

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

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

# GARR TOOL General Purpose Milling Guide

TECHNICAL

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"
<b>COBALT BASE ALLOYS</b>												
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"
<b>NICKEL BASE ALLOYS</b>												
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"
<b>IRON BASE ALLOYS</b>												
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 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"
<b>TITANIUM ALLOYS</b>												
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"
<b>STAINLESS STEELS</b>												
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"-.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"
<b>HIGH STRENGTH TOOL STEELS</b>												
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"
<b>MEDIUM ALLOY TOOL STEELS</b>												
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"
<b>CARBON STEELS</b>												
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"
<b>CAST MATERIAL</b>												
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"
<b>NON-FERROUS</b>												
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"
<b>COMPOSITE (non-ISO)</b>												
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 311)										

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

TECHNICAL

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
<b>COBALT BASE ALLOYS</b>												
Haynes 25/188, Stellite 21, Cobalt Chrome	< 40	24 - 35	.010-.020	.010-.020	.010-.020	.013-.025	.020-.038	.025-.046	.038-.076	.051-.076	.064-.089	.064-.089
	> 40	20 - 31	.008-.015	.008-.015	.008-.015	.008-.020	.013-.025	.020-.038	.025-.038	.038-.064	.038-.051	.038-.051
<b>NICKEL BASE ALLOYS</b>												
Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	22 - 35	.010-.020	.010-.020	.010-.020	.013-.025	.020-.038	.025-.046	.038-.076	.051-.076	.064-.089	.064-.089
	> 40	18 - 31	.008-.015	.008-.015	.008-.015	.008-.020	.013-.025	.020-.038	.025-.038	.038-.064	.038-.051	.038-.051
<b>IRON BASE ALLOYS</b>												
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40	22 - 35	.010-.020	.010-.020	.010-.020	.013-.025	.020-.038	.025-.046	.038-.076	.051-.076	.064-.089	.064-.089
	> 40	20 - 31	.008-.015	.008-.015	.008-.015	.008-.020	.013-.025	.020-.038	.025-.038	.038-.064	.038-.051	.038-.051
<b>TITANIUM ALLOYS</b>												
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si	< 40	39 - 59	.008-.020	.008-.020	.013-.030	.013-.030	.020-.038	.025-.038	.033-.051	.046-.064	.051-.076	.064-.089
	> 40	35 - 47	.008-.020	.008-.020	.010-.025	.010-.025	.013-.030	.020-.036	.025-.041	.025-.051	.038-.064	.038-.064
<b>STAINLESS STEELS</b>												
13/8, 15/5, 17-4, pH Types	< 40	39 - 59	.005-.013	.008-.015	.008-.018	.015-.023	.020-.030	.033-.046	.025-.051	.030-.064	.030-.051	.051-.071
	> 40	31 - 39	.005-.010	.005-.010	.005-.015	.008-.018	.010-.020	.018-.030	.020-.038	.025-.041	.033-.043	.038-.051
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	39 - 59	.008-.015	.008-.018	.013-.025	.020-.038	.023-.033	.025-.046	.038-.051	.046-.056	.046-.089	.058-.091
	> 40	31 - 39	.005-.010	.005-.013	.010-.018	.013-.025	.013-.025	.018-.025	.023-.038	.030-.046	.038-.064	.051-.076
400 Series - 403, 405, 420, 455	< 40	59 - 79	.013-.020	.018-.025	.023-.038	.023-.036	.028-.038	.033-.046	.038-.064	.051-.089	.056-.102	.076-.117
	> 40	39 - 59	.008-.018	.010-.020	.015-.025	.018-.028	.020-.030	.023-.038	.030-.051	.046-.076	.051-.089	.061-.107
<b>HIGH STRENGTH TOOL STEELS</b>												
A2, D2, P20, H13, S7, O1	< 40	59 - 79	.008-.020	.008-.020	.013-.025	.025-.038	.030-.051	.030-.051	.036-.061	.046-.066	.051-.071	.056-.076
	> 40	39 - 59	.008-.013	.008-.013	.008-.020	.013-.025	.013-.025	.013-.025	.025-.038	.030-.046	.036-.051	.038-.056
<b>MEDIUM ALLOY TOOL STEELS</b>												
4140, 4340, 52100, 6150, 8620	< 40	59 - 79	.008-.020	.008-.020	.013-.025	.025-.038	.030-.051	.030-.051	.036-.061	.046-.066	.051-.071	.056-.076
	> 40	39 - 59	.008-.013	.008-.013	.008-.020	.013-.025	.013-.025	.013-.025	.025-.038	.030-.046	.036-.051	.038-.056
<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	.056-.076
<b>CAST MATERIAL</b>												
Ductile Iron	< 40	69 - 89	.013-.020	.020-.031	.025-.038	.038-.064	.038-.064	.051-.076	.064-.089	.089-.114	.089-.114	.114-.140
	> 40	69 - 89	.013-.020	.020-.031	.025-.038	.038-.064	.038-.064	.051-.076	.064-.089	.089-.114	.089-.114	.114-.140
Gray Iron	< 40	69 - 89	.013-.020	.020-.031	.025-.038	.038-.064	.038-.064	.051-.076	.064-.089	.089-.114	.089-.114	.114-.140
	> 40	69 - 89	.013-.020	.020-.031	.025-.038	.038-.064	.038-.064	.051-.076	.064-.089	.089-.114	.089-.114	.114-.140
<b>NON-FERROUS</b>												
Aluminum	< 40	118 - 197	.008-.013	.015-.025	.020-.036	.030-.051	.036-.071	.051-.076	.089-.122	.127-.152	.147-.178	.173-.229
Magnesium	< 40	118 - 197	.008-.013	.015-.025	.020-.036	.030-.051	.036-.071	.051-.076	.089-.122	.127-.152	.147-.178	.173-.229
Copper	< 40	98 - 177	.008-.013	.015-.025	.020-.036	.030-.051	.036-.071	.051-.076	.089-.122	.127-.152	.147-.178	.173-.229
Brass, Bronze	< 40	79 - 157	.008-.013	.015-.025	.020-.036	.030-.051	.036-.071	.051-.076	.089-.122	.127-.152	.147-.178	.173-.229
<b>COMPOSITE (non-ISO)</b>												
Fiberglass, Plastics, G10	< 40	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 311)											

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

TECHNICAL

	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	<b>COBALT BASE ALLOYS</b>													
	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"		
	<b>NICKEL BASE ALLOYS</b>													
	Inconel-625/718, Waspalloy, 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"		
	<b>IRON BASE ALLOYS</b>													
	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"		
	<b>TITANIUM ALLOYS</b>													
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		125 - 175	.0005"-.0010"	.0005"-.0012"	.0008"-.0015"	.0010"-.0022"	.0018"-.0027"	.0023"-.0032"	.0025"-.0033"	.0027"-.0035"	.0028"-.0037"		
	5553 / Beta Titanium		100 - 150	.0004"-.0010"	.0004"-.0010"	.0006"-.0014"	.0008"-.0017"	.0015"-.0025"	.0022"-.0028"	.0024"-.0030"	.0026"-.0032"	.0028"-.0035"		
	M	<b>STAINLESS STEELS</b>												
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"		
<b>HIGH STRENGTH TOOL STEELS</b>														
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"			
P	<b>MEDIUM ALLOY TOOL STEELS</b>													
	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"		
	<b>CARBON STEELS</b>													
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"			
K	<b>CAST MATERIAL</b>													
	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	<b>NON-FERROUS</b>													
	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	<b>COMPOSITE (non-ISO)</b>													
	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 311)												

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
<b>COBALT BASE ALLOYS</b>											
Haynes 25/188, Stellite 21, Cobalt Chrome	< 40	28 - 43	.020 - .051	.010 - .025	.018 - .030	.025 - .046	.025 - .051	.046 - .071	.058 - .079	.069 - .086	.074 - .091
	> 40	20 - 35	.013 - .038	.010 - .018	.013 - .028	.020 - .036	.025 - .043	.038 - .064	.053 - .071	.061 - .076	.064 - .079
<b>NICKEL BASE ALLOYS</b>											
Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	26 - 43	.013 - .023	.013 - .023	.018 - .033	.025 - .041	.025 - .051	.051 - .071	.064 - .081	.074 - .091	.076 - .097
	> 40	22 - 35	.008 - .020	.010 - .018	.018 - .030	.023 - .038	.025 - .046	.038 - .064	.056 - .076	.066 - .084	.074 - .089
<b>IRON BASE ALLOYS</b>											
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolly	< 40	26 - 43	.013 - .025	.020 - .025	.015 - .030	.018 - .038	.028 - .041	.046 - .066	.064 - .076	.066 - .086	.081 - .097
	> 40	22 - 35	.008 - .020	.010 - .020	.013 - .025	.015 - .033	.020 - .036	.033 - .058	.056 - .071	.064 - .079	.076 - .089
<b>TITANIUM ALLOYS</b>											
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
		39 - 59	.010 - .025	.010 - .025	.015 - .036	.020 - .041	.038 - .064	.056 - .071	.061 - .076	.066 - .081	.071 - .089
<b>STAINLESS STEELS</b>											
13/8, 15/5, 17-4, PH Types	< 40	69 - 89	.013 - .018	.010 - .020	.018 - .025	.020 - .030	.033 - .046	.025 - .051	.030 - .064	.030 - .051	.051 - .071
	> 40	53 - 69	.005 - .010	.005 - .015	.007 - .018	.010 - .020	.018 - .030	.020 - .038	.025 - .041	.033 - .043	.038 - .051
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	79 - 89	.008 - .018	.013 - .025	.020 - .038	.023 - .033	.025 - .046	.038 - .051	.046 - .056	.046 - .089	.058 - .091
	> 40	61 - 79	.005 - .013	.010 - .018	.013 - .025	.013 - .025	.018 - .025	.023 - .038	.030 - .046	.038 - .064	.051 - .076
400 Series - 403, 405, 420, 455	< 40	79 - 89	.018 - .025	.023 - .038	.023 - .036	.028 - .038	.033 - .046	.038 - .064	.051 - .089	.056 - .102	.076 - .117
	> 40	59 - 79	.010 - .020	.015 - .025	.018 - .028	.020 - .030	.023 - .038	.030 - .051	.046 - .076	.051 - .089	.061 - .107
<b>HIGH STRENGTH TOOL STEELS</b>											
A2, D2, P20, H13, S2, O1	< 40	89 - 128	.013 - .020	.020 - .038	.038 - .051	.038 - .058	.038 - .064	.051 - .076	.051 - .076	.064 - .089	.076 - .102
	> 40	59 - 89	.008 - .013	.013 - .025	.020 - .030	.025 - .038	.025 - .046	.038 - .051	.038 - .051	.046 - .064	.051 - .076
<b>MEDIUM ALLOY TOOL STEELS</b>											
4140, 4340, 52100, 6150, 8620	< 40	89 - 128	.013 - .020	.020 - .038	.038 - .051	.038 - .058	.038 - .064	.051 - .076	.051 - .076	.064 - .089	.076 - .102
	> 40	59 - 89	.008 - .013	.013 - .025	.020 - .030	.025 - .038	.025 - .046	.038 - .051	.038 - .051	.046 - .064	.051 - .076
<b>CARBON STEELS</b>											
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
<b>CAST MATERIAL</b>											
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
<b>NON-FERROUS</b>											
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
<b>COMPOSITE (non-ISO)</b>											
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 311)									

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

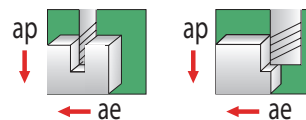
TECHNICAL

**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

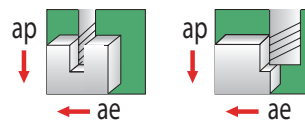
TECHNICAL

**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

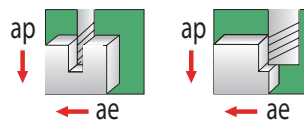
TECHNICAL

**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.



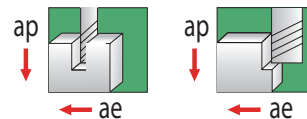
**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# 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



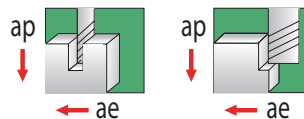
**ARC SERIES TOOLS ARE NOT DESIGNED FOR OVER 28Rc MATERIALS**

**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"	
<b>S</b>	<b>NICKEL BASE ALLOYS</b>									
	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"
<b>S</b>	<b>TITANIUM ALLOYS</b>									
	Titanium: 6AL4V, CP	150 - 200	.0008" - .0010"	.0010" - .0015"	.0010" - .0020"	.0015" - .0020"	.0020" - .0030"	.0025" - .0030"	.0030" - .0035"	.0030" - .0040"
<b>M</b>	<b>STAINLESS STEELS</b>									
	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"
<b>M</b>	<b>STAINLESS STEELS</b>									
	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"
	<b>HIGH STRENGTH TOOL STEELS</b>									
<b>P</b>	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"
	<b>CARBON STEELS</b>									
<b>P</b>	Carbon Steels: 1000 Series	275 - 425	.0006" - .0008"	.0008" - .0012"	.0010" - .0015"	.0010" - .0020"	.0015" - .0025"	.0020" - .0025"	.0020" - .0030"	.0025" - .0035"
	<b>CAST MATERIAL</b>									
<b>K</b>	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

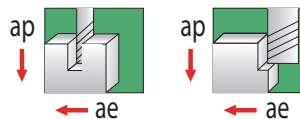


**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# 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	
<b>S</b>	<b>NICKEL BASE ALLOYS</b>										
	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
<b>S</b>	<b>TITANIUM ALLOYS</b>										
	Titanium: 6AL4V, CP	45 - 60	.010 - .020	.020 - .025	.025 - .038	.025 - .050	.038 - .050	.050 - .076	.063 - .076	.076 - .089	.076 - .102
<b>M</b>	<b>STAINLESS STEELS</b>										
	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
<b>M</b>	<b>STAINLESS STEELS</b>										
	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
	<b>HIGH STRENGTH TOOL STEELS</b>										
<b>P</b>	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
	<b>CARBON STEELS</b>										
<b>P</b>	Carbon Steels: 1000 Series	85 - 130	.008 - .015	.015 - .020	.020 - .030	.025 - .038	.025 - .050	.038 - .063	.050 - .063	.050 - .076	.063 - .089
	<b>CAST MATERIAL</b>										
<b>K</b>	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.**

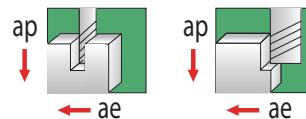
# GARR TOOL High Performance Milling Guide for VRX

**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"	
<b>COBALT BASE ALLOYS</b>													
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"	
<b>NICKEL BASE ALLOYS</b>													
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"	
<b>IRON BASE ALLOYS</b>													
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"	
<b>TITANIUM ALLOYS</b>													
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"	
<b>STAINLESS STEELS</b>													
M	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"
<b>HIGH STRENGTH TOOL STEELS</b>													
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"
	<b>MEDIUM ALLOY TOOL STEELS</b>												
	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"
<b>CARBON STEELS</b>													
	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"
<b>CAST MATERIAL</b>													
K	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.**

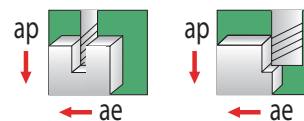
# GARR TOOL High Performance Milling Guide for VRX

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
<b>S</b>	<b>COBALT BASE ALLOYS</b>												
	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
	<b>NICKEL BASE ALLOYS</b>												
	Inconel-625/718, Waspaloy, 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
	<b>IRON BASE ALLOYS</b>												
	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
<b>M</b>	<b>TITANIUM ALLOYS</b>												
	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
	<b>STAINLESS STEELS</b>												
<b>M</b>	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
	<b>HIGH STRENGTH TOOL STEELS</b>												
<b>P</b>	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
	<b>MEDIUM ALLOY TOOL STEELS</b>												
	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
	<b>CARBON STEELS</b>												
<b>K</b>	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
	<b>CAST MATERIAL</b>												
<b>K</b>	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.

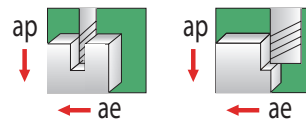
# GARR TOOL High Performance Milling Guide for V4

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"
<b>COBALT BASE ALLOYS</b>									
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"
<b>NICKEL BASE ALLOYS</b>									
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"
<b>IRON BASE ALLOYS</b>									
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolloy	< 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"
<b>TITANIUM ALLOYS</b>									
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"
<b>STAINLESS STEELS</b>									
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"
<b>HIGH STRENGTH TOOL STEELS</b>									
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"
<b>MEDIUM ALLOY TOOL STEELS</b>									
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"
<b>CARBON STEELS</b>									
1000's - 1018, 1020, 12L14	< 40	375 - 600	.0010" - .0018"	.0011" - .0021"	.0013" - .0025"	.0020" - .0036"	.0022" - .0042"	.0026" - .0050"	.0040" - .0072"
<b>CAST MATERIAL</b>									
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.

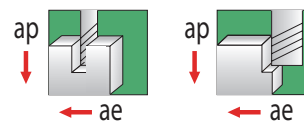
# GARR TOOL High Performance Milling Guide for V4

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	<b>COBALT BASE ALLOYS</b>										
	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	
	<b>NICKEL BASE ALLOYS</b>										
	Inconel-625/718, Waspaloy, 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	
	<b>IRON BASE ALLOYS</b>										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolloy	< 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	
	<b>TITANIUM ALLOYS</b>										
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si 5553 / Beta Titanium		60 - 115 45 - 85	.023 - .043 .023 - .038	.025 - .051 .025 - .046	.030 - .061 .030 - .056	.046 - .086 .046 - .076	.051 - .102 .051 - .091	.061 - .122 .061 - .112	.091 - .173 .081 - .152	
	M	<b>STAINLESS STEELS</b>									
		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	
<b>HIGH STRENGTH TOOL STEELS</b>											
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		
P	<b>MEDIUM ALLOY TOOL STEELS</b>										
	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	
	<b>CARBON STEELS</b>										
1000's - 1018, 1020, 12L14	< 40	115 - 180	.025 - .046	.028 - .053	.033 - .064	.051 - .091	.056 - .107	.066 - .127	.102 - .183		
K	<b>CAST MATERIAL</b>										
	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)

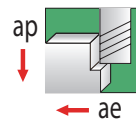
TECHNICAL

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	<b>COBALT BASE ALLOYS</b>										
	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"	
	<b>NICKEL BASE ALLOYS</b>										
	Inconel-625/718, Waspalloy, 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"	
	<b>IRON BASE ALLOYS</b>										
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolly	< 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"	
M	<b>TITANIUM ALLOYS</b>										
	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	<b>STAINLESS STEELS</b>										
	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"	
	<b>HIGH STRENGTH TOOL STEELS</b>										
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	<b>MEDIUM ALLOY TOOL STEELS</b>										
	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"	
	<b>CARBON STEELS</b>										
1000's - 1018, 1020, 12L14	< 40	450 - 720	.0011" - .0019"	.0012" - .0022"	.0014" - .0026"	.0022" - .0038"	.0024" - .0044"	.0028" - .0052"	.0044" - .0076"		
K	<b>CAST MATERIAL</b>										
	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.

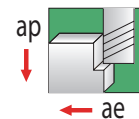
# GARR TOOL High Performance Milling Guide for V5, V5C (HIGH EFFICIENCY MILLING)

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
<b>COBALT BASE ALLOYS</b>									
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
<b>NICKEL BASE ALLOYS</b>									
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
<b>IRON BASE ALLOYS</b>									
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
<b>TITANIUM ALLOYS</b>									
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
<b>STAINLESS STEELS</b>									
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
<b>HIGH STRENGTH TOOL STEELS</b>									
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
<b>MEDIUM ALLOY TOOL STEELS</b>									
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
<b>CARBON STEELS</b>									
1000's - 1018, 1020, 12L14	< 40	135 - 220	.028 - .048	.030 - .056	.036 - .066	.056 - .097	.061 - .112	.071 - .132	.112 - .193
<b>CAST MATERIAL</b>									
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.

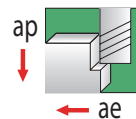
# GARR TOOL High Performance Milling Guide for VRX-6 (HIGH EFFICIENCY MILLING)

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	<b>COBALT BASE ALLOYS</b>									
	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"	
	<b>NICKEL BASE ALLOYS</b>									
	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"	
	<b>IRON BASE ALLOYS</b>									
	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"	
	<b>TITANIUM ALLOYS</b>									
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si 5553 / Beta Titanium		250 - 470 185 - 350	.0010" - .0015" .0008" - .0014"	.0015" - .0025" .0012" - .0022"	.0020" - .0030" .0016" - .0028"	.0025" - .0035" .0023" - .0034"	.0030" - .0050" .0024" - .0044"	.0040" - .0060" .0032" - .0056"	
	M	<b>STAINLESS STEELS</b>								
		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"	
<b>HIGH STRENGTH TOOL STEELS</b>										
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	<b>MEDIUM ALLOY TOOL STEELS</b>									
	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"	
	<b>CARBON STEELS</b>									
1000's - 1018, 1020, 12L14	< 40	465 - 750	.0010" - .0017"	.0013" - .0025"	.0018" - .0029"	.0024" - .0034"	.0034" - .0044"	.0036" - .0048"		
K	<b>CAST MATERIAL</b>									
	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.

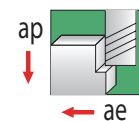
# GARR TOOL High Performance Milling Guide for VRX-6 (HIGH EFFICIENCY MILLING)

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	<b>COBALT BASE ALLOYS</b>									
	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
	<b>NICKEL BASE ALLOYS</b>									
	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
	<b>IRON BASE ALLOYS</b>									
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolly	< 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
	<b>TITANIUM ALLOYS</b>									
	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	<b>STAINLESS STEELS</b>								
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
<b>HIGH STRENGTH TOOL STEELS</b>										
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	<b>MEDIUM ALLOY TOOL STEELS</b>									
	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
	<b>CARBON STEELS</b>									
1000's - 1018, 1020, 12L14	< 40	140 - 230	.025 - .043	.029 - .053	.033 - .064	.046 - .061	.061 - .086	.086 - .112	.091 - .122	
K	<b>CAST MATERIAL</b>									
	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)

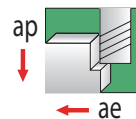
TECHNICAL

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"
<b>S</b>	<b>COBALT BASE ALLOYS</b>							
	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"
	<b>NICKEL BASE ALLOYS</b>							
	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"
	<b>IRON BASE ALLOYS</b>							
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolloy	< 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"
	<b>TITANIUM ALLOYS</b>							
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25Ni-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"
	<b>M</b>	<b>STAINLESS STEELS</b>						
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"
<b>HIGH STRENGTH TOOL STEELS</b>								
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"
<b>P</b>	<b>MEDIUM ALLOY TOOL STEELS</b>							
	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"
	<b>CARBON STEELS</b>							
	1000's - 1018, 1020, 12L14	< 40	490 - 780	.0016" - .0030"	.0024" - .0043"	.0026" - .0050"	.0032" - .0060"	.0048" - .0086"
<b>K</b>	<b>CAST MATERIAL</b>							
	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.

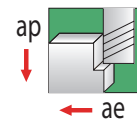
# GARR TOOL High Performance Milling Guide for VX-7, VX-7C (HIGH EFFICIENCY MILLING)

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
<b>S</b>	<b>COBALT BASE ALLOYS</b>								
	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
	<b>NICKEL BASE ALLOYS</b>								
	Inconel-625/718, Waspaloy, 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
	<b>IRON BASE ALLOYS</b>								
	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
	<b>TITANIUM ALLOYS</b>								
	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
	<b>M</b>	<b>STAINLESS STEELS</b>							
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
<b>HIGH STRENGTH TOOL STEELS</b>									
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
<b>P</b>	<b>MEDIUM ALLOY TOOL STEELS</b>								
	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
	<b>CARBON STEELS</b>								
1000's - 1018, 1020, 12L14	< 40	150 - 240	.032 - .053	.041 - .076	.061 - .109	.066 - .127	.081 - .152	.122 - .218	
<b>K</b>	<b>CAST MATERIAL</b>								
	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.

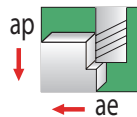
# GARR TOOL Milling Guide for TMS / TMR (HIGH EFFICIENCY MILLING)

**NOTE - CHIP THINNING CALCULATION ALREADY APPLIED**

**CHIPLOAD PER TOOTH (Fz) AT 2% RADIAL ENGAGEMENT (USING PROGRAMMED CALCULATION - SEE PAGE 304)**

**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"	
<b>S</b>	<b>TITANIUM ALLOYS</b>								
	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"
<b>M</b>	<b>STAINLESS STEELS</b>								
	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"	
<b>P</b>	<b>MEDIUM ALLOY TOOL STEELS</b>								
	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"
	<b>CARBON STEELS</b>								
	1000 Series, A36, 12L14	300 - 500	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"
	<b>CAST STEELS</b>								
Steel	250 - 350	.0020" - .0042"	.0027" - .0052"	.0035" - .0065"	.0043" - .0078"	.0052" - .0095"	.0065" - .0115"	.0080" - .0143"	
<b>K</b>	<b>CAST MATERIAL</b>								
	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"
<b>N</b>	<b>NON-FERROUS</b>								
	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.**

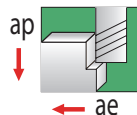
# GARR TOOL Milling Guide for TMS / TMR (HIGH EFFICIENCY MILLING)

**NOTE - CHIP THINNING CALCULATION ALREADY APPLIED**

**CHIPLOAD PER TOOTH (Fz) AT 2% RADIAL ENGAGEMENT (USING PROGRAMMED CALCULATION - SEE PAGE 305)**

**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	
<b>S</b>	<b>TITANIUM ALLOYS</b>								
	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
<b>M</b>	<b>STAINLESS STEELS</b>								
	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
<b>P</b>	<b>MEDIUM ALLOY TOOL STEELS</b>								
	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
	<b>CARBON STEELS</b>								
	1000 Series, A36, 12L14	118 - 197	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.203 - .363
	<b>CAST STEELS</b>								
	Steel	98 - 138	.051 - .107	.069 - .132	.089 - .165	.109 - .198	.132 - .241	.165 - .292	.203 - .363
<b>K</b>	<b>CAST MATERIAL</b>								
	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
<b>N</b>	<b>NON-FERROUS</b>								
	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



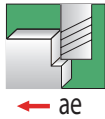
ap = full flute length

ae = 2%

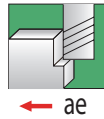
**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

# Chip Thinning Calculations for TMS / TMR End Mills

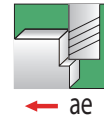
ae = 3%



ae = 2%



ae = 1%



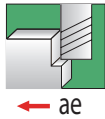
3% Radial Engagement (.03 x d)	
Actual (CPT)	Programmed (CPT)
.0002"	.0005"
.0003"	.0010"
.0005"	.0015"
.0007"	.0020"
.0009"	.0025"
.0010"	.0030"
.0012"	.0035"
.0014"	.0040"
.0015"	.0045"
.0017"	.0050"
.0019"	.0055"
.0020"	.0060"
.0022"	.0065"
.0024"	.0070"
.0026"	.0075"
.0027"	.0080"
.0029"	.0085"
.0031"	.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"

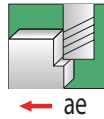
1% Radial Engagement (.01 x d)	
Actual (CPT)	Programmed (CPT)
.0001"	.0005"
.0002"	.0010"
.0003"	.0015"
.0004"	.0020"
.0005"	.0025"
.0006"	.0030"
.0007"	.0035"
.0008"	.0040"
.0009"	.0045"
.0010"	.0050"
.0011"	.0055"
.0012"	.0060"
.0013"	.0065"
.0014"	.0070"
.0015"	.0075"
.0016"	.0080"
.0017"	.0085"
.0018"	.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

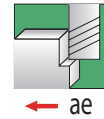
ae = 3%



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

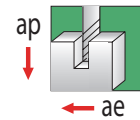
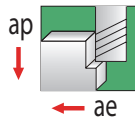
# GARR TOOL Milling Guide for High Rc Finishers in Hardened Steel

(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	
	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	
	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.

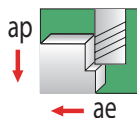
**NOTE - ABOVE ARE STARTING PARAMETERS ONLY. HIGHER RESULTS MAY BE ACHIEVED WITH OPTIMUM CONDITIONS.**

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

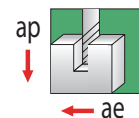
(Reference Series: 545MA, 545BA, 545RA, VRX)

DIAMETER	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						
	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

DIAMETER	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						
	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

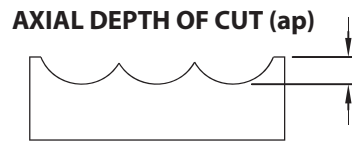
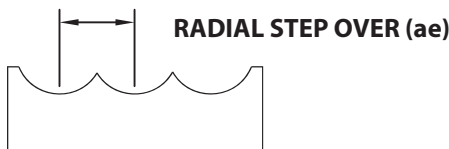
## Roughing

(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"



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.**

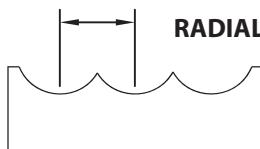
## Roughing

(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.

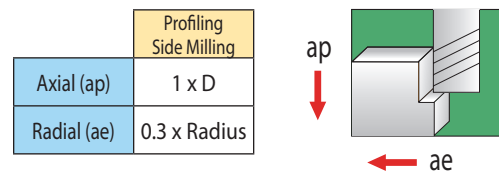
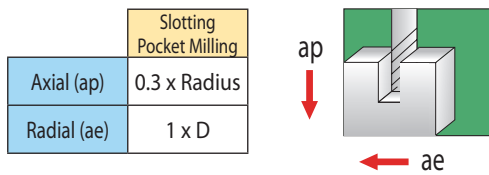
Finishing	
Axial (ap)	1% - 3% of Dia.
Radial (ae)	.5% - 1% of Dia.

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

DIAMETER	UP TO 40 HRC			40 - 45 HRC			45 - 55 HRC			55 - 60 HRC		
	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	-



**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.**

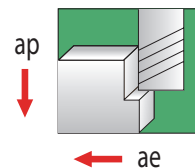
# GARR TOOL Milling Guide for Diamond Coated End Mills in Graphite

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"
<b>S</b>	<b>COBALT BASE ALLOYS</b>						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	80 - 120 60 - 80	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"
	<b>NICKEL BASE ALLOYS</b>						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	100 - 125 80 - 110	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"
	<b>IRON BASE ALLOYS</b>						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	150 - 175 120 - 150	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
<b>TITANIUM ALLOYS</b>							
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"	
<b>M</b>	<b>STAINLESS STEELS</b>						
	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"
<b>P</b>	<b>HIGH STRENGTH TOOL STEELS</b>						
	A2, D2, P20, H13, S7, O1	< 40 > 40	100 - 125 80 - 110	.0003" - .0008"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"
	<b>MEDIUM ALLOY TOOL STEELS</b>						
	4140, 4340, 52100, 6150, 8620	< 40 > 40	100 - 125 80 - 110	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"
<b>CARBON STEELS</b>							
1000's - 1018, 1020, 12L14	< 40	100 - 125	.0004" - .0009"	.0006" - .0012"	.0009" - .0013"	.0010" - .0017"	
<b>K</b>	<b>CAST MATERIAL</b>						
	Ductile Iron		150 - 225	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
	Gray Iron		125 - 200	.0005" - .0010"	.0007" - .0012"	.0010" - .0015"	.0010" - .0018"
<b>N</b>	<b>NON-FERROUS</b>						
	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"
<b>O</b>	<b>COMPOSITE (non-ISO)</b>						
	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
<b>S</b>	<b>COBALT BASE ALLOYS</b>						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40 > 40	25 - 40 15 - 25	.008 - .020	.013 - .025	.020 - .030	.025 - .040
	<b>NICKEL BASE ALLOYS</b>						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40 > 40	30 - 40 25 - 35	.008 - .020	.013 - .025	.020 - .030	.025 - .040
	<b>IRON BASE ALLOYS</b>						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	45 - 50 35 - 45	.010 - .023	.015 - .030	.023 - .035	.025 - .045
<b>M</b>	<b>TITANIUM ALLOYS</b>						
	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
<b>P</b>	<b>STAINLESS STEELS</b>						
	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
<b>K</b>	<b>HIGH STRENGTH TOOL STEELS</b>						
	A2, D2, P20, H13, S7, O1	< 40 > 40	30 - 40 25 - 35	.008 - .020	.013 - .025	.020 - .030	.025 - .040
	<b>MEDIUM ALLOY TOOL STEELS</b>						
<b>N</b>	4140, 4340, 52100, 6150, 8620	< 40 > 40	30 - 40 25 - 35	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	<b>CARBON STEELS</b>						
<b>O</b>	1000's - 1018, 1020, 12L14	< 40	30 - 40	.010 - .023	.015 - .030	.023 - .035	.025 - .045
	<b>CAST MATERIAL</b>						
	Ductile Iron		45 - 70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
<b>N</b>	Gray Iron		35 - 70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	<b>NON-FERROUS</b>						
	Aluminum (6061, 7075)		70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	Magnesium		70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
<b>O</b>	Copper		70	.013 - .025	.018 - .025	.025 - .040	.025 - .050
	Brass, Bronze		40 - 60	.013 - .025	.018 - .025	.025 - .040	.025 - .050
<b>O</b>	<b>COMPOSITE (non-ISO)</b>						
	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 \*

TECHNICAL

ISO Material	HRC	SFM (Vc) 154M, 154MA 152M, 152MA	CHIPLOAD PER TOOTH (Fz)								
			1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	
<b>COBALT BASE ALLOYS</b>											
Haynes 25/188, Stellite 21, Cobalt Chrome	< 40	60 - 90	.0004" - .0008"	.0004" - .0008"	.0005" - .0010"	.0008" - .0015"	.0010" - .0018"	.0015" - .0030"	.0020" - .0030"	.0025" - .0035"	
	> 40	50 - 80	.0003" - .0006"	.0003" - .0006"	.0003" - .0008"	.0005" - .0010"	.0008" - .0015"	.0010" - .0015"	.0015" - .0025"	.0015" - .0020"	
<b>NICKEL BASE ALLOYS</b>											
Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	55 - 90	.0004" - .0008"	.0004" - .0008"	.0005" - .0010"	.0008" - .0015"	.0010" - .0018"	.0015" - .0030"	.0020" - .0030"	.0025" - .0035"	
	> 40	45 - 80	.0003" - .0006"	.0003" - .0006"	.0003" - .0008"	.0005" - .0010"	.0008" - .0015"	.0010" - .0015"	.0015" - .0025"	.0015" - .0020"	
<b>IRON BASE ALLOYS</b>											
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40	55 - 90	.0004" - .0008"	.0004" - .0008"	.0005" - .0010"	.0008" - .0015"	.0010" - .0018"	.0015" - .0030"	.0020" - .0030"	.0025" - .0035"	
	> 40	50 - 80	.0003" - .0006"	.0003" - .0006"	.0003" - .0008"	.0005" - .0010"	.0008" - .0015"	.0010" - .0015"	.0015" - .0025"	.0015" - .0020"	
<b>TITANIUM ALLOYS</b>											
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si	< 40	100 - 150	.0003" - .0008"	.0005" - .0012"	.0005" - .0012"	.0008" - .0015"	.0010" - .0015"	.0013" - .0020"	.0018" - .0025"	.0025" - .0035"	
	> 40	90 - 120	.0003" - .0008"	.0004" - .0010"	.0004" - .0010"	.0005" - .0012"	.0008" - .0014"	.0010" - .0016"	.0010" - .0020"	.0015" - .0025"	
<b>5553 / Beta Titanium</b>											
			.0003" - .0008"	.0004" - .0010"	.0004" - .0010"	.0005" - .0012"	.0008" - .0014"	.0010" - .0016"	.0010" - .0020"	.0015" - .0025"	
<b>STAINLESS STEELS</b>											
13/8, 15/5, 17-4, pH Types	< 40	100 - 150	.0003" - .0006"	.0003" - .0007"	.0006" - .0009"	.0008" - .0012"	.0013" - .0018"	.0010" - .0020"	.0012" - .0025"	.0012" - .0020"	
	> 40	80 - 100	.0002" - .0004"	.0002" - .0006"	.0003" - .0007"	.0004" - .0008"	.0007" - .0012"	.0008" - .0015"	.0010" - .0016"	.0013" - .0017"	
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	150 - 225	.0002" - .0006"	.0005" - .0008"	.0008" - .0015"	.0010" - .0018"	.0010" - .0018"	.0015" - .0025"	.0018" - .0028"	.0022" - .0032"	
	> 40	125 - 220	.0003" - .0005"	.0003" - .0007"	.0005" - .0010"	.0008" - .0012"	.0009" - .0015"	.0013" - .0018"	.0013" - .0018"	.0017" - .0025"	
400 Series - 403, 405, 420, 455	< 40	150 - 200	.0007" - .0010"	.0009" - .0015"	.0009" - .0014"	.0011" - .0015"	.0013" - .0018"	.0015" - .0025"	.0020" - .0035"	.0030" - .0046"	
	> 40	100 - 150	.0004" - .0008"	.0006" - .0010"	.0007" - .0011"	.0008" - .0012"	.0009" - .0015"	.0012" - .0020"	.0018" - .0030"	.0024" - .0042"	
<b>HIGH STRENGTH TOOL STEELS</b>											
A2, D2, P20, H13, S7, O1	< 40	150 - 200	.0003" - .0008"	.0005" - .0010"	.0010" - .0015"	.0012" - .0020"	.0012" - .0020"	.0014" - .0024"	.0018" - .0026"	.0020" - .0028"	
	> 40	100 - 150	.0003" - .0005"	.0003" - .0008"	.0005" - .0010"	.0005" - .0010"	.0005" - .0010"	.0010" - .0015"	.0012" - .0018"	.0015" - .0022"	
<b>MEDIUM ALLOY TOOL STEELS</b>											
4140, 4340, 52100, 6150, 8620	< 40	150 - 200	.0003" - .0008"	.0005" - .0010"	.0010" - .0015"	.0012" - .0020"	.0012" - .0020"	.0014" - .0024"	.0018" - .0026"	.0020" - .0028"	
	> 40	100 - 150	.0003" - .0005"	.0003" - .0008"	.0005" - .0010"	.0005" - .0010"	.0005" - .0010"	.0010" - .0015"	.0012" - .0018"	.0015" - .0022"	
<b>CARBON STEELS</b>											
1000's - 1018, 1020, 12L14	< 40	150 - 200	.0003" - .0008"	.0005" - .0010"	.0010" - .0015"	.0012" - .0020"	.0012" - .0020"	.0014" - .0024"	.0018" - .0026"	.0020" - .0028"	
<b>CAST MATERIAL</b>											
Ductile Iron	< 40	175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"	
	> 40	175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"	
Gray Iron	< 40	175 - 225	.0008" - .0012"	.0010" - .0015"	.0015" - .0025"	.0015" - .0025"	.0020" - .0030"	.0025" - .0035"	.0035" - .0045"	.0035" - .0045"	
<b>NON-FERROUS</b>											
Aluminum (6061, 7075)	< 40	300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	
	> 40	300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	
Magnesium	< 40	300 - 500	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	
Copper	< 40	250 - 450	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	
Brass, Bronze	< 40	200 - 400	.0006" - .0010"	.0008" - .0014"	.0012" - .0020"	.0014" - .0028"	.0020" - .0030"	.0035" - .0048"	.0050" - .0060"	.0058" - .0070"	
<b>COMPOSITE (non-ISO)</b>											
Glass Epoxy, Fiberglass, Plastics	< 40	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) 154M, 154MA 152M, 152MA	CHIPLOAD PER TOOTH (Fz)								
			3.0mm	4.0mm	5.0mm	6.0mm	8.0mm	10.0mm	12.0mm	16.00mm	20.0mm
<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, 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
<b>IRON BASE ALLOYS</b>											
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolloy	< 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>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>											
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>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>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>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 Drilling Guide for Drill Mills

## \* Through Hole \*

TECHNICAL

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

TECHNICAL

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>COBALT BASE ALLOYS</b>												
Haynes 25/188, Stellite 21, Cobalt Chrome	< 40	24 - 35	.010 - .020	.010 - .020	.010 - .020	.013 - .025	.020 - .038	.025 - .046	.038 - .076	.051 - .076	.064 - .089	
	> 40	20 - 31	.008 - .015	.008 - .015	.008 - .015	.008 - .020	.013 - .025	.020 - .038	.025 - .038	.038 - .064	.038 - .051	
<b>NICKEL BASE ALLOYS</b>												
Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	22 - 35	.010 - .020	.010 - .020	.010 - .020	.013 - .025	.020 - .038	.025 - .046	.038 - .076	.051 - .076	.064 - .089	
	> 40	18 - 31	.008 - .015	.008 - .015	.008 - .015	.008 - .020	.013 - .025	.020 - .038	.025 - .038	.038 - .064	.038 - .051	
<b>IRON BASE ALLOYS</b>												
A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascocolloy	< 40	22 - 35	.010 - .020	.010 - .020	.010 - .020	.013 - .025	.020 - .038	.025 - .046	.038 - .076	.051 - .076	.064 - .089	
	> 40	20 - 31	.008 - .015	.008 - .015	.008 - .015	.008 - .020	.013 - .025	.020 - .038	.025 - .038	.038 - .064	.038 - .051	
<b>TITANIUM ALLOYS</b>												
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si	< 40	20 - 31	.008 - .020	.008 - .020	.013 - .030	.013 - .030	.020 - .038	.025 - .038	.033 - .051	.046 - .064	.051 - .076	
	> 40	35 - 47	.008 - .020	.008 - .020	.010 - .025	.010 - .025	.013 - .030	.020 - .036	.025 - .041	.025 - .051	.038 - .064	
<b>STAINLESS STEELS</b>												
13/8, 15/5, 17-4, pH Types	< 40	39 - 59	.008 - .015	.008 - .015	.008 - .018	.015 - .023	.020 - .030	.033 - .046	.025 - .051	.030 - .064	.030 - .051	
	> 40	31 - 39	.005 - .010	.005 - .010	.005 - .015	.008 - .018	.010 - .020	.018 - .030	.020 - .038	.025 - .041	.033 - .043	
300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	59 - 89	.005 - .015	.005 - .015	.013 - .020	.020 - .038	.038 - .046	.025 - .046	.038 - .064	.046 - .071	.056 - .081	
	> 40	49 - 87	.008 - .013	.008 - .013	.008 - .018	.013 - .025	.020 - .030	.018 - .030	.033 - .046	.038 - .058	.043 - .064	
400 Series - 403, 405, 420, 455	< 40	59 - 79	.018 - .025	.018 - .025	.023 - .038	.023 - .036	.028 - .038	.033 - .046	.038 - .064	.051 - .089	.056 - .102	
	> 40	39 - 59	.010 - .020	.010 - .020	.015 - .025	.018 - .028	.020 - .030	.023 - .038	.030 - .051	.046 - .076	.051 - .089	
<b>HIGH STRENGTH TOOL STEELS</b>												
A2, D2, P20, H13, S7, O1	< 40	59 - 79	.008 - .020	.008 - .020	.013 - .025	.025 - .038	.030 - .051	.030 - .051	.036 - .061	.046 - .066	.051 - .071	
	> 40	39 - 59	.008 - .013	.008 - .013	.008 - .020	.013 - .025	.013 - .025	.013 - .025	.025 - .038	.030 - .046	.036 - .051	
<b>MEDIUM ALLOY TOOL STEELS</b>												
4140, 4340, 52100, 6150, 8620	< 40	59 - 79	.008 - .020	.008 - .020	.013 - .025	.025 - .038	.030 - .051	.030 - .051	.036 - .061	.046 - .066	.051 - .071	
	> 40	39 - 59	.008 - .013	.008 - .013	.008 - .020	.013 - .025	.013 - .025	.013 - .025	.025 - .038	.030 - .046	.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>CAST MATERIAL</b>												
Ductile Iron	< 40	69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114	
	> 40	69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114	
Gray Iron	< 40	69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114	
	> 40	69 - 89	.020 - .031	.023 - .035	.025 - .038	.038 - .064	.038 - .064	.051 - .076	.064 - .089	.089 - .114	.089 - .114	
<b>NON-FERROUS</b>												
Aluminum (6061, 7075)	< 40	118 - 197	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	
	> 40	118 - 197	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	
	< 40	98 - 177	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	
	> 40	98 - 157	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	
<b>COMPOSITE (non-ISO)</b>												
Glass Epoxy, Fiberglass, Plastics	< 40	79 - 157	.015 - .025	.015 - .025	.020 - .036	.030 - .051	.036 - .071	.051 - .076	.089 - .122	.127 - .152	.147 - .178	

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# GARR TOOL General Purpose Drilling Guide

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

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# GARR TOOL General Purpose Drilling Guide

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

	ISO Material	HRC	M/Min. (by Series)			
			1100	1200, 1205, 1520	1500, 1510	1600
S	<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>					
	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
	M	<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>						
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	
P	<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
K	<b>CAST MATERIAL</b>					
	Ductile Iron		21 - 43	37 - 52	37 - 52	32 - 45
	Gray Iron		21 - 50	37 - 58	37 - 58	32 - 52
N	<b>NON-FERROUS</b>					
	Aluminum (6061, 7075)		-	60 - 90	-	50 - 75
	Magnesium		-	37 - 65	-	25 - 50
	Copper		-	30 - 50	-	18 - 38
	Brass, Bronze		-	37 - 65	-	25 - 50
O	<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

	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	<b>COBALT BASE ALLOYS</b>						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40	.008 - .020	.015 - .028	.025 - .043	.036 - .061	.048 - .081
		> 40	.005 - .015	.010 - .023	.020 - .038	.030 - .056	.043 - .076
	<b>NICKEL BASE ALLOYS</b>						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	.008 - .020	.015 - .028	.025 - .043	.036 - .061	.048 - .081
		> 40	.005 - .015	.010 - .023	.020 - .038	.030 - .056	.043 - .076
	<b>IRON BASE ALLOYS</b>						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40	.008 - .020	.015 - .028	.025 - .043	.036 - .061	.048 - .081
		> 40	.005 - .015	.010 - .023	.020 - .038	.030 - .056	.043 - .076
	<b>TITANIUM ALLOYS</b>						
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	<b>STAINLESS STEELS</b>						
	13/8, 15/5, 17-4, pH Types	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
		> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
		> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
	400 Series - 403, 405, 420, 455	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
	> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076	
P	<b>HIGH STRENGTH TOOL STEELS</b>						
	A2, D2, P20, H13, S7, O1	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
		> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
	Thompson Shaft, Armor Plate (Class 1)	> 50	.005 - .015	.013 - .023	.023 - .038	.033 - .056	.046 - .071
	<b>MEDIUM ALLOY TOOL STEELS</b>						
	4140, 4340, 52100, 6150, 8620	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
	> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076	
<b>CARBON STEELS</b>							
1000's - 1018, 1020, 12L14	< 40	.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084	
K	<b>CAST MATERIAL</b>						
	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	<b>NON-FERROUS</b>						
	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	<b>COMPOSITE (non-ISO)</b>						
	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

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

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

	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	-	17 - 23	17 - 23	-
		> 40	-	13 - 20	13 - 20	-
	<b>NICKEL BASE ALLOYS</b>					
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	-	17 - 25	17 - 25	-
		> 40	-	13 - 21	13 - 21	-
	<b>IRON BASE ALLOYS</b>					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40	-	17 - 25	17 - 25	-
		> 40	-	13 - 21	13 - 21	-
	<b>TITANIUM ALLOYS</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>M</b>	<b>STAINLESS STEELS</b>					
	13/8, 15/5, 17-4, pH Types	< 40	-	18 - 27	18 - 27	-
		> 40	-	13 - 21	13 - 21	-
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	-	17 - 26	17 - 26	-
		> 40	-	13 - 20	13 - 20	-
	400 Series - 403, 405, 420, 455	< 40	-	21 - 30	21 - 30	-
	> 40	-	15 - 23	15 - 23	-	
<b>P</b>	<b>HIGH STRENGTH TOOL STEELS</b>					
	A2, D2, P20, H13, S7, O1	< 40	-	27 - 43	27 - 43	-
		> 40	-	21 - 37	21 - 37	-
	Thompson Shaft, Armor Plate (Class 1)	> 50	-	-	17 - 27	-
	<b>MEDIUM ALLOY TOOL STEELS</b>					
	4140, 4340, 52100, 6150, 8620	< 40	-	34 - 45	34 - 45	-
		> 40	-	25 - 40	25 - 40	-
<b>CARBON STEELS</b>						
1000's - 1018, 1020, 12L14	< 40	-	40 - 55	40 - 55	-	
<b>K</b>	<b>CAST MATERIAL</b>					
	Ductile Iron		25 - 45	40 - 55	40 - 55	-
	Gray Iron		25 - 53	40 - 60	40 - 60	-
<b>N</b>	<b>NON-FERROUS</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	-	-

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

# GARR TOOL General Purpose Drilling Guide

	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	<b>COBALT BASE ALLOYS</b>						
	Haynes 25/188, Stellite 21, Cobalt Chrome	< 40	.008 - .020	.015 - .028	.025 - .043	.036 - .061	.048 - .081
		> 40	.005 - .015	.010 - .023	.020 - .038	.030 - .056	.043 - .076
	<b>NICKEL BASE ALLOYS</b>						
	Inconel-625/718, Waspaloy, Invar, Rene, Hastelloy, Monel	< 40	.008 - .020	.015 - .028	.025 - .043	.036 - .061	.048 - .081
		> 40	.005 - .015	.010 - .023	.020 - .038	.030 - .056	.043 - .076
	<b>IRON BASE ALLOYS</b>						
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40	.008 - .020	.015 - .028	.025 - .043	.036 - .061	.048 - .081
		> 40	.005 - .015	.010 - .023	.020 - .038	.030 - .056	.043 - .076
	<b>TITANIUM ALLOYS</b>						
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	<b>STAINLESS STEELS</b>						
	13/8, 15/5, 17-4, pH Types	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
		> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
	300 Series, 304L, Nitronic 50, Duplex, Super-Austenitic	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
		> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
	400 Series - 403, 405, 420, 455	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
	> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076	
P	<b>HIGH STRENGTH TOOL STEELS</b>						
	A2, D2, P20, H13, S7, O1	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
		> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076
	Thompson Shaft, Armor Plate (Class 1)	> 50	.005 - .015	.013 - .023	.023 - .038	.033 - .056	.046 - .071
	<b>MEDIUM ALLOY TOOL STEELS</b>						
	4140, 4340, 52100, 6150, 8620	< 40	.010 - .023	.018 - .033	.028 - .048	.038 - .066	.051 - .081
	> 40	.008 - .018	.015 - .028	.025 - .043	.036 - .061	.048 - .076	
<b>CARBON STEELS</b>							
1000's - 1018, 1020, 12L14	< 40	.013 - .025	.020 - .036	.030 - .051	.041 - .069	.053 - .084	
K	<b>CAST MATERIAL</b>						
	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	<b>NON-FERROUS</b>						
	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	<b>COMPOSITE (non-ISO)</b>						
	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

	ISO Material	HRC	SFM (Vc)	CHIPLOAD PER TOOTH (Fz)		
				.0312" - .0390"	.0394" - .0787"	.0791" - .1250"
S	<b>COBALT BASE ALLOYS</b>					
	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"
	<b>NICKEL BASE ALLOYS</b>					
	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"
	<b>IRON BASE ALLOYS</b>					
	A286, Dicaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	70 - 100 50 - 85	.0002" - .0004" .0002" - .0004"	.0004" - .0007" .0003" - .0006"	.0006" - .0010" .0005" - .0009"
	<b>TITANIUM ALLOYS</b>					
	Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		90 - 130	.0003" - .0006"	.0004" - .0008"	.0006" - .0012"
	5553 / Beta Titanium		75 - 115	.0002" - .0004"	.0003" - .0006"	.0005" - .0010"
	M	<b>STAINLESS STEELS</b>				
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"
<b>HIGH STRENGTH TOOL STEELS</b>						
A2, D2, P20, H13, S7, O1		< 40 > 40	100 - 175 60 - 80	.0003" - .0006" .0002" - .0004"	.0004" - .0008" .0003" - .0006"	.0006" - .0012" .0005" - .0010"
P	<b>MEDIUM ALLOY TOOL STEELS</b>					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	125 - 175 80 - 125	.0004" - .0008" .0003" - .0005"	.0006" - .0012" .0004" - .0008"	.0008" - .0015" .0006" - .0012"
	<b>CARBON STEELS</b>					
	1000's - 1018, 1020, 12L14	< 40	125 - 175	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
K	<b>CAST MATERIAL</b>					
	Ductile Iron		100 - 200	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
	Gray Iron		80 - 175	.0004" - .0008"	.0006" - .0012"	.0008" - .0015"
N	<b>NON-FERROUS</b>					
	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"

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

# GARR TOOL High Performance Drilling Guide for Mini Drills

	ISO Material	HRC	M/Min. (Vc)	CHIPLOAD PER TOOTH (Fz)		
				0.79 - 0.99mm	1.00 - 2.00mm	2.01 - 3.17mm
S	<b>COBALT BASE ALLOYS</b>					
	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
	<b>NICKEL BASE ALLOYS</b>					
	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
	<b>IRON BASE ALLOYS</b>					
	A286, Discaloy, Haynes 556, Carpenter 22, Greek Ascology	< 40 > 40	20 - 30 15 - 25	.005 - .013 .005 - .010	.010 - .020 .008 - .018	.013 - .025 .010 - .023
	<b>TITANIUM ALLOYS</b>					
Commercially Pure, 6Al-4V, Astm 1/2/3, 6Al-25N-4Zr-2Mo-Si		25 - 40	.008 - .015	.010 - .020	.015 - .030	
5553 / Beta Titanium		20 - 35	.005 - .010	.008 - .015	.013 - .025	
M	<b>STAINLESS STEELS</b>					
	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
	<b>HIGH STRENGTH TOOL STEELS</b>					
A2, D2, P20, H13, S7, O1	< 40 > 40	30 - 50 20 - 25	.008 - .015 .005 - .010	.010 - .020 .008 - .015	.015 - .030 .013 - .025	
P	<b>MEDIUM ALLOY TOOL STEELS</b>					
	4140, 4340, 52100, 6150, 8620	< 40 > 40	40 - 50 25 - 40	.010 - .020 .008 - .013	.015 - .030 .010 - .020	.020 - .038 .015 - .030
	<b>CARBON STEELS</b>					
1000's - 1018, 1020, 12L14	< 40	40 - 50	.010 - .020	.015 - .030	.020 - .038	
K	<b>CAST MATERIAL</b>					
	Ductile Iron		30 - 60	.010 - .020	.015 - .030	.020 - .038
Gray Iron		25 - 50	.010 - .020	.015 - .030	.020 - .038	
N	<b>NON-FERROUS</b>					
	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 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"	
<b>S</b>	<b>COBALT BASE ALLOYS</b>									
	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"	
	<b>NICKEL BASE ALLOYS</b>									
	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"	
	<b>IRON BASE ALLOYS</b>									
	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"	
	<b>TITANIUM ALLOYS</b>									
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"		
<b>M</b>	<b>STAINLESS STEELS</b>									
	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"	
	<b>HIGH STRENGTH TOOL STEELS</b>									
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"		
<b>P</b>	<b>MEDIUM ALLOY TOOL STEELS</b>									
	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"	
	<b>CARBON STEELS</b>									
1000's - 1018, 1020, 12L14	< 40	225	275	.0014" - .0023"	.0018" - .0027"	.0023" - .0033"	.0028" - .0039"	.0033" - .0045"		
<b>K</b>	<b>CAST MATERIAL</b>									
	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"	
<b>N</b>	<b>NON-FERROUS</b>									
	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"		

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

# 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, Waspaloy, 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
	5553 / Beta Titanium		20	30	.020 - .038	.030 - .051	.043 - .066	.056 - .081	.069 - .097
	<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>									
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>P</b>	<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"	.0065" - .0100"
	Cast Aluminum	380	300 - 500	.0015" - .0030"	.0020" - .0040"	.0030" - .0050"	.0030" - .0060"	.0035" - .0070"	.0040" - .0080"
	Magnesium		250 - 500	.0015" - .0030"	.0020" - .0040"	.0030" - .0050"	.0030" - .0060"	.0035" - .0070"	.0040" - .0080"
	Copper & Brass		250 - 400	.0010" - .0025"	.0020" - .0030"	.0020" - .0030"	.0020" - .0040"	.0030" - .0050"	.0030" - .0060"
	Titanium	6Al-4V	100 - 300	.0010" - .0020"	.0020" - .0030"	.0020" - .0030"	.0020" - .0040"	.0030" - .0050"	.0030" - .0060"

			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	.165 - .250
	Cast Aluminum	380	90 - 150	.038 - .075	.050 - .100	.075 - .125	.075 - .150	.090 - .175	.100 - .200
	Magnesium		75 - 150	.038 - .075	.050 - .100	.075 - .125	.075 - .150	.090 - .175	.100 - .200
	Copper, Brass		75 - 120	.025 - .060	.050 - .075	.050 - .075	.050 - .100	.075 - .125	.075 - .150
	Titanium	6Al-4V	30 - 90	.025 - .050	.050 - .075	.050 - .075	.050 - .100	.075 - .125	.075 - .150



**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

# Hardness Conversion Chart

ROCKWELL HARDNESS (HRb)	ROCKWELL HARDNESS (HRc)	BRINELL HARDNESS (HB)	VICKERS HARDNESS (HV)	TENSILE STRENGTH (N/mm <sup>2</sup> )	PSI (1000 lb/in <sup>2</sup> )
67	-	116	122	401	58
70	-	121	127	432	63
73	-	126	132	448	65
75	-	131	137	455	66
77	-	137	143	463	67
80	-	143	150	479	69
82	-	149	156	494	72
84	-	156	163	525	76
86	-	163	171	540	78
89	-	170	178	556	81
91	-	179	188	602	88
93	-	187	196	632	92
96	-	197	212	664	97
97	-	207	218	695	101
98	-	212	222	710	103
-	20	217	228	741	107
-	21	223	234	756	110
-	22	229	241	772	112
-	23	235	247	787	114
-	24	241	255	818	118
-	25	248	261	849	123
-	27	255	269	865	125
-	28	262	275	895	130
-	29	269	284	911	132
-	30	277	292	942	136
-	31	285	300	973	141
-	32	293	308	988	143
-	33	302	318	1019	147
-	34	311	327	1050	152
-	35	321	337	1096	159
-	37	331	349	1127	163
-	38	341	359	1158	168
-	39	352	370	1189	172
-	40	363	381	1235	179
-	41	375	395	1266	183
-	42	388	408	1312	190
-	44	401	422	1359	197
-	45	415	437	1420	206
-	46	429	452	1467	212
-	48	444	470	1513	219
-	50	461	497	1559	226
-	51	477	517	1621	235
-	52	495	532	1668	241
-	54	543	572	1729	250
-	56	514	609	1807	262
-	57	555	630	1884	273
-	59	578	670	1961	284
-	60	601	698	2039	295
-	61	-	720	-	-
-	62	-	746	-	-
-	63	-	772	-	-
-	64	-	800	-	-
-	65	-	832	-	-
-	66	-	865	-	-
-	67	-	900	-	-
-	68	-	940	-	-

*Conversions from each scale are approximate*

# Decimal Equivalent Chart

Diameter	Decimal Equiv.
#80	.0135
0.35mm	.0138
#79	.0145
1/64"	.0156
0.40mm	.0158
#78	.0160
0.45mm	.0177
#77	.0180
0.50mm	.0197
#76	.0200
#75	.0210
0.55mm	.0217
#74	.0225
0.60mm	.0236
#73	.0240
#72	.0250
0.65mm	.0256
#71	.0260
0.70mm	.0276
#70	.0280
#69	.0292
0.75mm	.0295
#68	.0310
1/32"	.0312
0.80mm	.0315
#67	.0320
#66	.0330
0.85mm	.0335
#65	.0350
0.90mm	.0354
#64	.0360
#63	.0370
0.95mm	.0374
#62	.0380
#61	.0390
1.00mm	.0394
#60	.0400
#59	.0410
1.05mm	.0413
#58	.0420
#57	.0430
1.10mm	.0433
1.15mm	.0453
#56	.0465
3/64"	.0469
1.20mm	.0472
1.25mm	.0492
1.30mm	.0512
#55	.0520
1.35mm	.0531
#54	.0550
1.40mm	.0551
1.45mm	.0571
1.50mm	.0591
#53	.0595
1.55mm	.0610
1/16"	.0625
1.60mm	.0630
#52	.0635
1.65mm	.0650
1.70mm	.0669
#51	.0670
1.75mm	.0689
#50	.0700
1.80mm	.0709
1.85mm	.0728

Diameter	Decimal Equiv.
#49	.0730
1.90mm	.0748
#48	.0760
1.95mm	.0768
5/64"	.0781
#47	.0785
2.00mm	.0787
2.05mm	.0807
#46	.0810
#45	.0820
2.10mm	.0827
2.15mm	.0846
#44	.0860
2.20mm	.0866
2.25mm	.0886
#43	.0890
2.30mm	.0906
2.35mm	.0925
#42	.0935
3/32"	.0938
2.40mm	.0945
#41	.0960
2.45mm	.0965
#40	.0980
2.50mm	.0984
#39	.0995
#38	.1015
2.60mm	.1024
#37	.1040
2.70mm	.1063
#36	.1065
2.75mm	.1083
7/64"	.1094
#35	.1100
2.80mm	.1102
#34	.1110
#33	.1130
2.90mm	.1142
#32	.1160
3.00mm	.1181
#31	.1200
3.10mm	.1220
1/8"	.1250
3.20mm	.1260
3.25mm	.1280
#30	.1285
3.30mm	.1299
3.40mm	.1339
#29	.1360
3.50mm	.1378
#28	.1405
9/64"	.1406
3.60mm	.1417
#27	.1440
3.70mm	.1457
#26	.1470
3.75mm	.1476
#25	.1495
3.80mm	.1496
#24	.1520
3.90mm	.1535
#23	.1540
5/32"	.1562
#22	.1570
4.00mm	.1575
#21	.1590
#20	.1610

Diameter	Decimal Equiv.
4.10mm	.1614
4.20mm	.1654
#19	.1660
4.25mm	.1673
4.30mm	.1693
#18	.1695
11/64"	.1719
#17	.1730
4.40mm	.1732
#16	.1770
4.50mm	.1772
#15	.1800
4.60mm	.1811
#14	.1820
#13	.1850
4.70mm	.1850
4.75mm	.1870
3/16"	.1875
4.80mm	.1890
#12	.1890
#11	.1910
4.90mm	.1929
#10	.1935
#9	.1960
5.00mm	.1969
#8	.1990
5.10mm	.2008
#7	.2010
13/64"	.2031
#6	.2040
5.20mm	.2047
#5	.2055
5.25mm	.2067
5.30mm	.2087
#4	.2090
5.40mm	.2126
#3	.2130
5.50mm	.2165
7/32"	.2188
5.60mm	.2205
#2	.2210
5.70mm	.2244
5.75mm	.2264
#1	.2280
5.80mm	.2283
5.90mm	.2323
A	.2340
15/64"	.2344
6.00mm	.2362
B	.2380
6.10mm	.2402
C	.2420
6.20mm	.2441
D	.2460
6.25mm	.2461
6.30mm	.2480
1/4"	.2500
E	.2500
6.40mm	.2520
6.50mm	.2559
F	.2570
6.60mm	.2598
G	.2610
6.70mm	.2638
17/64"	.2656
6.75mm	.2657
H	.2660

Diameter	Decimal Equiv.
6.80mm	.2677
6.90mm	.2717
I	.2720
7.00mm	.2756
J	.2770
7.10mm	.2795
K	.2810
9/32"	.2812
7.20mm	.2835
7.25mm	.2854
7.30mm	.2874
L	.2900
7.40mm	.2913
M	.2950
7.50mm	.2953
19/64"	.2969
7.60mm	.2992
N	.3020
7.70mm	.3031
7.75mm	.3051
7.80mm	.3071
7.90mm	.3110
5/16"	.3125
8.00mm	.3150
O	.3160
8.10mm	.3189
8.20mm	.3228
P	.3230
8.25mm	.3248
8.30mm	.3268
21/64"	.3281
8.40mm	.3307
Q	.3320
8.50mm	.3346
8.60mm	.3386
R	.3390
8.70mm	.3425
11/32"	.3438
8.75mm	.3445
8.80mm	.3465
S	.3480
8.90mm	.3504
9.00mm	.3543
T	.3580
9.10mm	.3583
23/64"	.3594
9.20mm	.3622
9.25mm	.3642
9.30mm	.3661
U	.3680
9.40mm	.3701
9.50mm	.3740
3/8"	.3750
V	.3770
9.60mm	.3780
9.70mm	.3819
9.75mm	.3839
9.80mm	.3858
W	.3860
9.90mm	.3898
25/64"	.3906
10.00mm	.3937
X	.3970
Y	.4040
13/32"	.4062
Z	.4130
10.50mm	.4134

Diameter	Decimal Equiv.
27/64"	.4219
11.00mm	.4331
7/16"	.4375
11.50mm	.4528
29/64"	.4531
15/32"	.4688
12.00mm	.4724
31/64"	.4844
12.50mm	.4921
1/2"	.5000
13.00mm	.5118
33/64"	.5156
17/32"	.5312
13.50mm	.5315
35/64"	.5469
14.00mm	.5512
9/16"	.5625
14.50mm	.5709
37/64"	.5781
15.00mm	.5906
19/32"	.5938
39/64"	.6094
15.50mm	.6102
5/8"	.6250
16.00mm	.6299
41/64"	.6406
16.50mm	.6496
21/32"	.6562
17.00mm	.6693
43/64"	.6719
11/16"	.6875
17.50mm	.6890
45/64"	.7031
18.00mm	.7087
23/32"	.7188
18.50mm	.7283
47/64"	.7344
19.00mm	.7480
3/4"	.7500
49/64"	.7656
19.50mm	.7677
25/32"	.7812
20.00mm	.7874
51/64"	.7969
20.50mm	.8071
13/16"	.8125
21.00mm	.8268
53/64"	.8281
27/32"	.8438
21.50mm	.8465
55/64"	.8594
22.00mm	.8661
7/8"	.8750
22.50mm	.8858
57/64"	.8906
23.00mm	.9055
29/32"	.9062
59/64"	.9219
23.50mm	.9252
15/16"	.9375
24.00mm	.9449
61/64"	.9531
24.50mm	.9646
31/32"	.9688
25.00mm	.9843
63/64"	.9844
1"	1.0000