

Troubleshooting Guides	278
Weldon Flat Specs	280
Formulas	281
Definitions of Tool Coatings	282
SFM/RPM Conversion Charts	283
General Purpose Milling Guide - <i>fractional</i>	284
General Purpose Milling Guide - <i>metric</i>	285
High Performance Milling Guide - <i>fractional</i>	286
High Performance Milling Guide - <i>metric</i>	287
Aluminum High Performance Milling Guide	288
ARC High Performance Milling Guide	291
VHM High Performance Milling Guide - <i>fractional</i>	292
VHM High Performance Milling Guide - <i>metric</i>	293
VRX High Performance Milling Guide - <i>fractional</i>	294
VRX High Performance Milling Guide - <i>metric</i>	295
V4 High Speed Milling Guide - <i>fractional</i>	296
V4 High Speed Milling Guide - <i>metric</i>	297
V5 High Speed Milling Guide - <i>fractional</i>	298
V5 High Speed Milling Guide - <i>metric</i>	299
VRX-6 High Performance Milling Guide - <i>fractional</i>	300
VRX-6 High Performance Milling Guide - <i>metric</i>	301
VX-7 High Performance Milling Guide - <i>fractional</i>	302
VX-7 High Performance Milling Guide - <i>metric</i>	303
TMS/TMR High Performance Milling Guide - <i>fractional</i>	304
TMS/TMR High Performance Milling Guide - <i>metric</i>	305
TMS/TMR Chip Thinning Calculations - <i>fractional</i>	306
TMS/TMR Chip Thinning Calculations - <i>metric</i>	307
High Rc Finisher Milling Guide - <i>fractional</i>	308
High Rc Finisher Milling Guide - <i>metric</i>	309
Die Mold Cutter Milling Guide - <i>fractional</i>	310
Die Mold Cutter Milling Guide - <i>metric</i>	311
High Feed Milling Guide	312
Diamond Coated Milling Guide	313
Reaming Guide - <i>fractional</i>	314
Reaming Guide - <i>metric</i>	315
Drill Mills, Chamfering Milling Guide - <i>fractional</i>	316
Drill Mills, Chamfering Milling Guide - <i>metric</i>	317
Drill Mills, Through Hole Drilling Guide - <i>fractional</i>	318
Drill Mills, Through Hole Drilling Guide - <i>metric</i>	319
General Purpose Drilling Guide Bright Finish - <i>fractional</i>	320
General Purpose Drilling Guide Bright Finish - <i>metric</i>	322
General Purpose Drilling Guide Coated - <i>fractional</i>	324
General Purpose Drilling Guide Coated - <i>metric</i>	326
Mini Drills High Performance Drilling Guide - <i>fractional</i>	328
Mini Drills High Performance Drilling Guide - <i>metric</i>	329
HTD 12 High Performance Drilling Guide - <i>fractional</i>	330
HTD 12 High Performance Drilling Guide - <i>metric</i>	331
High Performance Drilling Guide - <i>fractional</i>	332
High Performance Drilling Guide - <i>metric</i>	333
3-Flute for Aluminum High Performance Drilling Guide	334
Parameters for Burrs	335
Material Hardness Conversion Chart	336
Decimal Equivalent Chart	337

# Troubleshooting for Drills

PROBLEM	SUGGESTIONS
Chipping on point	Reduce feed rate
	Check part rigidity
	Constant feed rate
	Verify speeds and feeds
	Minimum drill overhang
	Reduce number of peck cycles
Chipping on O.D.	Reduce feed rate
	Confirm concentricity of drill in holder
	Check coolant flow and location
	Check part rigidity
Breakage	Reduce feed rate
	Check your program - is 'R' clearing the part
	Check coolant flow and location
	Check part rigidity
Heavy wear on corners	Increase feed rate
	Check coolant flow and location
	Confirm concentricity of drill in holder
	Check part rigidity
Long, stringy chips	Increase feed rate
	Increase hone relief
	Constant feed rate
	Increase number of peck cycles
Excessive noise	Check drill
	Check part rigidity
	Check for proper speeds and feeds
Tool life	Lower speeds and feeds
	Check coolant flow and location
	Confirm concentricity of drill in holder
	Confirm coolant concentration
Hole too small	Increase feed rate
	Confirm coolant concentration
	Confirm drill diameter
Hole too large	Reduce feed rate
	Slow feed rate to start hole
	Increase RPMs
	Spot hole
Chip welding	Increase RPMs by 20%
	Confirm coolant concentration
	Check coolant flow and location
Chip packing	Add a peck cycle to clear chips
	Increase RPMs
	Reduce feed rate
	Check coolant flow and location

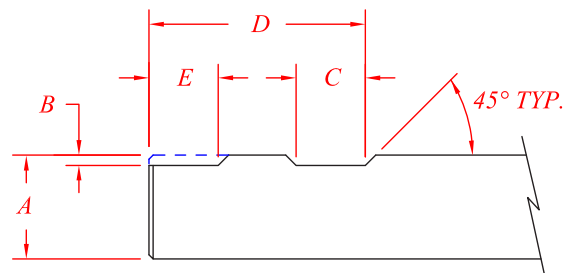
PROBLEM	SUGGESTIONS
Chipping	Check part rigidity
	Verify speeds and feeds
	Confirm concentricity of end mill in holder
	Decrease ramp angle or slow down approach
	Check coolant flow and location
Breakage	Decrease feed rate
	Decrease axial depth
	Use shorter tool or stub holder
	Resharpen earlier
Chattering	Too light of a cut
	Leave more stock for finish pass
	Decrease axial depth
	Adjust speeds and feeds
Part finish	Confirm concentricity of end mill in holder
	Decrease feed rate
	Use different style of end mill
	Check coolant flow and location
	Check part rigidity
Burr	Change end mill sooner / too much wear
	Verify speeds and feeds
	Increase spindle speed
	Decrease feed rate
	Use different style of end mill
Excessive noise	Check part rigidity
	Verify speeds and feeds
	Too light of a cut
	Confirm concentricity of end mill in holder
Tool life	Work material harder than expected
	Verify speeds and feeds
	Recutting chips
	Too light of a cut
	Use different style of end mill
Wear	Speed too fast
	Too light of a feed
	Confirm concentricity of end mill in holder
	Verify speeds and feeds
Chip welding	Verify speeds and feeds
	Check coolant flow and location
	Use different style of end mill
Chip packing	Check coolant flow and location
	Decrease axial depth
	Adjust speeds and feeds
	Use different style of end mill
Wall not straight	Decrease feed rate
	Decrease axial depth
	Use shorter tool or stub holder
	Use different style of end mill

# Troubleshooting for Reamers

PROBLEM	SUGGESTIONS
Hole diameter too large	Check part rigidity
	Verify speeds and feeds
	Confirm concentricity of reamer in holder
	Confirm diameter of reamer
	Check coolant flow and location
Hole diameter too small	Leave more stock before reaming
	Reamer worn
	Check coolant flow and concentration
	Resharpen earlier
Hole not straight	Hole was not drilled properly
	Leave more stock before reaming
	Confirm concentricity of reamer in holder
	Check part rigidity
Part finish	Reamer worn
	Verify speeds and feeds
	Confirm concentricity of reamer in holder
	Check coolant flow and location
	Check part rigidity
Tool life	Work material harder than expected
	Verify speeds and feeds
	Not evacuating chips properly
	Too light of a cut
Wear	Speed too fast
	Too light of a feed
	Confirm concentricity of reamer in holder
	Check coolant flow, location, and concentration
Not evacuating	Verify speeds and feeds
	Check coolant flow, location, and concentration
	Reamer worn

## Weldon Flat Specs

STANDARD WELDON SHANK DIMENSIONS					
Diameter (A)	B	C	D	E	
3/8"	.3750"	.050" - .065"	.280" - .282"	.921"	-
7/16"	.4375"	.050" - .065"	.312" - .314"	.991"	-
1/2"	.5000"	.060" - .075"	.330" - .332"	1.055"	-
9/16"	.5625"	.065" - .080"	.400" - .402"	1.154"	-
5/8"	.6250"	.065" - .080"	.400" - .402"	1.154"	-
3/4"	.7500"	.075" - .090"	.455" - .457"	1.242"	-
7/8"	.8750"	.065" - .080"	.455" - .457"	1.242"	.500"
1"	1.0000"	.075" - .090"	.515" - .517"	1.398"	.500"
1-1/4"	1.2500"	.094" - .109"	.515" - .517"	1.398"	.500"



$$\text{SFM} = \frac{\pi \times \text{Diameter} \times \text{RPM}}{12}$$

$$\text{CPT} = \frac{\text{IPM}}{\text{RPM} \times \text{Number of Teeth}}$$

$$\text{RPM} = \frac{\text{SFM} \times 3.82}{\text{Diameter}}$$

$$\text{IPM} = \text{RPM} \times \text{Number of Teeth} \times \text{CPT}$$

## Chip Thinning Calculation:

$$\frac{.50 \left( \frac{\text{Diameter}}{\text{Radial Stepover}} \right)}{\sqrt{\left( \frac{\text{Diameter}}{\text{Radial Stepover}} \right) - 1}} \times \text{CPT}_{(\text{Actual})} = \text{CPT}_{(\text{Programmed})}$$

Example below:

$$\frac{.50 \left( \frac{0.50}{.015} \right)}{\sqrt{\left( \frac{0.50}{.015} \right) - 1}} = \frac{16.667}{5.6} = 2.93 \times .0015 = .0045$$

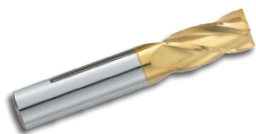
(Chip Thinning reference charts on pages 306-307)

For additional help:

Check out our web site, the MC-20 machinist calculator or, if you have a smartphone, search for the feedrate calculator from the App Store.

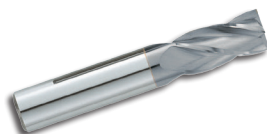
h6 TOLERANCE FOR SHRINK FIT HOLDERS (as taken from the Machinery's Handbook)		
SHANK DIAMETER		TOLERANCE
Decimal	Nominal	
≤ .1181"	≤ 3mm	-.00000" / -.00024"
> .1181" - .2362"	> 3mm - 6mm	-.00000" / -.00032"
> .2362" - .3937"	> 6mm - 10mm	-.00000" / -.00035"
> .3937" - .7087"	> 10mm - 18mm	-.00000" / -.00043"
> .7087" - 1.1811"	> 18mm - 30mm	-.00000" / -.00050"
> 1.1811"	> 30mm	-.00000" / -.00050"

# Definitions of Tool Coatings on GARR TOOL Standard Products



**TiN**  
(Titanium Nitride)

A general purpose coating, BALINIT® A has low heat resistance and good lubricity.



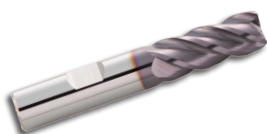
**TiCN**  
(Titanium Carbonitride)

With good abrasion resistance, BALINIT® B is recommended for aluminum, brass and bronze applications. It has low heat resistance and good lubricity.



**TiAlN**  
(Titanium Aluminum Nitride)

BALINIT® FUTURA is a multi-layer coating with good thermal stability for increased speeds and feeds. It is designed for semi-dry to dry cutting of most steels, high-nickel alloys, stainless steel and cast iron and has excellent heat resistance, good lubricity. It is useful in materials that are 40Rc and under.



**AlTiN**  
(Aluminum Titanium Nitride)

BALINIT® LATUMA is a single-layer coating whose hardness, oxidation resistance and thermal stability were optimized for material hardness above 38Rc as well as high-speed machining of materials that are difficult to work (titanium alloys, Inconel).



**ALUMASTAR®**  
(Titanium Diboride)

A thin film coating with a low affinity for aluminum, ALUMASTAR® is ideal for machining aluminum alloys. The resistance to adhesion of aluminum allows higher speeds or feeds. Its coating thickness is intentionally kept lower in order to maintain a sharp edge.



**CRYSTALLINE DIAMOND**  
(CVD)

Improved productivity in composites. Excellent choice for cutting graphite and fiberglass. Can be added to a special for milling or drilling applications.



**AlCrN**  
(Aluminum Chromium Nitride)

Aluminum Chromium-based coatings have excellent wear resistance, thermal shock stability, and hot hardness. BALINIT® ALNOVA is well suited for Titanium, Inconel, and carbon fiber.



**DURANA**  
(AlTiN-based with TiSiXN)

With a combination of AlTiN-based and TiSiXN layers, BALINIT® DURANA has a high degree of ductility and superior abrasive wear resistance even at extreme service temperatures, resulting in vastly improved performance during demanding machining operations and longer tool service life.



**ALTINOS**  
(AlTiN-based)

This premium AlTiN-based coating, BALIQ® ALTINOS is highly wear-resistant, even at high operating temperatures, making it particularly beneficial even up to HRC 56. With its perfectly smooth surface, this coating offers significant performance advantages such as optimum chip removal and reduced built-up edge formation.



**ALCRONOS**  
(AlCrN-based)

BALIQ® ALCRONOS, an AlCrN-based coating is considerably less prone to built-up edge formation. Its revolutionary smooth coating, with excellent adhesion to the substrate, ensures outstanding surfaces and high production quality, especially in ductile alloys like 300 series stainless and steels up to HRC 50.

# SFM (M/Min.) / RPM Conversion Charts

SFM	DIAMETER														
	.0625"	.0938"	.1250"	.1562"	.1875"	.2188"	.2500"	.3125"	.3750"	.4375"	.5000"	.6250"	.7500"	.8750"	1.000"
	1/16"	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"
	RPM														
50	3050	2040	1530	1220	1020	875	765	610	510	440	380	310	250	220	190
75	4580	3060	2290	1830	1530	1310	1150	920	760	570	570	460	380	330	285
100	6100	4080	3050	2450	2040	1750	1530	1220	1020	760	760	610	510	440	385
125	7630	5100	3820	3050	2550	2180	1920	1530	1270	950	950	770	630	550	475
150	9150	6120	4570	3670	3060	2620	2290	1830	1530	1140	1140	920	760	660	575
175	10,680	7140	5350	4270	3570	3060	2680	2140	1780	1330	1330	1080	880	770	665
200	12,200	8150	6100	4900	4070	3500	3100	2450	2000	1500	1500	1200	1000	875	750
300	18,500	12,200	9200	7300	6100	5250	4600	3700	3100	2300	2300	1800	1500	1300	1100
400	24,500	16,300	12,200	9800	8150	7000	6100	4900	4100	3050	3050	2450	2050	1750	1525
500	30,500	20,400	15,300	12,200	10,200	8700	7600	6100	5100	3800	3800	3100	2500	2200	1900
750	45,800	36,700	22,900	18,300	15,300	13,100	11,500	9200	7600	5700	5700	4600	3800	3770	2850
1000	-	40,800	30,600	24,500	20,400	17,500	15,300	12,200	10,200	7650	7650	6100	5100	4400	3800
1500	-	-	40,800	36,700	30,600	26,200	22,900	18,300	15,300	11,300	11,300	9200	7600	6500	5700
2000	-	-	-	49,000	40,800	35,000	30,600	24,400	20,400	15,300	15,300	12,200	10,200	8700	7600
3000	-	-	-	-	-	52,500	45,900	36,600	30,600	22,900	22,900	18,300	15,300	13,100	11,400
4000	-	-	-	-	-	-	-	48,800	40,800	30,600	30,600	24,400	20,400	17,500	15,200
5000	-	-	-	-	-	-	-	-	51,000	38,200	38,200	30,600	25,500	21,800	19,000

M/Min.	DIAMETER														
	.0394"	.0787"	.1181"	.1575"	.1969"	.2362"	.3150"	.3937"	.4724"	.5512"	.6299"	.7087"	.7874"	.8661"	.9843"
	1.0mm	2.0mm	3.0mm	4.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	14.0mm	16.0mm	18.0mm	20.0mm	22.0mm	25.0mm
	RPM														
15	4800	2400	1600	1200	960	800	600	480	400	340	300	265	240	220	190
22	7000	3500	2300	1750	1400	1170	875	700	585	500	440	390	350	320	280
30	10,000	4800	3200	2400	1900	1590	1200	955	800	685	600	530	480	440	380
38	12,100	6000	4000	3025	2420	2020	1515	1210	1000	870	760	670	600	550	485
45	14,300	7200	4800	3600	2870	2390	1790	1430	1200	1020	900	800	710	650	575
53	16,880	8440	5630	4220	3375	2815	2110	1690	1400	1200	1055	940	845	770	675
60	19,110	9550	6370	4780	3825	3185	2390	1910	1590	1365	1200	1060	955	870	765
90	28,770	14,350	9550	7165	5735	4780	3585	2870	2390	2050	1790	1590	1430	1300	1150
120	38,220	19,100	12,750	9550	7645	6370	4780	3820	3185	2730	2490	2120	1910	1740	1530
150	47,770	23,885	15,925	11,950	9550	7965	5970	4780	3980	3410	2990	2650	2390	2170	1900
230	-	36,625	24,400	18,315	14,650	12,210	9150	7325	6100	5230	4580	4070	3660	3330	2930
300	-	47,770	31,850	23,885	19,110	15,925	11,950	9550	7960	6825	5970	5300	4780	4340	3820
450	-	-	47,770	35,830	28,660	23,885	17,915	14,330	11,950	10,240	8960	7960	7170	6510	5730
600	-	-	-	47,770	38,220	31,850	23,885	19,100	15,920	13,650	12,000	10,600	9550	8685	7600
900	-	-	-	-	-	47,770	35,830	28,660	23,885	20,475	17,900	15,900	14,330	13,030	11,500
1200	-	-	-	-	-	-	47,770	38,210	31,850	27,300	23,885	21,230	19,100	17,370	15,300
1500	-	-	-	-	-	-	-	47,770	39,810	34,210	29,860	26,540	23,885	21,710	19,100



# GARR TOOL General Purpose Milling Guide

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)									
				1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
S	COBALT BASE ALLOYS												
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	60 - 90 50 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"	.0025" - .0035" .0015" - .0020"
	NICKEL BASE ALLOYS												
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	55 - 90 45 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"	.0025" - .0035" .0015" - .0020"
	IRON BASE ALLOYS												
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Asccolloy	< 40 > 40	55 - 90 50 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"	.0025" - .0035" .0015" - .0020"
	TITANIUM ALLOYS												
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		100 - 150	.0003" - .0008"	.0003" - .0008"	.0005" - .0012"	.0005" - .0012"	.0008" - .0015"	.0010" - .0015"	.0013" - .0020"	.0018" - .0025"	.0020" - .0030"	.0025" - .0035"
5553 / Beta Titanium		90 - 120	.0003" - .0008"	.0003" - .0008"	.0004" - .0010"	.0004" - .0010"	.0005" - .0012"	.0008" - .0014"	.0010" - .0016"	.0010" - .0020"	.0015" - .0025"	.0015" - .0025"	
M	STAINLESS STEELS												
	13/8, 15/5, 17-4, pH Types	< 40 > 40	100 - 150 80 - 100	.0002" - .0005" .0002" - .0004"	.0003" - .0006" .0002" - .0004"	.0003" - .0007" .0002" - .0006"	.0006" - .0009" .0003" - .0007"	.0008" - .0012" .0004" - .0008"	.0013" - .0018" .0007" - .0012"	.0010" - .0020" .0008" - .0015"	.0012" - .0025" .0010" - .0016"	.0012" - .0020" .0013" - .0017"	.0020" - .0028" .0015" - .0020"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	100 - 150 80 - 100	.0003" - .0006" .0002" - .0004"	.0003" - .0007" .0002" - .0005"	.0005" - .0010" .0004" - .0007"	.0008" - .0015" .0005" - .0010"	.0009" - .0013" .0005" - .0010"	.0010" - .0018" .0007" - .0010"	.0015" - .0020" .0009" - .0015"	.0018" - .0022" .0012" - .0018"	.0018" - .0035" .0015" - .0025"	.0023" - .0036" .0020" - .0030"
	400 Series - 403, 405, 420, 455	< 40 > 40	150 - 200 100 - 150	.0005" - .0008" .0003" - .0007"	.0007" - .0010" .0004" - .0008"	.0009" - .0015" .0006" - .0010"	.0009" - .0015" .0007" - .0011"	.0011" - .0015" .0008" - .0012"	.0013" - .0018" .0009" - .0015"	.0015" - .0025" .0012" - .0020"	.0020" - .0035" .0018" - .0030"	.0022" - .0040" .0020" - .0035"	.0030" - .0046" .0024" - .0042"
	HIGH STRENGTH TOOL STEELS												
A2, D2, P20, H13, S7, O1	< 40 > 40	150 - 200 100 - 150	.0003" - .0008" .0003" - .0005"	.0003" - .0008" .0003" - .0005"	.0005" - .0010" .0003" - .0008"	.0010" - .0015" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0014" - .0024" .0010" - .0015"	.0018" - .0026" .0012" - .0018"	.0020" - .0028" .0014" - .0020"	.0022" - .0030" .0015" - .0022"	
P	MEDIUM ALLOY TOOL STEELS												
	4140, 4340, 52100, 6150, 8620	< 40 > 40	150 - 200 100 - 150	.0003" - .0008" .0003" - .0005"	.0003" - .0008" .0003" - .0005"	.0005" - .0010" .0003" - .0008"	.0010" - .0015" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0014" - .0024" .0010" - .0015"	.0018" - .0026" .0012" - .0018"	.0020" - .0028" .0014" - .0020"	.0022" - .0030" .0015" - .0022"
	CARBON STEELS												
1000's - 1018, 1020, 12L14	< 40	150 - 200	.0003" - .0008"	.0003" - .0008"	.0005" - .0010"	.0010" - .0015"	.0012" - .0020"	.0012" - .0020"	.0014" - .0024"	.0018" - .0026"	.0020" - .0028"	.0022" - .0030"	
K	CAST MATERIAL												
	Ductile Iron		175 - 225	.0005" - .0008"	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"	.0045" - .0055"
	Gray Iron		175 - 225	.0005" - .0008"	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"	.0045" - .0055"
N	NON-FERROUS												
	Aluminum		300 - 500	.0003" - .0005"	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	.0068" - .0090"
	Magnesium		300 - 500	.0003" - .0005"	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	.0068" - .0090"
	Copper		250 - 450	.0003" - .0005"	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	.0068" - .0090"
	Brass, Bronze		200 - 400	.0003" - .0005"	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	.0068" - .0090"
O	COMPOSITE (non-ISO)												
	Fiberglass, Plastics, G10		200 - 400	.0003" - .0005"	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	.0068" - .0090"
	Graphite	(See Graphite Chart - page 313)											

When plunging into a solid, drop feed by approximately 50%. 20% of diameter for basic engagement parameters.

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**



# GARR TOOL General Purpose Milling Guide

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)									
				1.5mm	3.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm
S	COBALT BASE ALLOYS												
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	24 - 35 20 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051	.064 - .089 .038 - .051
	NICKEL BASE ALLOYS												
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	22 - 35 18 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051	.064 - .089 .038 - .051
	IRON BASE ALLOYS												
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascotloy	< 40 > 40	22 - 35 20 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051	.064 - .089 .038 - .051
	TITANIUM ALLOYS												
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		39 - 59	.008 - .020	.008 - .020	.013 - .030	.013 - .030	.020 - .038	.025 - .038	.033 - .051	.046 - .064	.051 - .076	.064 - .089
5553 / Beta Titanium		35 - 47	.008 - .020	.008 - .020	.010 - .025	.010 - .025	.013 - .030	.020 - .036	.025 - .041	.025 - .051	.038 - .064	.038 - .064	
M	STAINLESS STEELS												
	13/8, 15/5, 17-4, pH Types	< 40 > 40	39 - 59 31 - 39	.005 - .013 .005 - .010	.008 - .015 .005 - .010	.008 - .018 .005 - .015	.015 - .023 .008 - .018	.020 - .030 .010 - .020	.033 - .046 .018 - .030	.025 - .051 .020 - .038	.030 - .064 .025 - .041	.030 - .051 .033 - .043	.051 - .071 .038 - .051
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	39 - 59 31 - 39	.008 - .015 .005 - .010	.008 - .018 .005 - .013	.013 - .025 .010 - .018	.020 - .038 .013 - .025	.023 - .033 .013 - .025	.025 - .046 .018 - .025	.038 - .051 .023 - .038	.046 - .056 .030 - .046	.046 - .089 .038 - .064	.058 - .091 .051 - .076
	400 Series - 403, 405, 420, 455	< 40 > 40	59 - 79 39 - 59	.013 - .020 .008 - .018	.018 - .025 .010 - .020	.023 - .038 .015 - .025	.023 - .036 .018 - .028	.028 - .038 .020 - .030	.033 - .046 .023 - .038	.038 - .064 .030 - .051	.051 - .089 .046 - .076	.056 - .102 .051 - .089	.076 - .117 .061 - .107
	HIGH STRENGTH TOOL STEELS												
A2, D2, P20, H13, S7, O1	< 40 > 40	59 - 79 39 - 59	.008 - .020 .008 - .013	.008 - .020 .008 - .013	.013 - .025 .008 - .020	.025 - .038 .013 - .025	.030 - .051 .013 - .025	.030 - .051 .013 - .025	.036 - .061 .025 - .038	.046 - .066 .030 - .046	.051 - .071 .036 - .051	.056 - .076 .038 - .056	
P	MEDIUM ALLOY TOOL STEELS												
	4140, 4340, 52100, 6150, 8620	< 40 > 40	59 - 79 39 - 59	.008 - .020 .008 - .013	.008 - .020 .008 - .013	.013 - .025 .008 - .020	.025 - .038 .013 - .025	.030 - .051 .013 - .025	.030 - .051 .013 - .025	.036 - .061 .025 - .038	.046 - .066 .030 - .046	.051 - .071 .036 - .051	.056 - .076 .038 - .056
	CARBON STEELS												
1000's - 1018, 1020, 12L14	< 40	59 - 79	.008 - .020	.008 - .020	.013 - .025	.025 - .038	.030 - .051	.030 - .051	.036 - .061	.046 - .066	.051 - .071	.056 - .076	
K	CAST MATERIAL												
	Ductile Iron		69 - 89	.013 - .020	.020 - .031	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114	.114 - .140
	Gray Iron		69 - 89	.013 - .020	.020 - .031	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114	.114 - .140
N	NON-FERROUS												
	Aluminum		118 - 197	.008 - .013	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229
	Magnesium		118 - 197	.008 - .013	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229
	Copper		98 - 177	.008 - .013	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229
	Brass, Bronze		79 - 157	.008 - .013	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229
O	COMPOSITE (non-ISO)												
	Fiberglass, Plastics, G10		79 - 157	.008 - .013	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229
	Graphite	(See Graphite Chart - page 313)											

When plunging into a solid, drop feed by approximately 50%. 20% of diameter for basic engagement parameters.

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL High Performance Milling Guide for 246MA, 253MA, 255MA, 263MA

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)								
				1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
S	COBALT BASE ALLOYS											
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	70 - 110 50 - 90	.0008"- .0020" .0005"- .0015"	.0004"- .0010" .0004"- .0007"	.0007"- .0012" .0005"- .0011"	.0010"- .0018" .0008"- .0014"	.0010"- .0020" .0010"- .0017"	.0018"- .0028" .0015"- .0025"	.0023"- .0031" .0021"- .0028"	.0027"- .0034" .0024"- .0030"	.0029"- .0036" .0025"- .0031"
	NICKEL BASE ALLOYS											
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	65 - 110 55 - 90	.0005"- .0009" .0003"- .0008"	.0005"- .0009" .0004"- .0007"	.0007"- .0013" .0007"- .0012"	.0010"- .0017" .0009"- .0015"	.0010"- .0020" .0010"- .0018"	.0020"- .0028" .0015"- .0025"	.0025"- .0032" .0022"- .0030"	.0029"- .0036" .0026"- .0033"	.0030"- .0038" .0029"- .0035"
	IRON BASE ALLOYS											
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	65 - 110 55 - 90	.0005"- .0010" .0003"- .0008"	.0008"- .0010" .0004"- .0008"	.0006"- .0012" .0005"- .0010"	.0007"- .0015" .0006"- .0013"	.0011"- .0016" .0008"- .0014"	.0018"- .0026" .0013"- .0023"	.0025"- .0030" .0022"- .0028"	.0026"- .0034" .0025"- .0031"	.0032"- .0038" .0030"- .0035"
	TITANIUM ALLOYS											
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium		125 - 175  100 - 150	.0005"- .0010"  .0004"- .0010"	.0005"- .0012"  .0004"- .0010"	.0008"- .0015"  .0006"- .0014"	.0010"- .0022"  .0008"- .0017"	.0018"- .0027"  .0015"- .0025"	.0023"- .0032"  .0022"- .0028"	.0025"- .0033"  .0024"- .0030"	.0027"- .0035"  .0026"- .0032"	.0028"- .0037"  .0028"- .0035"
M	STAINLESS STEELS											
	13/8, 15/5, 17-4, PH Types	< 40 > 40	175 - 225 135 - 175	.0005"- .0007" .0002"- .0004"	.0004"- .0008" .0002"- .0006"	.0007"- .0010" .0003"- .0007"	.0008"- .0012" .0004"- .0008"	.0013"- .0018" .0007"- .0012"	.0010"- .0020" .0008"- .0015"	.0012"- .0025" .0010"- .0016"	.0012"- .0020" .0013"- .0017"	.0020"- .0028" .0015"- .0020"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	200 - 225 155 - 200	.0003"- .0007" .0002"- .0005"	.0005"- .0010" .0004"- .0007"	.0008"- .0015" .0005"- .0010"	.0009"- .0013" .0005"- .0010"	.0010"- .0018" .0007"- .0010"	.0015"- .0020" .0009"- .0015"	.0018"- .0022" .0012"- .0018"	.0018"- .0035" .0015"- .0025"	.0023"- .0036" .0020"- .0030"
	400 Series - 403, 405, 420, 455	< 40 > 40	200 - 225 150 - 200	.0007"- .0010" .0004"- .0008"	.0009"- .0015" .0006"- .0010"	.0009"- .0014" .0007"- .0011"	.0011"- .0015" .0008"- .0012"	.0013"- .0018" .0009"- .0015"	.0015"- .0025" .0012"- .0020"	.0020"- .0035" .0018"- .0030"	.0022"- .0040" .0020"- .0035"	.0030"- .0046" .0024"- .0042"
P	HIGH STRENGTH TOOL STEELS											
	A2, D2, P20, H13, S2, O1	< 40 > 40	225 - 325 150 - 225	.0005"- .0008" .0003"- .0005"	.0008"- .0015" .0005"- .0010"	.0015"- .0020" .0008"- .0012"	.0015"- .0023" .0010"- .0015"	.0015"- .0025" .0010"- .0018"	.0020"- .0030" .0015"- .0020"	.0020"- .0030" .0015"- .0020"	.0025"- .0035" .0018"- .0025"	.0030"- .0040" .0020"- .0030"
	MEDIUM ALLOY TOOL STEELS											
	4140, 4340, 52100, 6150, 8620	< 40 > 40	225 - 325 150 - 225	.0005"- .0008" .0003"- .0005"	.0008"- .0015" .0005"- .0010"	.0015"- .0020" .0008"- .0012"	.0015"- .0023" .0010"- .0015"	.0015"- .0025" .0010"- .0018"	.0020"- .0030" .0015"- .0020"	.0020"- .0030" .0015"- .0020"	.0025"- .0035" .0018"- .0025"	.0030"- .0040" .0020"- .0030"
K	CARBON STEELS											
	1000's - 1018, 1020, 12L14	< 40	225 - 325	.0005"- .0008"	.0008"- .0015"	.0015"- .0020"	.0015"- .0023"	.0015"- .0025"	.0020"- .0030"	.0020"- .0030"	.0025"- .0035"	.0030"- .0040"
	CAST MATERIAL											
K	Ductile Iron		225 - 325	.0010"- .0015"	.0015"- .0020"	.0020"- .0030"	.0025"- .0035"	.0025"- .0035"	.0030"- .0045"	.0040"- .0050"	.0040"- .0050"	.0050"- .0060"
	Gray Iron		300 - 400	.0015"- .0025"	.0020"- .0030"	.0025"- .0035"	.0030"- .0040"	.0030"- .0040"	.0040"- .0050"	.0050"- .0060"	.0060"- .0070"	.0060"- .0070"
N	NON-FERROUS											
	Aluminum		300 - 500	.0006"- .0010"	.0008"- .0014"	.0012"- .0020"	.0014"- .0028"	.0020"- .0030"	.0035"- .0048"	.0050"- .0060"	.0058"- .0070"	.0068"- .0090"
	Magnesium		300 - 500	.0006"- .0010"	.0008"- .0014"	.0012"- .0020"	.0014"- .0028"	.0020"- .0030"	.0035"- .0048"	.0050"- .0060"	.0058"- .0070"	.0068"- .0090"
	Copper		250 - 450	.0006"- .0010"	.0008"- .0014"	.0012"- .0020"	.0014"- .0028"	.0020"- .0030"	.0035"- .0048"	.0050"- .0060"	.0058"- .0070"	.0068"- .0090"
	Brass, Bronze		200 - 400	.0006"- .0010"	.0008"- .0014"	.0012"- .0020"	.0014"- .0028"	.0020"- .0030"	.0035"- .0048"	.0050"- .0060"	.0058"- .0070"	.0068"- .0090"
O	COMPOSITE (non-ISO)											
	Fiberglass, Plastics, G10		200 - 400	.0006"- .0010"	.0008"- .0014"	.0012"- .0020"	.0014"- .0028"	.0020"- .0030"	.0035"- .0048"	.0050"- .0060"	.0058"- .0070"	.0068"- .0090"
	Graphite	(See Graphite Chart - page 313)										

Beryllium added to any material adds hardness and some nickel content. If tool displays chatter, increase feed (IPM) up to 30% and reduce speed (RPM) by 10%.  
More detailed information is available on succeeding pages regarding the following materials: Aluminum, High Rockwell Steels, Graphite, and VRX end mills

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL High Performance Milling Guide

## for 846MA, 853MA, 855MA, 863MA

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)									
				3.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm	
S	COBALT BASE ALLOYS												
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	28 - 43 20 - 35	.020 - .051 .013 - .038	.010 - .025 .010 - .018	.018 - .030 .013 - .028	.025 - .046 .020 - .036	.025 - .051 .025 - .043	.046 - .071 .038 - .064	.058 - .079 .053 - .071	.069 - .086 .061 - .076	.074 - .091 .064 - .079	
	NICKEL BASE ALLOYS												
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	26 - 43 22 - 35	.013 - .023 .008 - .020	.013 - .023 .010 - .018	.018 - .033 .018 - .030	.025 - .041 .023 - .038	.025 - .051 .025 - .046	.051 - .071 .038 - .064	.064 - .081 .056 - .076	.074 - .091 .066 - .084	.076 - .097 .074 - .089	
	IRON BASE ALLOYS												
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolloy	< 40 > 40	26 - 43 22 - 35	.013 - .025 .008 - .020	.020 - .025 .010 - .020	.015 - .030 .013 - .025	.018 - .038 .015 - .033	.028 - .041 .020 - .036	.046 - .066 .033 - .058	.064 - .076 .056 - .071	.066 - .086 .064 - .079	.081 - .097 .076 - .089	
	TITANIUM ALLOYS												
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		49 - 69	.013 - .025	.013 - .030	.020 - .038	.025 - .056	.046 - .069	.058 - .081	.064 - .084	.069 - .089	.071 - .094		
5553 / Beta Titanium		39 - 59	.010 - .025	.010 - .025	.015 - .036	.020 - .041	.038 - .064	.056 - .071	.061 - .076	.066 - .081	.071 - .089		
M	STAINLESS STEELS												
	13/8, 15/5, 17-4, PH Types	< 40 > 40	69 - 89 53 - 69	.013 - .018 .005 - .010	.010 - .020 .005 - .015	.018 - .025 .007 - .018	.020 - .030 .010 - .020	.033 - .046 .018 - .030	.025 - .051 .020 - .038	.030 - .064 .025 - .041	.030 - .051 .033 - .043	.051 - .071 .038 - .051	
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	79 - 89 61 - 79	.008 - .018 .005 - .013	.013 - .025 .010 - .018	.020 - .038 .013 - .025	.023 - .033 .013 - .025	.025 - .046 .018 - .025	.038 - .051 .023 - .038	.046 - .056 .030 - .046	.046 - .089 .038 - .064	.058 - .091 .051 - .076	
	400 Series - 403, 405, 420, 455	< 40 > 40	79 - 89 59 - 79	.018 - .025 .010 - .020	.023 - .038 .015 - .025	.023 - .036 .018 - .028	.028 - .038 .020 - .030	.033 - .046 .023 - .038	.038 - .064 .030 - .051	.051 - .089 .046 - .076	.056 - .102 .051 - .089	.076 - .117 .061 - .107	
	HIGH STRENGTH TOOL STEELS												
A2, D2, P20, H13, S2, O1	< 40 > 40	89 - 128 59 - 89	.013 - .020 .008 - .013	.020 - .038 .013 - .025	.038 - .051 .020 - .030	.038 - .058 .025 - .038	.038 - .064 .025 - .046	.051 - .076 .038 - .051	.051 - .076 .038 - .051	.064 - .089 .046 - .064	.076 - .102 .051 - .076		
P	MEDIUM ALLOY TOOL STEELS												
	4140, 4340, 52100, 6150, 8620	< 40 > 40	89 - 128 59 - 89	.013 - .020 .008 - .013	.020 - .038 .013 - .025	.038 - .051 .020 - .030	.038 - .058 .025 - .038	.038 - .064 .025 - .046	.051 - .076 .038 - .051	.051 - .076 .038 - .051	.064 - .089 .046 - .064	.076 - .102 .051 - .076	
	CARBON STEELS												
1000's - 1018, 1020, 12L14	< 40	89 - 128	.013 - .020	.020 - .038	.038 - .051	.038 - .058	.038 - .064	.051 - .076	.051 - .076	.064 - .089	.076 - .102		
K	CAST MATERIAL												
	Ductile Iron		89 - 128	.025 - .038	.038 - .051	.051 - .076	.064 - .089	.064 - .089	.076 - .114	.102 - .127	.102 - .127	.127 - .152	
	Gray Iron		118 - 157	.038 - .064	.051 - .076	.064 - .089	.076 - .102	.076 - .102	.102 - .127	.127 - .152	.152 - .178	.152 - .178	
N	NON-FERROUS												
	Aluminum		118 - 197	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229	
	Magnesium		118 - 197	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229	
	Copper		98 - 177	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229	
	Brass, Bronze		79 - 157	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229	
O	COMPOSITE (non-ISO)												
	Fiberglass, Plastics, G10		79 - 157	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	.173 - .229	
	Graphite		(See Graphite Chart - page 313)										

Beryllium added to any material adds hardness and some nickel content. If tool displays chatter, increase feed (IPM) up to 30% and reduce speed (RPM) by 10%.  
More detailed information is available on succeeding pages regarding the following materials: Aluminum, High Rockwell Steels, Graphite, and VRX end mills

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for Aluminum (Machining Centers with Low-Range HP/Torque)

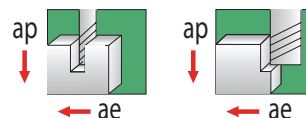
Series 242M/842M/A3 End Mills

**NOTES:** Spindle interface must be scrutinized when using 5/8" diameter and larger end mills

Diameter	SLOTTING		PROFILING
	Axial = .5xD	Axial = 1xD	Axial ≤ 1xD Radial ≤ .5xD
	SFM = 400 - 600	SFM = 300 - 450	SFM = 500 - 650
	CPT (Fz) = .5% - 1.5% of diameter	CPT (Fz) = .5% - 1% of diameter	CPT (Fz) = 1% - 2% of diameter
1/8"	.0006" - .0018"	.0006" - .0012"	.0012" - .0024"
3/16"	.0009" - .0028"	.0009" - .0018"	.0018" - .0036"
1/4"	.0013" - .0038"	.0013" - .0025"	.0025" - .0050"
5/16"	.0016" - .0047"	.0016" - .0031"	.0031" - .0062"
3/8"	.0019" - .0056"	.0019" - .0037"	.0037" - .0074"
1/2"	.0025" - .0075"	.0025" - .0050"	.0050" - .0100"
5/8"	.0031" - .0094"	.0031" - .0062"	.0062" - .0120"
3/4"	.0038" - .0110"	.0038" - .0075"	.0075" - .0150"
1"	.0050" - .0150"	.0050" - .0100"	.0100" - .0200"

Diameter	SLOTTING		PROFILING
	Axial = .5xD	Axial = 1xD	Axial ≤ 1xD Radial ≤ 0.5xD
	M/Min. = 125 - 180	M/Min. = 90 - 140	M/Min. = 150 - 200
	CPT (Fz) = .5% - 1.5% of diameter	CPT (Fz) = .5% - 1% of diameter	CPT (Fz) = 1% - 2% of diameter
3.0mm	.015 - .045	.015 - .030	.030 - .060
4.0mm	.020 - .060	.020 - .040	.040 - .080
6.0mm	.030 - .090	.030 - .060	.060 - .120
8.0mm	.040 - .120	.040 - .080	.080 - .160
10.0mm	.050 - .150	.050 - .100	.100 - .200
12.0mm	.060 - .180	.060 - .120	.120 - .240
16.0mm	.080 - .240	.080 - .160	.160 - .320
20.0mm	.100 - .300	.100 - .200	.200 - .400
25.0mm	.125 - .375	.125 - .250	.250 - .500

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1xD	up to 1xD
Radial (ae)	1xD	up to 50% of Dia.



**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for Aluminum (Machining Centers with Mid-Range HP/Torque)

Series 142M/143M/A3 End Mills

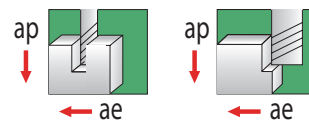
TECHNICAL

**NOTES:** In cases for tools with slower SFM (M/Min.), reference Series 242M/842M  
Spindle interface must be scrutinized when using 5/8" diameter and larger end mills

Diameter	SLOTTING		PROFILING
	Axial = .5xD	Axial = 1xD	Axial ≤ 1xD Radial ≤ .5xD
	SFM = 1500 - 2000	SFM = 750 - 1500	SFM = 1500 - 2000
	CPT (Fz) = 1.5% - 2.5% of diameter	CPT (Fz) = 1% - 2% of diameter	CPT (Fz) = 1.5% - 2.5% of diameter
1/8"	.0019" - .0031"	.0013" - .0025"	.0019" - .0031"
3/16"	.0028" - .0047"	.0018" - .0037"	.0028" - .0047"
1/4"	.0037" - .0062"	.0025" - .0050"	.0037" - .0062"
5/16"	.0052" - .0078"	.0031" - .0062"	.0052" - .0078"
3/8"	.0055" - .0094"	.0037" - .0074"	.0055" - .0094"
1/2"	.0075" - .0125"	.0050" - .0100"	.0075" - .0125"
5/8"	.0093" - .0156"	.0062" - .0125"	.0093" - .0156"
3/4"	.0112" - .0188"	.0075" - .0150"	.0112" - .0188"
1"	.0150" - .0250"	.0100" - .0200"	.0150" - .0250"

Diameter	SLOTTING		PROFILING
	Axial = .5xD	Axial = 1xD	Axial ≤ 1xD Radial ≤ 0.5xD
	M/Min. = 450 - 760	M/Min. = 225 - 450	M/Min. = 450 - 760
	CPT (Fz) = 1.5% - 2.5% of diameter	CPT (Fz) = 1% - 2% of diameter	CPT (Fz) = 1.5% - 2.5% of diameter
3.0mm	.045 - .075	.030 - .060	.045 - .075
4.0mm	.060 - .100	.040 - .080	.060 - .100
6.0mm	.090 - .150	.060 - .120	.090 - .150
8.0mm	.120 - .200	.080 - .160	.120 - .200
10.0mm	.150 - .250	.100 - .200	.150 - .250
12.0mm	.180 - .300	.120 - .240	.180 - .300
16.0mm	.240 - .400	.160 - .320	.240 - .400
20.0mm	.300 - .500	.200 - .400	.300 - .500
25.0mm	.375 - .625	.250 - .500	.375 - .625

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1xD	up to 1xD
Radial (ae)	1xD	up to 50% of Dia.



**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for Aluminum (Machining Centers with High-Range HP/Torque)

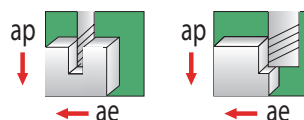
## Series A3 End Mills

**NOTES:** Contact your OEM for your machine's optimal running parameters  
CPT parameters shown are for 2xD LOC tooling and 2.5xD Reach Lengths  
Spindle interface must be scrutinized when using 5/8" diameter and larger end mills  
Preferred tool holders: Rego Fix powRgrip or Shrink Fit

Diameter	SLOTTING		PROFILING	FINISHING
	Axial = .5xD	Axial = 1xD	Axial = 2xD Radial = 30%-40%xD	Axial = Max LOC Radial = 2.5%xD
	SFM = Maximum RPM	SFM = Maximum RPM	SFM = Maximum RPM	SFM = up to 80% Max RPM
	CPT (Fz) = 1.5% - 3% of diameter	CPT (Fz) = 1% - 2% of diameter	CPT (Fz) = 2% - 3% of diameter	CPT (Fz) = 1% of diameter
3/16"	.0028" - .0056"	.0018" - .0037"	.0037" - .0056"	.0018"
1/4"	.0037" - .0074"	.0025" - .0050"	.0050" - .0075"	.0025"
5/16"	.0052" - .0104"	.0031" - .0062"	.0062" - .0094"	.0031"
3/8"	.0055" - .0110"	.0037" - .0074"	.0075" - .0112"	.0037"
1/2"	.0075" - .0150"	.0050" - .0100"	.0100" - .0150"	.0050"
5/8"	.0093" - .0186"	.0062" - .0125"	.0125" - .0187"	.0062"
3/4"	.0112" - .0224"	.0075" - .0150"	.0150" - .0225"	.0075"
1"	.0150" - .0300"	.0100" - .0200"	.0200" - .0300"	.0100"

Diameter	SLOTTING		PROFILING	FINISHING
	Axial = .5xD	Axial = 1xD	Axial = 2xD Radial = 30%-40%xD	Axial = Max LOC Radial = 2.5%xD
	M/Min. = Maximum RPM	M/Min. = Maximum RPM	M/Min. = Maximum RPM	M/Min. = up to 80% Max RPM
	CPT (Fz) = 1.5% - 3% of diameter	CPT (Fz) = 1% - 2% of diameter	CPT (Fz) = 2% - 3% of diameter	CPT (Fz) = 1% of diameter
4.0mm	.060 - .120	.040 - .080	.080 - .120	.040
6.0mm	.090 - .180	.060 - .120	.120 - .180	.060
8.0mm	.120 - .240	.080 - .160	.160 - .240	.080
10.0mm	.150 - .300	.100 - .200	.200 - .300	.100
12.0mm	.180 - .360	.120 - .240	.240 - .360	.120
16.0mm	.240 - .480	.160 - .320	.320 - .480	.160
20.0mm	.300 - .600	.200 - .400	.400 - .600	.200
25.0mm	.375 - .750	.250 - .500	.500 - .750	.250

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1xD	up to 2xD
Radial (ae)	1xD	up to 50% of Dia.



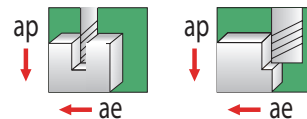
**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for ARC Series 3-Flute Rougher

	ISO Material	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)							
			3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
<b>S</b>	<b>TITANIUM ALLOYS</b>									
	Titanium: 6AL4V, CP	150 - 250	.0005" - .0008"	.0007" - .0010"	.0008" - .0013"	.0012" - .0018"	.0015" - .0023"	.0018" - .0028"	.0020" - .0035"	.0025" - .0045"
<b>N</b>	<b>NON-FERROUS</b>									
	Aluminum	700 - 1000	.0010" - .0020"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0030" - .0040"	.0040" - .0050"	.0050" - .0060"	.0060" - .0070"
	Copper, Brass, Bronze	300 - 500	.0008" - .0013"	.0012" - .0018"	.0015" - .0023"	.0018" - .0028"	.0020" - .0035"	.0025" - .0045"	.0030" - .0050"	.0040" - .0060"

	ISO Material	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)							
			4.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm
<b>S</b>	<b>TITANIUM ALLOYS</b>									
	Titanium: 6AL4V, CP	40 - 80	.010 - .020	.015 - .025	.020 - .035	.025 - .050	.035 - .055	.045 - .075	.050 - .090	.060 - .115
<b>N</b>	<b>NON-FERROUS</b>									
	Aluminum	200 - 350	.025 - .050	.040 - .065	.050 - .075	.060 - .090	.075 - .100	.100 - .125	.125 - .150	.150 - .180
	Copper, Brass, Bronze	80 - 150	.020 - .035	.025 - .050	.035 - .055	.045 - .075	.050 - .090	.060 - .115	.075 - .125	.100 - .150

	Slotting	Profiling
Axial (ap)	1xD	2xD
Radial (ae)	1xD	0.5xD



**ARC SERIES TOOLS ARE NOT DESIGNED FOR OVER 28Rc MATERIALS**

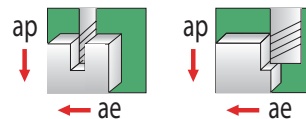
**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**



# GARR TOOL Milling Guide for VHM Series 4-Flute Rougher

ISO Material		SFM (Vc)	CHIPLOAD PER TOOTH (Fz)							
			3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
S	NICKEL BASE ALLOYS									
	High Temperature Alloys: Inconel 625/718, A286	100 - 175	.0007" - .0010"	.0008" - .0010"	.0010" - .0015"	.0010" - .0015"	.0010" - .0015"	.0012" - .0020"	.0015" - .0025"	.0015" - .0025"
	TITANIUM ALLOYS									
	Titanium: 6AL4V, CP	150 - 200	.0008" - .0010"	.0010" - .0015"	.0010" - .0020"	.0015" - .0020"	.0020" - .0030"	.0025" - .0030"	.0030" - .0035"	.0030" - .0040"
M	STAINLESS STEELS									
	Stainless Steel: 303	290 - 375	.0008" - .0010"	.0010" - .0015"	.0013" - .0020"	.0015" - .0020"	.0020" - .0030"	.0025" - .0035"	.0030" - .0040"	.0035" - .0045"
	Stainless Steel: 304, 316, 400 Series, Kovar, Invar	250 - 300	.0006" - .0010"	.0008" - .0015"	.0010" - .0020"	.0012" - .0020"	.0015" - .0020"	.0020" - .0025"	.0025" - .0030"	.0025" - .0035"
	Stainless Steel: 304L, 316L, 8620, 17/4, 15/5, 13/8, PH Mat'l	200 - 250	.0006" - .0008"	.0007" - .0010"	.0008" - .0010"	.0010" - .0015"	.0010" - .0020"	.0015" - .0025"	.0020" - .0030"	.0020" - .0030"
P	HIGH STRENGTH TOOL STEELS									
	High Strength Tool Steel: 4130, 4140, A2, D2, P20, H13	250 - 400	.0006" - .0008"	.0007" - .0010"	.0008" - .0010"	.0010" - .0015"	.0010" - .0020"	.0015" - .0025"	.0020" - .0030"	.0020" - .0030"
	CARBON STEELS									
	Carbon Steels: 1000 Series	275 - 425	.0006" - .0008"	.0008" - .0012"	.0010" - .0015"	.0010" - .0020"	.0015" - .0025"	.0020" - .0025"	.0020" - .0030"	.0025" - .0035"
K	CAST MATERIAL									
	Cast Iron	400 - 500	.0010" - .0020"	.0010" - .0020"	.0015" - .0020"	.0015" - .0025"	.0020" - .0035"	.0025" - .0035"	.0030" - .0040"	.0040" - .0050"

	Slotting	Profiling
Axial (ap)	0.5xD	2xD
Radial (ae)	1xD	0.2xD

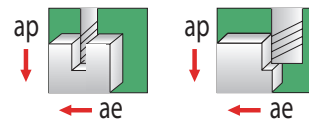


**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for VHM Series 4-Flute Rougher

ISO Material		M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)								
			4.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm
S	NICKEL BASE ALLOYS										
	High Temperature Alloys: Inconel 625/718, A286	30 - 55	.008 - .015	.018 - .025	.020 - .025	.025 - .038	.025 - .038	.025 - .038	.030 - .050	.038 - .063	.038 - .063
	TITANIUM ALLOYS										
	Titanium: 6AL4V, CP	45 - 60	.010 - .020	.020 - .025	.025 - .038	.025 - .050	.038 - .050	.050 - .076	.063 - .076	.076 - .089	.076 - .102
M	STAINLESS STEELS										
	Stainless Steel: 303	90 - 115	.010 - .020	.020 - .025	.025 - .038	.033 - .050	.038 - .050	.050 - .076	.063 - .089	.076 - .102	.089 - .114
	Stainless Steel: 304, 316, 400 Series, Kovar, Invar	75 - 90	.008 - .015	.015 - .025	.020 - .038	.025 - .050	.030 - .050	.038 - .050	.050 - .063	.063 - .076	.063 - .089
	Stainless Steel: 304L, 316L, 8620, 17/4, 15/5, 13/8, PH Mat'l	60 - 75	.008 - .015	.015 - .020	.018 - .025	.020 - .025	.025 - .038	.025 - .050	.038 - .063	.050 - .076	.050 - .076
P	HIGH STRENGTH TOOL STEELS										
	High Strength Tool Steel: 4130, 4140, A2, D2, P20, H13	75 - 125	.006 - .015	.015 - .020	.018 - .025	.020 - .025	.025 - .038	.025 - .050	.038 - .063	.050 - .076	.050 - .076
	CARBON STEELS										
	Carbon Steels: 1000 Series	85 - 130	.008 - .015	.015 - .020	.020 - .030	.025 - .038	.025 - .050	.038 - .063	.050 - .063	.050 - .076	.063 - .089
K	CAST MATERIAL										
	Cast Iron	125 - 150	.013 - .025	.025 - .050	.025 - .050	.038 - .050	.038 - .063	.050 - .089	.063 - .089	.076 - .102	.102 - .127

	Slotting	Profiling
Axial (ap)	0.5xD	2xD
Radial (ae)	1xD	0.2xD



**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

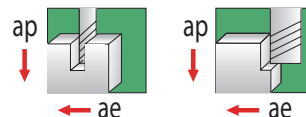
# GARR TOOL High Performance Milling Guide for VRX

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 5/8" DIAMETER AND LARGER END MILLS

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)										
				1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"	
S	COBALT BASE ALLOYS													
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	75 - 150 60 - 125	.0003" - .0006" .0003" - .0005"	.0004" - .0007" .0003" - .0006"	.0005" - .0008" .0004" - .0007"	.0007" - .0012" .0006" - .0010"	.0008" - .0015" .0007" - .0013"	.0010" - .0019" .0009" - .0017"	.0014" - .0024" .0012" - .0020"	.0016" - .0030" .0014" - .0026"	.0020" - .0038" .0018" - .0034"	.0028" - .0048" .0024" - .0040"	
	NICKEL BASE ALLOYS													
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	75 - 150 60 - 125	.0003" - .0006" .0003" - .0005"	.0004" - .0007" .0003" - .0006"	.0005" - .0008" .0004" - .0007"	.0007" - .0012" .0006" - .0010"	.0008" - .0015" .0007" - .0013"	.0010" - .0019" .0009" - .0017"	.0014" - .0024" .0012" - .0020"	.0016" - .0030" .0014" - .0026"	.0020" - .0038" .0018" - .0034"	.0028" - .0048" .0024" - .0040"	
	IRON BASE ALLOYS													
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	75 - 150 60 - 125	.0003" - .0006" .0003" - .0005"	.0004" - .0007" .0003" - .0006"	.0005" - .0008" .0004" - .0007"	.0007" - .0012" .0006" - .0010"	.0008" - .0015" .0007" - .0013"	.0010" - .0019" .0009" - .0017"	.0014" - .0024" .0012" - .0020"	.0016" - .0030" .0014" - .0026"	.0020" - .0038" .0018" - .0034"	.0028" - .0048" .0024" - .0040"	
	TITANIUM ALLOYS													
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		175 - 300	.0003" - .0006"	.0004" - .0007"	.0005" - .0008"	.0007" - .0014"	.0008" - .0017"	.0010" - .0021"	.0014" - .0028"	.0016" - .0034"	.0020" - .0042"	.0028" - .0056"	
	5553 / Beta Titanium		125 - 225	.0003" - .0006"	.0003" - .0007"	.0004" - .0008"	.0007" - .0012"	.0008" - .0015"	.0010" - .0019"	.0014" - .0024"	.0016" - .0030"	.0020" - .0038"	.0028" - .0048"	
	M	STAINLESS STEELS												
13/8, 15/5, 17-4, pH Types		< 40 > 40	175 - 300 150 - 225	.0003" - .0006" .0003" - .0005"	.0004" - .0007" .0003" - .0006"	.0005" - .0008" .0004" - .0007"	.0007" - .0012" .0006" - .0010"	.0008" - .0015" .0007" - .0013"	.0010" - .0019" .0009" - .0017"	.0014" - .0024" .0012" - .0020"	.0016" - .0030" .0014" - .0026"	.0020" - .0038" .0018" - .0034"	.0028" - .0048" .0022" - .0040"	
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic		< 40 > 40	200 - 325 175 - 250	.0003" - .0006" .0003" - .0005"	.0004" - .0007" .0003" - .0006"	.0005" - .0008" .0004" - .0007"	.0007" - .0012" .0006" - .0011"	.0008" - .0015" .0007" - .0014"	.0010" - .0019" .0009" - .0018"	.0014" - .0024" .0012" - .0022"	.0016" - .0030" .0014" - .0028"	.0020" - .0038" .0018" - .0036"	.0028" - .0048" .0024" - .0044"	
400 Series - 403, 405, 420, 455		< 40 > 40	225 - 350 175 - 250	.0003" - .0006" .0003" - .0005"	.0004" - .0007" .0003" - .0006"	.0005" - .0008" .0004" - .0007"	.0007" - .0013" .0006" - .0011"	.0008" - .0016" .0007" - .0014"	.0010" - .0020" .0009" - .0018"	.0014" - .0026" .0012" - .0022"	.0016" - .0032" .0014" - .0028"	.0024" - .0043" .0018" - .0036"	.0028" - .0052" .0024" - .0044"	
HIGH STRENGTH TOOL STEELS														
P	A2, D2, P20, H13, S7, O1	< 40 > 40	175 - 300 125 - 275	.0004" - .0007" .0003" - .0005"	.0005" - .0008" .0003" - .0005"	.0006" - .0010" .0005" - .0008"	.0008" - .0013" .0007" - .0010"	.0009" - .0016" .0008" - .0013"	.0011" - .0020" .0010" - .0017"	.0016" - .0026" .0014" - .0020"	.0018" - .0032" .0016" - .0026"	.0022" - .0040" .0020" - .0034"	.0032" - .0052" .0028" - .0040"	
	MEDIUM ALLOY TOOL STEELS													
	4140, 4340, 52100, 6150, 8620	< 40 > 40	250 - 400 225 - 300	.0004" - .0007" .0003" - .0005"	.0005" - .0008" .0003" - .0005"	.0006" - .0010" .0005" - .0008"	.0008" - .0014" .0007" - .0011"	.0009" - .0017" .0008" - .0014"	.0011" - .0021" .0010" - .0018"	.0016" - .0026" .0014" - .0022"	.0018" - .0034" .0016" - .0028"	.0022" - .0042" .0020" - .0036"	.0032" - .0056" .0028" - .0044"	
	CARBON STEELS													
	1000's - 1018, 1020, 12L14	< 40	300 - 425	.0004" - .0007"	.0005" - .0008"	.0006" - .0010"	.0008" - .0015"	.0009" - .0018"	.0011" - .0022"	.0016" - .0030"	.0018" - .0036"	.0022" - .0044"	.0032" - .0060"	
K	CAST MATERIAL													
	Ductile Iron		300 - 425	.0004" - .0007"	.0005" - .0008"	.0006" - .0010"	.0009" - .0016"	.0010" - .0019"	.0012" - .0023"	.0018" - .0032"	.0020" - .0038"	.0024" - .0046"	.0036" - .0064"	
	Gray Iron		325 - 475	.0005" - .0008"	.0007" - .0010"	.0007" - .0012"	.0010" - .0017"	.0011" - .0020"	.0013" - .0024"	.0020" - .0034"	.0022" - .0040"	.0026" - .0048"	.0040" - .0068"	

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1.5xD	up to 2xD
Radial (ae)	1xD	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

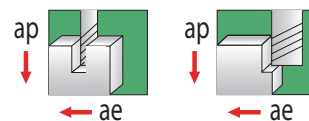
# GARR TOOL High Performance Milling Guide for VRX

**NOTE - DATA DOES NOT REFLECT CHIP THINNING.**

**SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 16mm DIAMETER AND LARGER END MILLS**

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)									
				1.5mm	3.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm
S	COBALT BASE ALLOYS												
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	25 - 45 20 - 40	.008 - .015 .008 - .012	.010 - .018 .008 - .015	.013 - .020 .010 - .018	.018 - .030 .015 - .025	.020 - .038 .018 - .033	.025 - .048 .023 - .043	.036 - .061 .030 - .051	.041 - .076 .036 - .066	.051 - .097 .046 - .086	.071 - .122 .061 - .102
	NICKEL BASE ALLOYS												
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	25 - 45 20 - 40	.008 - .015 .008 - .012	.010 - .018 .008 - .015	.013 - .020 .010 - .018	.018 - .030 .015 - .025	.020 - .038 .018 - .033	.025 - .048 .023 - .043	.036 - .061 .030 - .051	.041 - .076 .036 - .066	.051 - .097 .046 - .086	.071 - .122 .061 - .102
	IRON BASE ALLOYS												
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	25 - 45 20 - 40	.008 - .015 .008 - .012	.010 - .018 .008 - .015	.013 - .020 .010 - .018	.018 - .030 .015 - .025	.020 - .038 .018 - .033	.025 - .048 .023 - .043	.036 - .061 .030 - .051	.041 - .076 .036 - .066	.051 - .097 .046 - .086	.071 - .122 .061 - .102
	TITANIUM ALLOYS												
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		55 - 90	.008 - .015	.010 - .018	.013 - .020	.018 - .036	.020 - .043	.025 - .053	.036 - .071	.041 - .086	.051 - .107	.071 - .142	
5553 / Beta Titanium		40 - 70	.008 - .015	.008 - .018	.010 - .020	.018 - .030	.020 - .038	.025 - .048	.036 - .061	.041 - .076	.051 - .097	.071 - .122	
M	STAINLESS STEELS												
	13/8, 15/5, 17-4, pH Types	< 40 > 40	55 - 90 45 - 70	.008 - .015 .008 - .013	.010 - .018 .008 - .015	.013 - .020 .010 - .018	.018 - .030 .015 - .025	.020 - .038 .018 - .033	.025 - .048 .023 - .043	.036 - .061 .030 - .051	.041 - .076 .036 - .066	.051 - .097 .046 - .086	.071 - .122 .056 - .102
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	60 - 100 55 - 75	.008 - .015 .008 - .013	.010 - .018 .008 - .015	.013 - .020 .010 - .018	.018 - .030 .015 - .028	.020 - .038 .018 - .036	.025 - .048 .023 - .046	.036 - .061 .030 - .056	.041 - .076 .036 - .071	.051 - .097 .046 - .091	.071 - .122 .061 - .112
	400 Series - 403, 405, 420, 455	< 40 > 40	70 - 110 55 - 75	.008 - .015 .008 - .013	.010 - .018 .008 - .015	.013 - .020 .010 - .018	.018 - .033 .015 - .028	.020 - .041 .018 - .036	.025 - .051 .023 - .046	.036 - .066 .030 - .056	.041 - .081 .036 - .071	.061 - .109 .046 - .091	.071 - .132 .061 - .112
	HIGH STRENGTH TOOL STEELS												
A2, D2, P20, H13, S7, O1	< 40 > 40	55 - 90 40 - 85	.010 - .018 .008 - .013	.013 - .020 .008 - .013	.015 - .025 .013 - .020	.020 - .033 .018 - .025	.023 - .041 .020 - .033	.028 - .051 .025 - .043	.041 - .066 .036 - .051	.046 - .081 .041 - .066	.056 - .102 .051 - .086	.081 - .132 .071 - .102	
P	MEDIUM ALLOY TOOL STEELS												
	4140, 4340, 52100, 6150, 8620	< 40 > 40	75 - 120 70 - 90	.010 - .018 .008 - .013	.013 - .020 .008 - .013	.015 - .025 .013 - .020	.020 - .036 .018 - .028	.023 - .043 .020 - .036	.028 - .053 .025 - .046	.041 - .071 .036 - .056	.046 - .086 .041 - .071	.056 - .107 .051 - .091	.081 - .142 .071 - .112
	CARBON STEELS												
1000's - 1018, 1020, 12L14	< 40	90 - 130	.010 - .018	.013 - .020	.015 - .025	.020 - .038	.023 - .046	.028 - .056	.041 - .076	.046 - .091	.056 - .112	.081 - .152	
K	CAST MATERIAL												
	Ductile Iron		90 - 130	.010 - .018	.013 - .020	.015 - .025	.023 - .041	.025 - .048	.030 - .058	.046 - .081	.051 - .097	.061 - .117	.091 - .163
	Gray Iron		100 - 145	.013 - .020	.018 - .025	.018 - .030	.025 - .043	.028 - .051	.033 - .061	.051 - .086	.056 - .102	.066 - .122	.102 - .173

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1.5xD	up to 2xD
Radial (ae)	1xD	5% - 15% of Dia.



**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

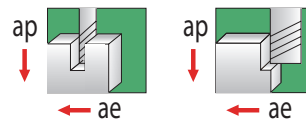
# GARR TOOL High Performance Milling Guide for V4

**NOTE - DATA DOES NOT REFLECT CHIP THINNING.**

**SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 5/8" DIAMETER AND LARGER END MILLS**

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)							
				1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"	
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	90 - 185 75 - 150	.0008" - .0015" .0006" - .0013"	.0009" - .0018" .0007" - .0016"	.0011" - .0022" .0009" - .0020"	.0016" - .0030" .0012" - .0026"	.0018" - .0036" .0014" - .0032"	.0022" - .0044" .0018" - .0040"	.0032" - .0060" .0024" - .0052"	
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	90 - 185 75 - 150	.0008" - .0015" .0006" - .0013"	.0009" - .0018" .0007" - .0016"	.0011" - .0022" .0009" - .0020"	.0016" - .0030" .0012" - .0026"	.0018" - .0036" .0014" - .0032"	.0022" - .0044" .0018" - .0040"	.0032" - .0060" .0024" - .0052"	
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	90 - 185 75 - 150	.0008" - .0015" .0006" - .0013"	.0009" - .0018" .0007" - .0016"	.0011" - .0022" .0009" - .0020"	.0016" - .0030" .0012" - .0026"	.0018" - .0036" .0014" - .0032"	.0022" - .0044" .0018" - .0040"	.0032" - .0060" .0024" - .0052"	
	TITANIUM ALLOYS										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		200 - 375	.0009" - .0017"	.0010" - .0020"	.0012" - .0024"	.0018" - .0034"	.0020" - .0040"	.0024" - .0048"	.0036" - .0068"	
	5553 / Beta Titanium		150 - 280	.0009" - .0015"	.0010" - .0018"	.0012" - .0022"	.0018" - .0030"	.0020" - .0036"	.0024" - .0044"	.0032" - .0060"	
	M	STAINLESS STEELS									
13/8, 15/5, 17-4, pH Types		< 40 > 40	225 - 375 175 - 275	.0008" - .0015" .0006" - .0013"	.0009" - .0018" .0007" - .0016"	.0011" - .0022" .0009" - .0020"	.0016" - .0030" .0012" - .0026"	.0018" - .0036" .0014" - .0032"	.0022" - .0044" .0018" - .0040"	.0032" - .0060" .0024" - .0052"	
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic		< 40 > 40	250 - 400 175 - 275	.0008" - .0016" .0006" - .0013"	.0009" - .0018" .0007" - .0016"	.0011" - .0022" .0009" - .0020"	.0016" - .0030" .0012" - .0026"	.0018" - .0036" .0014" - .0032"	.0022" - .0044" .0018" - .0040"	.0032" - .0060" .0024" - .0052"	
400 Series - 403, 405, 420, 455		< 40 > 40	225 - 425 175 - 325	.0008" - .0016" .0006" - .0014"	.0009" - .0019" .0007" - .0017"	.0011" - .0023" .0009" - .0021"	.0016" - .0032" .0012" - .0028"	.0018" - .0038" .0014" - .0034"	.0022" - .0046" .0018" - .0042"	.0032" - .0064" .0024" - .0056"	
HIGH STRENGTH TOOL STEELS											
A2, D2, P20, H13, S7, O1		< 40 > 40	225 - 400 150 - 325	.0008" - .0016" .0006" - .0013"	.0011" - .0019" .0010" - .0016"	.0013" - .0023" .0012" - .0020"	.0016" - .0032" .0012" - .0026"	.0022" - .0038" .0020" - .0032"	.0026" - .0056" .0024" - .0040"	.0040" - .0064" .0036" - .0052"	
P	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	350 - 500 250 - 375	.0008" - .0017" .0006" - .0014"	.0011" - .0020" .0010" - .0017"	.0013" - .0024" .0012" - .0020"	.0016" - .0034" .0012" - .0028"	.0022" - .0040" .0020" - .0034"	.0026" - .0048" .0024" - .0040"	.0040" - .0068" .0036" - .0056"	
	CARBON STEELS										
	1000's - 1018, 1020, 12L14	< 40	375 - 600	.0010" - .0018"	.0011" - .0021"	.0013" - .0025"	.0020" - .0036"	.0022" - .0042"	.0026" - .0050"	.0040" - .0072"	
K	CAST MATERIAL										
	Ductile Iron		350 - 525	.0010" - .0018"	.0013" - .0022"	.0015" - .0026"	.0020" - .0036"	.0026" - .0044"	.0030" - .0052"	.0040" - .0072"	
	Gray Iron		450 - 590	.0011" - .0020"	.0014" - .0023"	.0016" - .0027"	.0022" - .0040"	.0028" - .0046"	.0032" - .0054"	.0044" - .0080"	

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1.5xD	up to 2xD
Radial (ae)	1xD	5% - 15% of Dia.



**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

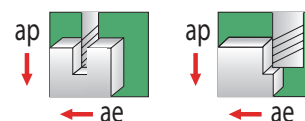
# GARR TOOL High Performance Milling Guide for V4

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 16mm DIAMETER AND LARGER END MILLS

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)							
				6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm	
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	27 - 57 25 - 45	.020 -.038 .015 -.033	.023 -.046 .018 -.041	.028 -.056 .023 -.051	.041 -.076 .030 -.066	.046 -.091 .036 -.081	.056 -.112 .046 -.102	.081 -.152 .061 -.132	
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	27 - 57 25 - 45	.020 -.038 .015 -.033	.023 -.046 .018 -.041	.028 -.056 .023 -.051	.041 -.076 .030 -.066	.046 -.091 .036 -.081	.056 -.112 .046 -.102	.081 -.152 .061 -.132	
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	27 - 57 25 - 45	.020 -.038 .015 -.033	.023 -.046 .018 -.041	.028 -.056 .023 -.051	.041 -.076 .030 -.066	.046 -.091 .036 -.081	.056 -.112 .046 -.102	.081 -.152 .061 -.132	
	TITANIUM ALLOYS										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		60 - 115	.023 -.043	.025 -.051	.030 -.061	.046 -.086	.051 -.102	.061 -.122	.091 -.173	
5553 / Beta Titanium		45 - 85	.023 -.038	.025 -.046	.030 -.056	.046 -.076	.051 -.091	.061 -.112	.081 -.152		
M	STAINLESS STEELS										
	13/8, 15/5, 17-4, pH Types	< 40 > 40	70 - 115 55 - 85	.020 -.038 .015 -.033	.023 -.046 .018 -.041	.028 -.056 .023 -.051	.041 -.076 .030 -.066	.046 -.091 .036 -.081	.056 -.112 .046 -.102	.081 -.152 .061 -.132	
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	75 - 120 55 - 85	.020 -.038 .015 -.033	.023 -.046 .018 -.041	.028 -.056 .023 -.051	.041 -.076 .030 -.066	.046 -.091 .036 -.081	.056 -.112 .046 -.102	.081 -.152 .061 -.132	
	400 Series - 403, 405, 420, 455	< 40 > 40	70 - 130 55 - 100	.020 -.041 .015 -.036	.023 -.048 .018 -.043	.028 -.058 .023 -.053	.041 -.081 .030 -.071	.046 -.097 .036 -.086	.056 -.117 .046 -.107	.081 -.163 .061 -.142	
	HIGH STRENGTH TOOL STEELS										
P	A2, D2, P20, H13, S7, O1	< 40 > 40	70 - 120 45 - 100	.020 -.041 .015 -.033	.028 -.048 .025 -.041	.033 -.058 .030 -.051	.041 -.081 .030 -.066	.056 -.097 .051 -.081	.066 -.142 .061 -.102	.102 -.163 .091 -.132	
	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	110 - 150 75 - 115	.020 -.043 .015 -.036	.028 -.051 .025 -.043	.033 -.061 .030 -.051	.041 -.086 .030 -.071	.056 -.102 .051 -.086	.066 -.122 .061 -.102	.102 -.173 .091 -.142	
	CARBON STEELS										
	1000's - 1018, 1020, 12L14	< 40	115 - 180	.025 -.046	.028 -.053	.033 -.064	.051 -.091	.056 -.107	.066 -.127	.102 -.183	
K	CAST MATERIAL										
	Ductile Iron		110 - 160	.025 -.046	.033 -.056	.038 -.066	.051 -.091	.066 -.112	.076 -.132	.102 -.183	
	Gray Iron		135 - 180	.028 -.051	.036 -.058	.041 -.069	.056 -.102	.071 -.117	.081 -.137	.112 -.203	

	Slotting Pocket Milling	Profiling Side Milling
Axial (ap)	up to 1.5xD	up to 2xD
Radial (ae)	1xD	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL High Performance Milling Guide for V5, V5C

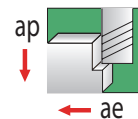
## (HIGH EFFICIENCY MILLING)

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 5/8" DIAMETER AND LARGER END MILLS

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)							
				1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"	
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	105 - 220 90 - 180	.0009" - .0016" .0007" - .0014"	.0010" - .0019" .0008" - .0017"	.0012" - .0023" .0010" - .0021"	.0018" - .0032" .0014" - .0028"	.0020" - .0038" .0016" - .0034"	.0024" - .0046" .0020" - .0042"	.0036" - .0064" .0028" - .0056"	
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	105 - 220 90 - 180	.0009" - .0016" .0007" - .0014"	.0010" - .0019" .0008" - .0017"	.0012" - .0023" .0010" - .0021"	.0018" - .0032" .0014" - .0028"	.0020" - .0038" .0016" - .0034"	.0024" - .0046" .0020" - .0042"	.0036" - .0064" .0028" - .0056"	
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	105 - 220 90 - 180	.0009" - .0016" .0007" - .0014"	.0010" - .0019" .0008" - .0017"	.0012" - .0023" .0010" - .0021"	.0018" - .0032" .0014" - .0028"	.0020" - .0038" .0016" - .0034"	.0024" - .0046" .0020" - .0042"	.0036" - .0064" .0028" - .0056"	
	TITANIUM ALLOYS										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		240 - 450	.0010" - .0018"	.0011" - .0021"	.0013" - .0025"	.0020" - .0036"	.0022" - .0042"	.0026" - .0050"	.0040" - .0072"	
	5553 / Beta Titanium		180 - 340	.0010" - .0016"	.0011" - .0019"	.0013" - .0023"	.0020" - .0032"	.0022" - .0038"	.0026" - .0046"	.0040" - .0064"	
	M	STAINLESS STEELS									
13/8, 15/5, 17-4, pH Types		< 40 > 40	300 - 450 210 - 330	.0009" - .0016" .0007" - .0014"	.0010" - .0019" .0008" - .0017"	.0012" - .0023" .0010" - .0021"	.0018" - .0032" .0014" - .0028"	.0020" - .0038" .0016" - .0034"	.0024" - .0046" .0020" - .0042"	.0036" - .0064" .0028" - .0056"	
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic		< 40 > 40	300 - 480 210 - 330	.0009" - .0016" .0007" - .0014"	.0010" - .0019" .0008" - .0017"	.0012" - .0023" .0010" - .0021"	.0018" - .0032" .0014" - .0028"	.0020" - .0038" .0016" - .0034"	.0024" - .0046" .0020" - .0042"	.0036" - .0064" .0028" - .0056"	
400 Series - 403, 405, 420, 455		< 40 > 40	270 - 510 210 - 390	.0009" - .0017" .0007" - .0015"	.0010" - .0020" .0008" - .0018"	.0012" - .0024" .0010" - .0022"	.0018" - .0034" .0014" - .0030"	.0020" - .0040" .0016" - .0036"	.0024" - .0048" .0020" - .0044"	.0036" - .0068" .0028" - .0060"	
HIGH STRENGTH TOOL STEELS											
A2, D2, P20, H13, S7, O1		< 40 > 40	270 - 480 180 - 390	.0009" - .0017" .0007" - .0014"	.0010" - .0020" .0008" - .0017"	.0012" - .0024" .0010" - .0021"	.0018" - .0034" .0014" - .0028"	.0020" - .0040" .0016" - .0034"	.0024" - .0048" .0020" - .0042"	.0036" - .0068" .0028" - .0056"	
P	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	420 - 600 300 - 450	.0009" - .0018" .0007" - .0015"	.0010" - .0021" .0008" - .0018"	.0012" - .0025" .0010" - .0022"	.0018" - .0036" .0014" - .0030"	.0020" - .0042" .0016" - .0036"	.0024" - .0050" .0020" - .0044"	.0036" - .0072" .0028" - .0060"	
	CARBON STEELS										
	1000's - 1018, 1020, 12L14	< 40	450 - 720	.0011" - .0019"	.0012" - .0022"	.0014" - .0026"	.0022" - .0038"	.0024" - .0044"	.0028" - .0052"	.0044" - .0076"	
K	CAST MATERIAL										
	Ductile Iron		420 - 630	.0011" - .0019"	.0012" - .0022"	.0014" - .0026"	.0022" - .0038"	.0024" - .0044"	.0028" - .0052"	.0044" - .0076"	
	Gray Iron		540 - 710	.0012" - .0021"	.0013" - .0024"	.0015" - .0028"	.0024" - .0042"	.0026" - .0048"	.0030" - .0056"	.0048" - .0084"	

	Profile/Trochoidal Milling
Axial (ap)	up to 2xD
Radial (ae)	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.



# GARR TOOL High Performance Milling Guide for V5, V5C

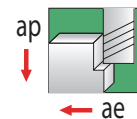
## (HIGH EFFICIENCY MILLING)

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 16mm DIAMETER AND LARGER END MILLS

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)							
				6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm	
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	30 - 70 27 - 55	.023 - .041 .018 - .036	.025 - .048 .020 - .043	.030 - .058 .025 - .053	.046 - .081 .036 - .071	.051 - .097 .041 - .086	.061 - .117 .051 - .107	.091 - .163 .071 - .142	
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	30 - 70 27 - 55	.023 - .041 .018 - .036	.025 - .048 .020 - .043	.030 - .058 .025 - .053	.046 - .081 .036 - .071	.051 - .097 .041 - .086	.061 - .117 .051 - .107	.091 - .163 .071 - .142	
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	30 - 70 27 - 55	.023 - .041 .018 - .036	.025 - .048 .020 - .043	.030 - .058 .025 - .053	.046 - .081 .036 - .071	.051 - .097 .041 - .086	.061 - .117 .051 - .107	.091 - .163 .071 - .142	
	TITANIUM ALLOYS										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		75 - 135	.025 - .046	.028 - .053	.033 - .064	.051 - .091	.056 - .107	.066 - .127	.102 - .183	
5553 / Beta Titanium		55 - 105	.025 - .041	.028 - .048	.033 - .058	.051 - .081	.056 - .097	.066 - .117	.102 - .163		
M	STAINLESS STEELS										
	13/8, 15/5, 17-4, pH Types	< 40 > 40	90 - 135 65 - 100	.023 - .041 .018 - .036	.025 - .048 .020 - .043	.030 - .058 .025 - .053	.046 - .081 .036 - .071	.051 - .097 .041 - .086	.061 - .117 .051 - .107	.091 - .163 .071 - .142	
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	90 - 145 65 - 100	.023 - .041 .018 - .036	.025 - .048 .020 - .043	.030 - .058 .025 - .053	.046 - .081 .036 - .071	.051 - .097 .041 - .086	.061 - .117 .051 - .107	.091 - .163 .071 - .142	
	400 Series - 403, 405, 420, 455	< 40 > 40	85 - 155 65 - 120	.023 - .043 .018 - .038	.025 - .051 .020 - .046	.030 - .061 .025 - .056	.046 - .086 .036 - .076	.051 - .102 .041 - .091	.061 - .122 .051 - .112	.091 - .173 .071 - .152	
	HIGH STRENGTH TOOL STEELS										
	A2, D2, P20, H13, S7, O1	< 40 > 40	85 - 145 55 - 120	.023 - .043 .018 - .036	.025 - .051 .020 - .043	.030 - .061 .025 - .053	.046 - .086 .036 - .071	.051 - .102 .041 - .086	.061 - .122 .051 - .107	.091 - .173 .071 - .142	
P	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	130 - 180 90 - 135	.023 - .046 .018 - .038	.025 - .053 .020 - .046	.030 - .064 .025 - .056	.046 - .091 .036 - .076	.051 - .107 .041 - .091	.061 - .127 .051 - .112	.091 - .183 .071 - .152	
	CARBON STEELS										
	1000's - 1018, 1020, 12L14	< 40	135 - 220	.028 - .048	.030 - .056	.036 - .066	.056 - .097	.061 - .112	.071 - .132	.112 - .193	
K	CAST MATERIAL										
	Ductile Iron		130 - 190	.028 - .048	.030 - .056	.036 - .066	.056 - .097	.061 - .112	.071 - .132	.112 - .193	
	Gray Iron		170 - 215	.030 - .053	.033 - .061	.038 - .071	.061 - .107	.066 - .122	.076 - .142	.122 - .213	

	Profile/Trochoidal Milling
Axial (ap)	up to 2xD
Radial (ae)	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL High Performance Milling Guide for VRX-6

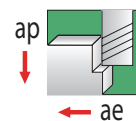
## (HIGH EFFICIENCY MILLING)

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 5/8" DIAMETER AND LARGER END MILLS

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)						
				1/4"	3/8"	1/2"	5/8"	3/4"	1"	
S	COBALT BASE ALLOYS									
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	115 - 230 95 - 190	.0006" - .0012" .0004" - .0010"	.0006" - .0014" .0005" - .0013"	.0011" - .0023" .0008" - .0020"	.0011" - .0023" .0009" - .0021"	.0012" - .0028" .0010" - .0026"	.0022" - .0046" .0016" - .0040"	
	NICKEL BASE ALLOYS									
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	115 - 230 95 - 190	.0006" - .0013" .0003" - .0007"	.0008" - .0016" .0007" - .0015"	.0012" - .0024" .0008" - .0020"	.0012" - .0025" .0011" - .0022"	.0016" - .0032" .0014" - .0030"	.0024" - .0048" .0016" - .0040"	
	IRON BASE ALLOYS									
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	115 - 230 95 - 190	.0006" - .0012" .0003" - .0007"	.0008" - .0014" .0005" - .0013"	.0011" - .0023" .0007" - .0019"	.0012" - .0024" .0010" - .0022"	.0016" - .0028" .0010" - .0026"	.0022" - .0046" .0014" - .0038"	
	TITANIUM ALLOYS									
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		250 - 470	.0010" - .0015"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0030" - .0050"	.0040" - .0060"	
	5553 / Beta Titanium		185 - 350	.0008" - .0014"	.0012" - .0022"	.0016" - .0028"	.0023" - .0034"	.0024" - .0044"	.0032" - .0056"	
M	STAINLESS STEELS									
	13/8, 15/5, 17-4, pH Types	< 40 > 40	280 - 470 215 - 345	.0008" - .0015" .0006" - .0013"	.0010" - .0017" .0009" - .0016"	.0016" - .0030" .0012" - .0026"	.0018" - .0031" .0013" - .0028"	.0020" - .0034" .0018" - .0032"	.0032" - .0060" .0024" - .0052"	
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	310 - 500 215 - 345	.0008" - .0015" .0006" - .0013"	.0010" - .0017" .0008" - .0015"	.0016" - .0030" .0012" - .0026"	.0017" - .0028" .0014" - .0024"	.0020" - .0034" .0016" - .0030"	.0032" - .0060" .0022" - .0038"	
	400 Series - 403, 405, 420, 455	< 40 > 40	280 - 530 215 - 405	.0008" - .0016" .0006" - .0014"	.0010" - .0018" .0009" - .0017"	.0016" - .0032" .0012" - .0028"	.0020" - .0035" .0013" - .0030"	.0020" - .0036" .0018" - .0034"	.0032" - .0064" .0024" - .0056"	
	HIGH STRENGTH TOOL STEELS									
	A2, D2, P20, H13, S7, O1	< 40 > 40	280 - 500 185 - 410	.0008" - .0015" .0006" - .0013"	.0013" - .0023" .0012" - .0020"	.0018" - .0029" .0014" - .0022"	.0024" - .0034" .0020" - .0028"	.0034" - .0044" .0024" - .0032"	.0036" - .0048" .0030" - .0040"	
P	MEDIUM ALLOY TOOL STEELS									
	4140, 4340, 52100, 6150, 8620	< 40 > 40	435 - 625 310 - 470	.0010" - .0016" .0007" - .0012"	.0013" - .0024" .0012" - .0020"	.0018" - .0029" .0014" - .0022"	.0024" - .0034" .0020" - .0028"	.0034" - .0044" .0024" - .0032"	.0036" - .0048" .0030" - .0040"	
	CARBON STEELS									
	1000's - 1018, 1020, 12L14	< 40	465 - 750	.0010" - .0017"	.0013" - .0025"	.0018" - .0029"	.0024" - .0034"	.0034" - .0044"	.0036" - .0048"	
K	CAST MATERIAL									
	Ductile Iron		435 - 660	.0012" - .0019"	.0015" - .0026"	.0024" - .0038"	.0026" - .0050"	.0030" - .0052"	.0048" - .0076"	
	Gray Iron		560 - 740	.0013" - .0021"	.0016" - .0027"	.0026" - .0042"	.0028" - .0052"	.0032" - .0064"	.0052" - .0084"	

	Profile/Trochoidal Milling
Axial (ap)	up to 2xD
Radial (ae)	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL High Performance Milling Guide for VRX-6

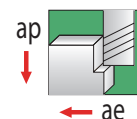
## (HIGH EFFICIENCY MILLING)

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 16mm DIAMETER AND LARGER END MILLS

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)							
				6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm	
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	35 - 70 30 - 57	.015 -.030 .010 -.025	.015 -.033 .010 -.030	.015 -.036 .013 -.033	.028 -.058 .020 -.051	.028 -.058 .023 -.053	.030 -.071 .025 -.066	.056 -.117 .041 -.102	
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	35 - 70 30 - 57	.015 -.033 .008 -.018	.020 -.035 .013 -.028	.020 -.041 .018 -.038	.030 -.061 .020 -.051	.030 -.064 .028 -.056	.041 -.081 .036 -.076	.061 -.122 .041 -.102	
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	35 - 70 30 - 57	.015 -.030 .008 -.018	.020 -.033 .010 -.025	.020 -.036 .013 -.033	.028 -.058 .018 -.048	.030 -.061 .025 -.056	.041 -.071 .025 -.066	.056 -.117 .036 -.097	
	TITANIUM ALLOYS										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		75 - 140	.025 -.038	.030 -.050	.038 -.064	.051 -.076	.064 -.089	.076 -.127	.102 -.152	
5553 / Beta Titanium		57 - 110	.020 -.036	.025 -.046	.030 -.056	.041 -.071	.058 -.086	.061 -.112	.081 -.142		
M	STAINLESS STEELS										
	13/8, 15/5, 17-4, pH Types	< 40 > 40	85 - 140 65 - 105	.020 -.038 .015 -.033	.023 -.040 .020 -.038	.025 -.043 .023 -.041	.041 -.076 .030 -.066	.046 -.079 .033 -.071	.051 -.086 .046 -.081	.081 -.152 .061 -.132	
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	95 - 150 65 - 105	.020 -.038 .015 -.033	.023 -.040 .018 -.035	.025 -.043 .020 -.038	.041 -.076 .030 -.066	.043 -.071 .036 -.061	.051 -.086 .041 -.076	.081 -.152 .056 -.097	
	400 Series - 403, 405, 420, 455	< 40 > 40	85 - 160 65 - 125	.020 -.041 .015 -.036	.023 -.043 .020 -.040	.025 -.046 .023 -.043	.041 -.081 .030 -.071	.051 -.089 .033 -.076	.051 -.091 .046 -.086	.081 -.163 .061 -.142	
	HIGH STRENGTH TOOL STEELS										
	A2, D2, P20, H13, S7, O1	< 40 > 40	85 - 150 57 - 125	.020 -.038 .015 -.033	.025 -.048 .022 -.042	.033 -.058 .030 -.051	.046 -.061 .041 -.056	.061 -.086 .051 -.071	.086 -.112 .061 -.081	.091 -.122 .076 -.102	
P	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	130 - 190 95 - 140	.025 -.041 .018 -.030	.029 -.051 .025 -.041	.033 -.061 .030 -.051	.046 -.061 .041 -.056	.061 -.086 .051 -.071	.086 -.112 .061 -.081	.091 -.122 .076 -.102	
	CARBON STEELS										
	1000's - 1018, 1020, 12L14	< 40	140 - 230	.025 -.043	.029 -.053	.033 -.064	.046 -.061	.061 -.086	.086 -.112	.091 -.122	
K	CAST MATERIAL										
	Ductile Iron		130 - 200	.030 -.048	.034 -.056	.038 -.066	.061 -.097	.066 -.127	.076 -.132	.122 -.193	
	Gray Iron		170 - 225	.033 -.053	.037 -.061	.041 -.069	.066 -.107	.071 -.132	.081 -.163	.132 -.213	

	Profile/Trochoidal Milling
Axial (ap)	up to 2xD
Radial (ae)	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL High Performance Milling Guide for VX-7, VX-7C

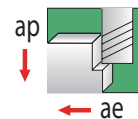
## (HIGH EFFICIENCY MILLING)

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 5/8" DIAMETER AND LARGER END MILLS

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)				
				3/8"	1/2"	5/8"	3/4"	1"
S	COBALT BASE ALLOYS							
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	120 - 240 100 - 195	.0013" - .0026" .0010" - .0024"	.0019" - .0036" .0014" - .0031"	.0021" - .0043" .0017" - .0038"	.0026" - .0052" .0020" - .0048"	.0038" - .0072" .0028" - .0062"
	NICKEL BASE ALLOYS							
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	120 - 240 100 - 195	.0013" - .0026" .0010" - .0024"	.0019" - .0036" .0014" - .0031"	.0021" - .0043" .0017" - .0038"	.0026" - .0052" .0020" - .0048"	.0038" - .0072" .0028" - .0062"
	IRON BASE ALLOYS							
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	120 - 240 100 - 195	.0013" - .0026" .0010" - .0024"	.0019" - .0036" .0014" - .0031"	.0021" - .0043" .0017" - .0038"	.0026" - .0052" .0020" - .0048"	.0038" - .0072" .0028" - .0062"
	TITANIUM ALLOYS							
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		260 - 490	.0014" - .0028"	.0021" - .0040"	.0026" - .0048"	.0028" - .0056"	.0042" - .0080"
	5553 / Beta Titanium		195 - 365	.0014" - .0026"	.0021" - .0036"	.0026" - .0043"	.0028" - .0052"	.0042" - .0072"
	M	STAINLESS STEELS						
13/8, 15/5, 17-4, pH Types		< 40 > 40	290 - 490 225 - 360	.0013" - .0026" .0010" - .0024"	.0019" - .0036" .0014" - .0031"	.0022" - .0043" .0017" - .0039"	.0026" - .0052" .0020" - .0048"	.0038" - .0072" .0028" - .0062"
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic		< 40 > 40	325 - 520 225 - 360	.0013" - .0026" .0010" - .0024"	.0019" - .0036" .0014" - .0031"	.0022" - .0043" .0017" - .0039"	.0026" - .0052" .0020" - .0048"	.0038" - .0072" .0028" - .0062"
400 Series - 403, 405, 420, 455		< 40 > 40	290 - 555 225 - 425	.0013" - .0028" .0010" - .0025"	.0019" - .0038" .0014" - .0034"	.0022" - .0046" .0017" - .0041"	.0026" - .0056" .0020" - .0050"	.0038" - .0076" .0028" - .0068"
HIGH STRENGTH TOOL STEELS								
A2, D2, P20, H13, S7, O1		< 40 > 40	290 - 520 195 - 425	.0016" - .0028" .0014" - .0024"	.0024" - .0038" .0022" - .0031"	.0026" - .0046" .0024" - .0038"	.0032" - .0056" .0028" - .0048"	.0048" - .0076" .0044" - .0062"
P	MEDIUM ALLOY TOOL STEELS							
	4140, 4340, 52100, 6150, 8620	< 40 > 40	455 - 650 325 - 490	.0016" - .0029" .0014" - .0024"	.0024" - .0040" .0022" - .0033"	.0026" - .0048" .0024" - .0040"	.0032" - .0058" .0028" - .0048"	.0048" - .0080" .0044" - .0066"
	CARBON STEELS							
	1000's - 1018, 1020, 12L14	< 40	490 - 780	.0016" - .0030"	.0024" - .0043"	.0026" - .0050"	.0032" - .0060"	.0048" - .0086"
K	CAST MATERIAL							
	Ductile Iron		455 - 685	.0018" - .0031"	.0029" - .0046"	.0031" - .0053"	.0036" - .0062"	.0058" - .0092"
	Gray Iron		585 - 770	.0019" - .0032"	.0031" - .0048"	.0034" - .0055"	.0038" - .0064"	.0062" - .0096"

	Profile/Trochoidal Milling
Axial (ap)	up to 2xD
Radial (ae)	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL High Performance Milling Guide for VX-7, VX-7C

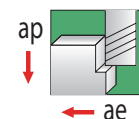
## (HIGH EFFICIENCY MILLING)

NOTE - DATA DOES NOT REFLECT CHIP THINNING.

SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 16mm DIAMETER AND LARGER END MILLS

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)					
				8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm
S	COBALT BASE ALLOYS								
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	35 - 75 30 - 60	.024 -.046 .018 -.040	.033 -.066 .025 -.061	.048 -.091 .036 -.079	.053 -.109 .043 -.097	.066 -.132 .051 -.122	.097 -.183 .071 -.157
	NICKEL BASE ALLOYS								
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	35 - 75 30 - 60	.024 -.046 .018 -.040	.033 -.066 .025 -.061	.048 -.091 .036 -.079	.053 -.109 .043 -.097	.066 -.132 .051 -.122	.097 -.183 .071 -.157
	IRON BASE ALLOYS								
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	35 - 75 30 - 60	.024 -.046 .018 -.040	.033 -.066 .025 -.061	.048 -.091 .036 -.079	.053 -.109 .043 -.097	.066 -.132 .051 -.122	.097 -.183 .071 -.157
	TITANIUM ALLOYS								
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		80 - 150	.026 -.051	.036 -.071	.053 -.102	.066 -.122	.071 -.142	.107 -.203
5553 / Beta Titanium		60 - 110	.026 -.046	.036 -.066	.053 -.091	.066 -.109	.071 -.132	.107 -.183	
M	STAINLESS STEELS								
	13/8, 15/5, 17-4, pH Types	< 40 > 40	90 - 150 70 - 110	.024 -.046 .018 -.040	.033 -.066 .025 -.061	.048 -.091 .036 -.079	.056 -.109 .043 -.099	.066 -.132 .051 -.122	.097 -.183 .071 -.157
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	100 - 160 70 - 110	.024 -.052 .018 -.040	.033 -.066 .025 -.061	.048 -.091 .036 -.079	.056 -.109 .043 -.099	.066 -.132 .051 -.122	.097 -.183 .071 -.157
	400 Series - 403, 405, 420, 455	< 40 > 40	90 - 170 70 - 130	.024 -.051 .018 -.043	.033 -.071 .025 -.064	.048 -.097 .036 -.086	.056 -.117 .043 -.104	.066 -.142 .051 -.127	.097 -.193 .071 -.173
	HIGH STRENGTH TOOL STEELS								
P	A2, D2, P20, H13, S7, O1	< 40 > 40	90 - 160 60 - 130	.032 -.051 .026 -.040	.041 -.071 .036 -.061	.061 -.097 .056 -.079	.066 -.117 .061 -.097	.081 -.142 .071 -.122	.122 -.193 .112 -.157
	MEDIUM ALLOY TOOL STEELS								
	4140, 4340, 52100, 6150, 8620	< 40 > 40	140 - 200 100 - 150	.032 -.053 .026 -.040	.041 -.074 .036 -.061	.061 -.102 .056 -.084	.066 -.122 .061 -.102	.081 -.147 .071 -.122	.122 -.203 .112 -.168
	CARBON STEELS								
	1000's - 1018, 1020, 12L14	< 40	150 - 240	.032 -.053	.041 -.076	.061 -.109	.066 -.127	.081 -.152	.122 -.218
K	CAST MATERIAL								
	Ductile Iron		140 - 210	.035 -.057	.046 -.079	.074 -.117	.079 -.135	.091 -.157	.147 -.234
	Gray Iron		180 - 235	.036 -.060	.048 -.081	.079 -.122	.086 -.140	.097 -.163	.157 -.244

	Profile/Trochoidal Milling
Axial (ap)	up to 2xD
Radial (ae)	5% - 15% of Dia.



NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL Milling Guide for TMS / TMR

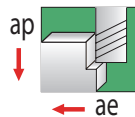
## (HIGH EFFICIENCY MILLING)

**NOTE - CHIP THINNING CALCULATION ALREADY APPLIED**

**CHIPLOAD PER TOOTH (Fz) AT 2% RADIAL ENGAGEMENT (USING PROGRAMMED CALCULATION - SEE PAGE 306)**

**SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 5/8" DIAMETER AND LARGER END MILLS**

ISO Material		SFM (Vc)	CHIPLOAD PER TOOTH (Fz)						
			1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
S	TITANIUM ALLOYS								
	6Al-4V	250 - 400	.0020" - .0042"	.0030" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
	5553	150 - 250	.0015" - .0028"	.0018" - .0035"	.0025" - .0043"	.0030" - .0055"	.0035" - .0065"	.0042" - .0080"	.0052" - .0095"
M	STAINLESS STEELS								
	Free Machining (303)	300 - 400	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
	Austenitic (304 / 304L)	225 - 350	.0017" - .0035"	.0025" - .0043"	.0030" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"
	Martensitic (17-4 / 416)	200 - 250	.0015" - .0028"	.0018" - .0035"	.0025" - .0043"	.0030" - .0055"	.0035" - .0065"	.0042" - .0080"	.0052" - .0095"
P	MEDIUM ALLOY TOOL STEELS								
	8620	250 - 400	.0017" - .0035"	.0025" - .0043"	.0030" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"
	4140, D2, S7	250 - 350	.0015" - .0028"	.0018" - .0035"	.0025" - .0043"	.0030" - .0055"	.0035" - .0065"	.0042" - .0080"	.0052" - .0095"
	CARBON STEELS								
	1000 Series, A36, 12L14	300 - 500	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
	CAST STEELS								
	Steel	250 - 350	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
K	CAST MATERIAL								
	Ductile Iron	250 - 350	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
	Gray Iron	250 - 350	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
N	NON-FERROUS								
	Aluminum (6061-T6)	300 - 500	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
	Copper, Brass	175 - 350	.0017" - .0042"	.0025" - .0052"	.0030" - .0065"	.0035" - .0078"	.0043" - .0095"	.0052" - .0115"	.0065" - .0143"



ap = full flute length

ae = 2%

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for TMS / TMR

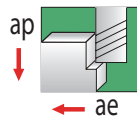
## (HIGH EFFICIENCY MILLING)

**NOTE - CHIP THINNING CALCULATION ALREADY APPLIED**

**CHIPLOAD PER TOOTH (Fz) AT 2% RADIAL ENGAGEMENT (USING PROGRAMMED CALCULATION - SEE PAGE 307)**

**SPINDLE INTERFACE MUST BE SCRUTINIZED WHEN USING 16mm DIAMETER AND LARGER END MILLS**

ISO Material		M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)						
			6.0mm	8.0mm	10.0mm	12.0mm	16.0mm	20.0mm	25.0mm
S	TITANIUM ALLOYS								
	6Al-4V	98 - 157	.051 - .107	.076 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.132 - .363
	5553	59 - 98	.038 - .071	.046 - .089	.064 - .109	.076 - .140	.089 - .165	.107 - .203	.132 - .241
M	STAINLESS STEELS								
	Free Machining (303)	118 - 157	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.132 - .363
	Austenitic (304 / 304L)	89 - 138	.043 - .089	.064 - .109	.076 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292
	Martensitic (17-4 / 416)	79 - 98	.038 - .071	.046 - .089	.064 - .109	.076 - .140	.089 - .165	.107 - .203	.132 - .241
P	MEDIUM ALLOY TOOL STEELS								
	8620	98 - 157	.043 - .089	.064 - .109	.076 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292
	4140, D2, S7	98 - 138	.038 - .071	.046 - .089	.064 - .109	.076 - .140	.089 - .165	.107 - .203	.132 - .241
	CARBON STEELS								
	1000 Series, A36, 12L14	118 - 197	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.203 - .363
	CAST STEELS								
	Steel	98 - 138	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.203 - .363
K	CAST MATERIAL								
	Ductile Iron	98 - 138	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.203 - .363
	Gray Iron	98 - 138	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.203 - .363
N	NON-FERROUS								
	Aluminum (6061-T6)	90 - 150	.050 - .105	.075 - .130	.090 - .165	.105 - .200	.130 - .240	.165 - .292	.203 - .363
	Copper, Brass	60 - 110	.043 - .105	.064 - .130	.076 - .165	.089 - .200	.109 - .240	.132 - .292	.165 - .363



ap = full flute length

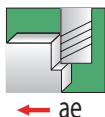
ae = 2%

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

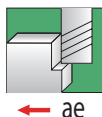


# Chip Thinning Calculations for TMS / TMR End Mills

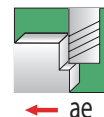
ae = 3%



ae = 2%



ae = 1%



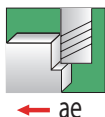
3% Radial Engagement (.03 x d)	
Actual (CPT)	Programmed (CPT)
.0002"	.0005"
.0003"	.0010"
.0005"	.0015"
.0007"	.0020"
.0009"	.0025"
.0010"	.0030"
.0012"	.0035"
.0014"	.0040"
.0015"	.0045"
.0017"	.0050"
.0019"	.0055"
.0020"	.0060"
.0022"	.0065"
.0024"	.0070"
.0026"	.0075"
.0027"	.0080"
.0029"	.0085"
.0031"	.0090"
.0032"	.0095"
.0034"	.0100"
.0036"	.0105"
.0037"	.0110"
.0039"	.0115"
.0041"	.0120"
.0043"	.0125"
.0044"	.0130"
.0046"	.0135"
.0048"	.0140"
.0049"	.0145"
.0051"	.0150"
.0053"	.0155"
.0054"	.0160"
.0056"	.0165"
.0058"	.0170"
.0060"	.0175"
.0061"	.0180"
.0063"	.0185"
.0065"	.0190"
.0066"	.0195"
.0068"	.0200"

2% Radial Engagement (.02 x d)	
Actual (CPT)	Programmed (CPT)
.0001"	.0005"
.0003"	.0010"
.0004"	.0015"
.0006"	.0020"
.0007"	.0025"
.0008"	.0030"
.0010"	.0035"
.0011"	.0040"
.0013"	.0045"
.0014"	.0050"
.0015"	.0055"
.0017"	.0060"
.0018"	.0065"
.0020"	.0070"
.0021"	.0075"
.0022"	.0080"
.0024"	.0085"
.0025"	.0090"
.0027"	.0095"
.0028"	.0100"
.0029"	.0105"
.0031"	.0110"
.0032"	.0115"
.0034"	.0120"
.0035"	.0125"
.0036"	.0130"
.0038"	.0135"
.0039"	.0140"
.0041"	.0145"
.0042"	.0150"
.0043"	.0155"
.0045"	.0160"
.0046"	.0165"
.0048"	.0170"
.0049"	.0175"
.0050"	.0180"
.0052"	.0185"
.0053"	.0190"
.0055"	.0195"
.0056"	.0200"

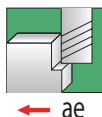
1% Radial Engagement (.01 x d)	
Actual (CPT)	Programmed (CPT)
.0001"	.0005"
.0002"	.0010"
.0003"	.0015"
.0004"	.0020"
.0005"	.0025"
.0006"	.0030"
.0007"	.0035"
.0008"	.0040"
.0009"	.0045"
.0010"	.0050"
.0011"	.0055"
.0012"	.0060"
.0013"	.0065"
.0014"	.0070"
.0015"	.0075"
.0016"	.0080"
.0017"	.0085"
.0018"	.0090"
.0019"	.0095"
.0020"	.0100"
.0021"	.0105"
.0022"	.0110"
.0023"	.0115"
.0024"	.0120"
.0025"	.0125"
.0026"	.0130"
.0027"	.0135"
.0028"	.0140"
.0029"	.0145"
.0030"	.0150"
.0031"	.0155"
.0032"	.0160"
.0033"	.0165"
.0034"	.0170"
.0035"	.0175"
.0036"	.0180"
.0037"	.0185"
.0038"	.0190"
.0039"	.0195"
.0040"	.0200"

# Chip Thinning Calculations for TMS / TMR End Mills

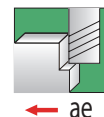
ae = 3%



ae = 2%



ae = 1%



3% Radial Engagement (.03 x d)	
Actual (CPT)	Programmed (CPT)
.0043mm	.0127mm
.0086mm	.0254mm
.0130mm	.0381mm
.0173mm	.0508mm
.0216mm	.0635mm
.0259mm	.0762mm
.0302mm	.0889mm
.0345mm	.1016mm
.0389mm	.1143mm
.0432mm	.1270mm
.0475mm	.1397mm
.0518mm	.1524mm
.0561mm	.1651mm
.0605mm	.1778mm
.0648mm	.1905mm
.0691mm	.2032mm
.0734mm	.2159mm
.0777mm	.2286mm
.0820mm	.2413mm
.0864mm	.2540mm
.0907mm	.2667mm
.0950mm	.2794mm
.0993mm	.2921mm
.1036mm	.3048mm
.1080mm	.3175mm
.1123mm	.3302mm
.1166mm	.3429mm
.1209mm	.3556mm
.1252mm	.3683mm
.1295mm	.3810mm
.1339mm	.3937mm
.1382mm	.4064mm
.1425mm	.4191mm
.1468mm	.4318mm
.1511mm	.4445mm
.1554mm	.4572mm
.1598mm	.4699mm
.1641mm	.4826mm
.1684mm	.4953mm
.1727mm	.5080mm

2% Radial Engagement (.02 x d)	
Actual (CPT)	Programmed (CPT)
.0036mm	.0127mm
.0071mm	.0254mm
.0107mm	.0381mm
.0142mm	.0508mm
.0178mm	.0635mm
.0213mm	.0762mm
.0249mm	.0889mm
.0284mm	.1016mm
.0320mm	.1143mm
.0356mm	.1270mm
.0391mm	.1397mm
.0427mm	.1524mm
.0462mm	.1651mm
.0498mm	.1778mm
.0533mm	.1905mm
.0569mm	.2032mm
.0605mm	.2159mm
.0640mm	.2286mm
.0676mm	.2413mm
.0711mm	.2540mm
.0747mm	.2667mm
.0782mm	.2794mm
.0818mm	.2921mm
.0853mm	.3048mm
.0889mm	.3175mm
.0925mm	.3302mm
.0960mm	.3429mm
.0996mm	.3556mm
.1031mm	.3683mm
.1067mm	.3810mm
.1102mm	.3937mm
.1138mm	.4064mm
.1173mm	.4191mm
.1209mm	.4318mm
.1245mm	.4445mm
.1280mm	.4572mm
.1316mm	.4699mm
.1351mm	.4826mm
.1387mm	.4953mm
.1422mm	.5080mm

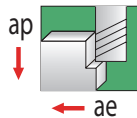
1% Radial Engagement (.01 x d)	
Actual (CPT)	Programmed (CPT)
.0025mm	.0127mm
.0051mm	.0254mm
.0076mm	.0381mm
.0102mm	.0508mm
.0127mm	.0635mm
.0152mm	.0762mm
.0178mm	.0889mm
.0203mm	.1016mm
.0229mm	.1143mm
.0254mm	.1270mm
.0279mm	.1397mm
.0305mm	.1524mm
.0330mm	.1651mm
.0356mm	.1778mm
.0381mm	.1905mm
.0406mm	.2032mm
.0432mm	.2159mm
.0457mm	.2286mm
.0483mm	.2413mm
.0508mm	.2540mm
.0533mm	.2667mm
.0559mm	.2794mm
.0584mm	.2921mm
.0610mm	.3048mm
.0635mm	.3175mm
.0660mm	.3302mm
.0686mm	.3429mm
.0711mm	.3556mm
.0737mm	.3683mm
.0762mm	.3810mm
.0787mm	.3937mm
.0813mm	.4064mm
.0838mm	.4191mm
.0864mm	.4318mm
.0889mm	.4445mm
.0914mm	.4572mm
.0940mm	.4699mm
.0965mm	.4826mm
.0991mm	.4953mm
.1016mm	.5080mm

# GARR TOOL Milling Guide for High Rc Finishers in Hardened Steel

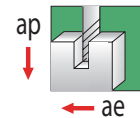
(Reference Series: 545MA, 545BA, 545RA, VRX)

DIAMETER	38 - 45 HRC		45 - 50 HRC		50 - 55 HRC		55 - 60 HRC		60 - 65 HRC		65 - 70 HRC	
	SFM = 450		SFM = 250		SFM = 175		SFM = 125		SFM = 75		SFM = 60	
	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)
1/8"	13750	.0009"	7650	.0008"	5350	.0006"	3820	.0005"	2300	.0004"	1850	.0003"
3/16"	9200	.0012"	5100	.0010"	3570	.0008"	2550	.0007"	1530	.0006"	1225	.0004"
1/4"	6900	.0015"	3850	.0012"	2675	.0010"	1910	.0008"	1150	.0007"	925	.0006"
3/8"	4600	.0018"	2550	.0015"	1800	.0012"	1275	.0010"	765	.0009"	615	.0008"
1/2"	3450	.0022"	1950	.0018"	1350	.0014"	955	.0012"	575	.0012"	460	.0010"
5/8"	2750	.0027"	1550	.0022"	1100	.0020"	765	.0018"	460	.0015"	370	.0013"
3/4"	2300	.0030"	1275	.0027"	900	.0025"	640	.0022"	390	.0017"	310	.0017"
1"	1720	.0033"	960	.0030"	675	.0027"	480	.0025"	290	.0023"	230	.0019"

Profiling / Side Milling	
Axial (ap)	1xD
Radial (ae)	5% of Dia.



Slotting / Pocket Milling	
Axial (ap)	5% of Dia.
Radial (ae)	1xD



## High Speed Machining

DIAMETER	38 - 45 HRC		45 - 50 HRC		50 - 55 HRC		55 - 60 HRC		60 - 65 HRC		65 - 70 HRC	
	SFM = 1200		SFM = 1000		SFM = 800		SFM = 600		SFM = 450		SFM = 375	
	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)	RPM	CPT (Fz)
1/8"	36670	.0006"	30600	.0005"	24500	.0004"	18340	.0004"	13750	.0003"	11460	.0002"
3/16"	24450	.0009"	20400	.0008"	16300	.0006"	12230	.0005"	9200	.0004"	7650	.0003"
1/4"	18340	.0012"	15300	.0010"	12230	.0008"	9200	.0007"	6900	.0005"	5750	.0004"
3/8"	12225	.0015"	10200	.0012"	8150	.0010"	6100	.0008"	4600	.0007"	3850	.0006"
1/2"	9170	.0018"	7650	.0015"	6100	.0012"	4600	.0010"	3450	.0009"	2870	.0008"
5/8"	7335	.0022"	6100	.0018"	4900	.0014"	3700	.0012"	2750	.0011"	2300	.0010"
3/4"	6115	.0027"	5100	.0022"	4100	.0020"	3100	.0018"	2300	.0014"	1900	.0013"
1"	4585	.0030"	3820	.0027"	3100	.0025"	2300	.0022"	1720	.0019"	1450	.0017"

Profiling / Side Milling	
Axial (ap)	1xD
Radial (ae)	2% of Dia.

Slotting / Pocket Milling	
Axial (ap)	2% of Dia.
Radial (ae)	1xD

**D = Tool Diameter**

**Example: 2% of Dia., when D = 1/2" (.02 x .500") = .010" per pass**

Preferable method is to run tools with air blast to keep chips away from the cutting edge.  
If air is not available, either coolant spray or dry machining is acceptable.

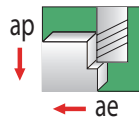
**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for High Rc Finishers in Hardened Steel

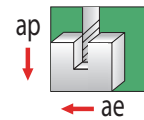
(Reference Series: 545MA, 545BA, 545RA, VRX)

	38 - 45 HRC			45 - 50 HRC			50 - 55 HRC			55 - 60 HRC			60 - 65 HRC			65 - 70 HRC		
	M/Min. = 135			M/Min. = 75			M/Min. = 50			M/Min. = 40			M/Min. = 25			M/Min. = 20		
DIAMETER	RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)	
3.0mm	14500	.025		8100	.020		5650	.015		4050	.010		2400	.008		1950	.007	
4.0mm	10900	.030		6100	.025		4200	.020		3000	.015		1800	.010		1450	.008	
6.0mm	7300	.035		4050	.030		2800	.025		2000	.020		1200	.015		970	.010	
8.0mm	5450	.040		3000	.035		2100	.030		1500	.025		900	.020		725	.015	
12.0mm	3650	.055		2000	.045		1400	.035		1000	.030		600	.025		480	.020	
16.0mm	2700	.065		1500	.055		1050	.050		750	.045		450	.030		360	.025	
18.0mm	2400	.075		1350	.065		950	.060		675	.055		400	.045		320	.030	
20.0mm	2150	.078		1200	.070		850	.065		600	.058		360	.050		290	.040	
25.0mm	1750	.080		1000	.075		700	.070		500	.060		300	.055		250	.045	

	Profiling / Side Milling
Axial (ap)	1xD
Radial (ae)	5% of Dia.



	Slotting / Pocket Milling
Axial (ap)	5% of Dia.
Radial (ae)	1xD



## High Speed Machining

	38 - 45 HRC			45 - 50 HRC			50 - 55 HRC			55 - 60 HRC			60 - 65 HRC			65 - 70 HRC		
	M/Min. = 365			M/Min. = 305			M/Min. = 240			M/Min. = 180			M/Min. = 135			M/Min. = 115		
DIAMETER	RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)		RPM	CPT (Fz)	
3.0mm	38800	.020		32300	.015		25800	.008		19400	.008		14500	.007		12100	.005	
4.0mm	29100	.025		24200	.020		19400	.015		14500	.010		10900	.008		9100	.007	
6.0mm	19400	.030		16100	.025		12900	.020		9700	.015		7300	.010		6050	.008	
8.0mm	14500	.035		12100	.030		9700	.025		7250	.020		5450	.015		4500	.010	
12.0mm	9700	.045		8075	.035		6450	.030		4850	.025		3650	.020		3000	.015	
16.0mm	7250	.055		6050	.045		4850	.035		3600	.030		2700	.025		2300	.020	
18.0mm	6450	.065		5400	.055		4300	.050		3200	.045		2400	.030		2000	.025	
20.0mm	5800	.070		4850	.060		3850	.055		2900	.050		2150	.040		1800	.028	
25.0mm	4650	.075		3870	.065		3100	.060		2300	.055		1750	.045		1450	.030	

	Profiling / Side Milling
Axial (ap)	1xD
Radial (ae)	2% of Dia.

	Slotting / Pocket Milling
Axial (ap)	2% of Dia.
Radial (ae)	1xD

**D = Tool Diameter**

**Example: 2% of Dia., when D = 12mm (.02 x 12mm) = .24mm per pass**

Preferable method is to run tools with air blast to keep chips away from the cutting edge.  
If air is not available, either coolant spray or dry machining is acceptable.

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for Die Mold Cutters

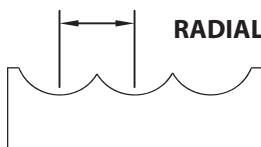
## Roughing

(Reference series: 350MX)

DIAMETER	RPM		CHIPLOAD PER TOOTH (Fz)	
	40 - 50 HRC	50 - 60 HRC	40 - 50 HRC	50 - 60 HRC
1/32"	20,000 - 40,000	20,000 - 40,000	.0005" - .0007"	.0004" - .0005"
1/16"	20,000 - 40,000	20,000 - 40,000	.0010" - .0015"	.0008" - .0010"
3/32"	20,000 - 32,000	20,000 - 30,000	.0015" - .0020"	.0010" - .0015"
1/8"	18,000 - 24,000	15,000 - 20,000	.0020" - .0025"	.0015" - .0020"
3/16"	12,000 - 16,000	10,000 - 14,000	.0030" - .0040"	.0020" - .0030"
1/4"	9,000 - 12,000	7,500 - 10,000	.0040" - .0050"	.0025" - .0040"
5/16"	7,000 - 10,000	6,000 - 8,500	.0050" - .0065"	.0035" - .0050"
3/8"	6,000 - 8,000	5,000 - 7,000	.0060" - .0075"	.0045" - .0060"
1/2"	4,500 - 6,000	4,000 - 5,500	.0080" - .0100"	.0055" - .0080"
5/8"	3,500 - 5,000	3,000 - 4,500	.0090" - .0110"	.0065" - .0090"
3/4"	3,000 - 4,000	2,500 - 3,500	.0100" - .0120"	.0075" - .0100"
1"	2,300 - 3,000	2,000 - 2,500	.0110" - .0130"	.0085" - .0110"

## Semi-Finishing and Finishing

DIAMETER	RPM		CHIPLOAD PER TOOTH (Fz)	
	40 - 50 HRC	50 - 60 HRC	40 - 50 HRC	50 - 60 HRC
1/32"	20,000 - 40,000	20,000 - 40,000	.0004" - .0005"	.0003" - .0004"
1/16"	20,000 - 40,000	20,000 - 40,000	.0008" - .0010"	.0005" - .0008"
3/32"	20,000 - 40,000	20,000 - 40,000	.0010" - .0015"	.0008" - .0012"
1/8"	20,000 - 40,000	20,000 - 36,000	.0015" - .0020"	.0010" - .0015"
3/16"	20,000 - 32,000	20,000 - 25,000	.0020" - .0030"	.0015" - .0020"
1/4"	18,000 - 25,000	15,000 - 18,000	.0025" - .0040"	.0020" - .0030"
5/16"	14,000 - 19,000	12,000 - 14,000	.0035" - .0050"	.0025" - .0040"
3/8"	12,000 - 16,000	10,000 - 12,000	.0045" - .0060"	.0030" - .0045"
1/2"	9,000 - 12,000	7,500 - 9,000	.0055" - .0080"	.0040" - .0060"
5/8"	6,500 - 9,000	5,000 - 7,000	.0065" - .0090"	.0050" - .0070"
3/4"	5,500 - 7,500	4,000 - 6,000	.0075" - .0100"	.0060" - .0080"
1"	4,000 - 6,000	3,500 - 5,500	.0085" - .0110"	.0070" - .0090"



**RADIAL STEP OVER (ae)**

**AXIAL DEPTH OF CUT (ap)**



Roughing	
Axial (ap)	15% - 25% of Dia.
Radial (ae)	20% - 30% of Dia.

Semi-Finishing	
Axial (ap)	5% - 8% of Dia.
Radial (ae)	2% - 5% of Dia.

Finishing	
Axial (ap)	1% - 3% of Dia.
Radial (ae)	.5% - 1% of Dia.

High pressure air is recommended for clearing chips away from the cut.

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

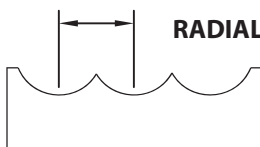
## Roughing

(Reference series: 950MX)

DIAMETER	RPM		CHIPLOAD PER TOOTH (Fz)	
	40 - 50 HRC	50 - 60 HRC	40 - 50 HRC	50 - 60 HRC
1.0mm	20,000 - 40,000	20,000 - 40,000	.013 - .018	.010 - .013
1.5mm	20,000 - 40,000	20,000 - 40,000	.025 - .038	.020 - .025
2.0mm	20,000 - 32,000	20,000 - 30,000	.038 - .050	.025 - .038
3.0mm	18,000 - 24,000	15,000 - 20,000	.050 - .065	.038 - .050
4.0mm	12,000 - 16,000	10,000 - 14,000	.075 - .100	.050 - .075
6.0mm	9,000 - 12,000	7,500 - 10,000	.100 - .125	.065 - .100
8.0mm	7,000 - 10,000	6,000 - 8,500	.125 - .165	.088 - .125
10.0mm	6,000 - 8,000	5,000 - 7,000	.150 - .190	.110 - .150
12.0mm	4,500 - 6,000	4,000 - 5,500	.200 - .250	.140 - .200
16.0mm	3,500 - 5,000	3,000 - 4,500	.225 - .275	.165 - .225
20.0mm	3,000 - 4,000	2,500 - 3,500	.250 - .300	.190 - .250
25.0mm	2,300 - 3,000	2,000 - 2,500	.275 - .325	.215 - .275

## Semi-Finishing and Finishing

DIAMETER	RPM		CHIPLOAD PER TOOTH (Fz)	
	40 - 50 HRC	50 - 60 HRC	40 - 50 HRC	50 - 60 HRC
1.0mm	20,000 - 40,000	20,000 - 40,000	.010 - .013	.008 - .010
1.5mm	20,000 - 40,000	20,000 - 40,000	.020 - .025	.013 - .020
2.0mm	20,000 - 40,000	20,000 - 40,000	.025 - .038	.020 - .030
3.0mm	20,000 - 40,000	20,000 - 36,000	.038 - .050	.025 - .038
4.0mm	20,000 - 32,000	20,000 - 25,000	.050 - .075	.038 - .050
6.0mm	18,000 - 25,000	15,000 - 18,000	.065 - .100	.050 - .075
8.0mm	14,000 - 19,000	12,000 - 14,000	.088 - .125	.065 - .100
10.0mm	12,000 - 16,000	10,000 - 12,000	.110 - .150	.075 - .110
12.0mm	9,000 - 12,000	7,500 - 9,000	.140 - .200	.100 - .150
16.0mm	6,500 - 9,000	5,000 - 7,000	.165 - .225	.125 - .175
20.0mm	5,500 - 7,500	4,000 - 6,000	.190 - .250	.150 - .200
25.0mm	4,000 - 6,000	3,500 - 5,500	.215 - .275	.175 - .225



**RADIAL STEP OVER (ae)**

**AXIAL DEPTH OF CUT (ap)**



Roughing	
Axial (ap)	15% - 25% of Dia.
Radial (ae)	20% - 30% of Dia.

Semi-Finishing	
Axial (ap)	5% - 8% of Dia.
Radial (ae)	2% - 5% of Dia.

Finishing	
Axial (ap)	1% - 3% of Dia.
Radial (ae)	.5% - 1% of Dia.

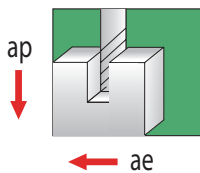
High pressure air is recommended for clearing chips away from the cut.

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

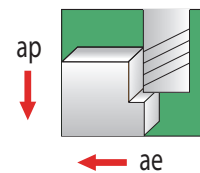
# GARR TOOL Milling Guide for H-45 High Feed End Mills

	UP TO 40 HRC			40 - 45 HRC			45 - 55 HRC			55 - 60 HRC		
DIAMETER	SPEED RPM	FEED IN/MIN	FEED MM/MIN	SPEED RPM	FEED IN/MIN	FEED MM/MIN	SPEED RPM	FEED IN/MIN	FEED MM/MIN	SPEED RPM	FEED IN/MIN	FEED MM/MIN
3.0mm	16000	-	3100	13000	-	2032	11300	-	1778	9700	-	889
1/8"	15200	120	-	12000	80	-	10700	70	-	9200	35	-
4.0mm	12100	-	3700	9700	-	2540	8500	-	2159	7300	-	1016
3/16"	10200	160	-	8200	110	-	7100	90	-	6100	45	-
5.0mm	9700	-	4000	7700	-	2667	6800	-	2286	5800	-	1143
6.0mm	8100	-	4600	6500	-	3048	5700	-	2540	4900	-	1270
1/4"	7650	180	-	6100	120	-	5400	100	-	4600	50	-
5/16"	6100	195	-	4900	130	-	4300	110	-	3700	55	-
8.0mm	6050	-	4950	4850	-	3302	4300	-	2794	3650	-	1397
3/8"	5100	200	-	4100	135	-	3600	115	-	3100	60	-
10.0mm	4850	-	5100	3900	-	3429	3400	-	2921	2900	-	1524
12.0mm	4050	-	6400	3200	-	4064	2800	-	3429	2400	-	1651
1/2"	3800	240	-	3100	160	-	2700	135	-	2300	65	-

	Slotting Pocket Milling
Axial (ap)	0.3 x Radius
Radial (ae)	1 x D



	Profiling Side Milling
Axial (ap)	1 x D
Radial (ae)	0.3 x Radius



**D = Tool Diameter**

**Example: Axial = 0.3 x radius, when D = 1/2" with .060" corner radius (.3 x .060") = .018" per pass**

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**



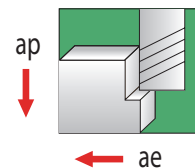
# GARR TOOL Milling Guide for Diamond Coated End Mills in Graphite

DIAMETER	RPM	CHIPLOAD PER TOOTH (Fz)
1/32" - 1/16"	15,000 - 35,000	.0005" - .0010"
1/16" - 1/8"	8,000 - 31,000	.0008" - .0015"
1/8" - 3/16"	8,000 - 31,000	.0010" - .0020"
3/16" - 1/4"	8,000 - 25,000	.0010" - .0020"
1/4" - 5/16"	6,000 - 23,000	.0020" - .0040"
5/16" - 3/8"	6,000 - 20,000	.0020" - .0040"
3/8" - 1/2"	6,000 - 20,000	.0030" - .0050"
1/2" - 5/8"	4,500 - 15,000	.0050" - .0060"
5/8" - 3/4"	4,500 - 12,000	.0060" - .0070"
3/4" - 1"	4,500 - 12,000	.0070" - .0080"

DIAMETER	RPM	CHIPLOAD PER TOOTH (Fz)
1.0 - 3.0mm	15,000 - 35,000	.015 - .030
3.0 - 6.0mm	8,000 - 31,000	.030 - .050
6.0 - 10.0mm	6,000 - 31,000	.050 - .100
10.0 - 12.0mm	6,000 - 25,000	.080 - .130
16.0 - 20.0mm	4,500 - 15,000	.130 - .150
20.0 - 25.0mm	4,500 - 12,000	.150 - .200

Generally, tools will run at maximum RPM in relation to the corresponding parameters below:

	Slotting	Profiling
Axial (ap)	5% of Dia.	1xD
Radial (ae)	1xD	10% of Dia.



These recommendations are suggested for use primarily in graphite cutting applications.  
Rigid work holding, machine stability and part integrity are critical!

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL Reaming Guide

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)			
				.0590" - .1250"	.1251" - .2500"	.2501" - .3750"	.3751" - .5020"
S	COBALT BASE ALLOYS						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	80 - 120 60 - 80	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"
	NICKEL BASE ALLOYS						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	100 - 125 80 - 110	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"
	IRON BASE ALLOYS						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	150 - 175 120 - 150	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
	TITANIUM ALLOYS						
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		120 - 150	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
	5553 / Beta Titanium		90 - 110	.0004" - .0007"	.0006" - .0010"	.0009" - .0011"	.0010" - .0015"
M	STAINLESS STEELS						
	13/8, 15/5, 17-4, pH Types	< 40 > 40	100 - 125 80 - 110	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	100 - 125 80 - 110	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
	400 Series - 403, 405, 420, 455	< 40 > 40	100 - 125 80 - 110	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
P	HIGH STRENGTH TOOL STEELS						
	A2, D2, P20, H13, S7, O1	< 40 > 40	100 - 125 80 - 110	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"
	MEDIUM ALLOY TOOL STEELS						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	100 - 125 80 - 110	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
	CARBON STEELS						
	1000's - 1018, 1020, 12L14	< 40	100 - 125	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
K	CAST MATERIAL						
	Ductile Iron		150 - 225	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
	Gray Iron		125 - 200	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
N	NON-FERROUS						
	Aluminum (6061, 7075)		225	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
	Magnesium		225	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
	Copper		225	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
	Brass, Bronze		125 - 200	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
O	COMPOSITE (non-ISO)						
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		150	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)			
				1.50 - 3.00mm	3.01 - 6.00mm	6.01 - 9.00mm	9.01 - 13.00mm
S	COBALT BASE ALLOYS						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	25 - 40 15 - 25	.008 - .020	.013 - .025	.020 - .030	.025 - .040
	NICKEL BASE ALLOYS						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	30 - 40 25 - 35	.008 - .020	.013 - .025	.020 - .030	.025 - .040
	IRON BASE ALLOYS						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascolloy	< 40 > 40	45 - 50 35 - 45	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	TITANIUM ALLOYS						
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		40 - 45	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	5553 / Beta Titanium		30 - 35	.010 - .020	.015 - .025	.023 - .030	.025 - .040
M	STAINLESS STEELS						
	13/8, 15/5, 17-4, pH Types	< 40 > 40	30 - 40 25 - 35	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	30 - 40 25 - 35	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	400 Series - 403, 405, 420, 455	< 40 > 40	30 - 40 25 - 35	.010 - .023	.015 - .030	.023 - .035	.025 - .045
P	HIGH STRENGTH TOOL STEELS						
	A2, D2, P20, H13, S7, O1	< 40 > 40	30 - 40 25 - 35	.008 - .020	.013 - .025	.020 - .030	.025 - .040
	MEDIUM ALLOY TOOL STEELS						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	30 - 40 25 - 35	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	CARBON STEELS						
	1000's - 1018, 1020, 12L14	< 40	30 - 40	.010 - .023	.015 - .030	.023 - .035	.025 - .045
K	CAST MATERIAL						
	Ductile Iron		45 - 70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	Gray Iron		35 - 70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
N	NON-FERROUS						
	Aluminum (6061, 7075)		70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	Magnesium		70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	Copper		70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	Brass, Bronze		40 - 60	.013 - .025	.018 - .025	.025 - .040	.025 - .050
O	COMPOSITE (non-ISO)						
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		40 - 45	.008 - .020	.013 - .025	.020 - .030	.025 - .040

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Milling Guide for Drill Mills

## \* Chamfering \*

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)							
			154M, 154MA 152M, 152MA	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	60 - 90 50 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	55 - 90 45 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascolloy	< 40 > 40	55 - 90 50 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"
	TITANIUM ALLOYS										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium		100 - 150  90 - 120	.0003" - .0008"  .0003" - .0008"	.0005" - .0012"  .0004" - .0010"	.0005" - .0012"  .0004" - .0010"	.0008" - .0015"  .0005" - .0012"	.0010" - .0015"  .0008" - .0014"	.0013" - .0020"  .0010" - .0016"	.0018" - .0025"  .0010" - .0020"	.0025" - .0035"  .0015" - .0025"
M	STAINLESS STEELS										
	13/8, 15/5, 17-4, pH Types	< 40 > 40	100 - 150 80 - 100	.0003" - .0006" .0002" - .0004"	.0003" - .0007" .0002" - .0006"	.0006" - .0009" .0003" - .0007"	.0008" - .0012" .0004" - .0008"	.0013" - .0018" .0007" - .0012"	.0010" - .0020" .0008" - .0015"	.0012" - .0025" .0010" - .0016"	.0012" - .0020" .0013" - .0017"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	150 - 225 125 - 220	.0002" - .0006" .0003" - .0005"	.0005" - .0008" .0003" - .0007"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0012"	.0010" - .0018" .0009" - .0015"	.0015" - .0025" .0013" - .0018"	.0018" - .0028" .0013" - .0018"	.0022" - .0032" .0017" - .0025"
	400 Series - 403, 405, 420, 455	< 40 > 40	150 - 200 100 - 150	.0007" - .0010" .0004" - .0008"	.0009" - .0015" .0006" - .0010"	.0009" - .0014" .0007" - .0011"	.0011" - .0015" .0008" - .0012"	.0013" - .0018" .0009" - .0015"	.0015" - .0025" .0012" - .0020"	.0020" - .0035" .0018" - .0030"	.0030" - .0046" .0024" - .0042"
	HIGH STRENGTH TOOL STEELS										
P	A2, D2, P20, H13, S7, O1	< 40 > 40	150 - 200 100 - 150	.0003" - .0008" .0003" - .0005"	.0005" - .0010" .0003" - .0008"	.0010" - .0015" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0014" - .0024" .0010" - .0015"	.0018" - .0026" .0012" - .0018"	.0020" - .0028" .0015" - .0022"
	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	150 - 200 100 - 150	.0003" - .0008" .0003" - .0005"	.0005" - .0010" .0003" - .0008"	.0010" - .0015" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0014" - .0024" .0010" - .0015"	.0018" - .0026" .0012" - .0018"	.0020" - .0028" .0015" - .0022"
	CARBON STEELS										
K	1000's - 1018, 1020, 12L14	< 40	150 - 200	.0003" - .0008"	.0005" - .0010"	.0010" - .0015"	.0012" - .0020"	.0012" - .0020"	.0014" - .0024"	.0018" - .0026"	.0020" - .0028"
	CAST MATERIAL										
	Ductile Iron		175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"
N	Gray Iron		175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"
	NON-FERROUS										
	Aluminum (6061, 7075)		300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
	Magnesium		300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
	Copper		250 - 450	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
O	Brass, Bronze		200 - 400	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
	COMPOSITE (non-ISO)										
	Glass Epoxy, Fiberglass, Plastics		200 - 400	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL Milling Guide for Drill Mills

## \* Chamfering \*

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)								
			154M, 154MA 152M, 152MA	3.0mm	4.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.00mm	20.0mm
S	COBALT BASE ALLOYS											
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	24 - 35 20 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051
	NICKEL BASE ALLOYS											
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	22 - 35 18 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051
	IRON BASE ALLOYS											
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	22 - 35 20 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051
	TITANIUM ALLOYS											
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		20 - 31	.008 - .020	.008 - .020	.013 - .030	.013 - .030	.020 - .038	.025 - .038	.033 - .051	.046 - .064	.051 - .076	
5553 / Beta Titanium		35 - 47	.008 - .020	.008 - .020	.010 - .025	.010 - .025	.013 - .030	.020 - .036	.025 - .041	.025 - .051	.038 - .064	
M	STAINLESS STEELS											
	13/8, 15/5, 17-4, pH Types	< 40 > 40	39 - 59 31 - 39	.008 - .015 .005 - .010	.008 - .015 .005 - .010	.008 - .018 .005 - .015	.015 - .023 .008 - .018	.020 - .030 .010 - .020	.033 - .046 .018 - .030	.025 - .051 .020 - .038	.030 - .064 .025 - .041	.030 - .051 .033 - .043
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	59 - 89 49 - 87	.005 - .015 .008 - .013	.005 - .015 .008 - .013	.013 - .020 .008 - .018	.020 - .038 .013 - .025	.038 - .046 .020 - .030	.025 - .046 .018 - .030	.038 - .064 .033 - .046	.046 - .071 .038 - .058	.056 - .081 .043 - .064
	400 Series - 403, 405, 420, 455	< 40 > 40	59 - 79 39 - 59	.018 - .025 .010 - .020	.018 - .025 .010 - .020	.023 - .038 .015 - .025	.023 - .036 .018 - .028	.028 - .038 .020 - .030	.033 - .046 .023 - .038	.038 - .064 .030 - .051	.051 - .089 .046 - .076	.056 - .102 .051 - .089
	HIGH STRENGTH TOOL STEELS											
A2, D2, P20, H13, S7, O1	< 40 > 40	59 - 79 39 - 59	.008 - .020 .008 - .013	.008 - .020 .008 - .013	.013 - .025 .008 - .020	.025 - .038 .013 - .025	.030 - .051 .013 - .025	.030 - .051 .013 - .025	.036 - .061 .025 - .038	.046 - .066 .030 - .046	.051 - .071 .036 - .051	
P	MEDIUM ALLOY TOOL STEELS											
	4140, 4340, 52100, 6150, 8620	< 40 > 40	59 - 79 39 - 59	.008 - .020 .008 - .013	.008 - .020 .008 - .013	.013 - .025 .008 - .020	.025 - .038 .013 - .025	.030 - .051 .013 - .025	.030 - .051 .013 - .025	.036 - .061 .025 - .038	.046 - .066 .030 - .046	.051 - .071 .036 - .051
	CARBON STEELS											
	1000's - 1018, 1020, 12L14	< 40	59 - 79	.008 - .020	.008 - .020	.013 - .025	.025 - .038	.030 - .051	.030 - .051	.036 - .061	.046 - .066	.051 - .071
K	CAST MATERIAL											
	Ductile Iron		69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114
	Gray Iron		69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114
N	NON-FERROUS											
	Aluminum (6061, 7075)		118 - 197	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
	Magnesium		118 - 197	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
	Copper		98 - 177	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
	Brass, Bronze		98 - 157	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
O	COMPOSITE (non-ISO)											
	Glass Epoxy, Fiberglass, Plastics		79 - 157	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL Drilling Guide for Drill Mills

## \* Through Hole \*

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)							
			152DA	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"
S	COBALT BASE ALLOYS										
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	60 - 90 50 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"
	NICKEL BASE ALLOYS										
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	55 - 90 45 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"
	IRON BASE ALLOYS										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascolloy	< 40 > 40	55 - 90 50 - 80	.0004" - .0008" .0003" - .0006"	.0004" - .0008" .0003" - .0006"	.0005" - .0010" .0003" - .0008"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0015"	.0015" - .0030" .0010" - .0015"	.0020" - .0030" .0015" - .0025"	.0025" - .0035" .0015" - .0020"
	TITANIUM ALLOYS										
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		100 - 150	.0003" - .0008"	.0005" - .0012"	.0005" - .0012"	.0008" - .0015"	.0010" - .0015"	.0013" - .0020"	.0018" - .0025"	.0025" - .0035"	
5553 / Beta Titanium		90 - 120	.0003" - .0008"	.0004" - .0010"	.0004" - .0010"	.0005" - .0012"	.0008" - .0014"	.0010" - .0016"	.0010" - .0020"	.0015" - .0025"	
M	STAINLESS STEELS										
	13/8, 15/5, 17-4, pH Types	< 40 > 40	100 - 150 80 - 100	.0003" - .0006" .0002" - .0004"	.0003" - .0007" .0002" - .0006"	.0006" - .0009" .0003" - .0007"	.0008" - .0012" .0004" - .0008"	.0013" - .0018" .0007" - .0012"	.0010" - .0020" .0008" - .0015"	.0012" - .0025" .0010" - .0016"	.0012" - .0020" .0013" - .0017"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	150 - 225 125 - 220	.0002" - .0006" .0003" - .0005"	.0005" - .0008" .0003" - .0007"	.0008" - .0015" .0005" - .0010"	.0010" - .0018" .0008" - .0012"	.0010" - .0018" .0009" - .0015"	.0015" - .0025" .0013" - .0018"	.0018" - .0028" .0013" - .0018"	.0022" - .0032" .0017" - .0025"
	400 Series - 403, 405, 420, 455	< 40 > 40	150 - 200 100 - 150	.0007" - .0010" .0004" - .0008"	.0009" - .0015" .0006" - .0010"	.0009" - .0014" .0007" - .0011"	.0011" - .0015" .0008" - .0012"	.0013" - .0018" .0009" - .0015"	.0015" - .0025" .0012" - .0020"	.0020" - .0035" .0018" - .0030"	.0030" - .0046" .0024" - .0042"
P	HIGH STRENGTH TOOL STEELS										
	A2, D2, P20, H13, S7, O1	< 40 > 40	150 - 200 100 - 150	.0003" - .0008" .0003" - .0005"	.0005" - .0010" .0003" - .0008"	.0010" - .0015" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0014" - .0024" .0010" - .0015"	.0018" - .0026" .0012" - .0018"	.0020" - .0028" .0015" - .0022"
	MEDIUM ALLOY TOOL STEELS										
	4140, 4340, 52100, 6150, 8620	< 40 > 40	150 - 200 100 - 150	.0003" - .0008" .0003" - .0005"	.0005" - .0010" .0003" - .0008"	.0010" - .0015" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0012" - .0020" .0005" - .0010"	.0014" - .0024" .0010" - .0015"	.0018" - .0026" .0012" - .0018"	.0020" - .0028" .0015" - .0022"
	CARBON STEELS										
1000's - 1018, 1020, 12L14	< 40	150 - 200	.0003" - .0008"	.0005" - .0010"	.0010" - .0015"	.0012" - .0020"	.0012" - .0020"	.0014" - .0024"	.0018" - .0026"	.0020" - .0028"	
K	CAST MATERIAL										
	Ductile Iron		175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"
	Gray Iron		175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"
N	NON-FERROUS										
	Aluminum (6061, 7075)		300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
	Magnesium		300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
	Copper		250 - 450	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
	Brass, Bronze		200 - 400	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"
O	COMPOSITE (non-ISO)										
	Glass Epoxy, Fiberglass, Plastics		200 - 400	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL Drilling Guide for Drill Mills

## \* Through Hole \*

ISO Material	HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)									
		152DA	3.0mm	4.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.00mm	20.0mm	
<b>S</b>	<b>COBALT BASE ALLOYS</b>											
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	24 - 35 20 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051
	<b>NICKEL BASE ALLOYS</b>											
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	22 - 35 18 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051
	<b>IRON BASE ALLOYS</b>											
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	22 - 35 20 - 31	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.010 - .020 .008 - .015	.013 - .025 .008 - .020	.020 - .038 .013 - .025	.025 - .046 .020 - .038	.038 - .076 .025 - .038	.051 - .076 .038 - .064	.064 - .089 .038 - .051
	<b>TITANIUM ALLOYS</b>											
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		20 - 31	.008 - .020	.008 - .020	.013 - .030	.013 - .030	.020 - .038	.025 - .038	.033 - .051	.046 - .064	.051 - .076
	5553 / Beta Titanium		35 - 47	.008 - .020	.008 - .020	.010 - .025	.010 - .025	.013 - .030	.020 - .036	.025 - .041	.025 - .051	.038 - .064
<b>M</b>	<b>STAINLESS STEELS</b>											
	13/8, 15/5, 17-4, pH Types	< 40 > 40	39 - 59 31 - 39	.008 - .015 .005 - .010	.008 - .015 .005 - .010	.008 - .018 .005 - .015	.015 - .023 .008 - .018	.020 - .030 .010 - .020	.033 - .046 .018 - .030	.025 - .051 .020 - .038	.030 - .064 .025 - .041	.030 - .051 .033 - .043
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	59 - 89 49 - 87	.005 - .015 .008 - .013	.005 - .015 .008 - .013	.013 - .020 .008 - .018	.020 - .038 .013 - .025	.038 - .046 .020 - .030	.025 - .046 .018 - .030	.038 - .064 .033 - .046	.046 - .071 .038 - .058	.056 - .081 .043 - .064
	400 Series - 403, 405, 420, 455	< 40 > 40	59 - 79 39 - 59	.018 - .025 .010 - .020	.018 - .025 .010 - .020	.023 - .038 .015 - .025	.023 - .036 .018 - .028	.028 - .038 .020 - .030	.033 - .046 .023 - .038	.038 - .064 .030 - .051	.051 - .089 .046 - .076	.056 - .102 .051 - .089
	<b>HIGH STRENGTH TOOL STEELS</b>											
<b>P</b>	A2, D2, P20, H13, S7, O1	< 40 > 40	59 - 79 39 - 59	.008 - .020 .008 - .013	.008 - .020 .008 - .013	.013 - .025 .008 - .020	.025 - .038 .013 - .025	.030 - .051 .013 - .025	.030 - .051 .013 - .025	.036 - .061 .025 - .038	.046 - .066 .030 - .046	.051 - .071 .036 - .051
	<b>MEDIUM ALLOY TOOL STEELS</b>											
	4140, 4340, 52100, 6150, 8620	< 40 > 40	59 - 79 39 - 59	.008 - .020 .008 - .013	.008 - .020 .008 - .013	.013 - .025 .008 - .020	.025 - .038 .013 - .025	.030 - .051 .013 - .025	.030 - .051 .013 - .025	.036 - .061 .025 - .038	.046 - .066 .030 - .046	.051 - .071 .036 - .051
	<b>CARBON STEELS</b>											
	1000's - 1018, 1020, 12L14	< 40	59 - 79	.008 - .020	.008 - .020	.013 - .025	.025 - .038	.030 - .051	.030 - .051	.036 - .061	.046 - .066	.051 - .071
<b>K</b>	<b>CAST MATERIAL</b>											
	Ductile Iron		69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114
	Gray Iron		69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114
<b>N</b>	<b>NON-FERROUS</b>											
	Aluminum (6061, 7075)		118 - 197	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
	Magnesium		118 - 197	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
	Copper		98 - 177	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
	Brass, Bronze		98 - 157	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178
<b>O</b>	<b>COMPOSITE (non-ISO)</b>											
	Glass Epoxy, Fiberglass, Plastics		79 - 157	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL General Purpose Drilling Guide (Bright Finish)

ISO Material		HRC	SFM (by Series)			
			1100	1200, 1205, 1520	1500, 1510	1600
S	COBALT BASE ALLOYS					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	- -	45 - 70 35 - 60	45 - 70 35 - 60	30 - 55 20 - 45
	NICKEL BASE ALLOYS					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	- -	45 - 70 35 - 60	45 - 70 35 - 60	30 - 55 20 - 45
	IRON BASE ALLOYS					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	- -	45 - 70 35 - 60	45 - 70 35 - 60	30 - 55 20 - 45
	TITANIUM ALLOYS					
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium	  	- -	60 - 90 45 - 65	60 - 90 45 - 65	45 - 75 30 - 50
M	STAINLESS STEELS					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	- -	50 - 80 35 - 60	50 - 80 35 - 60	35 - 65 20 - 45
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	- -	45 - 75 35 - 55	45 - 75 35 - 55	30 - 60 20 - 40
	400 Series - 403, 405, 420, 455	< 40 > 40	- -	60 - 90 40 - 65	60 - 90 40 - 65	45 - 75 25 - 50
	HIGH STRENGTH TOOL STEELS					
P	A2, D2, P20, H13, S7, O1	< 40 > 40	- -	80 - 130 60 - 110	80 - 130 60 - 110	65 - 110 45 - 90
	Thompson Shaft, Armor Plate (Class 1)	> 50	-	-	45 - 80	30 - 60
	MEDIUM ALLOY TOOL STEELS					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	- -	100 - 140 70 - 120	100 - 140 70 - 120	65 - 120 55 - 100
	CARBON STEELS					
	1000's - 1018, 1020, 12L14	< 40	-	120 - 170	120 - 170	105 - 150
K	CAST MATERIAL					
	Ductile Iron		70 - 140	120 - 170	120 - 170	105 - 150
	Gray Iron		70 - 165	120 - 190	120 - 190	105 - 170
N	NON-FERROUS					
	Aluminum (6061, 7075)		-	200 - 300	-	160 - 250
	Magnesium		-	120 - 215	-	80 - 165
	Copper		-	100 - 165	-	60 - 125
	Brass, Bronze		-	120 - 215	-	80 - 165
O	COMPOSITE (non-ISO)					
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		140	100 - 230	105 - 230	-

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.



# GARR TOOL General Purpose Drilling Guide (Bright Finish)

ISO Material		HRC	CHIPLOAD PER TOOTH (Fz)				
			1/16" - 1/8"	1/8" - 1/4"	1/4" - 3/8"	3/8" - 1/2"	1/2" - 5/8"
S	COBALT BASE ALLOYS						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	.0003" - .0008" .0002" - .0006"	.0006" - .0011" .0004" - .0009"	.0010" - .0017" .0008" - .0015"	.0014" - .0024" .0012" - .0022"	.0019" - .0032" .0017" - .0030"
	NICKEL BASE ALLOYS						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	.0003" - .0008" .0002" - .0006"	.0006" - .0011" .0004" - .0009"	.0010" - .0017" .0008" - .0015"	.0014" - .0024" .0012" - .0022"	.0019" - .0032" .0017" - .0030"
	IRON BASE ALLOYS						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	.0003" - .0008" .0002" - .0006"	.0006" - .0011" .0004" - .0009"	.0010" - .0017" .0008" - .0015"	.0014" - .0024" .0012" - .0022"	.0019" - .0032" .0017" - .0030"
	TITANIUM ALLOYS						
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		.0004" - .0009"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
	5553 / Beta Titanium		.0003" - .0007"	.0006" - .0011"	.0010" - .0017"	.0014" - .0024"	.0019" - .0030"
M	STAINLESS STEELS						
	13/8, 15/5, 17-4, pH Types	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	400 Series - 403, 405, 420, 455	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
P	HIGH STRENGTH TOOL STEELS						
	A2, D2, P20, H13, S7, O1	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	Thompson Shaft, Armor Plate (Class 1)	> 50	.0002" - .0006"	.0005" - .0009"	.0009" - .0015"	.0013" - .0022"	.0018" - .0028"
	MEDIUM ALLOY TOOL STEELS						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	CARBON STEELS						
	1000's - 1018, 1020, 12L14	< 40	.0005" - .0010"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
K	CAST MATERIAL						
	Ductile Iron		.0005" - .0010"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
	Gray Iron		.0005" - .0010"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
N	NON-FERROUS						
	Aluminum (6061, 7075)		.0006" - .0011"	.0009" - .0015"	.0013" - .0021"	.0017" - .0028"	.0022" - .0034"
	Magnesium		.0005" - .0010"	.0009" - .0014"	.0013" - .0020"	.0017" - .0027"	.0022" - .0033"
	Copper		.0004" - .0008"	.0008" - .0012"	.0012" - .0018"	.0016" - .0025"	.0021" - .0031"
	Brass, Bronze		.0005" - .0009"	.0009" - .0013"	.0013" - .0019"	.0017" - .0026"	.0022" - .0032"
O	COMPOSITE (non-ISO)						
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		.0003" - .0008"	.0007" - .0012"	.0011" - .0018"	.0015" - .0025"	.0020" - .0031"

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL General Purpose Drilling Guide (Bright Finish)

	ISO Material	HRC	M/Min. (by Series)			
			1100	1200, 1205, 1520	1500, 1510	1600
<b>S</b>	<b>COBALT BASE ALLOYS</b>					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	- -	14 - 21 10 - 18	14 - 21 10 - 18	10 - 17 6 - 14
	<b>NICKEL BASE ALLOYS</b>					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	- -	14 - 21 10 - 18	14 - 21 10 - 18	10 - 17 6 - 14
	<b>IRON BASE ALLOYS</b>					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	- -	14 - 21 10 - 18	14 - 21 10 - 18	10 - 17 6 - 14
	<b>TITANIUM ALLOYS</b>					
<b>M</b>	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		-	18 - 27	18 - 27	14 - 23
	5553 / Beta Titanium		-	14 - 20	14 - 20	10 - 15
	<b>STAINLESS STEELS</b>					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	- -	15 - 25 10 - 18	15 - 25 10 - 18	10 - 20 6 - 14
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	- -	14 - 23 10 - 17	14 - 23 10 - 17	10 - 18 6 - 12
	400 Series - 403, 405, 420, 455	< 40 > 40	- -	18 - 27 12 - 20	18 - 27 12 - 20	14 - 23 8 - 15
	<b>HIGH STRENGTH TOOL STEELS</b>					
<b>P</b>	A2, D2, P20, H13, S7, O1	< 40 > 40	- -	25 - 40 18 - 34	25 - 40 18 - 34	20 - 34 14 - 27
	Thompson Shaft, Armor Plate (Class 1)	> 50	-	-	14 - 25	10 - 20
	<b>MEDIUM ALLOY TOOL STEELS</b>					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	- -	30 - 43 21 - 37	30 - 43 21 - 37	20 - 37 17 - 30
	<b>CARBON STEELS</b>					
	1000's - 1018, 1020, 12L14	< 40	-	37 - 52	37 - 52	32 - 45
	<b>CAST MATERIAL</b>					
<b>K</b>	Ductile Iron		21 - 43	37 - 52	37 - 52	32 - 45
	Gray Iron		21 - 50	37 - 58	37 - 58	32 - 52
	<b>NON-FERROUS</b>					
<b>N</b>	Aluminum (6061, 7075)		-	60 - 90	-	50 - 75
	Magnesium		-	37 - 65	-	25 - 50
	Copper		-	30 - 50	-	18 - 38
	Brass, Bronze		-	37 - 65	-	25 - 50
<b>O</b>	<b>COMPOSITE (non-ISO)</b>					
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		43	30 - 70	32 - 70	-

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL General Purpose Drilling Guide (Bright Finish)

ISO Material		HRC	CHIPLOAD PER TOOTH (Fz)				
			2.0 - 3.0mm	3.0 - 6.0mm	6.0 - 10.0mm	10.0 - 13.0mm	13.0 - 16.0mm
S	COBALT BASE ALLOYS						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	.008 - .020 .005 - .015	.015 - .028 .010 - .023	.025 - .043 .020 - .038	.036 - .061 .030 - .056	.048 - .081 .043 - .076
	NICKEL BASE ALLOYS						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	.008 - .020 .005 - .015	.015 - .028 .010 - .023	.025 - .043 .020 - .038	.036 - .061 .030 - .056	.048 - .081 .043 - .076
	IRON BASE ALLOYS						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	.008 - .020 .005 - .015	.015 - .028 .010 - .023	.025 - .043 .020 - .038	.036 - .061 .030 - .056	.048 - .081 .043 - .076
	TITANIUM ALLOYS						
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium	  	.010 - .023  .008 - .018	.020 - .036  .015 - .028	.030 - .051  .025 - .043	.041 - .069  .036 - .061	.053 - .084  .048 - .076
M	STAINLESS STEELS						
	13/8, 15/5, 17-4, pH Types	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	400 Series - 403, 405, 420, 455	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	HIGH STRENGTH TOOL STEELS						
	A2, D2, P20, H13, S7, O1  Thompson Shaft, Armor Plate (Class 1)	< 40 > 40 > 50	.010 - .023 .008 - .018 .005 - .015	.018 - .033 .015 - .028 .013 - .023	.028 - .048 .025 - .043 .023 - .038	.038 - .066 .036 - .061 .033 - .056	.051 - .081 .048 - .076 .046 - .071
P	MEDIUM ALLOY TOOL STEELS						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	CARBON STEELS						
	1000's - 1018, 1020, 12L14	< 40	.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084
K	CAST MATERIAL						
	Ductile Iron		.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084
	Gray Iron		.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084
N	NON-FERROUS						
	Aluminum (6061, 7075)		.015 - .028	.023 - .038	.033 - .053	.043 - .071	.056 - .086
	Magnesium		.013 - .025	.023 - .036	.033 - .051	.043 - .069	.056 - .084
	Copper		.010 - .020	.020 - .030	.030 - .046	.041 - .064	.053 - .079
	Brass, Bronze		.013 - .023	.023 - .033	.033 - .048	.043 - .066	.056 - .081
O	COMPOSITE (non-ISO)						
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		.008 - .020	.018 - .030	.028 - .046	.038 - .064	.051 - .079

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL General Purpose Drilling Guide (Durana Coated)

ISO Material		HRC	SFM (by Series)			
			1100H, 1120H	1200H, 1205H, 1520H	1500H, 1510H	1800H
S	COBALT BASE ALLOYS					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	- -	55 - 75 45 - 65	55 - 75 45 - 65	- -
	NICKEL BASE ALLOYS					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	- -	55 - 80 45 - 70	55 - 80 45 - 70	- -
	IRON BASE ALLOYS					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	- -	55 - 80 45 - 70	55 - 80 45 - 70	- -
	TITANIUM ALLOYS					
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium	  	- -	70 - 100 55 - 75	70 - 100 55 - 75	- -
M	STAINLESS STEELS					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	- -	60 - 90 45 - 70	60 - 90 45 - 70	- -
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	- -	55 - 85 45 - 65	55 - 85 45 - 65	- -
	400 Series - 403, 405, 420, 455	< 40 > 40	- -	70 - 100 50 - 75	70 - 100 50 - 75	- -
P	HIGH STRENGTH TOOL STEELS					
	A2, D2, P20, H13, S7, O1	< 40 > 40	- -	90 - 140 70 - 120	90 - 140 70 - 120	- -
	Thompson Shaft, Armor Plate (Class 1)	> 50	-	-	55 - 90	-
	MEDIUM ALLOY TOOL STEELS					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	- -	110 - 150 80 - 130	110 - 150 80 - 130	- -
	CARBON STEELS					
	1000's - 1018, 1020, 12L14	< 40	-	130 - 180	130 - 180	-
K	CAST MATERIAL					
	Ductile Iron		80 - 150	130 - 180	130 - 180	-
	Gray Iron		80 - 175	130 - 200	130 - 200	-
N	NON-FERROUS					
	Aluminum (6061, 7075)		-	200 - 300	-	200 - 300
	Magnesium		-	130 - 225	-	130 - 225
	Copper		-	110 - 175	-	110 - 175
	Brass, Bronze		-	130 - 225	-	130 - 225
O	COMPOSITE (non-ISO)					
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		160	125 - 250	125 - 250	-

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL General Purpose Drilling Guide

## (Durana Coated)

ISO Material		HRC	CHIPLOAD PER TOOTH (Fz)				
			1/16" - 1/8"	1/8" - 1/4"	1/4" - 3/8"	3/8" - 1/2"	1/2" - 5/8"
S	COBALT BASE ALLOYS						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	.0003" - .0008" .0002" - .0006"	.0006" - .0011" .0004" - .0009"	.0010" - .0017" .0008" - .0015"	.0014" - .0024" .0012" - .0022"	.0019" - .0032" .0017" - .0030"
	NICKEL BASE ALLOYS						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	.0003" - .0008" .0002" - .0006"	.0006" - .0011" .0004" - .0009"	.0010" - .0017" .0008" - .0015"	.0014" - .0024" .0012" - .0022"	.0019" - .0032" .0017" - .0030"
	IRON BASE ALLOYS						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	.0003" - .0008" .0002" - .0006"	.0006" - .0011" .0004" - .0009"	.0010" - .0017" .0008" - .0015"	.0014" - .0024" .0012" - .0022"	.0019" - .0032" .0017" - .0030"
	TITANIUM ALLOYS						
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		.0004" - .0009"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
	5553 / Beta Titanium		.0003" - .0007"	.0006" - .0011"	.0010" - .0017"	.0014" - .0024"	.0019" - .0030"
M	STAINLESS STEELS						
	13/8, 15/5, 17-4, pH Types	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	400 Series - 403, 405, 420, 455	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	HIGH STRENGTH TOOL STEELS						
	A2, D2, P20, H13, S7, O1	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
P	Thompson Shaft, Armor Plate (Class 1)	> 50	.0002" - .0006"	.0005" - .0009"	.0009" - .0015"	.0013" - .0022"	.0018" - .0028"
	MEDIUM ALLOY TOOL STEELS						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	.0004" - .0009" .0003" - .0007"	.0007" - .0013" .0006" - .0011"	.0011" - .0019" .0010" - .0017"	.0015" - .0026" .0014" - .0024"	.0020" - .0032" .0019" - .0030"
	CARBON STEELS						
	1000's - 1018, 1020, 12L14	< 40	.0005" - .0010"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
K	CAST MATERIAL						
	Ductile Iron		.0005" - .0010"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
	Gray Iron		.0005" - .0010"	.0008" - .0014"	.0012" - .0020"	.0016" - .0027"	.0021" - .0033"
N	NON-FERROUS						
	Aluminum (6061, 7075)		.0006" - .0011"	.0009" - .0015"	.0013" - .0021"	.0017" - .0028"	.0022" - .0034"
	Magnesium		.0005" - .0010"	.0009" - .0014"	.0013" - .0020"	.0017" - .0027"	.0022" - .0033"
	Copper		.0004" - .0008"	.0008" - .0012"	.0012" - .0018"	.0016" - .0025"	.0021" - .0031"
	Brass, Bronze		.0005" - .0009"	.0009" - .0013"	.0013" - .0019"	.0017" - .0026"	.0022" - .0032"
O	COMPOSITE (non-ISO)						
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		.0003" - .0008"	.0007" - .0012"	.0011" - .0018"	.0015" - .0025"	.0020" - .0031"

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL General Purpose Drilling Guide (Durana Coated)

	ISO Material	HRC	M/Min. (by Series)			
			1100H, 1120H	1200H, 1205H, 1520H	1500H, 1510H	1800H
<b>S</b>	<b>COBALT BASE ALLOYS</b>					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	- -	17 - 23 13 - 20	17 - 23 13 - 20	- -
	<b>NICKEL BASE ALLOYS</b>					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	- -	17 - 25 13 - 21	17 - 25 13 - 21	- -
	<b>IRON BASE ALLOYS</b>					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	- -	17 - 25 13 - 21	17 - 25 13 - 21	- -
	<b>TITANIUM ALLOYS</b>					
<b>M</b>	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		-	21 - 30	21 - 30	-
	5553 / Beta Titanium		-	17 - 23	17 - 23	-
	<b>STAINLESS STEELS</b>					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	- -	18 - 27 13 - 21	18 - 27 13 - 21	- -
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	- -	17 - 26 13 - 20	17 - 26 13 - 20	- -
	400 Series - 403, 405, 420, 455	< 40 > 40	- -	21 - 30 15 - 23	21 - 30 15 - 23	- -
	<b>HIGH STRENGTH TOOL STEELS</b>					
<b>P</b>	A2, D2, P20, H13, S7, O1	< 40 > 40	- -	27 - 43 21 - 37	27 - 43 21 - 37	- -
	Thompson Shaft, Armor Plate (Class 1)	> 50	-	-	17 - 27	-
	<b>MEDIUM ALLOY TOOL STEELS</b>					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	- -	34 - 45 25 - 40	34 - 45 25 - 40	- -
	<b>CARBON STEELS</b>					
	1000's - 1018, 1020, 12L14	< 40	-	40 - 55	40 - 55	-
	<b>CAST MATERIAL</b>					
<b>K</b>	Ductile Iron		25 - 45	40 - 55	40 - 55	-
	Gray Iron		25 - 53	40 - 60	40 - 60	-
	<b>NON-FERROUS</b>					
<b>N</b>	Aluminum (6061, 7075)		-	60 - 90	-	60 - 90
	Magnesium		-	40 - 68	-	40 - 68
	Copper		-	34 - 53	-	34 - 53
	Brass, Bronze		-	40 - 68	-	40 - 68
<b>O</b>	<b>COMPOSITE (non-ISO)</b>					
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		50	38 - 75	-	-

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# GARR TOOL General Purpose Drilling Guide (Durana Coated)

ISO Material		HRC	CHIPLOAD PER TOOTH (Fz)				
			2.0 - 3.0mm	3.0 - 6.0mm	6.0 - 10.0mm	10.0 - 13.0mm	13.0 - 16.0mm
S	COBALT BASE ALLOYS						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	.008 - .020 .005 - .015	.015 - .028 .010 - .023	.025 - .043 .020 - .038	.036 - .061 .030 - .056	.048 - .081 .043 - .076
	NICKEL BASE ALLOYS						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	.008 - .020 .005 - .015	.015 - .028 .010 - .023	.025 - .043 .020 - .038	.036 - .061 .030 - .056	.048 - .081 .043 - .076
	IRON BASE ALLOYS						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	.008 - .020 .005 - .015	.015 - .028 .010 - .023	.025 - .043 .020 - .038	.036 - .061 .030 - .056	.048 - .081 .043 - .076
	TITANIUM ALLOYS						
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		.010 - .023	.020 - .036	.030 - .051	.041 - .069	.053 - .084
	5553 / Beta Titanium		.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
M	STAINLESS STEELS						
	13/8, 15/5, 17-4, pH Types	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	400 Series - 403, 405, 420, 455	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
P	HIGH STRENGTH TOOL STEELS						
	A2, D2, P20, H13, S7, O1	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	Thompson Shaft, Armor Plate (Class 1)	> 50	.005 - .015	.013 - .023	.023 - .038	.033 - .056	.046 - .071
	MEDIUM ALLOY TOOL STEELS						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	.010 - .023 .008 - .018	.018 - .033 .015 - .028	.028 - .048 .025 - .043	.038 - .066 .036 - .061	.051 - .081 .048 - .076
	CARBON STEELS						
	1000's - 1018, 1020, 12L14	< 40	.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084
K	CAST MATERIAL						
	Ductile Iron		.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084
	Gray Iron		.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084
N	NON-FERROUS						
	Aluminum (6061, 7075)		.015 - .028	.023 - .038	.033 - .053	.043 - .071	.056 - .086
	Magnesium		.013 - .025	.023 - .036	.033 - .051	.043 - .069	.056 - .084
	Copper		.010 - .020	.020 - .030	.030 - .046	.041 - .064	.053 - .079
	Brass, Bronze		.013 - .023	.023 - .033	.033 - .048	.043 - .066	.056 - .081
O	COMPOSITE (non-ISO)						
	Glass Epoxy, Fiberglass, Plastics, Graphite, G10		.008 - .020	.018 - .030	.028 - .046	.038 - .064	.051 - .079

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL High Performance Drilling Guide for Mini Drills

(Series 1550H,1250H,1850H)

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)		
				.0312" - .0390"	.0394" - .0787"	.0791" - .1250"
S	COBALT BASE ALLOYS					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	70 - 100 50 - 85	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	NICKEL BASE ALLOYS					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	70 - 100 50 - 85	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	IRON BASE ALLOYS					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	70 - 100 50 - 85	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	TITANIUM ALLOYS					
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium	  	90 - 130  75 - 115	.0003" - .0006"  .0002" - .0004"	.0004" - .0008"  .0003" - .0006"	.0006" - .0012"  .0005" - .0010"
M	STAINLESS STEELS					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	95 - 135 80 - 125	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	90 - 125 80 - 115	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	400 Series - 403, 405, 420, 455	< 40 > 40	100 - 150 80 - 125	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	HIGH STRENGTH TOOL STEELS					
P	A2, D2, P20, H13, S7, O1	< 40 > 40	100 - 175 60 - 80	.0003" - .0006" .0002" - .0004"	.0004" - .0008" .0003" - .0006"	.0006" - .0012" .0005" - .0010"
	MEDIUM ALLOY TOOL STEELS					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	125 - 175 80 - 125	.0004" - .0008" .0003" - .0005"	.0006" - .0012" .0004" - .0008"	.0008" - .0015" .0006" - .0012"
	CARBON STEELS					
	1000's - 1018, 1020, 12L14	< 40	125 - 175	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
K	CAST MATERIAL					
	Ductile Iron		100 - 200	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
	Gray Iron		80 - 175	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
N	NON-FERROUS					
	Aluminum 2014, 2024, 6061-(T1-T6), 7075, Extruded		125 - 300	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
	Magnesium		125 - 250	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
	Copper		125 - 250	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
	Brass		100 - 250	.0003" - .0008"	.0004" - .0012"	.0006" - .0015"
	Bronze		80 - 250	.0003" - .0008"	.0004" - .0012"	.0006" - .0015"

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# GARR TOOL High Performance Drilling Guide for Mini Drills

(Series 1550H,1250H,1850H)

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)		
				0.79 - 0.99mm	1.00 - 2.00mm	2.01 - 3.17mm
S	COBALT BASE ALLOYS					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	20 - 30 15 - 25	.005 - .010 .005 - .010	.010 - .018 .008 - .015	.015 - .025 .013 - .023
	NICKEL BASE ALLOYS					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	20 - 30 15 - 25	.008 - .013 .005 - .010	.010 - .018 .008 - .015	.015 - .025 .013 - .023
	IRON BASE ALLOYS					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascolloy	< 40 > 40	20 - 30 15 - 25	.005 - .013 .005 - .010	.010 - .020 .008 - .018	.013 - .025 .010 - .023
	TITANIUM ALLOYS					
	Commercially Pure, 6Al-4V, Astrm 1/2/3, 6Al-25N-4Zr-2Mo-Si 5553 / Beta Titanium	  	25 - 40 20 - 35	.008 - .015 .005 - .010	.010 - .020 .008 - .015	.015 - .030 .013 - .025
M	STAINLESS STEELS					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	30 - 40 25 - 40	.005 - .010 .005 - .010	.010 - .018 .008 - .015	.015 - .025 .013 - .023
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	25 - 40 25 - 35	.005 - .010 .005 - .010	.010 - .018 .008 - .015	.015 - .025 .013 - .023
	400 Series - 403, 405, 420, 455	< 40 > 40	30 - 45 25 - 40	.005 - .010 .005 - .010	.010 - .018 .008 - .015	.015 - .025 .013 - .023
	HIGH STRENGTH TOOL STEELS					
P	A2, D2, P20, H13, S7, O1	< 40 > 40	30 - 50 20 - 25	.008 - .015 .005 - .010	.010 - .020 .008 - .015	.015 - .030 .013 - .025
	MEDIUM ALLOY TOOL STEELS					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	40 - 50 25 - 40	.010 - .020 .008 - .013	.015 - .030 .010 - .020	.020 - .038 .015 - .030
	CARBON STEELS					
	1000's - 1018, 1020, 12L14	< 40	40 - 50	.010 - .020	.015 - .030	.020 - .038
K	CAST MATERIAL					
	Ductile Iron		30 - 60	.010 - .020	.015 - .030	.020 - .038
	Gray Iron		25 - 50	.010 - .020	.015 - .030	.020 - .038
N	NON-FERROUS					
	Aluminum 2014, 2024, 6061-(T1-T6), 7075, Extruded		40 - 90	.010 - .020	.015 - .030	.020 - .038
	Magnesium		40 - 75	.010 - .020	.015 - .030	.020 - .038
	Copper		40 - 75	.010 - .020	.015 - .030	.020 - .038
	Brass		30 - 75	.008 - .020	.010 - .030	.015 - .038
	Bronze		25 - 75	.008 - .020	.010 - .030	.015 - .038

NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.

# GARR TOOL HTD 12 High Performance Drilling Guide

ISO Material		HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)		
				1/8" - 1/4"	1/4" - 3/8"	3/8" - 1/2"
S	COBALT BASE ALLOYS					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	110 70	.0006" - .0016" .0004" - .0012"	.0016" - .0022" .0012" - .0018"	.0022" - .0035" .0018" - .0031"
	NICKEL BASE ALLOYS					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	120 80	.0006" - .0016" .0004" - .0012"	.0016" - .0022" .0012" - .0018"	.0022" - .0035" .0018" - .0031"
	IRON BASE ALLOYS					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	120 80	.0006" - .0016" .0004" - .0012"	.0016" - .0022" .0012" - .0018"	.0022" - .0035" .0018" - .0031"
	TITANIUM ALLOYS					
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si 5553 / Beta Titanium		170 120	.0006" - .0026" .0005" - .0023"	.0026" - .0040" .0023" - .0034"	.0040" - .0055" .0034" - .0047"
M	STAINLESS STEELS					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	150 105	.0006" - .0018" .0005" - .0013"	.0018" - .0035" .0013" - .0030"	.0035" - .0049" .0030" - .0043"
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	150 105	.0006" - .0018" .0005" - .0013"	.0018" - .0035" .0013" - .0030"	.0035" - .0049" .0030" - .0043"
	400 Series - 403, 405, 420, 455	< 40 > 40	160 105	.0006" - .0018" .0005" - .0013"	.0018" - .0035" .0013" - .0030"	.0035" - .0049" .0030" - .0043"
P	HIGH STRENGTH TOOL STEELS					
	A2, D2, P20, H13, S7, O1	< 40 > 40	170 105	.0008" - .0026" .0006" - .0020"	.0026" - .0038" .0020" - .0032"	.0038" - .0050" .0032" - .0043"
	MEDIUM ALLOY TOOL STEELS					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	260 110	.0008" - .0026" .0006" - .0020"	.0026" - .0038" .0020" - .0032"	.0038" - .0050" .0032" - .0043"
	CARBON STEELS					
	1000's - 1018, 1020, 12L14	< 40	320	.0008" - .0029"	.0030" - .0045"	.0045" - .0060"
K	CAST MATERIAL					
	Ductile Iron		340	.0008" - .0029"	.0029" - .0045"	.0045" - .0060"
	Gray Iron		350	.0008" - .0029"	.0029" - .0045"	.0045" - .0060"
N	NON-FERROUS					
	Aluminum 2014, 2024, 6061-(T1-T6), 7075		400	.0016" - .0030"	.0030" - .0046"	.0046" - .0062"
	Aluminum Die Cast		375	.0014" - .0027"	.0027" - .0040"	.0040" - .0054"
	Magnesium		275	.0014" - .0026"	.0026" - .0037"	.0037" - .0049"
	Copper		250	.0013" - .0024"	.0024" - .0031"	.0031" - .0044"
	Brass		360	.0016" - .0030"	.0030" - .0044"	.0044" - .0060"
	Bronze		260	.0013" - .0024"	.0024" - .0031"	.0031" - .0044"

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# GARR TOOL HTD 12 High Performance Drilling Guide

ISO Material		HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)		
				3.0 - 6.0mm	6.0 - 10.0mm	10.0 - 13.0mm
S	COBALT BASE ALLOYS					
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	33 21	.015 - .041 .010 - .030	.041 - .056 .030 - .046	.056 - .089 .046 - .079
	NICKEL BASE ALLOYS					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	36 24	.015 - .041 .010 - .030	.041 - .056 .030 - .046	.056 - .089 .046 - .079
	IRON BASE ALLOYS					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	36 24	.015 - .041 .010 - .030	.041 - .056 .030 - .046	.056 - .089 .046 - .079
	TITANIUM ALLOYS					
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si  5553 / Beta Titanium		52  36	.015 - .066  .013 - .058	.066 - .102  .058 - .086	.102 - .140  .086 - .119
M	STAINLESS STEELS					
	13/8, 15/5, 17-4, pH Types	< 40 > 40	45 32	.015 - .046 .013 - .033	.046 - .089 .033 - .076	.089 - .124 .076 - .109
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	45 32	.015 - .046 .013 - .033	.046 - .089 .033 - .076	.089 - .124 .076 - .109
	400 Series - 403, 405, 420, 455	< 40 > 40	48 32	.015 - .046 .013 - .033	.046 - .089 .033 - .076	.089 - .124 .076 - .109
	HIGH STRENGTH TOOL STEELS					
	A2, D2, P20, H13, S7, O1	< 40 > 40	52 32	.020 - .066 .015 - .051	.066 - .097 .051 - .081	.097 - .127 .081 - .109
P	MEDIUM ALLOY TOOL STEELS					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	79 33	.020 - .066 .015 - .051	.066 - .097 .051 - .081	.097 - .127 .081 - .109
	CARBON STEELS					
	1000's - 1018, 1020, 12L14	< 40	97	.020 - .074	.074 - .114	.114 - .152
K	CAST MATERIAL					
	Ductile Iron		103	.020 - .074	.074 - .114	.114 - .152
	Gray Iron		106	.020 - .074	.074 - .114	.114 - .152
N	NON-FERROUS					
	Aluminum 2014, 2024, 6061-(T1-T6), 7075		122	.041 - .076	.076 - .117	.117 - .157
	Aluminum Die Cast		114	.036 - .069	.069 - .102	.102 - .137
	Magnesium		83	.036 - .066	.066 - .094	.094 - .124
	Copper		76	.033 - .061	.061 - .079	.079 - .112
	Brass		109	.041 - .076	.076 - .112	.112 - .152
	Bronze		79	.033 - .061	.061 - .079	.079 - .112

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# GARR TOOL High Performance Drilling Guide

ISO Material		HRC	SFM (Vc)		CHIPLOAD PER TOOTH (Fz)					
			NON-COOLANT	COOLANT FED	1/8" - 1/4"	1/4" - 3/8"	3/8" - 1/2"	1/2" - 5/8"	5/8" - 3/4"	
S	COBALT BASE ALLOYS									
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	80 60	100 75	.0008" - .0015" .0005" - .0012"	.0012" - .0020" .0009" - .0017"	.0017" - .0026" .0014" - .0023"	.0022" - .0032" .0019" - .0029"	.0027" - .0038" .0024" - .0035"	
	NICKEL BASE ALLOYS									
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	90 70	110 75	.0008" - .0015" .0005" - .0012"	.0012" - .0020" .0009" - .0017"	.0017" - .0026" .0014" - .0023"	.0022" - .0032" .0019" - .0029"	.0027" - .0038" .0024" - .0035"	
	IRON BASE ALLOYS									
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	90 60	115 75	.0008" - .0015" .0005" - .0012"	.0012" - .0020" .0009" - .0017"	.0017" - .0026" .0014" - .0023"	.0022" - .0032" .0019" - .0029"	.0027" - .0038" .0024" - .0035"	
	TITANIUM ALLOYS									
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		110	135	.0010" - .0018"	.0015" - .0023"	.0020" - .0029"	.0025" - .0035"	.0030" - .0041"		
5553 / Beta Titanium		70	100	.0008" - .0015"	.0012" - .0020"	.0017" - .0026"	.0022" - .0032"	.0027" - .0038"		
M	STAINLESS STEELS									
	13/8, 15/5, 17-4, pH Types	< 40 > 40	100 80	120 90	.0010" - .0017" .0007" - .0015"	.0014" - .0022" .0011" - .0020"	.0019" - .0028" .0016" - .0026"	.0024" - .0034" .0021" - .0032"	.0029" - .0040" .0026" - .0038"	
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	90 70	110 80	.0010" - .0017" .0007" - .0015"	.0014" - .0022" .0011" - .0020"	.0019" - .0028" .0016" - .0026"	.0024" - .0034" .0021" - .0032"	.0029" - .0040" .0026" - .0038"	
	400 Series - 403, 405, 420, 455	< 40 > 40	110 80	130 105	.0010" - .0017" .0007" - .0015"	.0014" - .0022" .0011" - .0020"	.0019" - .0028" .0016" - .0026"	.0024" - .0034" .0021" - .0032"	.0029" - .0040" .0026" - .0038"	
	HIGH STRENGTH TOOL STEELS									
A2, D2, P20, H13, S7, O1	< 40 > 40	160 130	200 150	.0011" - .0020" .0007" - .0014"	.0015" - .0025" .0011" - .0019"	.0020" - .0031" .0016" - .0025"	.0025" - .0037" .0021" - .0031"	.0030" - .0043" .0026" - .0037"		
P	MEDIUM ALLOY TOOL STEELS									
	4140, 4340, 52100, 6150, 8620	< 40 > 40	175 145	215 170	.0011" - .0020" .0007" - .0014"	.0015" - .0025" .0011" - .0019"	.0020" - .0031" .0016" - .0025"	.0025" - .0037" .0021" - .0031"	.0030" - .0043" .0026" - .0037"	
	CARBON STEELS									
	1000's - 1018, 1020, 12L14	< 40	225	275	.0014" - .0023"	.0018" - .0027"	.0023" - .0033"	.0028" - .0039"	.0033" - .0045"	
K	CAST MATERIAL									
	Ductile Iron		250	350	.0015" - .0023"	.0019" - .0028"	.0024" - .0034"	.0029" - .0040"	.0034" - .0046"	
	Gray Iron		275	375	.0016" - .0024"	.0020" - .0029"	.0025" - .0035"	.0030" - .0041"	.0035" - .0047"	
N	NON-FERROUS									
	Aluminum 2014, 2024, 6061-(T1-T6), 7075		350	425	.0023" - .0033"	.0027" - .0038"	.0033" - .0044"	.0038" - .0050"	.0043" - .0056"	
	Aluminum Die Cast		300	375	.0018" - .0028"	.0022" - .0033"	.0027" - .0039"	.0032" - .0045"	.0037" - .0051"	
	Magnesium		275	350	.0020" - .0030"	.0024" - .0035"	.0029" - .0041"	.0034" - .0047"	.0039" - .0053"	
	Copper		200	300	.0017" - .0025"	.0021" - .0030"	.0026" - .0036"	.0031" - .0042"	.0036" - .0048"	
	Brass		250	350	.0020" - .0032"	.0024" - .0037"	.0029" - .0043"	.0034" - .0049"	.0039" - .0055"	
	Bronze		200	275	.0018" - .0025"	.0022" - .0030"	.0027" - .0036"	.0032" - .0042"	.0037" - .0048"	

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# GARR TOOL High Performance Drilling Guide

ISO Material	HRC	M/Min. (Vc)		CHIPLOAD PER TOOTH (Fz)					
		NON-COOLANT	COOLANT FED	3.0 - 6.0mm	6.0 - 10.0mm	10.0 - 13.0mm	13.0 - 16.0mm	16.0 - 20.0mm	
<b>S</b>	<b>COBALT BASE ALLOYS</b>								
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	25 20	30 25	.020 - .038 .013 - .030	.030 - .051 .023 - .043	.043 - .066 .036 - .058	.056 - .081 .048 - .074	.069 - .097 .061 - .089
	<b>NICKEL BASE ALLOYS</b>								
	Inconel-625/718, Waspalloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	25 20	35 25	.020 - .038 .013 - .030	.030 - .051 .023 - .043	.043 - .066 .036 - .058	.056 - .081 .048 - .074	.069 - .097 .061 - .089
	<b>IRON BASE ALLOYS</b>								
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	25 20	35 25	.020 - .038 .013 - .030	.030 - .051 .023 - .043	.043 - .066 .036 - .058	.056 - .081 .048 - .074	.069 - .097 .061 - .089
	<b>TITANIUM ALLOYS</b>								
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si			35 40	.025 - .046 .038 - .058	.051 - .074 .064 - .089	.076 - .104 .089 - .117		
<b>M</b>	<b>STAINLESS STEELS</b>								
	13/8, 15/5, 17-4, pH Types	< 40 > 40	30 25	35 25	.025 - .043 .018 - .038	.036 - .056 .028 - .051	.048 - .071 .041 - .066	.061 - .086 .053 - .081	.074 - .102 .066 - .097
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40 > 40	25 20	35 25	.025 - .043 .018 - .038	.036 - .056 .028 - .051	.048 - .071 .041 - .066	.061 - .086 .053 - .081	.074 - .102 .066 - .097
	400 Series - 403, 405, 420, 455	< 40 > 40	35 25	40 30	.025 - .043 .018 - .038	.036 - .056 .028 - .051	.048 - .071 .041 - .066	.061 - .086 .053 - .081	.074 - .102 .066 - .097
	<b>HIGH STRENGTH TOOL STEELS</b>								
<b>P</b>	A2, D2, P20, H13, S7, O1	< 40 > 40	50 40	60 45	.028 - .051 .018 - .036	.038 - .064 .028 - .048	.051 - .079 .041 - .064	.064 - .094 .053 - .079	.076 - .109 .066 - .094
	<b>MEDIUM ALLOY TOOL STEELS</b>								
	4140, 4340, 52100, 6150, 8620	< 40 > 40	55 45	65 50	.028 - .051 .018 - .036	.038 - .064 .028 - .048	.051 - .079 .041 - .064	.064 - .094 .053 - .079	.076 - .109 .066 - .094
	<b>CARBON STEELS</b>								
	1000's - 1018, 1020, 12L14	< 40	70	85	.036 - .058	.048 - .069	.058 - .064	.071 - .099	.084 - .114
<b>K</b>	<b>CAST MATERIAL</b>								
	Ductile Iron		75	105	.038 - .058	.048 - .071	.061 - .086	.074 - .102	.086 - .117
	Gray Iron		85	115	.041 - .061	.051 - .074	.064 - .089	.076 - .104	.089 - .119
<b>N</b>	<b>NON-FERROUS</b>								
	Aluminum 2014, 2024, 6061-(T1-T6), 7075		105	130	.058 - .084	.069 - .097	.084 - .112	.097 - .127	.109 - .142
	Aluminum Die Cast		90	115	.046 - .071	.056 - .084	.069 - .099	.081 - .114	.094 - .130
	Magnesium		85	105	.051 - .076	.061 - .089	.074 - .104	.086 - .119	.099 - .135
	Copper		60	90	.043 - .064	.053 - .076	.066 - .091	.079 - .107	.091 - .122
	Brass		75	105	.051 - .081	.061 - .094	.074 - .109	.086 - .124	.099 - .140
	Bronze		60	85	.048 - .064	.056 - .076	.069 - .091	.081 - .107	.094 - .122

**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# GARR TOOL Drilling Guide for Aluminum Series 3-Flute Drills

			CHIPLOAD PER TOOTH (Fz)					
ISO Material	Type	SFM (Vc)	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"
<b>N</b>	<b>NON-FERROUS</b>							
	Aluminum Alloy	6061	450 - 650	.0020" - .0040"	.0025" - .0050"	.0035" - .0060"	.0045" - .0070"	.0055" - .0080"
	Cast Aluminum	380	300 - 500	.0015" - .0030"	.0020" - .0040"	.0030" - .0050"	.0030" - .0060"	.0035" - .0070"
	Magnesium		250 - 500	.0015" - .0030"	.0020" - .0040"	.0030" - .0050"	.0030" - .0060"	.0035" - .0070"
	Copper & Brass		250 - 400	.0010" - .0025"	.0020" - .0030"	.0020" - .0030"	.0020" - .0040"	.0030" - .0050"
	Titanium	6Al-4V	100 - 300	.0010" - .0020"	.0020" - .0030"	.0020" - .0030"	.0020" - .0040"	.0030" - .0050"

			CHIPLOAD PER TOOTH (Fz)					
ISO Material	Type	M/Min. (Vc)	4.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.0mm
<b>N</b>	<b>NON-FERROUS</b>							
	Aluminum Alloy	6061	140 - 200	.050 - .100	.065 - .125	.090 - .150	.115 - .175	.150 - .200
	Cast Aluminum	380	90 - 150	.038 - .075	.050 - .100	.075 - .125	.075 - .150	.090 - .175
	Magnesium		75 - 150	.038 - .075	.050 - .100	.075 - .125	.075 - .150	.090 - .175
	Copper, Brass		75 - 120	.025 - .060	.050 - .075	.050 - .075	.050 - .100	.075 - .125
	Titanium	6Al-4V	30 - 90	.025 - .050	.050 - .075	.050 - .075	.050 - .100	.075 - .125



**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

OPERATING PARAMETERS		
TOOL DIAMETER	Vc	
	1500 SFM	3000 SFM
	RPM (n)	
1/16"	45,000	90,000
1/8"	45,000	90,000
3/16"	30,000	60,000
1/4"	23,000	45,000
3/8"	15,000	30,000
1/2"	11,000	22,000
3/4"	7,500	15,000
1"	5,500	10,000

## Speeds and Feeds

Carbide burrs typically operate between 1500 and 3000 SFM. Solid carbide burrs that are 1/8" diameter or less can typically be run at speeds up to 75,000 RPM (n). Burrs ranging in size from 3/16" to 3/8" diameter can utilize a 30,000 RPM (n) grinder. Burrs ranging in size from 1/4" to 1/2" diameter can utilize a 22,000 RPM (n) grinder. These are general speed recommendations that may need to be adjusted for optimal performance.

## Safety Information

Always wear the appropriate personal protective equipment, such as safety glasses and protective clothing, when using solid carbide or HSS cutting tools. Machines should be fully guarded. Technical data provided should be considered advisory only as variations may be necessary depending on the particular application.

BURR TROUBLESHOOTING OPTIONS	
PROBLEM	POSSIBLE SOLUTIONS
Broken Braze	Excessive Force Heat from rubbing shank Dull tool
Chatter	Improper location in collet Bad grinder bearings Bent shank Unstable control of process Lack of rigid setup
Plugged Flutes	Use coarser burr Working in soft material Use an anti-stick agent Faster RPM Slower RPM Lighter cuts
Excessive Vibration	Improper location in collet Bad grinder bearings Bent shank Unstable control of process Faster RPM Slower RPM Faster feed Slower feed Lack of rigid setup
Poor Finish	Improper location in collet Bad grinder bearings Bent shank Unstable control of process Faster RPM Slower RPM Switch to finer cut Don't use double cut Faster feed Lack of rigid setup
Poor Tool Life	Heat from rubbing shank Improper location in collet Bad grinder bearings Bent shank Unstable control of process Faster RPM Slower RPM Don't use double cut Faster feed Slower feed Cutting abrasive material Lack of rigid setup