AN AMERICAN NATIONAL STANDARD

ASME B5.60a-2005

ADDENDA

to

ASME B5.60-2002
WORKHOLDING CHUCKS: JAW TYPE CHUCKS

Incorporating ASME B5.60.1, ASME B5.60.4, and ASME B5.60.5

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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ASME B5.60a-2005

Following approval by the ASME B5 Committee and ASME, and after public review, ASME B5.60a-2005 was approved by the American National Standards Institute on February 24, 2005.

Addenda to the 2002 edition of ASME B5.60 are issued in the form of replacement pages. Revisions, additions, and deletions are incorporated directly into the affected pages. It is advisable, however, that this page, the Addenda title and copyright pages, and all replaced pages be retained for reference.

SUMMARY OF CHANGES

This is the first Addenda to be published to ASME B5.60-2002.

Replace or insert the pages. Changes given below are identified on the pages by a margin note, **(a)**, placed next to the affected area. The pages not listed are the reverse sides of the listed pages and contain no changes.

Page	*Location*	*Change*
iii	Contents	Updated to reflect Addenda
iv	Foreword	Updated to reflect Addenda
v	Committee Roster	Updated to reflect Addenda
vii	Preface	Updated to reflect Addenda
11–21	ASME B5.60.5	Added

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FOREWORD

During the review, revision, and update of the existing inch-based American National Standard B5.8 on Chucks and Chuck Jaws, Technical Committee 11 of the ASME B5 Committee on Machine Tools recognized the need for an industry standard on metric-dimensioned chucks.

This Standard was developed after reviewing currently available national and international standards, which were used as its foundation.

B5.60.1 and B5.60.4 were completed in November 1999 and submitted to ASME.

The standard titled, *Workholding Chucks: Jaw Type Chucks,* comprises six parts, with each covering a specific aspect of workholding chucks, as follows:

ASME B5.60.1: General Description and Definitions of Terms
ASME B5.60.2: Chuck-to-Spindle Interface
ASME B5.60.3: Jaw Mountings
ASME B5.60.4: Performance Testing
ASME B5.60.5: Safety Code of Practice
ASME B5.60.6: Chuck Assembly: Sizes and Designation

ASME B5.60.1 was approved by the American National Standards Institute on June 26, 2002.

ASME B5.60.4 was approved by the American National Standards Institute on June 26, 2002.

ASME B5.60.5 was approved by the American National Standards Institute on February 24, 2005.

ASME B5.60.2, ASME B5.60.3, and ASME B5.60.6 will be added.

ASME B5 STANDARDS COMMITTEE
Machine Tools — Components, Elements, Performance, and Equipment

(a)

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME Codes and Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by proposing revisions and attending Committee meetings. Correspondence should be addressed to:

Secretary, B5 Main Committee
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Proposed Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible: citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Attending Committee Meetings. The B5 Main Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B5 Main Committee.

PREFACE

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ORGANIZATION OF THIS DOCUMENT

This Standard compiles the following standards.

Standard	*Title*
ASME B5.60.1	General Description and Definitions of Terms
ASME B5.60.2	Chuck-to-Spindle Interface (to be added)
ASME B5.60.3	Jaw Mountings (to be added)
ASME B5.60.4	Performance Testing
ASME B5.60.5	Safety Code of Practice
ASME B5.60.6	Chuck Assembly: Sizes and Designation (to be added)

ADDENDA SERVICE

This edition of ASME B5.60 includes an automatic addenda subscription service up to the publication of the next edition. The addenda subscription service will include the additional B5.60 documents not already included in the initial publication, and approved revisions to the existing parts.

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ASME B5.60.5

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SAFETY CODE OF PRACTICE

1 INTRODUCTION

This American National Standard establishes technical requirements for workholding chucks.

There are hazards inherent in the design, use, and operation of jaw type chucks. Ignoring safety considerations will result in personal injury, including death.

2 SCOPE

This Part of the ASME B5.60 standard covers the safety requirements for jaw type workholding chucks that are primarily used in turning applications.

This Part addresses the requirements and/or measures to minimize the hazards and reduce the risks associated with workholding chucks.

NOTE: For specific limits and specifications, contact the workholding chuck manufacturer.

3 DESIGN AND CONSTRUCTION OF WORKHOLDING CHUCKS AND TOP JAWS

3.1 Workholding Chucks

Original chuck design shall address at a minimum the following:

3.1.1 Chuck and actuating equipment shall be compatible.

3.1.1.1 The input force of the actuating equipment is to meet or exceed the chuck's requirements.

3.1.1.2 The stroke of the actuating equipment is to meet or exceed the chuck's requirements (power chuck).

3.1.1.3 The maximum allowable speed of the actuating equipment is to meet or exceed the chuck's requirements (power chuck).

3.1.2 Chuck components shall be positively prevented from being flung out by centrifugal force.

3.1.2.1 The chuck's internal and external components are to have design features ensuring integrity at the maximum allowable speed.

3.1.2.2 Limits on the mass of top jaws and radial position are to be defined in the chuck's manual (i.e., the restrictions of speed and input force with regards to top jaws).

3.1.3 Balance of the chuck is to ensure safe operation up to the maximum allowable speed.

3.1.3.1 The chuck and actuator are to be balanced within 3 g at outside diameter as the standard.

3.1.3.2 The chuck's design is to allow for field balancing (if required). This could be done at the areas of the chuck prescribed for addition or removal of weight as per para. 3.1.3.1.

3.1.4 Chucks shall be equipped with means for the safe handling per ASME B18.15M (e.g., provision for lifting eye bolt).

3.1.5 The chuck's design is to have a convenient and reasonably accessible method for lubrication of the workholding chuck.

3.1.6 The power chuck and/or actuating equipment shall have stroke detection and/or confirmation provisions (e.g., sensing devices).

3.1.7 There shall be provisions to maintain clamping force until the spindle comes to a safe stop in the event of loss of input force.

3.1.8 In the event of power loss, the chuck and/or actuating equipment shall have provisions to maintain clamping force until the spindle comes to a safe stop.

3.2 Top Jaws

Top jaw design shall address, at a minimum, the following:

3.2.1 Top jaws and chucks shall be compatible.

3.2.1.1 Any top jaws used on a specific chuck shall have compatible mating surfaces.

3.2.1.2 Top jaw design must address weight, position, and speed limitations.

3.2.1.3 Top jaw material must be also considered for strength and durability.

3.2.1.4 Replacement top jaws must adhere to original workholding manufacturer's mounting dimensions and tolerances as specified by the chuck manufacturer. Deviations from these specifications could cause loss of gripping force, damage to the chuck, and possible injury.

3.2.2 Top jaws/components shall be positively prevented from being flung out by centrifugal force.

3.2.2.1 The mechanical connection between top jaws and master jaws shall be of an interlocking design that will resist separation, under centrifugal force, when properly connected with the specified fasteners. Other types of stops, blocks, and clamps properly bolted in place may be used.

3.2.2.2 Welded jaws shall not be used.

3.2.3 Jaw nuts and mounting bolts shall be compatible with original workholding manufacturer's specifications.

4 MARKING

4.1 Workholding Chucks

Marking shall be durable and last for the life of the product. Minimum requirements for marking shall include the following:

(a) manufacturer's name and model/identification number
(b) maximum input force
(c) maximum static clamping force.

4.2 Top Jaws

Marking shall be durable and last the life of the product. Minimum requirements for marking shall include the manufacturer's name and/or logo, model and/or identification number on a visible (when mounted) and not likely to be removed surface.

5 SAFETY INSTRUCTIONS

5.1 Workholding Chucks

The original chuck manufacturer shall provide an instruction manual.

Items to be addressed in the instruction manual, at a minimum, shall include the following:

(a) general specifications (e.g., dimensions, maximum speeds, and forces)
(b) instructions for the handling and installation of the workholding chuck
(c) instructions for the usage of the workholding chuck
  (1) jaw forming/boring
  (2) jaw mounting
  (3) component clamping
(d) methods for determining chuck forces
  (1) maximum drawbar-pull (Mandatory Appendix I, para. I-1)
  (2) static gripping force (Mandatory Appendix I, para. I-2)
  (3) dynamic gripping force and centrifugal force (Mandatory Appendix I, para. I-3)
  (4) driving torque (Mandatory Appendix I, para. I-4)
  (5) maximum rotation speed (Mandatory Appendix I, para. I-5)
(e) instructions for maintenance
  (1) assembly and disassembly instructions
  (2) assembly/component views
  (3) parts list
  (4) lubrication instructions
(f) periodic performance checks
  (1) jaw stroke
  (2) static clamping forces

5.2 Top Jaw Safety Instructions

The original top jaw manufacturer shall provide safety instructions.

Items to be addressed at a minimum shall include the following:

(a) method for calculating the maximum rpm
(b) mounting hardware to be specified (e.g., dimensions, grade/class)
(c) mounting instructions
(d) statements to be included:
  (1) "Follow chuck manufacturer's mounting and usage specs as outlined in the original workholding manufacturer's manual."
  (2) "Specific limits and specifications: contact the top jaw manufacturer."
  (3) "Maintenance recommendations — when applicable."

6 MACHINE TOOL BUILDER RESPONSIBILITIES

The machine tool builder's minimum responsibilities shall include the following:

6.1 Selection

A workholding system compatible with the machine tool shall be selected.

6.1.1 The machine tool builder shall select a workholding chuck based on the performance capability of the chuck being compatible with the machine tool's cutting capabilities. The items to be considered include but are not limited to maximum spindle rpm, machine swing, spindle horsepower, axis thrust, spindle nose, headstock length, chuck weight, maximum part diameter, length, weight, etc.

6.1.2 The machine tool builder shall limit (lockout) the maximum spindle speed so that it does not exceed the maximum rpm of the workholding system.

6.2 Documentation

The chuck manufacturer's manual shall be provided with the machine's documentation.

The machine tool builder shall provide a copy of the chuck manufacturer's manual with the machine tool's documentation.

6.3 Safety Instructions

Safety instructions shall include safe operation guidelines for workholding.

The machine tool manufacturers shall address the following issues in their manuals.

6.3.1 Safety. The end user must read, understand, and adhere to the chuck manufacturer's safety manual.

6.3.2 Chuck Gripping Force. Requirements for review and determination of proper gripping force required for the process being performed (para. 5.1.4.5) shall be explained.

6.3.3 Constant Surface Speed. The effects and safe corrective action when using constant surface speed shall be explained.

6.3.4 Jaw Gripping Area. The machine tool builder shall describe the importance of proper jaw gripping area [para. 5.1(c)].

6.3.5 Unbalanced Workpieces. The effects of an unbalanced workpiece/workholding system shall be explained.

6.3.6 Alteration to Workholding System. Before making any alterations or changes to the workholding system, the chuck manufacturer should be consulted.

6.3.7 Bar Applications. An explanation of the effects of bar passing through the spindle, and the required cautions, should be provided.

6.3.8 Double Chucking. The use of multiple workholding systems on the same machine should be addressed.

6.3.9 Additional Information. Information recognized by the machine tool builder to improve the safe operation of the workholding system should be included.

6.4 Safety Placard

Provide the safety placard with the following minimum information.

6.4.1 Chuck and/or Cylinder Make/Model Numbers. The manufacturer shall list the chuck and cylinder models selected and installed on the machine.

6.4.2 Maximum Input Pressure (Cylinder). The placard shall indicate the maximum input pressure that can be applied to the cylinder for the specific chuck installed.

6.4.3 Maximum Rated rpm. The maximum rpm capability of the workholding system shall be indicated.

6.4.4 Reference to Chuck Manual. The placard shall inform the user to review the chuck manufacturer's manual.

6.5 Power Chuck Clamped Confirmation

A suitable system for power chuck clamped confirmation shall be provided.

6.5.1 The machine tool builder shall provide a positive means for determining if the chuck is in the clamped position. Spindle rotation shall be inhibited when the chuck is not in the clamped position.

7 WORKHOLDING USER RESPONSIBILITIES

Workholding user minimum responsibilities include the following:

7.1 Power and Manual Chucks

7.1.1 The user must read, understand, and adhere to the instruction manual.

7.1.2 The user must select a workholding system compatible with the machine tool.

7.1.2.1 The user shall select a workholding chuck based on the performance capability of the chuck being compatible with the machine tool's cutting capabilities. The items to be considered include but are not limited to spindle rpm, maximum chuck size, spindle horsepower, axial thrust, spindle nose, headstock length, chuck weight, maximum part diameter, length, weight, etc.

7.1.2.2 The user shall limit (lockout) the maximum spindle speed not to exceed the maximum rpm of workholding system.

7.1.3 The chuck must be installed in accordance with manufacturer's recommendations to ensure the following:

(a) specified mounting bolts at recommended torque
(b) proper jaw travel
(c) balance within specifications
(d) maximum input force is not exceeded

7.1.4 Adequate guarding must protect the chuck and workpiece, when rotating.

7.1.5 The spindle shall never be run exceeding the maximum allowable chuck speed.

7.1.6 Jaws should not extend beyond the outside diameter of the chuck body.

7.1.7 Top jaws screws should be as specified with minimum thread engagement and torque to manufacturer's recommendation.

7.1.8 The chuck shall be disassembled, cleaned, inspected, and lubricated according to the manufacturer's maintenance schedule. The user shall

(a) verify jaw travel
(b) regularly inspect top jaws
(c) regularly inspect mounting hardware
(d) take remedial actions to comply with the instruction manual
(e) provide documented maintenance schedule to original manufacturer's specifications
(f) provide means of measuring static jaw clamping forces

7.2 Manual Chucks

7.2.1 An extension bar or hammer shall never be used on the chuck wrench.

7.2.2 The spindle should never be run without a part clamped in the chuck.

7.3 Power Chucks

The user shall

(a) position jaws to clamp the workpiece at midstroke of chuck
(b) validate the minimum jaw force and the maximum chuck speed before each application (using Mandatory Appendix I, paras. I-1 through I-5)
(c) check static jaw force periodically in accordance to manufacturer's maintenance schedule
(d) with loss of static jaw force, service chuck in accordance with manufacturer's recommendations

MANDATORY APPENDIX I
CALCULATION OF FORCE, TORQUE, AND SPEED

I-1 MAXIMUM DRAW-PULL

All chucks are limited to a maximum draw-pull ($F_{t_{max}}$) at the draw-tube (draw-bar) based on the sizes of the internal parts. The chuck manufacturer provides this value either in the technical features section of the catalog or it is inscribed on the chuck face. The draw-pull, in the case of drawing with a hydraulic cylinder, is the multiplication of the piston area (A) of the cylinder, the oil feed pressure (p), and the efficiency (η), which can be recognized as 0.95. In all cases forces will be expressed in kN (1 kN = 225 lbf).

$$F_t = A \times p \times 0.95$$

where

A = the piston area of the cylinder
F_t = maximum draw-pull
p = the pressure applied to the cylinder
0.95 = the efficiency factor of the cylinder

If we know the maximum draw-pull allowed and wish to solve this equation for p (the maximum pressure that can be applied to the cylinder), the formula then becomes

$$p = \frac{F_t}{A \times 0.95}$$

EXAMPLE: On a typical 210 mm, 3-jaw power chuck, the maximum draw-pull is 38 kN (8,550 lbf). The draw-pull is supplied by a cylinder with a 0.0138 m^2 (21.4 in.^{2}) piston area. If the equation for p (the maximum hydraulic pressure to apply) is solved, the formula becomes

$$p = \frac{F_t}{A \times 0.95} = \frac{38}{0.0138 \times 0.95} = 2{,}898 \text{ kPa (420 psi)}$$

$$1 \text{ psi} = 6.9 \text{ kPa}$$

$$1 \text{ kPa} = 1 \text{ kilopascal} = 1000 \text{ Pa} = \frac{1000 \text{ N}}{\text{m}^2}$$

A higher force at the draw-tube than the rated maximum shall never be applied. Excessive draw-pull can cause breakage of the internal parts of the chuck.

I-2 STATIC GRIPPING FORCE

A power chuck converts the axial stroke of the draw-tube to a radial stroke of the jaws by means of an inclined plane (wedge) system.

The wedge changes the draw-pull into a much greater gripping force by a factor of 2.5 to 3 times the draw-pull. This gripping force is applied to the workpiece, providing the necessary force to hold the workpiece securely and overcome the torque created by the cutting tools during the machining cycle. The maximum gripping force ($F_{s_{max}}$, which is the maximum gripping force a power chuck should apply to a workpiece) and the maximum draw force ($F_{t_{max}}$, which is the maximum draw-pull that should be applied to a power chuck) are contained in the technical features provided by the chuck manufacturer, or inscribed on the face of the power chuck. To calculate the static gripping force (F_{so}, which is the gripping force when the power chuck is gripping the workpiece without rotating) for each draw-pull (F_t, which is the varying levels of draw-pull applied to the power chuck), use constant, K, typical of every power chuck. The value of K can be calculated easily with the technical features in catalogs or on the face of the power chuck.

$$K = \frac{F_{s_{max}}}{F_{t_{max}}} = \frac{F_{so}}{F_t}$$

K = the constant representing the ratio of gripping force to draw-pull
$F_{s_{max}}$ = the maximum gripping force the chuck can apply
$F_{t_{max}}$ = the maximum draw-pull allowed for the chuck
F_{so} = any level of gripping force
F_t = the draw-pull necessary to create F_{so}

So each value of F_t (gripping force) corresponds to a value of F_{so} (draw-pull) according to the formula (where K is the constant calculated by the given values of maximum draw-pull and maximum gripping force):

$$F_{so} = F_t \times K$$

EXAMPLE: For a typical 210 mm, 3-jaw chuck, F_{so} (static gripping force) for $F_t = 30$ kN (6,750 lbf) will be determined. The assumed values from the technical features of this power chuck will be an $Fs_{\max}$ (maximum gripping force) of 110 kN and an $Ft_{\max}$ (maximum draw-pull) of 38 kN.

$$K = \frac{F_{s_{\max}}}{F_{t_{\max}}} = \frac{110 \text{ kN}}{38 \text{ kN}} \cong 3$$

$$F_{so} = 30 \text{ kN} \times 3 = 90 \text{ kN}$$

Once the constant K is known for each power chuck, solving the formula for any level of draw-pull becomes a simple task of multiplying the draw-pull by the constant K.

I-3 DYNAMIC GRIPPING FORCE AND CENTRIFUGAL FORCE

Power chucks are used on modern CNC lathes at high rotation speeds. When the power chuck rotates, all the parts that are not anchored radially, such as the master jaws, t-nuts, bolts, and top jaws, are subject to a centrifugal force, which decreases the gripping force on outside diameter clamping and increases it in inside diameter clamping.

For each speed there is a dynamic gripping force, F_{sd}, which is determined as follows:

$$F_{sd} = F_{so} - F_{ct}$$

where

F_{sd} = theoretical dynamic gripping force, kN
F_{so} = static gripping force, kN
F_{ct} = theoretical centrifugal force, kN

The theoretical centrifugal force is determined as

$$F_{ct} = M \times R \times \omega^2$$

where

F_{ct} = theoretical centrifugal force
M = mass of master jaws + jaw, t-nuts, and screws, kg
R = distance from axis of rotation to center of mass for M, m
ω = the angular velocity of the chuck, rad/sec

To complete the calculations it is necessary to determine the mass moment, $M \times R$, the two factors given above, as follows:

$$M \times R = (m_1 \times r_1 + m_2 \times r_2) \times Z$$

where

m_1 = mass of 1 master jaw with t-nuts and screws, kg
m_2 = mass of 1 gripping jaw, kg (hard jaw or soft jaw)
r_1 = radius of the center of gravity of m_1, m (the distance from the center of the chuck to approximately the middle of the master jaw in meters)
r_2 = radius of the center of gravity of m_2, m
Z = number of the chuck's jaws

The values for $m_1 \times r_1$ can generally be obtained from the chuck manufacturer. In this case we will take this value for a 210 mm 3-jaw chuck as 0.050 kg × *m*.

The values for $m_2 \times r_2$ are the mass and center of gravity radius of the top jaws only. These values are either provided by the chuck manufacturer or can be easily calculated by the user.

EXAMPLE: For a typical 210 mm, 3-jaw chuck, with standard soft top jaws in the most external position, but not outside of the external diameter, at 4,000 rpm, the calculation is as follows:

$$F_{ct} = M \times R \times \omega^2 = (m_1 \times r_1 + m_2 \times r_2) \times Z \times \omega^2$$

$$m_1 \times r_1 = 0.050 \text{ kg m (from manufacturer's data)}$$

$$m_2 \times r_2 = 0.72 \text{ kg} \times 0.060\ m = 0.043 \text{ kg m (calculated data)}$$

To solve our equation, it is necessary to determine the angular velocity of the chuck, our formula for this factor becomes

$$\omega = \frac{2\pi}{60} \times n = \frac{2 \times 3.14}{60} \times 4{,}000 = 419 \text{ rad/sec}$$

where n = rotational speed in rpm

Therefore, solving the equation for F_{ct}, the theoretical centrifugal force is calculated as

$$F_{ct} = (0.050 + 0.043) \times 3 \times 419^2 \cong 50 \text{ kN}$$

Measuring the internal performance of the power chuck, the effective centrifugal force (F_{ca}) measured experimentally is about 0.7 of the theoretical one; therefore

$$F_{ca} \approx F_{ct} \times 0.7$$

The effective dynamic gripping force (F_{sa}) is

$$F_{sa} = F_{so} - F_{ca}$$

This is the effective dynamic gripping force (F_{sa}) equals the static gripping force (F_{so}) minus the effective centrifugal force (F_{ca}).

EXAMPLE: Continuing the previous example, the effective or real centrifugal force can be calculated

$$F_{ca} \approx F_{ct} \times 0.7 = 50 \text{ kN} \times 0.7 = 35 \text{ kN}$$

And the effective dynamic gripping force (F_{sa}), the real gripping force after adjustment for centrifugal force, is

$$F_{sa} = F_{so} - F_{ca} = 110 \text{ kN} - 35 \text{ kN} = 75 \text{ kN}$$

Therefore, the true gripping force for this chuck at 4,000 rpm is 75 kN.

When using special jaws, which are heavier than standard jaws or in a more external position, it is necessary to calculate the F_{sa} (effective dynamic gripping force) and correspondingly reduce the rotation speed of the chuck.

I-4 DRIVING TORQUE (JAW/WORKPIECE INTERFACE)

To explain the concept of effective draw coupling (force), the effective dynamic gripping force (F_{sa}) as explained in para. I-3 must be addressed. The gripping force acts radially on the workpiece to create a coupling. This must be changed into effective draw force (F_{ra}), which acts tangentially on the workpiece, multiplying it by the coefficient of friction, μ_{sp}.

where
- F_{ra} = $F_{sa} \times \mu_{sp}$
- F_{ra} = effective draw force, or the torque transmitted to workpiece by the clamping jaws
- F_{sa} = effective dynamic gripping force of the jaws against the workpiece (calculated above)
- μ_{sp} = coefficient of friction for steel parts (see Table I-1)

TABLE I-1
COEFFICIENT OF FRICTION μ_{sp} FOR STEEL PARTS

Surface of Workpiece	Gripping Surface of Jaws		
	Smooth	Diamond Style	Serrated
Smooth machine finish ground	0.07	0.12	0.2
Rough to medium machined	0.1	0.2	0.35
Unmachined	0.15	0.3	0.45

GENERAL NOTE: Correction factors: Aluminum alloy = 0.95, Brass = 0.9, Gray cast iron = 0.8.

We have shown in Table I-1 the average values of the coefficient of friction μ_{sp} for the different types of jaws and surfaces of the workpiece.

For machining on lathes with a rotating piece it is necessary to consider the effective dynamic draw coupling (T_{da}) determined by multiplying the effective draw force (F_{ra}) by the clamping radius (b).

$$T_{da} = F_{ra} \times b$$

where
- b = clamping radius, m
- F_{ra} = effective draw force, N
- T_{da} = effective dynamic draw coupling, N/m

EXAMPLE: Clamping with a 210 mm, 3-jaw chuck, speed 4,000 rpm in a finishing operation with soft top jaws on machined work pieces (μ_{sp} = 0.1) with a clamping diameter of 160 mm (b = 0.08 m). The effective dynamic grip force, F_{sa}, was previously calculated above at 75 kN.

$$F_{ra} = F_{sa} \times \mu_{sp} = 75 \times 0.1 = 7.5 \text{ kN} = 7{,}500 \text{ N}$$

$$\begin{aligned} T_{da} &= F_{ra} \times b = 7{,}500 \times 0.08 \\ &= 600 \text{ N/m (effective dynamic draw coupling)} \end{aligned}$$

Once the draw coupling, T_{da}, has been calculated, it is necessary to determine the cutting coupling, T_z, generated by the contact of the tools with the workpiece. Verify that T_{da} is at least 2.5 times greater that T_z.

$$T_{da} \geq 2.5 \times T_z$$

I-5 MAXIMUM ROTATIONAL SPEED

The maximum rotational speed in revolutions/minute (rpm) is one of the main technical features of each power chuck. It is specified in all catalogs and engraved on the front of many power chucks.

The maximum speed is the one at which the power chuck loses two-thirds of maximum static clamping force due to the theoretical centrifugal force using standard hard top jaws in reversed position (high slot outwards) in an external position, but within the diameter of the power chuck.

To calculate the maximum rotational speed of a chuck, we must return to the formula for determining centrifugal force and in this case solve for *n*.

$$n_{\max} = \sqrt{\frac{2}{3} \times \frac{F_{s_{\max}}}{(m_1 \times r_1 + m_2 \times r_2) \times Z}} \times \frac{60}{2\pi}$$

where

$F_{s_{\max}}$ = maximum static gripping force, N

$m_1 \times r_1$ = mass moment of 1 master jaw, t-nuts and screws, kg m

$m_2 \times r_2$ = mass moment of 1 gripping jaw, kg m

MR = $(m_1 \times r_1 + m_2 \times r_2)$

$n_{\max}$ = maximum rpm

Z = number of jaws

EXAMPLE: A 210 mm, 2-jaw chuck with static gripping force F_{so} = maximum gripping force, $F_{s_{\max}}$ = 105 kN (105,000 N). The values of $m_1 \times r_1$ and $m_2 \times r_2$ are 0.050 and 0.043, respectively. These values were previously calculated. The maximum speed according to the ISO and DIN standards is calculated as follows:

$$n = \sqrt{\frac{2}{3} \times \frac{F_{s_{\max}}}{(m_1 \times r_1 + m_2 \times r_2) \times Z}} \times \frac{30}{\pi}$$

$$= \sqrt{\frac{2}{3} \times \frac{105{,}000}{(0.050 + 0.043) \times 3}} \times \frac{30}{3.14} = 4{,}900$$

Thus solving the equation for a maximum speed in this example of 4,900 rpm.

FORM 1 SAMPLE GRIP FORCE LOG SHEET

Date: ____________________ Machine ID: ____________________

Operator Name: ____________________ Workholding Device ID: ____________________

Test Frequency: ____________________ Top Tooling ID: ____________________

Hydraulic Cylinder Input Pressure: ____________________

Procedure: This procedure is the regular, scheduled checking of gripping force for this workholding device. Be sure to follow all safety guidelines.

(1) Mount testing top tooling (torque to specs).
(2) Adjust hydraulic cylinder input force to specs.
(3) Insert jaw force analyzer unit into the workholding device.
(4) Check that workholding device is in middle of stroke and properly gripping the jaw force analyzer unit.
(5) Check the jaw static gripping force and document results.
(6) Repeat steps above to ensure accurate readings as well as repeatability of test.

Date	Time	Operator Initials	Check #1	Check #2	Check #3

FORM 2 SAMPLE MAINTENANCE SCHEDULE SHEET

Date: ____________________ Machine ID: ____________________

Operator Name: ____________________ Workholding Device ID: ____________________

Lubrication Frequency: ____________________ Lubrication ID: ____________________

Lubrication Points: ____________________

Procedure: This procedure is the regular, scheduled lubrication of this workholding device. Be sure to follow all safety guidelines.

(1) Clean all grease zirks/fittings to eliminate possibility of contamination.
(2) Visually inspect the workholding device for signs of wear and/or damage.
(3) Lubricate all points as indicated; document amount of lubricant used.
(4) Actuate the workholding device.
(5) Document all points below.

Date	Time	Operator Initials	Lubrication Points	Notes

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