Gear Spindles
JAURE’s competence in power transmission system, is based on more than 40 years experience in the development and manufacturing of couplings and power transmission elements. This is particularly testified by the most extensive supply of the gear couplings and spindles all over the world, being one of the world’s leaders in the fields of power transmission.

Gear spindles are designed according to customers specifications, resulting in most of the cases special solutions. JAURE Engineering Department closely cooperates with customer’s engineers to create the best product for their needs.

Rolling mill couplings that connect the drives and the rolls were often taken for granted. However, market demand for greater productivity and improved quality of rolled products, has driven the design and manufacture of equipment to accommodate high operating speeds, torques and misalignments with minimum maintenance.

Gear spindles are a critical component of the drive train. Strip quality and thickness control can be influenced by the performance of the drive spindles. The modern and efficient gear type spindle, requires less maintenance and is much more economical than its predecessors. Gear spindles provide constant angular velocity at misalignment angles, which ensures even transmission of power. This results in uniform sizes and improved surface quality of rolled products.

In addition, the inherent dynamic balance characteristics of gear type flexible spindles minimize vibration, thus increasing the operating life of bearings, gears, and other components of the drive train.

Computer-aided designs and the latest manufacturing CNC machines and testing equipment, ensure that our products always reflect the state of the art of drive components. Furthermore research and development, including Finite Element Analysis and solid modelling design methods assure our customers that their equipment will be optimized by their application.

The design, manufacturing and sales of all of our gear couplings and drive components are integrated into our Quality System, according to UNE-EN-ISO 9001. This Quality Policy covers all the different departments at JAURE.
JAURE gear spindles are specially designed for those applications where driving and driven components are necessarily misaligned and where service dictates a changeable amount of misalignment.

Gear spindles more common application is for ferrous and non ferrous rolling mills drive, where technology is in continuous development to achieve a higher product quality with lower and maintenance costs.

Gear spindles are critical components of the drive train and for this reason, JAURE to meet the demands of the most up-date mill equipment, designed his gear spindles which ensure performances, operating efficiency, less and easier maintenance. All the above advantages have been realized by developing teeth profile, surface heat treatment, materials quality and seals.

To accommodate load and no load misalignment with minimum backlash is necessary to crown the flanks and the tips of the hub teeth. Teeth are also designed to allow higher no load angle to easy roll change.

Spindles with fully crowned gear teeth offer operational benefits of maximum load carrying capacity with minimum size, maximum reliability and long life.

Materials used in the production of spindle gear elements, include both medium carbon and forged alloy steels.

The material and heat treatment combinations commonly used for spindles applications are shown in page 6.

A vital aspect having a direct affect on spindles life and performances, is the provision of quality seals for efficient retention of the gear lubricant for exclusion external contaminates.
Product concept

Modern steel and non-ferrous mills, require top performance from the power transmission equipment with higher loads and speeds being needed.

Rolling mill spindle couplings are components of vital importance, with regard to productivity objectives and high quality standard of the end product.

Gear spindle coupling requirements:
• High torque capacity under minimum space condition.
• Suitability to endure high instantaneous peaks loads, due torque amplification, created by material entering or any disturbances during rolling process.
• Suitability to transmit the maximum torque with angular misalignment of 2° and over (max extreme limit 6°)

To be able to transmit large torques at large misalignment, spindle gear couplings use fewer teeth, high-strength alloyed steels, and superficial hardening: either nitriding or carburizing.

Because of the high contact pressures and the high sliding velocities between the teeth, the lubricant are greases with a large amount of anti-wear additives. Special sealing system avoids overflow of lubricant and keeps contamination out.
A gear coupling is one of the simplest and most common types in use today. It is also one of the most difficult to design and evaluate, because of the number of variables that can affect its successful operation. Some of these variables are:

1) Tooth design
2) Material
3) Lubrication

The main concept of the gear tooth design, is optimisation of the tooth geometry to obtain a higher percent of teeth in contact at the coupling operation conditions. In order to perform this optimisation, is very important to understand the variables that effect the actual percent of teeth in contact:

**Misalignment Angle**

Theoretically, there are only two teeth in contact when misalignment is present and no load is applied. There must be a load applied to obtain contact of more than two teeth. The degree of misalignment partly determines the number of teeth in contact for a given amount of torque. The lower the angle, the more teeth in contact and greater the torque capacity.

**Flank curvature**

This is the main contributor besides the misalignment angle in determining the gap between each tooth set. An optimized flank curvature will produce minimal gaps between each tooth set while maintaining an acceptable compressive stress. Proper flank crowning reduces contact stress, prevents tooth end bending and increases the contact area by moving the load closer to the centre of the tooth. JAURE can also design a compound curvature on the tooth flank to maximise the working area of the tooth reducing the Hertz contact stresses.

**Tooth Loading**

There are three basic loading conditions which can contribute to tooth failure:

- Hertz or compressive stress
- Bending stress
- Contact pressure/sliding velocity component

All of these variables and different variables must be considered in the design of a gear spindle. JAURE’s Engineering Department designs the spindles according to the misalignment angle and each type of tooth loading and misalignment angle, selecting the right material and heat treatment with the right design of the tooth, to suit your application based on over 40 years of experience in spindle design.
Gear tooth materials and heat treatments

Materials used by JAURE in the production of gear spindle components, include a proper combination of steel and heat treatment, depending on the stressing level and the required operating life. The best heat treatment for a coupling gear tooth gives the correct combination of core hardness versus case depth and hardness be used. For maximum strength and durability, its desirable to harden selected outer surfaces of spindles parts while leaving the inner cores ductile for shock resistance. Several heat treatment methods are available for case hardening the gear tooth components including nitriding, induction hardening and carburizing.

The selections of a proper combination of steel and heat treatment, depending on the stressing level and the required operating life, are:

- **NA** Heat treated nitrided alloy steel. This is for medium torque, high angle and high speed applications. Nitriding is also preferred for high temperature and high speeds applications where it is more durable than other forms of hardening.

- **NHA** Heat treated nitrided alloy high-strength steel. For medium to high torques.

- **CHA** Heat treated and carburized alloy high-strength steel. The carburizing process imparts a hard, deep case over a ductile and shock resistant core to resist wear and abrasion. Mainly used in high torque applications.

Nitrided hubs.
1) Compute torque to be transmitted, increased it multiplying by service factor SF and torque factor KA:

\[ T = \frac{P_a \cdot 9.55}{n} \cdot SF \cdot KA \ (kNm) \]

where:

- \( P_a \) = Absorbed power [kW]
- \( n \) = RPM

2) Select the service factor SF from table 1.

---

**APPLICATION** | **SF**
---|---
Auxiliary Mill Equipment | 1.5
Wire, Small Bar and Rod Mills: All Stands | 1.5
Medium Bar and Section Mills: Finishing Stands | 1.5
Cold Mills: Non-Reversing Straighteners | 1.75
Medium Bar and Section Mills: Roughing Stands | 2.0
Large Bar and Section Mill: Finishing Sands | 2.0
Cold Mills: Reversing Hot Strip Mills: Non-Reversing Finishing Stands | 2.5
Large Bar and Section Mills: Non-Reversing Roughing Stands | 2.5
Tube Mill Main Drive | 2.75
Hot Strip Mills: Non-Reversing Roughing Stands | 2.75
Edgers, Non-Reversing | 3.0
Hot Strip Mills: Reversing Roughing Stands | 3.0
Large Bar and Section Mills: Reversing Roughing Stands | 3.0
Edgers, Reversing, Steckel Mills | 3.0
Reversing Slab, Plate and Blooming Mills | 3.0

Table 1

3) Compute Torque factor KA, depending by working angle shown on graphic 1:

4) Select spindle size from engineering data on page 8. The torque capacity varies with spindle size and gearing material; chose a spindle size and a gearing material with:

\[ T_{nom} > T \]

5) Besides check that:

\[ T_{max} > T \times TAF \]

Where:

- \( T_{max} \) = Peak Torque (KNm)
- TAF = Torque amplification factor

6) Check the maximum speed \( n \), has to be equal or lower than the selected size coupling maximum speed multiplied by the speed factor KS, depending by operating misalignment, shown on graphic 2:

\[ n \leq K_s \cdot n_{max} \]

---

**GRAPHIC 1**

**GRAPHIC 2**

- For angles greater than 3° consult JAURE

---

**CONVERSION TABLE**

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<th>Conversion</th>
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<td>= 0.0394 inch</td>
</tr>
<tr>
<td>1 inch</td>
<td>= 25.4 mm</td>
</tr>
<tr>
<td>1 m</td>
<td>= 39.4 inch = 3.283 ft</td>
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<tr>
<td>1 Kg</td>
<td>= 2.2046 ibs (weight)</td>
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<td>= 1.34 HP</td>
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<tr>
<td>1 HP</td>
<td>= 0.746 kw</td>
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7
## Gear Spindles

### Gear size selection

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<tr>
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<th>Dimensions</th>
<th>Maximum 2(^{2}) bores</th>
<th>Weight (Kg.)</th>
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<td>AL-1100</td>
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<td>1,170</td>
<td>820</td>
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</table>

**NOTES:**
1. This design is only valid with an intermediate sleeve. See page 4.
2. Dimensions d\(_{\text{max}}\) and d\(_{\text{1max}}\) are valid for shaped bore on roll end side and finished bore and keyway UNI 6604-DIN 6885 on drive end side.
3. Shaft's weight is for a 100 mm length.
Standard designs

AL-S

AL-SD

AL-D
Special designs

Quick disenganging

Telescopic type

AL-SBR

AL-S-SAFESET® 1

SAFESET® is a trade mark from VOITH
Special designs

AL-S-SAFESET® 2

AL-ST

Continuous lubrication

Oil-lubrication

SAFESET® is a trade mark from VOITH
Spindle accessories

1) A serious roll entry problem is caused by drooping roll sleeve when spindle support is located under the shaft. This can be overcome with the use of a spring loaded sleeve aligning device, fig 1, which holds the roll sleeve in line with the spindle shaft when the roll is removed, and maintains it aligned and ready for re-entry of new roll.

2) Special seal, which assures a complete grease un leakage under the worst working conditions is shown in fig.2:

3) Numerous means of roll end connection are available. The simplest, provided for bases spindles, is a shaped bore in the spindle sleeve having the same configuration as the roll end with minimum clearance to allow roll removal and re-entry.

A similar but preferable connection is the use of flat, round or piloting ring inserts, fig 3, and 4, which are replaceable when the inevitable wear does occur. These keys and piloting rings are made of heat-treated alloy steel for maximum usable life.

4) Automatic tapered keys, fig.5 are the best device for tight sleeve-to-roll connection with ease of roll removal and replacement. It consists of a pair diametrically opposed tapered keys which are snugly scated against the spade flats when a roll is inserted, but which follow the roll neck for a limited distance during removal and produce ample clearance across the flats for roll removal and re-entry.

5) Flat journal profiles for spindle sleeves on the end roller.
Spindle accessories

Fig. 3 Replaceable wear flats

Fig. 4 Centering rings

Fig. 5 Automatic locking key
Spindle accessories

Fig. 6

Slotted profile for flat journals, used preferably in bores that are large in relationship to outer diameter of sleeve. Slanted surfaces around diameter centre roller journal exactly. Bore can be given optional special treatment to increase its surface strength and wear resistance.

Fig. 7

Flat journal profile with inserted, hardened and ground steel jaws. High wear resistance even despite angular vibrations or thrusts that would otherwise damage coupling sleeve during a roller change. Easy to replace steel jaws if necessary. Cost-efficient stock keeping.

Fig. 8

Flat journal profile with inserted jaws and guide profiles made of hard plastic. Good protection against formation of frictional corrosion when aggressive cooling agents are used. Cost-efficient stock keeping since only plastic parts have to be kept. Easy to replace parts subject to wear.
Spindle maintenance and lubrication instructions

The gear spindles must be lubricated in site with rolls in working position. If the spindle is lubricated with the rolls removed an excess of grease will come out once the roll is in. This pump of excess of grease can damage the seals.

**SPINDLE COUPLING LUBRICATION.**

If an anormally short life of the spindles is observed the first thing to check is the lubricant. A lack of proper lubrication will generate heat and will not dissipate it, therefore the spindle will fail by overheating.

**a) Recommended greases.**

Gear spindle couplings require very special lubricants with highly refined base oils that have high viscosity indexes, excellent extreme pressure qualities, water resistance and adhesiveness. The lubricant used should provide a low friction film between the working surfaces to reduce the possibility of wear. The lubricant should also have extreme pressure capability and good capacity for dissipating the heat generated from sliding and rolling action of mating gear teeth.

Examples of greases that comply with the above features are:
- BESLUX BMX H-1 from BRUGAROLAS
- MOBILUX EP-111 from MOBIL
- MULTIFAK EP-2 from TEXACO
- TRIBOSTAR 1MO from KLUBER

**b) Method of lubrication.**

When installing or reinstalling the spindle, be sure also to hand-pack the teeth with grease prior to greasing by normal methods, to ensure that the teeth will not run dry for the first few minutes of operation until the lubricant works its way to the gear mesh.

In order to proceed with greasing, remove one of the vent plugs and pump grease using one of the grease nipples placed in the spindle shaft or adapters. The lubrication would be completed when the grease comes out of the vent hole continuously. Do not forget to screw back the vent plugs since the spindle coupling can lose all the grease.

Always lubricate at both sides of the spindle.

When a telescopic shaft exists, use one of the three grease nipples in the shaft in order to lubricate the spline. Pump grease according to the amount specified in the specific drawing.

**c) Lubrication frequency.**

- **At start up**, lubricate after few hours of operation, check and add grease if necessary.
- **During the adjustment period**, for the first month of operation lubricate every 3 days.
- **In normal operation**, lubricate every 15 days. For applications involving reversing, severe shock or high misalignment, lubricate at least weekly.

If excessive rolling fluid or contaminants are present, or ambient temperatures are a problem more frequent lubrication may be necessary.

For longer lubrication periods, please ask our Technical Department.

---

**Grease technical features**

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<th>Feature</th>
<th>Specification</th>
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<tr>
<td>Thickener type</td>
<td>Lithium</td>
</tr>
<tr>
<td>Dropping point</td>
<td>175÷240ºC</td>
</tr>
<tr>
<td>Oil viscosity at 40ºC</td>
<td>Higher than 500 Cst</td>
</tr>
<tr>
<td>MoS2</td>
<td>5-10%</td>
</tr>
<tr>
<td>EP additive</td>
<td>Required</td>
</tr>
<tr>
<td>Oxidation inhibitors</td>
<td>Required</td>
</tr>
<tr>
<td>Timken EP Test</td>
<td>18÷32 Kg</td>
</tr>
<tr>
<td>Soap percentage</td>
<td>5-10 %</td>
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</tbody>
</table>

1) For speeds above 1000 rpm consult our Technical Dep.
Spindle maintenance and lubrication instructions

SPINDLE COUPLING MAINTENANCE

Scheduled inspections should be performed in order to achieve a long spindle life and proper operation. These first inspections are advised to be:

1) after 1-2 weeks.
2) after 4-6 weeks.
3) after 8-10 weeks.

Later on, the inspections are to be carried out every 5-6 months or every 4000-6000 hours, at least once a year. During these inspections, the spindle should be thoroughly cleaned and the following checking have to be performed:

a) Flange bolts tightening.
b) Gear teeth wear control.
c) Noise and vibrations. In case of anomalous noise/ or vibrations, check immediately the cause.
d) Be sure that no excessive grease leakage is present, caused by seal wear, grease nipple and plugs failure.

damaged components should be replaced. If toothed components are not replaced it is advantageous to re-engage the teeth in the same mesh in which they were running. Top and bottom spindles should be interchanged to equalize tooth wear.

Always maintain an inventory of spare parts sufficient to insure continuity of plant operation.

All rotating parts must be guarded to prevent accidents according to national and local safety rules.

Problems and causes

1. **Anomalous gearing wear**
   - Lubricant deficiency due to:
     - Unproper lubrication schedules
     - Seals wear or failure
     - Grease plugs leakage
     - Inadequate quantity of grease
   - Operation under conditions different from the original project.
   - Excessive backlash between roll neck and sleeve bore

2. **Teeth Failure**
   - Excessive misalignment
   - Overloads
   - Excessive backlash

3. **Flange bolts loosening and failure**
   - Flange and shaft mechanical contact
   - Unproper bolts tightening torques
   - Excessive spindle vibrations

4. **Roll sleeve bore anomalous wear**
   - Inadequate lubrication
   - Sleeve overheating in operation causing a reduction of bore surface hardness
   - High spindle vibrations
   - Worn out or excessively rough roll neck surfaces

5. **Vibrations**
   - Roll sleeve bore excessive wear
   - Flange bolts loosening or failure
   - Excessive gearing wear
After sales and reconditioning services

Repair and maintenance program

At the urging of gear spindle users, JAURE is engaged in the repair of the gear-type spindle couplings for over 40 years.

The program we established allows us to provide our customers with a quick turnaround (short time from receiving the coupling to delivery of the repaired unit), and at reduced costs (as compared with buying a new coupling).

Additionally, in analyzing the damaged couplings sent to us, we are able to advise our customers on improved maintenance procedures, so that the repaired units most often have a longer service life than the original coupling.

Analysis of the received coupling.

Our analysis has three aspects:

1) We observe the unit’s damaged parts. For instance: Do the teeth show excessive misalignment? Are the seals showing signs of leakage? Is the lubricant contaminated or was it subjected to high temperatures?

2) If in doubt of material quality, we cut samples of the damaged components and send them for metallurgical analysis.

3) We discuss the application with the customer’s maintenance personnel, and try to improve the maintenance. In some cases, through these discussions we find out that the coupling is not adequate for the application.

Our technicians have many years of experience in this field, and our engineers are often consulted in deciding which repairs are necessary.

A complete report is drafted of the technicians’ findings, and a list of the required repairs (including prices) is made and sent to our customer for approval. No work is done without customer consent.

Actual repair procedure

Evidently, the most costly components are the hubs and the intermediate gear rings. All effort is made to salvage these components, if it is possible. In many cases damaged teeth can restored to almost original condition, and parts can be reused. If repairing these components would reduce the quality of the coupling, then we recommend their replacement. In the case of very old couplings, we are able to offer replacement components made of better and newer materials, or better heat treatments, thus improving the life expectancy of the repaired coupling.

Some of the components are routinely replaced: this is always the case with the square keys, and any bolts or nuts that have worn or damaged threads. Also, all seals are replaced, so that the lubricant is held within the coupling, and water and or dirt is prevented to enter the coupling.

Inventory program of replacement parts

JAURE keeps a record of all the repairs since the coupling repair program is implemented. This records are computerized, and we can now predict which parts will be in demand. Therefore, JAURE can establish in his warehouse a stock of parts most frequently required for repairs. We are thus able to offer a quick turnround, as seldom do we need to manufacture parts from scratch, after the coupling is sent to us.

With many of our repeat customers we establish a program frequency of repairs, so that we are able to stock special components even before we receive a coupling. Parts are replaced only if necessary.

The advantages of JAURE’s repair program

• JAURE will repair your coupling in the shortest time possible.
• JAURE will repair your gear-type spindle coupling at lower cost than a new coupling.
• JAURE will work with your maintenance department to increase expected life of repaired units.
• JAURE technicians and engineers have a broad experience, both in manufacturing new spindle couplings, and in the repair of damaged gear-type spindle couplings.

You can rely on JAURE to have the best job done, at a competitive price.
JAURE Supplying Program for steel/aluminium mills

MT Crowned Tooth Gear Coupling.  
(Nominal Torque up to 7,000 kNm)

AL Gear Spindle.  
(Nominal Torque up to 6500 kNm)

MTX Heavy Duty Gear Spacer Coupling.  
(Nominal Torque up to 7000 kNm)

BM Elastomeric Coupling.  
(Nominal Torque up to 1600 kNm)

Safety element (1)

JG Universal Joint.  
(Nominal Torque up to 3500 kNm)

(1) Safeset® is a trade mark from Voith.
## Steel/Aluminium mills application list

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<tr>
<th>Mayor Applications</th>
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<th>Universal Joint</th>
<th>Elastomeric Coupling</th>
<th>Gear Coupling</th>
<th>Disc Coupling (Lamidisc®)</th>
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<td>✓</td>
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<td>Cranes</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Casters</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>
Applications

Cold strip mill spindle.

Spindle equipped with Safeset®.

Cold rolling mill spindles.

Hot strip mill spindles

Continuous lubricated spindle.

Horizontal and Vertical Stands with JAURE Spindles

SAFESET® is a trade mark from VOITH
Applications

MT-730 Main Drive Gear Coupling

Hot strip mill spindles.

Telescopic spindles

Wire mill spindle.

Main Drive Gear Coupling

Pumping oil into a spindle with Safeset®

SAFESET® is a trade mark from VOITH
Selection data required

Name

Company

Phone Fax E-mail

Date

Inquiry Number

Mill Type

Number of Stands

Number of Required Assemblies

Please include your comments:

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
Selection data required

Please provide the following information in the boxes provided:

<p>| | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>rpm</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Overload Rating</td>
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<td></td>
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</tr>
<tr>
<td>4</td>
<td>Motor Min.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Motor Max.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>Ratio</td>
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<tr>
<td>7</td>
<td>Shaft Centers</td>
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<td></td>
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<tr>
<td>8</td>
<td>Pinion Stand</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>Min. Roll Diameter</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>10</td>
<td>Max. Roll Diameter</td>
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<tr>
<td>11</td>
<td>Min. Roll Diameter</td>
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<tr>
<td>12</td>
<td>Max. Roll Diameter</td>
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<tr>
<td>13</td>
<td>Max. Angle Operating</td>
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<tr>
<td>14</td>
<td>Max. Angle Roll Change</td>
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</tr>
<tr>
<td>15</td>
<td>Min. Work Roll Centers</td>
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<tr>
<td>16</td>
<td>Max. Work Roll Centers</td>
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<tr>
<td>17</td>
<td>Required Service Factor</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>18</td>
<td>Min. and Max. if Axial Travel is required</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please note any other mill characteristics such as:
- Method of Roll Change
- Drive Orientation (Vertical or Horizontal, etc)
- Operating Environment
- Unidirectional of Reversing Drive
- Restrictions on Diameter
- Any Other Pertinent Information

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Fax: +34 943 69.02.95
Fax Tech. Dept. +34 943 69.03.17
Post address: P.O. Box, 47
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E-mail:sales.dep@jaure.com
http://www.jaure.com
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- LAMIDISC® all steel disc coupling.
- Barrel coupling TCB®.
- RECORD Flexible Spring Coupling.
- JAUFLEX® Flexible elastic coupling.
- Gear spindles for rolling mills.

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