Dorian International Tool®

The First Choice™ Technology

SOLUTION Tool™

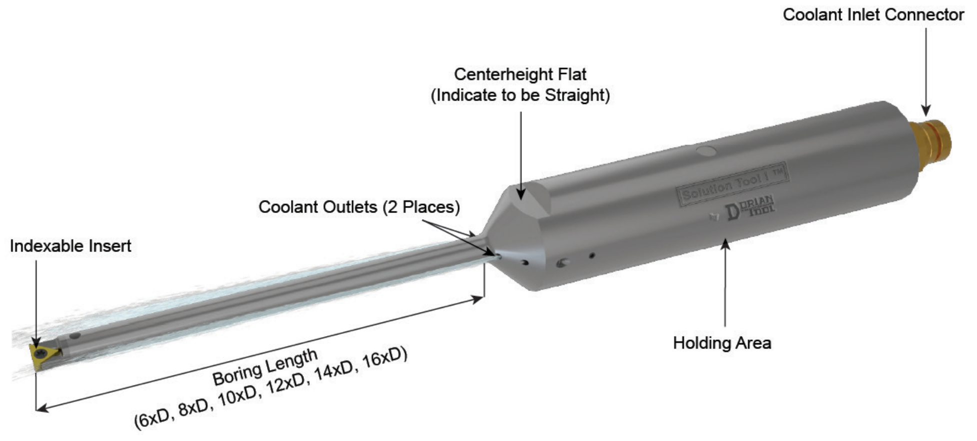
Makes Deep Hole Boring Simple!

Antivibration Boring and Threading Bars
Technical Support

Solution Tool!™

Re-Tunable Boring Bar

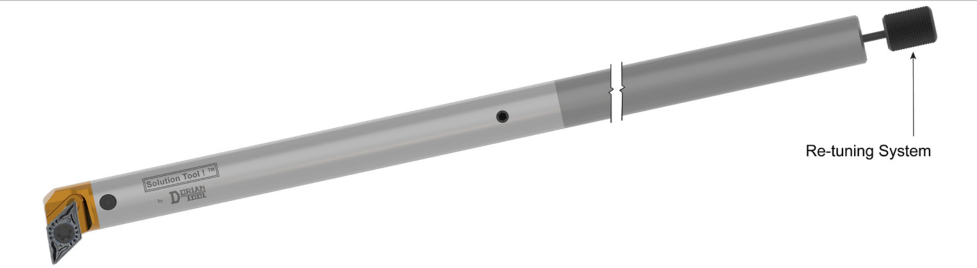
Makes Deep Hole Boring Simple!



Solution Tool!™
Miniature Bars

The NO! Vibration Re-Tunable Boring Bar
- Carbide Body
- For Small Boring Operation
- Multi Insert Geometry

- Inch and Metric Sizes
  Inch,1/4" Dia., 5/16" Dia.
  Metric, 6.00 mm, 8.00mm.
- Cutting Length
  6 x Dia., 8 x Dia., 10 x Dia., 12 x Dia., 14 x Dia., 16 x Dia



Solution Tool!™
Integral Bars

The NO! Vibration Re-Tunable Boring Bar
- Carbide Body
- For Small Boring Operation
- Multi Insert Geometry

16 x Dia.

- Inch and Metric Sizes
  Inch, 3/8"., 1/2" Dia., 5/8" Dia.
  Metric, 10mm, 12mm, 16mm.
- Cutting Length
  6 x Dia., 8 x Dia., 10 x Dia., 12 x Dia., 14 x Dia., 16 x Dia.

Solution Tool!™
Quick Change Bars

The NO! Vibration Re-Tunable Boring Bar
- Steel Body
- Carbide Body
- For Medium Boring Operation
- Quick Change Heads with Multi Insert Geometry
- Thru Coolant System

- Inch and Metric Sizes
  Inch, 3/4" Dia., 1" Dia., 1 1/4" Dia.
  Metric, 20mm, 25mm, 32mm.
- Cutting Length
  4 x Dia., 6 x Dia., 8 x Dia., 10 x Dia., 12 x Dia., 14 x Dia., 16 x Dia.

Solution Tool!™
Modular Jet-Stream™ Bars

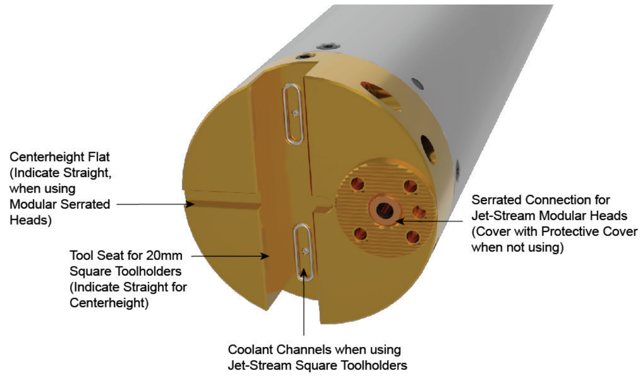
The NO! Vibration Re-Tunable Boring Bar
- Steel Body
- Carbide Body
- For Large Boring Operation
- Interchangeable Modular Heads with Multi Insert Geometry
- Jet-Stream Thru Coolant System

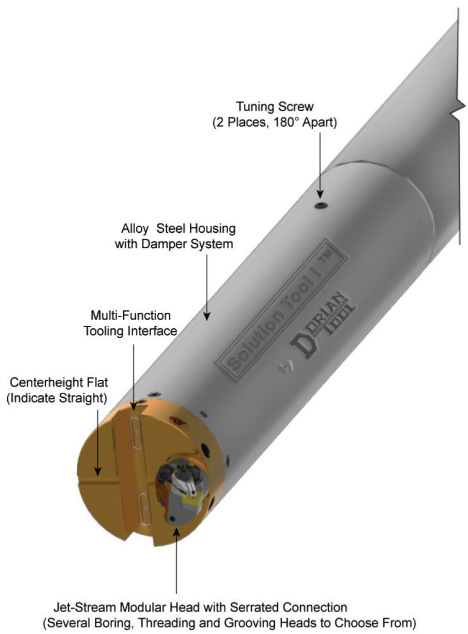
- Inch and Metric Sizes
  Inch, 1 1/2" Dia., 1 3/4" Dia., 2" Dia., 2 1/2" Dia. 3' Dia., 4' Dia., 5' Dia.
  Metric, 40mm, 50mm, 60mm, 80mm, 100mm, 120mm
- Cutting Length
  For detailed information, please refer to the tables on pages 27 to 37, which contain the boring length data for each bar.

The First Choice™ Technology

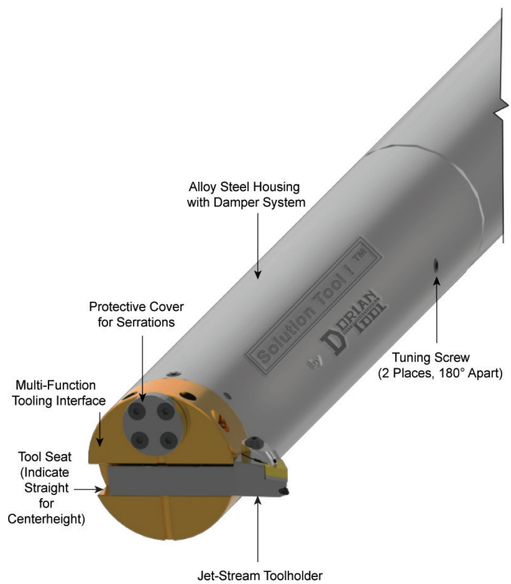
Solution Tool!™ Heavy Duty Jet-Stream™ Bars

Multi-Function Tooling Interface





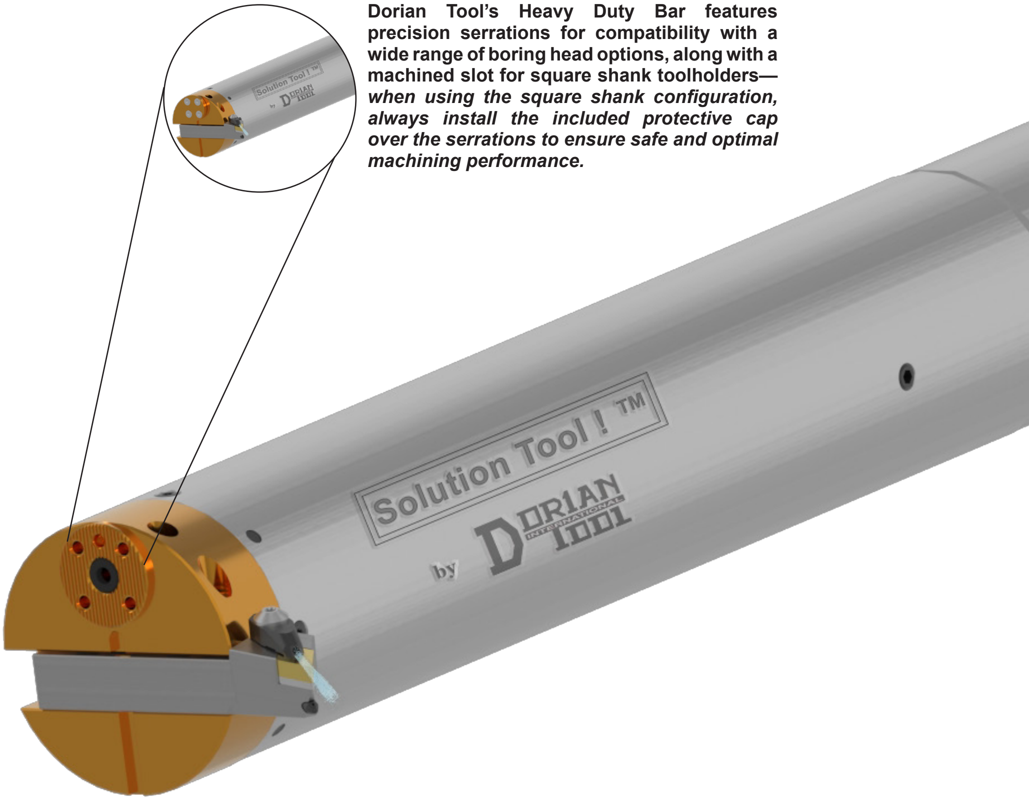
The serrated boring toolholder can be used for both right-hand and left-hand boring operations.



The square shank toolholder can be used for both right-hand and left-hand boring operations.

Heavy Duty Solution Tool!™

Dorian Tool's Heavy Duty Bar features precision serrations for compatibility with a wide range of boring head options, along with a machined slot for square shank toolholders—*when using the square shank configuration, always install the included protective cap over the serrations to ensure safe and optimal machining performance.*



Solution Tool!™

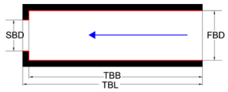
Heavy Duty Jet-Stream™ Bars

The NO! Vibration Re-Tunable Boring Bar

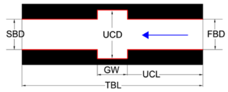
- Alloy Steel Body
- For Large Boring Operation
- Interchangeable Modular Heads with Multi Insert Geometry
- Jet-Stream Thru Coolant System
- Inch and Metric Sizes
  Inch, 6' Dia., 8' Dia., 10' Dia.
  Metric, 160mm, 200mm, 250mm
- Cutting Length
  8 x Dia., 10 x Dia., 12 x Dia.

The First Choice™ Technology

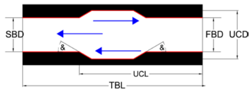
Technical Support for Deep Hole Boring



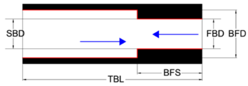
1. Straight Boring	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FBD	Finished Bore Diameter			
TBB	Total Blind Bore			
TBL	Total Bor E Length			



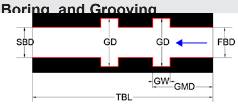
2. Straight Boring and Under-Cut	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FBD	Finished Bore Diameter			
TBL	Total Bore Length			
UCD	Under-Cut Diameter			
UCL	Under-Cut Distance			
GW	Groove Width			



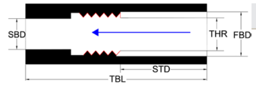
3. Straight Boring and Profiling	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FBD	Finished Bore Diameter			
TBL	Total Bore Length			
UCD	Under-Cut Diameter			
UCL	Under-Cut Distance			
&°	Angle Profile			



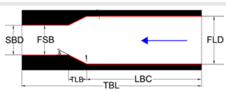
4. Straight Boring and Back Face	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FBD	Finished Bore Diameter			
TBL	Total Bore Length			
BFD	Back Face Diameter			
BFS	Back Face Shoulder			



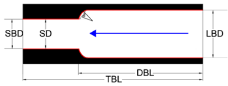
5. Straight Boring and Grooving	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FBD	Finished Bore Diameter			
TBL	Total Bore Length			
GD	Groove Diameter			
GW	Groove Width			
GMD	Groove Max. Distance			



6. Straigh	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FBD	Finished Bore Diameter			
TBL	Total Bore Length			
THR	Thread Specification			
STD	Starting Thread Deep			



7. Straigh	Boring Description	Material	Inch	Metric
SBD	Starting Bore Diameter			
FSB	Finished Small Diameter			
FLD	Finished Large Diameter			
TLB	Taping Bore Length			
LBC	Large Bore Length			
TBL	Total Bore Length			



8. Straigh ... bore	Boring Description	Material	Inch	Metric

Technical Support for Deep Hole Boring

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar		Recommended Boring Head		Recommended Insert	
Description	UPC No.	Description	UPC No.	Description	UPC No.

Recommended Boring Bar	Recommended Boring Head	Recommended Insert

Deep Hole Boring Application Form

When selecting a cutting tool & insert you must check the appropriate boxes and fax to 979-282-2951 or e-mail: sales@doriantool.com

Select Your Deep Hole Boring Operation:	
1. Straight Boring	
2. Straight & Under-Cut	
3. Straight & Profiling	
4. Straight Boring & Back Face	
5. Straight Boring & Grooving	
6. Straight Boring Groov-ing & Threading	
7. Straight Boring & Taper Bore	
8. Straight Boring with Ratio Shoulder small bore	

Select Your Material:	
P	Carbon & Alloy Steel
M	Stainless Steel
K	Cast Iron
N	Non Ferrous Materials
N	Aluminum
S	High Temp Super Alloy
H	Hardened Material

NOTES:

Company Name:

Contact Name:

Phone No: (   )

E-mail:

Deep Hole Boring Operation Set-Up

Workpiece Rigidity

1 Work-holding

Use the proper chuck and jaws to hold the work-piece, to assure that the part is held with maximum rigidity and stability under cutting force.

2 Steady Rest

When boring a long part, it is necessary to have extra support from the steady rest to eliminate any deflection of the part under the cutting force that causes vibration and poor surface finish.

Boring Bar Rigidity Overhang

3 Boring Bar Holding

For best results, hold the bar 4 x Dia. & choose a split collar boring bar holder. The 360° locking system offers the largest surface contact between the boring bar and the holder, maximizing bar rigidity and minimizing vibration.

4 Boring Bar Size

Choose a boring bar with the largest diameter to clear the bore, maximizing rigidity. Make sure to provide enough clearance between the bore and the bar for chip evacuation so damaging does not occur on the bore wall. Also choose the shortest overhang to reduce vibration.

Insert Parameter

5 Insert

To avoid and reduce vibration of the bar, that causes chattering. Use the insert with the as small of an angle geometry possible, small nose radius, high positive rake angle and sharp cutting edge.

6 Cutting Parameter

Use the recommended cutting data and parameter specified from the insert manufacturer, and use the cutting formula to maximize performance, quality, and tool life.

For a Roughing operation with a large depth of cut and a high feed rate, low RPM is recommended.

For a Finishing operation with a small depth of cut and a low feed rate, high RPM is recommended.

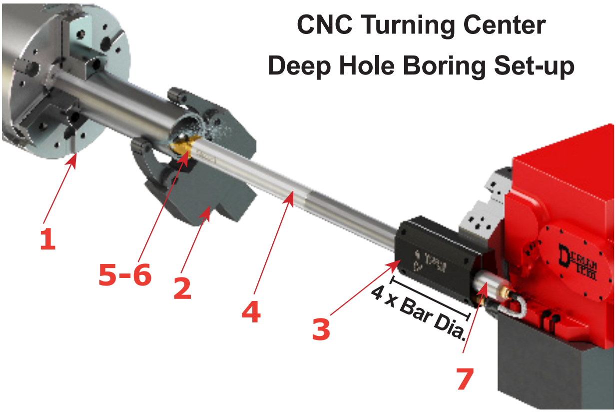
Minimum depth of cut is 1/2 of the insert radius.

Maximum feed rate is 1/2 of the insert radius.

Chip Clogging

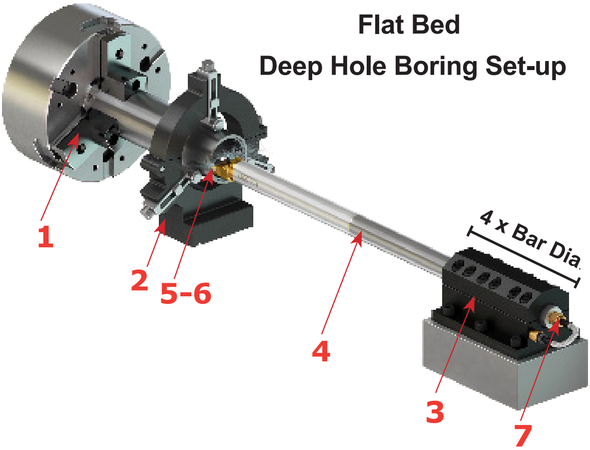
7 Coolant System

CNC Turning Center Deep Hole Boring Set-up



To Achieve Optimum Results for Deep Hole Boring
It is extremely important to follow steps 1-6.

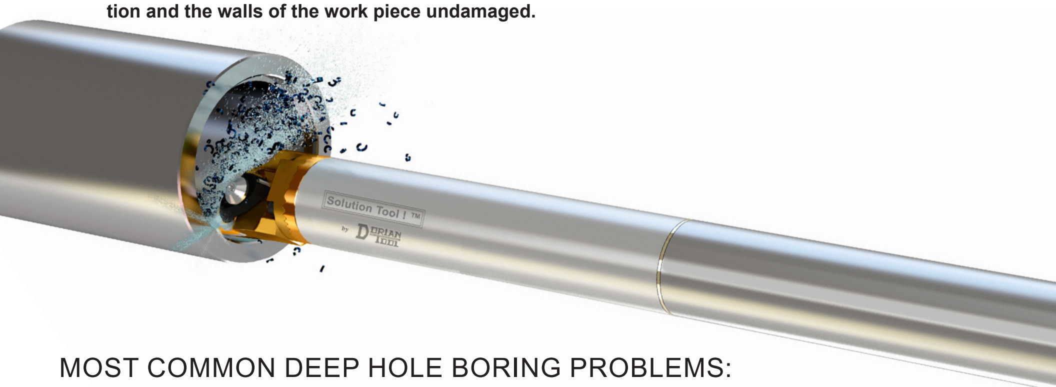
Flat Bed Deep Hole Boring Set-up



Deep Hole Boring Operation

IN A DEEP HOLE BORING OPERATION:

- **The diameter size of the boring bar is limited from the size of the hole diameter to be bored.**
- **The boring bar should have the largest diameter possible for maximum cutting rigidity, but small enough to clear the hole for chip evacuation.**
- **The Boring Bar has to be held with the maximum rigidity and the shortest overhang possible to maximize cutting stability and minimize vibration.**
- **The selection and use of the right insert grade, geometry, nose radius and rake angle will be critical for a good surface finish and close working tolerance.**
- **The cutting parameter is to be correct for the material machined in accordance of the insert manufacturing cutting data.**
- **The hole, while machined has to be kept clear from chips to avoid tool breakage, boring bar vibration and the walls of the work piece undamaged.**



MOST COMMON DEEP HOLE BORING PROBLEMS:

Poor Surface Finish, Poor Machining Tolerance & Poor Insert Life

MOST COMMON CAUSES:

1) Boring Bar Cutting Ratio:

If the incorrect boring bar cutting ratio is used, the boring bar will vibrate.

2) Boring Bar Diameter:

Too small boring bar diameter will deflect under pressure and vibrate, too large boring bar diameter, will obstruct the evacuation of the chips.

3) Boring Bar Holding System:

When boring bar is not held properly and rigidly in the boring bar holder, vibration will develop when cutting. A split Boring Bar Holder must to be used.

4) Boring Overhang:

When the boring bar is over extended it will vibrate (Steel bar 4 x Dia., Carbide bar 6 x Dia.,Solution Tool!™ (The NO! Vibration Re-Tunable Boring Bar) 8 - 14 x Dia.

5) Incorrect Insert:

Incorrect insert geometry, nose radius, rake angle, chip breaker, and clearance angle will cause vibrations.

6) Cutting Parameter:

When wrong cutting parameters are used for the specific material to be bored, and for the operation to be executed, the boring bar will not perform properly.

7) Chip Clogging:

When chips are clogged into the work piece bore, jamming the insert, wrapping around the boring bar, and thrown against the wall, the insert will be damaged.

The First Choice Technology

Bar Cutting Ratio Deep Hole Boring Solution:

Problem

Boring Bar Cutting Ratio: If the incorrect boring bar cutting ratio is used, the boring bar will not perform

Solution: Choose the correct boring bar cutting Ratio for optimum performance

Boring Depth: The depth of the machining bore determines on the style and the type material of the boring bar.

The general rule for boring bar depth is steel bar boring have a short depth, carbide bars have a medium depth, and anti vibration tunable boring bars have a long depth.

The Max. Boring Bar Overhangs: The maximum extended length of the boring bar before loss of rigidity and the start of vibration with poor cutting performance.

Boring Bar Overhangs: Is the distance measured from the face of the Boring Bar Holder to the Insert Cutting Edge.

Boring Bar Cutting Ratio: Maximum cutting length of the boring bar in relation to its own body diameter

Ex.: 1" (25mm) Boring Bar with 10 x Dia. Ratio, Maximum cutting length is 10" (250mm).

Threading Bar Cutting Ratio: When threading the radial force is higher then boring, the threading Ratio is reduced considerably over boring.

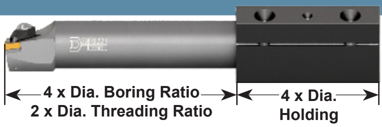
If the incorrect boring bar cutting ratio is used, the boring bar will not perform.

Maximum Boring Bar Performance

Steel Bar

4 x Dia. Boring Ratio
2 x Dia. Threading Ratio
2 x Dia. Grooving Ratio

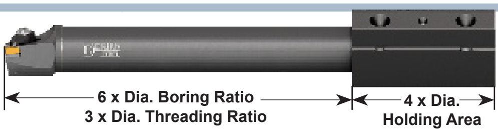
- General boring bar applications
- Roughing to finishing
- Stable for high material removal
- For small bores



Carbide Bar

6 x Dia. Boring Ratio
3 x Dia. Threading Ratio
3 x Dia. Grooving Ratio

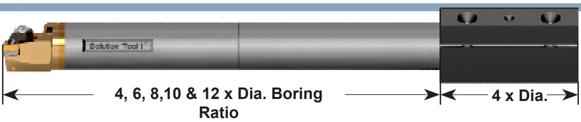
- Best for boring small holes
- Rigid for close tolerance and furnace finish
- Rigid for heavy material removal at high ap and fn

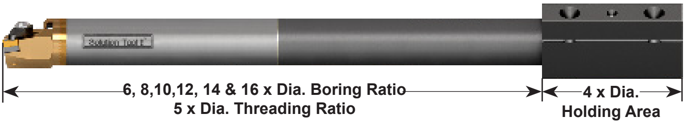


Steel Body (Solution Tool!™)

8 x Dia., 10 x Dia., 12 x Dia. Boring Ratio
4 x Dia., 6 x Dia., 10 x Dia. Threading Ratio
4 x Dia. Grooving Ratio

- For deep hole boring applications





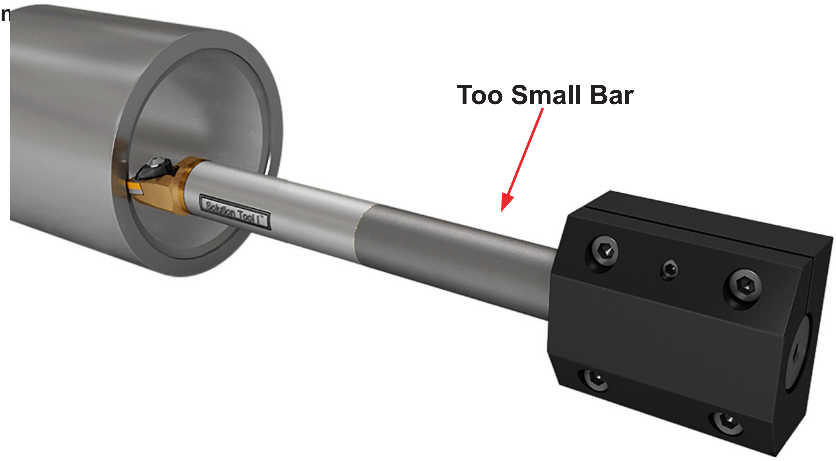
Bar Diameter Deep Hole Boring Solution:

Problem

Boring Bar Diameter: To small boring bar diameter will deflect under pressure and vibrate. To large boring bar diameter, will obstruct the evacuation of the chips.

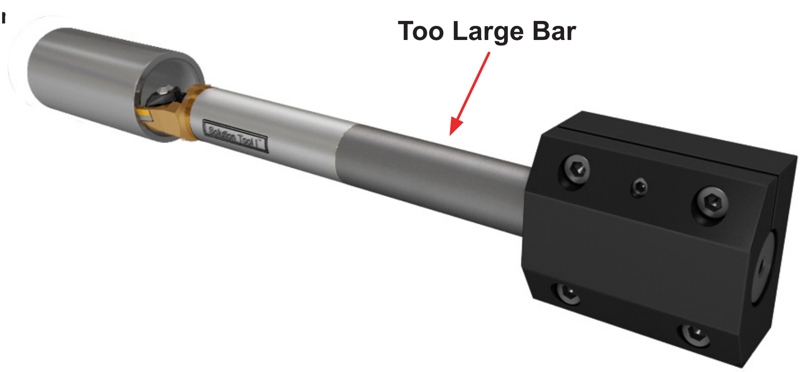
Solution: Use the largest boring bar for rigidity and performance, but small enough for the chips to evacuate

Small Boring Bar Diameter: If the diameter of the boring is to small, it has no rigidity to with-stand the
tangential and radial forces that generate under the cutting pressure. The bar will be easily pushed down below the center line, and deflect away from the cutting wall. When this
occurs, the boring bar is not any more in control of the boring operation to a point that the boring bar will vibrate with poor surface finish, poor machining tolerance, and short insert life. Use the largest borin



Large Boring Bar Diameter: If the diameter of the boring is to large, there will be no clearance between the bore diameter and the boring bar body, making impossible for the chips to evacuate. The chips will be jammed against the wall of the hole and the boring bar, damaging the work piece wall destroying the insert.

Use a sı



The First Choice Technology

Bar Holding System Deep Hole Boring Solution:

Problem

Boring Bar Holding System: When boring bar is not held properly and rigidly on to the boring bar holder, vibration will develop when cutting. A split boring bar holder must be used.

Solution:

When holding the boring bar, the boring bar holder must:

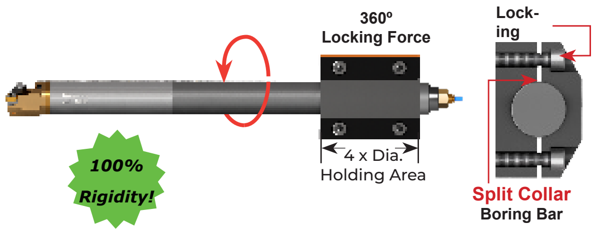
1. **Have a Precise and smooth bore**
2. **Use the most rigid holding system of the boring bar**
3. **Have a holding length of the boring bar at 4 x boring bar diameter**

BEST

Split Collar Holding System

Boring Bar Holding System

Locks the boring bar at 360º on the diameter, assuring the most rigidity and precise boring bar positioning *Without scarring or damaging the bar surface.*

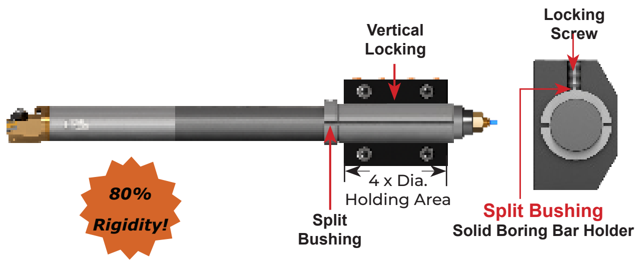


GOOD

Split Bushing Holding System

With a solid boring bar holder

The split bushing embraces the boring bar at 360º on the diameter. The screw will squeeze the bushing around
the boring bar *Without scarring or damaging the bar surface with precise positioning.*



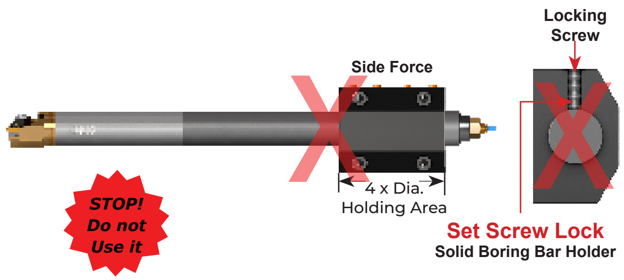
NOT GOOD

DO NOT USE IT

Set Screw Lock Holding System

Solid boring bar holder Without bushing

Never lock the screw over the boring bar. Locking a screw over the boring bar will create only one point of contact causing very poor rigidity. Additionally, the *screw will damage the boring bar surface and make posi-*



Bar Overhang and Deflection Deep Hole Boring Solution:

Problem

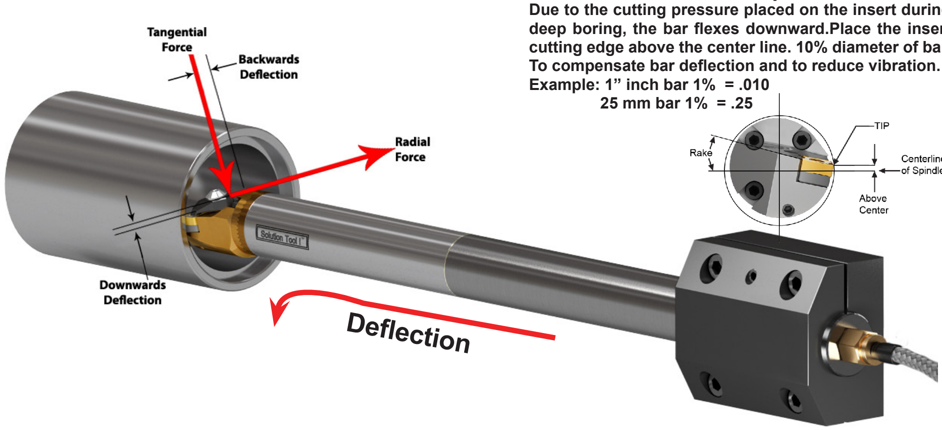
Boring Overhang: The boring bar is overextended, exceeding the overhang limit built for.
Boring Bar Deflection: The bar under the Cutting Pressure will deflect.

Overhang Solution: Use and set the boring bar to the correct overhang that is built for; Steel Boring bar 4 x Dia., Carbide 6 x Dia.
Solution Tool!™ NO! Vibration Re-Tunable Boring Bar Steel Body 8 x Dia.,10 x Dia., Carbide 12 x Dia., and 14 x Dia.

Deflection Solution: Place the insert cutting edge above the center line. 10% diameter of bar.
Example: 1" inch bar 1% = .010
25 mm bar 1% = .25

Insert Center Line Set-Up

Due to the cutting pressure placed on the insert during deep boring, the bar flexes downward.Place the insert cutting edge above the center line. 10% diameter of bar. To compensate bar deflection and to reduce vibration.
Example: 1" inch bar 1% = .010
25 mm bar 1% = .25



In the Boring Operation, the Boring Bar is to Withstand all the stress derived from the cutting force. In a long depth of cut, the stress is multiplied with a long overhang of the boring bar. The boring bar becomes unstable and very flexible under the cutting force.
When the Boring Bar is cutting, the Tangential and the Radial cutting force applied over the cutting edge of the insert will push the Boring Bar below the center line and away from the cutting wall. The Tangential Force generate under the cutting operation will increase with the depth of cut and feed rate in pushing the insert below the center line.

The insert clearance angle will be reduce, and the body of the insert will make contact with the cutting wall creating interference and friction with poor cutting results.
The Radial Force will push the insert away from the cutting surface creating a harmonic or weaving reaction.
The insert cutting edge, will be moving in and out from the cutting wall surface. The deflection of the boring bar is directly related to the overhang of the boring bar and the depth of cut and feed rate.
Use the shortest overhang boring bar possible to minimize deflection and maximize cutting performance.

Solution Tool! ™ Center line Set-up Values Chart (Inch)

Bar Size	Nominal	Insert Set-Up Above Center Line*			Depth of Cut	
Dia. (in.)	Center (in.)	Finish	Rough	Rough/ Finish	Finish-ing	Rough-ing
0.500	0.250	.005	.010	.0075	.001"	.020"
0.625	0.3125	.006	.012	.009	.001"	.030"
0.750	0.3750	.007	.014	.021	.001"	.050"
1.000	0.500	.010	.020	.015	.001"	.070"
1.250	0.625	.012	.024	.018	.001"	.075"
1.500	0.750	.015	.030	.0225	.002"	.080"
1.750	0.8750	.0175	.035	.026	.002"	.085"
2.000	1.000	.020	.040	.030	.002"	.090"
2.500	1.250	.025	.050	.0375	.002"	.095"
3.000	1.500	.030	.060	.045	.003"	.100"
4.000	2.000	.040	.080	.060	.003"	.120"

Solution Tool! ™ Center line Set-up Values Chart (Metric)

Bar Size	Nominal	Insert Set-Up Above Center Line*			Depth of Cut	
Dia. (mm)	Center (mm)	Finish	Rough	Rough/ Finish	Finish-ing	Rough-ing
12	6	.2	.4	.3	.025	.50
16	8	.25	.5	.375	.025	.75
20	10	.3	.6	.45	.025	1.2
25	12.5	.35	.7	.5	.025	1.7
32	16	.4	.8	.6	.025	1.8
40	20	.45	.9	.7	.050	2.0
N/A	N/A	N/A	N/A	N/A	N/A	N/A
50	25	.5	.10	.75	.050	2.1
60	30	.6	.12	.9	.050	2.3
80	40	.8	.16	.12	.075	2.5
100	50	1.0	2.0	1.5	.075	3.0

The above values can change depending on different aspects of machining.
For example a sharper insert will deflect less. Use table as reference only, as actual values may need to be adjusted as necessary.

Incorrect Insert Deep Hole Boring Solution:

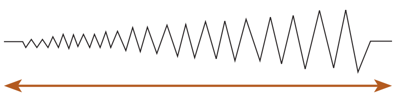
Problem

Use of Incorrect Insert: Incorrect insert grade and geometry for material or operation excited and/or any other insert characteristics of the insert, such as nose radius, rake angle, chip break clearance angle, and cutting leading angle, can contribute to the cutting problems.

Solution:

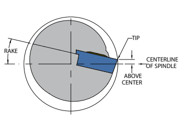
Use the correct insert grade, geometry and characteristics for the material to be machined and the operation to be executed.
For a Finishing operation and small depth of cut, use a wear resistant grade insert with a positive rake angle, small nose radius,sharp cutting edge, large chip break, and clearance angle. If the insert is too hard, it will chip and break under the cutting pressure, and vibration will develop. Switch to a softer grade.
For a Roughing operation and large depth of cut, use an impact resistant insert with a positive rake angle, medium to large nose radius, honed cutting edge, large chip break, and clearance angle. If the insert is too soft it will wear prematurely, and friction will develop losing tolerance and good surface finish, switch to a harder grade.
Minimum depth of cut is 1/2 of the insert radius. Maximum feed rate is 1/2 of the insert radius.
For a Deep Boring operation, always use a Solution Tool!™ boring bar with a high positive and sharp cutting edge insert.
Use the smallest insert angle geometry for the operation, like;
"V" for profiling and finishing
"D" for general application
"T" For light roughing and finishing
"C" For heavy roughing
Use the correct insert grade for the material and operation. Use a small angle geometry, like the "V","D" and "T" style insert, small nose radius, sharp cutting edge, high positive rake angle, large chip breaker and high clearance angle.

INSERT VIBRATION

FINISHING *		ROUGHING *
High RPM Small a_p Low f_n		Low RPM Large a_p High f_n

INSERT GEOMETRY	V 35°	D 55°	T 60°	C 80°
INSERT RADIUS Use a smaller radius to limit vibration	.004” 0.10 mm	.008” 0.20 mm	1/64” 0.40 mm	1/32” 0.79 mm
INSERT CUTTING RAKE Use a positive cutting rake to limit vibration.	High Positive (+)	Positive (+)	Neutral	Negative (-)
INSERT RELIEF ANGLE	D 15°	P 11°	C 7°	B 5°
INSERT EDGE PREP	Sharp F	Honed E	Chamfered T	Chamfered & Honed S
INSERT CUTTING EDGE ANGLE Use a cutting edge angle as close to 90º as possible.	3°	0°	15°	45°

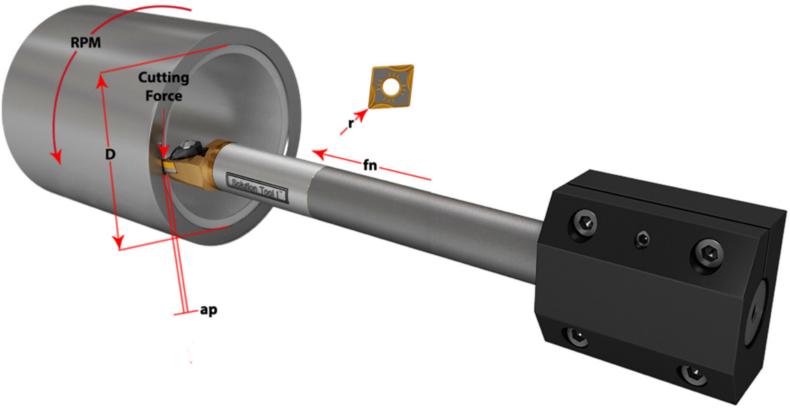
INSERT CENTER LINE
Insert Center Line, .002 to .025" [.050 to .635mm] above center line, to compensate for bar deflection and reduce vibration.



Cutting Parameter Deep Hole Boring Solution:

Problem

Cutting Parameter: If the cutting parameters are not correct for the specific material chattering and insert breakage will occur.



Inch Formulas for Turning and Boring

a_p= Depth of cut (DOC)	Inch	k_c= Specific cutting force	Lb/Inch^2
D_m= Diameter of part (DIA)	Inch	n= Spindle speed (RPM)	Rev/Min
f_n= Feed per revolution (FEED)	Inch/Rev	v_c= Cutting speed (SFM)	Feet/Min
l_m= Machined length (LEN)	Inch	T_c= Cutting time (TIM)	Min
Q= Metal removal rate (MMR)	Inch^3/ Min	R_{max}= Profile depth	µInch
P_c= Power requirements (POW)	Hp	r_ε= Insert nose radius	Inch

Cutting Speed Surface Feet Per Minute:

$$v_c = \frac{\pi \times D_m \times n}{12}$$

EX: Determine the cutting speed (v_c) required for turning a 2-1/2" diameter part with a spindle speed of 600 RPM.

$$v_c = \frac{\pi \times 2.5 \times 600}{12} = 392.70 \text{ Feet/Min}$$

Spindle Speed Revolution Per Minute:

$$n = \frac{V_c \times 12}{\pi \times D_m}$$

EX: Determine the spindle speed (n) required for turning a 2-1/2" diameter part with a cutting speed of 400 SFM.

$$n = \frac{400 \times 12}{\pi \times 2.5} = 611.15 \text{ Rev/Min}$$

Metal Removal Rate Inch^3/Min:

$$Q = v_c \times a_p \times f_n \times 12$$

EX: Determine the metal removal rate (Q) required for cutting with a depth of .062 with a cutting speed of 400 SFM and feed rate of .015 IPR.

Q = 400 x .062 x .015 x 12 = 4.464 inch³/min

Power Requirement Horsepower:

$$P_c = \frac{v_c \times a_p \times f_n \times k_c}{33{,}000}$$

EX: Determine the power requirement (P_c) for turning a material with a cutting force of 181,750, a depth of .062, a cutting speed of 400 SFM, and feed rate of .015 IPR.

$$P_c = \frac{400 \times .062 \times .015 \times 181{,}750}{33{,}000} = 2.05 \text{ HP}$$

Cutting Time Minute:

$$T_c = \frac{l_m}{f_n \times n}$$

EX: Determine the amount of time required to machine a 6" long part with a spindle speed of 600 RPM and feed rate of .015 IPR.

$$T_c = \frac{6}{.015 \times 600} = .67 \text{ Min (40 Sec)}$$

Profile Depth (µInch)

$$R_{max} = \frac{f_n^2 \times 10^6}{8 r_\varepsilon}$$

EX: Determine the profile depth (R_{max}) of a surface machined using an insert with a nose radius of .032 and a feed rate of .015 IPR.

$$R_{max} = \frac{.015^2 \times 10^6}{8 \times .032} = 879 \text{ µinch}$$

Metric Formulas for Turning and Boring

a_p= Depth of cut (DOC)	mm	k_c= Specific cutting force	Nm
D_m= Diameter of part (DIA)	mm	n= Spindle speed (RPM)	Rev/Min
f_n= Feed per revolution (FEED)	mm/Rev	v_c= Cutting speed (SFM)	m/Min
l_m= Machined length (LEN)	mm	T_c= Cutting time (TIM)	Min
Q= Metal removal rate (MMR)	mm^3/ Min	R_{max}= Profile depth	µm
P_c= Power requirements (POW)	kW	r_ε= Insert nose radius	mm

Cutting Speed Surface Meters Per Minute

$$v_c = \frac{\pi \times D_m \times n}{1000}$$

EX: Determine the cutting speed (v_c) required for turning a 50mm diameter part with a spindle speed of 600 RPM.

$$v_c = \frac{\pi \times 50 \times 600}{1000} = 94{,}25 \text{ m/Min}$$

Spindle Speed Revolution Per Minute

$$n = \frac{V_c \times 1000}{\pi \times D_m}$$

EX: Determine the spindle speed (n) required for turning a 32mm diameter part with a cutting speed of 100 m/Min.

$$n = \frac{100 \times 1000}{\pi \times 32} = 994{,}72 \text{ Rev/Min}$$

Metal Removal Rate mm^3/Min

$$Q = v_c \times a_p \times f_n \times 1000$$

EX: Determine the metal removal rate (Q) required for cutting with a depth of 1,5 with a cutting speed of 200 m/Min and feed rate of 0,4 mmPR.

Q = 200 x 1,5 x 0,4 x 1000 = 120.000 mm³/min

Power Requirement Kilowatts

$$P_c = \frac{v_c \times a_p \times f_n \times k_c}{1.460.000}$$

EX: Determine the power requirement (P_c) for turning a material with a specific cutting force of 20.500, a depth of 1,5, a cutting speed of 200 m/Min, and feed rate of 0,4 mmPR.

$$P_c = \frac{200 \times 1{,}5 \times 0{,}4 \times 20.500}{1.460.000} = 1{,}68 \text{ kW}$$

Cutting Time Minute

$$T_c = \frac{l_m}{f_n \times n}$$

EX: Determine the amount of time required to machine a 200mm long part with a spindle speed of 600 RPM and feed rate of 0,4 mmPR.

$$T_c = \frac{200}{0{,}4 \times 600} = {,}83 \text{ Min (50 Sec)}$$

Profile Depth (µm)

$$R_{max} = \frac{f_n^2 \times 10^6}{8 r_\varepsilon}$$

EX: Determine the profile depth (R_{max}) of a surface machined using an insert with a nose radius of 0,8 and a feed rate of 0,4 mmPR.

$$R_{max} = \frac{0{,}4^2 \times 10^6}{8 \times 0{,}8} = 25 \text{ µm}$$

Chip Clogging Deep Hole Boring Solution:

Problem

*** Chip Clogging: Chips are clogged into the work piece bore jamming the insert, wrapping around the boring bar, and thrown against the wall.**

- Insert Cutting Edge Chipping: Excessive load of chips will damage the cutting edge of the insert.

- Thermal Cracking: Temperature changes, intermittent machining and inconsistence to coolant supply will crack the insert.

Solution: Change the cutting length of the chips and use high pressure coolant or air to flush the chips out the bore.

Chip evacuation

Chip clogging during the boring operation creates a major machining problem effecting quality, performance and tooling life. Chips are to be removed from the bore as quickly as they are made to avoid and minimize the tooling insert damage, and poor surface finish. Evacuating chips from a bore is not always easy, and is more difficult when machining small diameters and deep bores. If the chips are very short and thick, a lot pressure is placed over the insert cutting edge making the boring bar vibrate. More tangential force is developed, requiring more horsepower (Kilowatts) for the boring operation.

In high speed rotation, the centrifugal force will push the chips against the wall surface making it difficult to remove out from the bore. It is more difficult when boring a small, blind, and deep hole. The chips will pack on the end of the bore. If chips are long and stringy they are easy to machine.

Little tangential force is developed requiring less horsepower (Kilowatts) for the boring operation, but the chips will wrap around the boring bar and jam the inside of bore, or to the end of the blind hole making it impossible to evacuate from the bore. When this occurs the operation must be stopped, and the chips have to be manually removed from the bore.

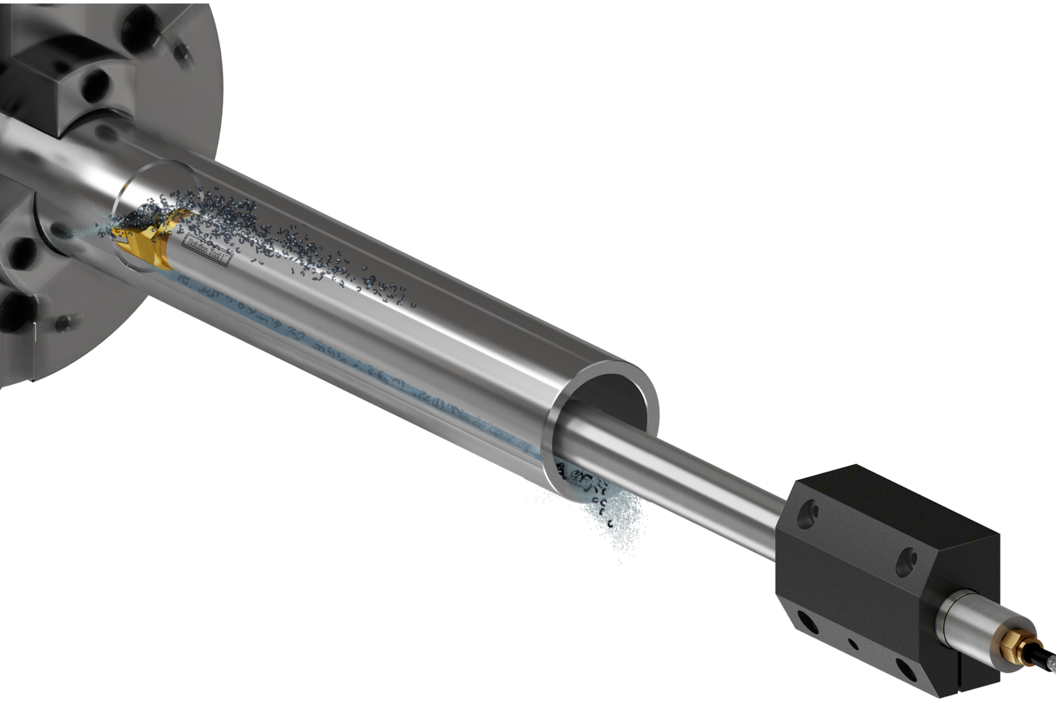
To control the chips from clogging and to evacuate them easily from the bore, the chips are to be cut the right length. Not too short to minimize insert damage and cutting force, not too long to prevent them from wrapping around the boring bar.

The insert rake angle and chip break, depth of cut, feed rate, and RPM will control the length of the chips.

High Pressure Coolant and or Air will remove chips from the bore.

Use a Thru Coolant Boring Bar.

It is best if a Dorian Jet Stream Thru Coolant Boring Bar combined with high pressure coolant system is used. The coolant is aimed directly over the cutting edge of the insert at a high velocity blowing the chips away from the insert and flushing them out the bore.



Solution Tool!™

Re-Tunable Boring Bar

To maximize performance, quality and to make deep hole boring simple!

EVERY Solution Tool!™ is retunable with it's own technology!

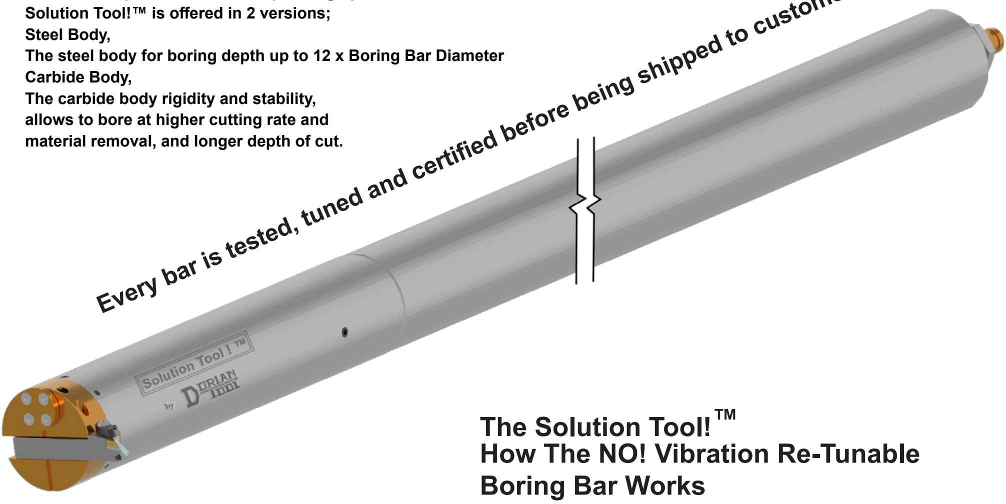
Solution Tool!™ The NO! Vibration Re-Tunable Boring Bar, *will suppress the natural vibration* of the boring bar body, developed when the insert comes in contact with the working piece in the cutting operation.

The internally tuned mechanical dampener system provides the optimum dynamic stability in deep hole boring operation, for a Better Machining Performance, Smooth Surface Finish, Precise Tolerance and Long Insert Life.

Solution Tool!™ The NO! Vibration Re-Tunable Boring Bar
will perform where no other types of boring bars,
steel or carbide will not perform!

To maximize performance in deep boring operation,
Solution Tool!™ is offered in 2 versions;
Steel Body,
The steel body for boring depth up to 12 x Boring Bar Diameter
Carbide Body,
The carbide body rigidity and stability,
allows to bore at higher cutting rate and
material removal, and longer depth of cut.

Every bar is tested, tuned and certified before being shipped to customers.



The Solution Tool!™ How The NO! Vibration Re-Tunable Boring Bar Works

The Solution Tool!™ The NO! Vibration Re-Tunable Boring Bar contains a mechanical floating dampener system dynamically tuned to suppress the natural boring bar vibration that generates machining chatters. The tuning process establishes the frequency rate per second of the boring bar.

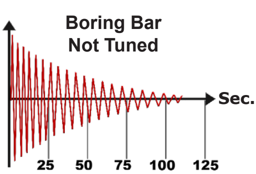
The mechanical dampener located inside the boring bar housing is moved forward or backward until all of the boring bar frequencies are nullified with zero vibration. At this point, the mechanical dampener is locked in position, restricting the longitudinal movement, but free to move in radial directions.

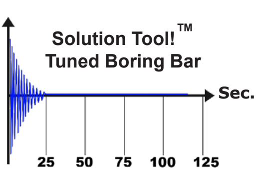
In essence, the energy in the Solution Tool!™ is absorbed by the mechanical dampener, and not released to the boring bar in form of vibrations that causes the chatters in the boring operation.

The Solution Tool!™ is dynamically tuned, tested and certified to meet Dorian Tool Quality control standards and performance and ready to be used.

Re-Turning The Solution Tool!™ can be-retuned on the machine to optimize the boring bar performance when;

- **Extreme and exotic materials change from very soft to very hard.**
- **Changing the boring depth. Ex: a boring bar with a 12 x Dia. boring Ratio will be used for a shorter boring Ratio like 6 x Dia.**
- **Improving performance for specific machining operations such as finishing, roughing boring, threading, and grooving.**





The First Choice Technology