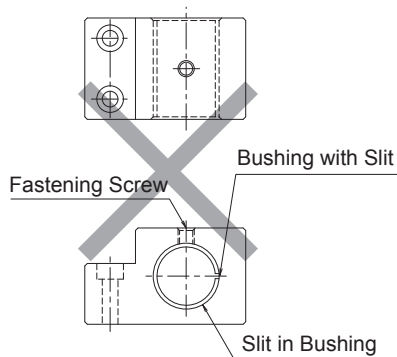


Fig. 7

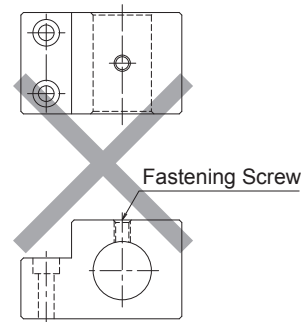


Fig. 8

## 11. CONNECTING WITH AIR LINE KIT

This air bearing spindle, NRAF-5080, requires the air line kit, and the AL-A0611/AL-982 is recommended.

Insert the  $\phi$  4 air hose from the inlet joint of the spindle to the secondary joint of the air line kit through the reducer ( $\phi$  6/  $\phi$  4mm Adaptor). (Fig.9)

Adjust the pressure required for the air bearing (0.5MPa) proximal to the Inlet Joint.

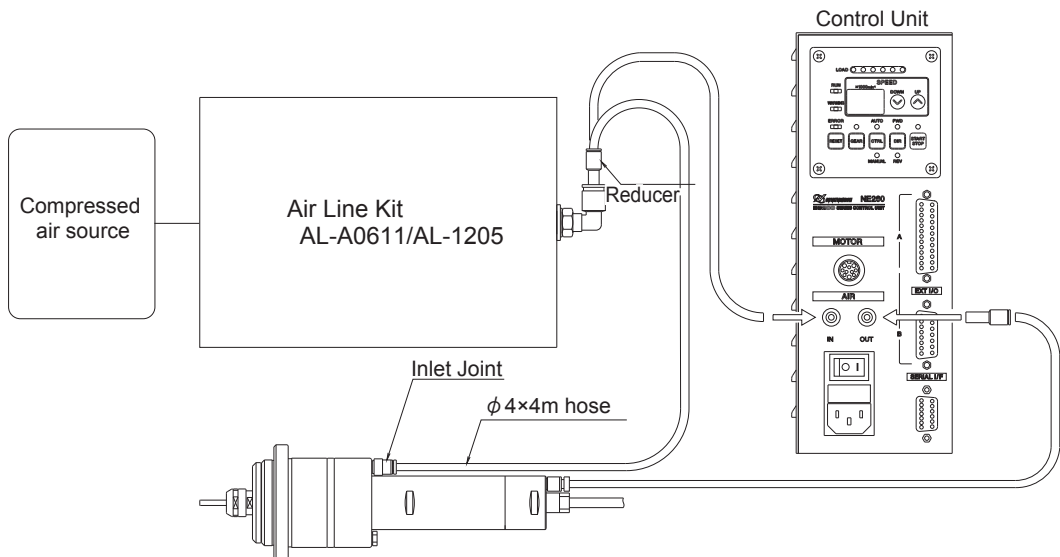


Fig.9 Connecting with Air Line Kit

### **⚠ Caution in use of Air Line Kit**

- ① It is important to supply clean, dry air to NRAF-5080. Install an air filter or air dryer between the compressor and NAKANISHI's air line kit. Mount it as close to the air line kit as possible. Although the air line kit has an air filter, it is suggested to additionally connect a large capacity air filter in high humidity seasons or where humidity is high.
- ② Do not supply oil by the lubricator. Oil could cause a rotation problem and failure.
- ③ Connect air hoses securely. The nominal air pressure for air hose is 1.0 MPa maximum. If this maximum pressure is exceeded, the hose can explode, causing injury. Set the air compressor to 1.0MPa or below.
- ④ Never forget to drain from the air filter to prevent water or contaminants from entering into the spindle. This will maintain the air cleanliness, and avoid rust or damage to the spindle.

## **12. OPERATING PROCEDURE**

### (1) Start to work the spindle

- ① Supply 0.5 MPa air from the air line kit to the air bearing spindle.
- ② Turn the spindle by hand and collet if it rotates lightly
- ③ Check if connected to the cutting tool and tighten the Collet Nut rightly.
- ④ Start to work the motor gradually. (Refer to the operation manual for E3000.)

### **⚠ WARNING**

- ① **First supply air to the air bearing of the spindle when operating the spindle. And operate the spindle gradually (continue to work it up to maximum motor speed for more than 3 sec.) after confirming spindle's float perfectly (after checking to operate by hand lightly). If not correctly, this will cause spindle's failure.**
- ② **When the cutting tool or the Collet nut is not set correctly, this may make it blow away and any damage to your body.**

### (2) To stop the spindle

- ① Stop the spindle rotation. (Refer to the operation manual for E3000.)
- ② Stop the air supply to the air bearing after the spindle stops rotating.

### **⚠ WARNING**

- ① **If stop operating the spindle, it is necessary to stop its rotation. After confirming it, be sure to stop air supply to the air bearing. If not correctly, this will cause spindle's failure.**
- ② **After stopping the air flow of the air bearing, never force to rotate the spindle, because the spindle is not floated. This will avoid the damage to spindle or the shaft retainer.**



### 13. CAUTIONS IN USE OF TOOLS

The following instructions are for the drill, the end mill, and the grindstone usage. Please read them carefully before using to ensure your safety.

- ① Do not use the cutting tools/grindstones in excess of their maximum peripheral speed. The proper surface speed for vitrified grindstones is 600-1800m/min.

$$\text{Peripheral Speed (m/min)} = \frac{3.14 \times \text{Diameter (mm)} \times \text{Rotation Speed (min}^{-1}\text{(rpm))}}{1,000}$$

- ② Do not exceed 24mm overhang for mounted grindstone O.D.  $\phi 6.0\text{mm}$  (See Fig.10 and Table 1.)  
In case overhang must exceed 24mm reduce the motor speed or shorten the overhang.
- ③ It is recommended to dress the grindstone as often as possible prior to use.
- ④ For grinding, one axial feed shall not exceed 0.005mm. Reciprocate the tool movement a few times per one cut feed depth, and move to the next step.
- ⑤ Run the tool within the tool manufacturer's recommended speed. (Use of tool beyond the recommended speed range could cause the tool to damage or fail.)
- ⑥ Always keep the tool shank clean. If foreign matter and debris are left in the collet, they could deteriorate the tool retaining force and the concentricity.
- ⑦ Only use tools with shank diameter tolerance similar to the Collet I.D. tolerance.

**⚠ CAUTION**

- ① Use the tools which are balanced enough. Never rotate the spindle over JIS G2.5 class "2.5mm / sec vibration speed" as a balanced.
- ② Do not use tools with poor concentricity or with cracks or damage.
- ③ Do not exceed a surface speed of 2000 m/min for grinding.

Table 1. Overhang Distance and Speed

Overhang (mm )	Speed (min <sup>-1</sup> )
20	N × 0.5
25	N × 0.3
50	N × 0.1

N : Max. operating speed at 13mm overhang.

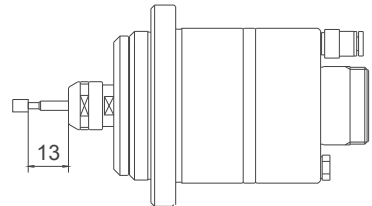


Fig. 10

## 14. MAINTENANCE AND INSPECTION

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### (1) Pre-operation check as a routine

It is necessary to always operate in a normal state in order to use for a long time. For this reason, check the items shown below before operation as a routine.

- Cleanliness of supplied air
- Air supply pressure to the air bearing
- Breakage of the cutting tool, collet, Collet Nut, piping fitting and air hose
- Excessive vibration, abnormal sound and heat generation during operation

### (2) Cleaning

- The spindle uses the air bearing functions by supplying compressed air into a narrow gap between the rotating shaft and bearing section and floating without contact. For this reason, if cleaning is performed with air supply to the air bearing being shut-off, and compressed air or coolant is blown onto the spindle, contaminants, oil or water will intrude into the gap of the bearing, and this will cause troubles. Never clean in this way. When cleaning is required, keep supplying air to the air bearing, and completely wipe away with a waste cloth. Never rotate the spindle by putting off the power of the control unit when mounting it. Keep in mind that it is very dangerous when the cutting tool rotates.
- Always clean the collet. If ground particles or metal chips stick to the inside of spindle or the collet, this will cause damage to the Collet or spindle and loss of precision.

### (3) Disassemble, rework

Never disassemble or rework. Structures in each part have been precisely adjusted and assembled, and once disassembled, precision at delivery cannot be recovered, and operation in that state will damage the rotating section, and this may cause seizing and failure. For this reason, absolutely never touch any part not specified in this operation manual.

Never rework this product as not only will performance not be maintained, but also unintended operating status may result by reworking.

### (4) Overhaul

The spindle using the air bearing is rotated without contact between the spindle shaft and bearing section, and its precision and performance can be maintained for a long time by the proper method while cleanliness is ensured, therefore, overhaul is basically not required. However, any trouble may affect its overall performance. As a countermeasure, overhaul may be required. If any abnormality occurs, contact us.

### (5) Cautions in handling

Handling as shown below may cause failure due to poor rotation, heat generation, deformation of sheath or deterioration in assembly accuracy. Pay sufficient attention to handling.

- Do not drop or hit the spindle.
- Do not tap the spindle with a hammer or apply excess shock.
- Do not loosen and tighten bolts on each part of the spindle.
- Do not disassemble, rework or overhaul.

### (6) For long-term storage

- Clean sufficiently so as to prevent contaminants from intruding into piping connecting sections and gap of the bearing. At this time, prevent rustproof spray and rust inhibitor from adhering to the spindle.
- Insert the attachment plugs(1 locations) into the piping connecting sections.
- Wrap the spindle with a vapor phase corrosion inhibitor wrapping film in which the spindle has been packaged, and properly arrange a quilting material into the quilting structured corrugated box and store the spindle.
- Store the spindle in a stable place away from vibration and avoid a high temperature and high humidity environment. In particular, pay attention so as to prevent condensation due to a temperature difference and select a dehumidified location.

## 15. TROUBLESHOOTING

If a problem or concern occur, please check the following items prior to consulting your dealer.

Trouble	Cause	Inspect/Corrective Action
Tool Slippage	Contaminants inside the Collet or the spindle	Clean the Collet or inside of the spindle. Replace the Collet nut or collet if there is any flaw on them.
	Collet is not properly positioned.	Set the Collet properly.
	Set the air pressure for Air Bearing too low.	Set air pressure for Air Bearing properly.
	Deformation due to excessive tightening of the Collet Nut.	Replace the Collet Nut and collet and tighten with proper torque. Carry out overhaul if there is any damage on the spindle shaft.
	Bent tool.	Change the tool.
Noise or vibration during rotation	Air pressure in the air bearing is not proper.	Set air pressure properly.
	The cutting tool is bent, or run-out of the tool is excessively large.	Re-grab the cutting tool again to adjust run-out to a proper value, or replace.
	Protrusion of the cutting tool is excessively large.	Return protrusion of the cutting tool into the allowable range.
Poor rotation	Pressure in the air supply source lowered.	Set the air supply source to the proper pressure.
	Contaminants, oil or water is mixed into the air supply piping (such as a bearing)	Carry out overhaul and clean, and further check air supply piping and devices used.
	When the spindle shaft is rotated by hand, there is some abnormal feeling or sticking feeling.	Rotate a few times by hand, and carry out overhaul if the problem is not solved.
	The spindle shaft has stopped during rotation.	Check air supply pressure and piping connection. If the spindle shaft is seizing, carry out.

## 16. EUROPEAN EC DIRECTIVE CONFORMATION

The Products are conformed to EC Directives & EC Standards.

Machinery Directive 2006/42/EC

Principle Standards : EN ISO 14121-1 : 2007

## 17. DISPOSAL OF THE AIR BEARING TURBINE SPINDLE

When disposal of an Air Bearing Turbine Spindle is necessary, follow the instructions from your local government agency for proper disposal of industrial components.

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**NAKANISHI INC.**   
700 Shimohinata, Kanuma  
Tochigi 322-8666  
Japan  
[www.nakanishi-inc.com](http://www.nakanishi-inc.com)

**NSK America Corp.**  
1800 Global Parkway  
Hoffman Estates  
IL 60192, USA  
[www.nskamericacorp.com](http://www.nskamericacorp.com)

**NSK Europe GmbH**   
Elly-Beinhorn-Strasse 8  
65760 Eschborn  
Germany

**NSK United Kingdom Ltd.**  
**UK Responsible Person**  
Office 4, Gateway 1000  
Arlington Business Park, Whittle Way  
Stevenage, SG1 2FP, UK