

SPEEDS & FEEDS

GENERAL PURPOSE

- Plunge Operations: Reduce feed per tooth 50-65%
- Slotting Applications: Surface speeds (sfm) should be reduced approximately 20% of the lowest value
- Light radial depths of cut, the higher of the recommended surface speeds (sfm) should be used
- Greater Radial depths of cut (more than 0.5 X diameter), the lower range of surface speeds (sfm) should be used
- Axial Depth of Cut: Recommendations are not to exceed 1.5 times the diameter. If this condition exists, Conventional Milling should be used and feed per tooth should be reduced by 50%

MATERIAL	SPEED (SFM)	END MILL DIAMETER FEED PER TOOTH (inches)		
		UP TO 1/4"	UP TO 1/2"	UP TO 1"
Aluminum/Aluminum Alloys	600-1300	.0002-.002	.002-.004	.004-.008
Brass/Soft Bronze	400-700	.0005-.002	.002-.003	.003-.005
Bronze/High Tensile	250-400	.001-.002	.002-.003	.004-.006
Copper/Copper Alloys	350-900	.005-.002	0.002	.002-.006
Iron-Cast (soft)	200-500	.0005-.002	.002-.003	.003-.008
Iron-Cast (hard)	100-450	.0003-.001	.0008-.002	.003-.005
Iron-Ductile	80-400	.0002-.001	.001-.002	.002-.006
Iron-Malleable	250-600	.001-.002	.001-.003	.003-.008
Magnesium/Magnesium Alloys	800-1400	.0005-.002	.002-.004	.004-.010
Monel/High Nickel Steel	150-300	.0002-.001	.001-.002	.002-.004
Nickel Base Hi-Temp Alloys	20-100	.0003-.0008	.0008-.001	.001-.002
Plastics	600-1200	.0006-.003	.003-.006	.006-.015
Plastics-Glass Filled	300-800	.0006-.003	.003-.004	.004-.012
Refractory Alloys	80-400	.0002-.001	0.001	.001-.002
Steel-Low Carbon	250-550	.0002-.001	.001-.003	.003-.007
Steel-Medium Carbon	100-250	.0004-.0015	.0015-.002	.002-.005
Steel-Up to Rc35	150-250	.0005-.001	.001-.002	.002-.003
Steel-Rc35 - Rc50	80-150	.0002-.0007	.0007-.001	.002-.003
Steel: Rc50- Rc60	25-120	.0002-.0005	.0005-.001	.002-.003
Steel-Mold	200-350	.0002-.001	.001-.002	.002-.006
Steel-Tool	100-300	.0002-.001	.001-.002	.002-.006
Stainless Steel-Soft	250-400	.0002-.001	.001-.002	.002-.006
Stainless Steel-Hard	50-250	.0002-.001	.001-.002	.001-.005
Titanium-Soft	120-350	.0002-.001	.001-.002	.002-.006
Titanium-Hard	30-150	.0002-.0005	.0005-.001	.001-.004

*** PLEASE NOTE: The above recommendations should be considered ONLY as a starting point; "fine tuning" may be required in order to maximize performance ***

SPEEDS & FEEDS

FEROCIOUS & FEROCIOUS 3x

- **Max Spindle Speeds Possible**
- **Dramatic Feed Rate Increase**
- **Vertical Chip Ejection**
- **Quiet Operation**
- **Longer Tool Life**

- THE IPT VALUES BELOW ARE MINIMUM STARTING POINTS - REDUCING IPT VALUES CAN CAUSE THE TOOL TO DEFLECT
- IF SFM CANNOT BE ACHIEVED DUE TO RPM LIMITS, PLEASE RUN AT MAXIMUM SAFE RPM AND MAINTAIN IPT RECOMMENDATION

SPEEDS AND FEEDS		
TOOL DIAMETER	I.P.T (INCH PER TOOTH)	STARTING RPM
1/8	.001	12,000
3/16	.002	10,000
1/4	.003	10,000
5/16	.004	8,000
3/8	.005	8,000
1/2	.006	8,000
5/8	.007	6,000
3/4	.008	4,000
1	.010	4,000

MATERIAL	CUT TYPE		Starting SFM Range	Target SFM	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
					ipt								
Aluminum Alloys	≥ 0.5xD to 1xD	Full Slot	395-786	590-1572	0.0009	0.0016	0.0024	0.0038	0.0046	0.0062	0.0070	0.0077	0.0088
	≤ 0.5xD	Profile			0.0012	0.0021	0.0031	0.0049	0.0059	0.0079	0.0090	0.0099	0.0113
	≤ 0.05xD	Finish Pass			0.0016	0.0028	0.0043	0.0068	0.0082	0.0110	0.0125	0.0137	0.0157
MATERIAL	CUT TYPE		Starting SFM Range	Target SFM	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
					ipt								
Cast Aluminum (High Silicon)	≥ 0.5xD to 1xD	Full Slot	395-786	590-1572	0.0008	0.0014	0.0022	0.0034	0.0041	0.0056	0.0063	0.0069	0.0079
	≤ 0.5xD	Profile			0.0010	0.0018	0.0028	0.0044	0.0053	0.0072	0.0081	0.0089	0.0102
	≤ 0.05xD	Finish Pass			0.0014	0.0026	0.0038	0.0061	0.0074	0.0099	0.0112	0.0123	0.0141
MATERIAL	CUT TYPE		Starting SFM Range	Target SFM	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
					ipt								
Copper Alloys / Brass	≥ 0.5xD to 1xD	Full Slot	395-786	590-1572	0.0008	0.0014	0.0022	0.0034	0.0041	0.0056	0.0063	0.0069	0.0079
	≤ 0.5xD	Profile			0.0010	0.0018	0.0028	0.0044	0.0053	0.0072	0.0081	0.0089	0.0102
	≤ 0.05xD	Finish Pass			0.0014	0.0026	0.0038	0.0061	0.0074	0.0099	0.0112	0.0123	0.0141
MATERIAL	CUT TYPE		Starting SFM Range	Target SFM	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	1
					ipt								
Plastics	≥ 0.5xD to 1xD	Full Slot	395-786	590-1572	0.0017	0.0031	0.0046	0.0073	0.0088	0.0119	0.0135	0.0148	0.0169
	≤ 0.5xD	Profile			0.0022	0.0039	0.0059	0.0094	0.0113	0.0153	0.0173	0.0190	0.0217
	≤ 0.05xD	Finish Pass			0.0031	0.0055	0.0082	0.0130	0.0158	0.0212	0.0240	0.0264	0.0301

WARNING: TOO LOW OF AN RPM COUPLED WITH TOO MUCH FEED MIGHT CAUSE THE TOOL TO SHATTER

FOR BEST RESULTS:

- DIRECT MULTIPLE COOLANT NOZZLES AT THE END MILL TO ASSURE CONSTANT COOLING OF THE TOOL AND TO FLUSH CHIPS.
- THESE TOOLS ARE SPECIALLY DESIGNED FOR HI-SPEED MILLING OF ALUMINUM.
- THE FEEDS LISTED ARE STARTING POINTS. VARIATIONS OF THESE WILL DEPEND ON THE RADIAL & AXIAL DEPTH-OF-CUT & WORK PIECE CONDITIONS
- REDUCE FEED BY 50% ON LONG AND LONG REACH TOOLS OR WHEN AXIAL DEPTH OF CUT EXCEEDS 1.5XD
- RADIAL RUNOUT OF TOOL TIP UNDER (.0005") WHEN RUNNING TO ACHIEVE OPTIMUM FEEDS
- CGS RECOMMENDS STARTING AT LOWER END OF SFM VALUES AND INCREASING AT CONTROLLED LEVELS TO ACHIEVE OPTIMUM FEEDS & SURFACE FINISHES

SPEEDS & FEEDS

HV & THE BEAST

		1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"	
Work Material	SFM	RPM - IPM	RPM - IPM	RPM - IPM	RPM - IPM	RPM - IPM	RPM - IPM	RPM - IPM	RPM - IPM	RPM - IPM	
Titanium Alloys											
	HIGH	250	7640 - 15.3	5093 - 10.2	3820 - 9.2	3056 - 11.0	2547 - 11.2	1910 - 10.7	1528 - 9.2	1273 - 11.2	955 - 9.9
	LOW	212	6479 - 13.0	4319 - 8.6	3239 - 7.7	2591 - 9.3	2160 - 9.5	1620 - 9.0	1296 - 7.7	1080 - 9.5	810 - 8.4
	<i>IPT</i>		0.0005	0.0005	0.0006	0.0009	0.0011	0.0014	0.0015	0.0022	0.0026
High Temp Alloys											
	HIGH	125	3820 - 6.1	2547 - 4.1	1910 - 5.4	1528 - 6.8	1273 - 5.6	955 - 6.5	764 - 5.8	637 - 6.1	478 - 4.6
	LOW	106	3239 - 5.2	2160 - 3.4	1620 - 4.5	1296 - 5.7	1080 - 4.7	810 - 5.5	648 - 4.9	540 - 5.2	405 - 3.9
	<i>IPT</i>		0.0004	0.0004	0.0007	0.0011	0.0011	0.0017	0.0019	0.0024	0.0024
Alloy Steels											
4140-4340	HIGH	575	17572 - 42.2	11715 - 46.8	8786 - 56.2	7029 - 56.2	5857 - 58.5	4393 - 54.5	3514 - 49.2	2929 - 43.3	2197 - 35.15
Below 36Rc	LOW	450	13752 - 33.0	9168 - 36.7	6876 - 44.0	5501 - 44.0	4584 - 45.8	3438 - 42.6	2750 - 38.5	2292 - 33.9	1719 - 27.5
	<i>IPT</i>		0.0006	0.001	0.0016	0.002	0.0025	0.0031	0.0035	0.0037	0.004
4140-4340	HIGH	387	11827 - 28.4	7884 - 31.5	5913 - 37.8	4731 - 37.8	3942 - 39.4	2957 - 36.7	2365 - 33.1	1971 - 29.2	1478 - 23.6
Above 36Rc	LOW	325	9932 - 23.8	6621 - 26.5	4966 - 31.8	3937 - 31.8	3311 - 33.1	2483 - 30.8	1986 - 27.8	1655 - 24.5	1242 - 19.9
	<i>IPT</i>		0.0006	0.001	0.0016	0.002	0.0025	0.0031	0.0035	0.0037	0.004
Grey Cast Iron											
	HIGH	700	21392 - 68.5	14242 - 45.8	10696 - 34.2	8557 - 41.1	7131 - 34.2	5348 - 38.5	4278 - 34.2	3565 - 34.2	2674 - 30.0
	LOW	575	17572 - 56.2	11715 - 37.5	8786 - 28.1	7029 - 33.7	5857 - 28.1	4393 - 31.6	3514 - 28.1	2929 - 28.1	2197 - 24.6
	<i>IPT</i>		0.0008	0.0008	0.0008	0.0012	0.0012	0.0018	0.002	0.0024	0.0028
Tool Steels											
Below 36Rc	HIGH	575	17572 - 35.1	11715 - 32.8	8786 - 49.2	7029 - 53.4	5857 - 46.9	4393 - 46.9	3514 - 43.6	2929 - 37.5	2197 - 30.8
	LOW	450	13752 - 27.5	9168 - 25.7	6876 - 38.5	5501 - 41.8	4584 - 36.7	3438 - 34.4	2750 - 34.1	2292 - 29.3	1719 - 24.1
	<i>IPT</i>		0.0005	0.0007	0.0014	0.0019	0.002	0.0025	0.0031	0.0032	0.0035
Above 36Rc	HIGH	262	8007 - 16.	5338 - 15.0	4003 - 22.4	3203 - 24.3	2669 - 21.4	2002 - 20.0	1601 - 19.9	1334 - 17.1	1001 - 14.0
	LOW	211	6448 - 12.9	4299 - 12.0	3224 - 18.0	2579 - 19.6	2149 - 17.2	1612 - 16.1	1290 - 16.0	1075 - 13.8	806 - 11.3
	<i>IPT</i>		0.0005	0.0007	0.0014	0.0019	0.002	0.0025	0.0031	0.0032	0.0035
Stainless Steels											
Hard to Machine	HIGH	362	11063 - 17.7	7375 - 11.8	5531 - 13.3	4425 - 17.7	3688 - 14.8	2766 - 17.7	2213 - 15.9	1844 - 16.2	1383 - 12.2
	LOW	325	9932 - 15.9	6621 - 10.6	4966 - 11.9	3973 - 15.9	3311 - 13.2	2483 - 15.9	1986 - 14.3	1655 - 14.6	1242 - 10.9
	<i>IPT</i>		0.0004	0.0004	0.0006	0.001	0.001	0.0016	0.0018	0.0022	0.0022
Mild to Machine	HIGH	375	11460 - 22.9	7640 - 15.3	5730 - 16.0	4584 - 20.2	3820 - 16.8	2865 - 19.5	2292 - 17.4	1910 - 17.6	1433 - 13.2
	LOW	337	10299 - 20.6	6866 - 13.7	5149 - 14.4	4119 - 18.1	3433 - 15.1	2575 - 17.5	2060 - 15.7	1716 - 15.8	1287 - 11.8
	<i>IPT</i>		0.0005	0.0005	0.0007	0.0011	0.0011	0.0017	0.0019	0.0023	0.0023
Easy to Machine			14883 - 35.7	9922 - 23.8	7441 - 23.8	5953 - 28.6	4961 - 23.8	3721 - 26.8	2977 - 23.8	2480 - 23.8	1860 - 17.9
			11827 - 28.4	7884 - 18.9	5913 - 18.9	4731 - 22.7	3942 - 18.9	2957 - 21.3	2365 - 18.9	1971 - 18.9	1478 - 14.2
	<i>IPT</i>		0.0006	0.0006	0.0008	0.0012	0.0012	0.0018	0.002	0.0024	0.0024
Soft Steels	HIGH	762	23287 - 55.9	15524 - 49.7	11643 - 37.3	9315 - 44.7	7762 - 37.3	5822 - 41.9	4657 - 37.3	3881 - 37.3	2911 - 32.6
	LOW	637	19467 - 46.7	12978 - 41.5	9733 - 31.2	7787 - 37.4	6489 - 31.2	4867 - 35.0	3893 - 31.1	3244 - 31.1	2433 - 27.3
	<i>IPT</i>		0.0006	0.0008	0.0008	0.0012	0.0012	0.0018	0.002	0.0024	0.0028
Die Steels											
Below 37Rc	HIGH	387	11827 - 28.4	7884 - 31.5	5913 - 37.8	4731 - 37.8	3942 - 39.4	2957 - 36.7	2365 - 33.1	1971 - 29.2	1478 - 23.6
	LOW	325	9932 - 23.8	6621 - 26.5	4966 - 31.8	3937 - 31.8	3311 - 33.1	2483 - 30.8	1986 - 27.8	1655 - 24.5	1242 - 19.9
	<i>IPT</i>		0.0006	0.001	0.0016	0.002	0.0025	0.0031	0.0035	0.0037	0.004

- Speed and feed recommendations are for **profile milling** (side cut) operations up to 20% of the cutter diameter
- Decrease values by 20% for **slotting operations**
- Rates based on **HIGH** values are for optimum working conditions

SPEEDS & FEEDS

STORM

Storm Series Application Guide - Speeds & Feeds (Inch)

Material Information			Feed (Inches per tooth)								
Work Material	HRC	SFM	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"
COBALT BASE ALLOYS											
Haynes 25/188, Stellite 21,	< 40	70 - 110	.0008" - .0020"	.0004" - .0010"	.0007" - .0012"	.0010" - .0018"	.0010" - .0020"	.0018" - .0028"	.0023" - .0031"	.0027" - .0034	.0029" - .0036"
Cobalt Chrome	> 40	50 - 90	.0005" - .0015"	.0004" - .0007"	.0005" - .0011"	.0008" - .0014"	.0010" - .0017"	.0015" - .0025"	.0021" - .0028"	.0024" - .0030"	.0025" - .0031"
NICKEL BASE ALLOYS											
Inconel-625/718, Waspaloy, Invar	< 40	65 - 110	.0005" - .0009"	.0005" - .0009"	.0007" - .0013"	.0010" - .0017"	.0010" - .0020"	.0020" - .0028"	.0025" - .0032"	.0029" - .0036"	.0030" - .0038"
Rene, Hastelloy, Monel	> 40	55 - 90	.0003" - .0008"	.0004" - .0007"	.0007" - .0012"	.0009" - .0015"	.0010" - .0018"	.0015" - .0025"	.0022" - .0030"	.0026" - .0033"	.0029" - .0035"
IRON BASE ALLOYS											
A286, Discaloy, Haynes 556,	< 40	65 - 110	.0005" - .0010"	.0008" - .0010"	.0006" - .0012"	.0007" - .0015"	.0011" - .0016"	.0018" - .0026"	.0025" - .0030"	.0026" - .0034"	.0032" - .0038"
Carpenter 22, Greek Ascology	> 40	55 - 90	.0003" - .0008"	.0004" - .0008"	.0005" - .0010"	.0006" - .0013"	.0008" - .0014"	.0013" - .0023"	.0022" - .0028"	.0025" - .0031"	.0030" - .0035"
TITANIUM ALLOYS											
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"
STAINLESS STEELS											
13/8, 15/5, 17-4, PH Types	< 40	175 - 225	.0005" - .0007"	.0004" - .0008"	.0007" - .0010"	.0008" - .0012"	.0013" - .0018"	.0010" - .0020"	.0012" - .0025"	.0012" - .0020"	.0020" - .0028"
-	> 40	135 - 175	.0002" - .0004"	.0002" - .0006"	.0003" - .0007"	.0004" - .0008"	.0007" - .0012"	.0008" - .0015"	.0010" - .0016"	.0013" - .0017"	.0015" - .0020"
300 Series, 304L, Nitronic 50,	< 40	200 - 225	.0003" - .0007"	.0005" - .0010"	.0008" - .0015"	.0009" - .0013"	.0010" - .0018"	.0015" - .0020"	.0018" - .0022"	.0018" - .0035"	.0023" - .0036"
Duplex, Super-Austenitic	> 40	155 - 200	.0002" - .0005"	.0004" - .0007"	.0005" - .0010"	.0005" - .0010"	.0007" - .0010"	.0009" - .0015"	.0012" - .0018"	.0015" - .0025"	.0020" - .0030"
400 Series - 403, 405, 420, 455	< 40	200 - 225	.0007" - .0010"	.0009" - .0015"	.0009" - .0014"	.0011" - .0015"	.0013" - .0018"	.0015" - .0025"	.0020" - .0035"	.0022" - .0040"	.0030" - .0046"
-	> 40	150 - 200	.0004" - .0008"	.0006" - .0010"	.0007" - .0011"	.0008" - .0012"	.0009" - .0015"	.0012" - .0020"	.0018" - .0030"	.0020" - .0035"	.0024" - .0042"
MEDIUM ALLOY TOOL STEEL HIGH STRENGTH TOOL STEEL											
4140, 4340, 52100, 6150, 8620	< 40	225 - 325	.0005" - .0008"	.0008" - .0015"	.0015" - .0020"	.0015" - .0023"	.0015" - .0025"	.0020" - .0030"	.0020" - .0030"	.0025" - .0035"	.0030" - .0040"
A2, D2, P20, H13, S2, O1	> 40	150 - 225	.0003" - .0005"	.0005" - .0010"	.0008" - .0012"	.0010" - .0015"	.0010" - .0018"	.0015" - .0020"	.0015" - .0020"	.0018" - .0025"	.0020" - .0030"
CARBON STEELS											
1000's - 1018, 1020, 12L14	< 40	225 - 325	.0005" - .0008"	.0008" - .0015"	.0015" - .0020"	.0015" - .0023"	.0015" - .0025"	.0020" - .0030"	.0020" - .0030"	.0025" - .0035"	.0030" - .0040"
CAST MATERIAL											
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"

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SPEEDS & FEEDS

EF-5 TORNADO

EF-5 Tornado Application Guide - Speeds and Feeds (Inch)

Material Information						Feed (Inches Per Tooth)									
Work Material	Type of Cut	Axial DOC	Radial DOC	Flutes	Speed (SFM)	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	1
Cast Iron	Slotting	0.5 x D	1 x D	5	300	0.0006	0.0009	0.0012	0.0015	0.0018	0.0021	0.0024	0.003	0.0036	0.0048
Gray	Peripheral - Rough	1.25 x D	.3 x D	5	375	0.0008	0.0012	0.0016	0.002	0.0025	0.0029	0.0033	0.0041	0.0049	0.0065
ASTM-A48 Class 20, 25, 30, 35 & 40	Finish	2 x D	.015 x D	5	375	0.0008	0.0012	0.0017	0.0021	0.0025	0.0029	0.0033	0.0042	0.005	0.0067
	Slotting	.5 x D	1 x D	5	275	0.0005	0.0008	0.001	0.0013	0.0015	0.0018	0.002	0.0025	0.003	0.004
	Peripheral - Rough	1.25 x D	.3 x D	5	350	0.0007	0.001	0.0014	0.0017	0.002	0.0024	0.0027	0.0034	0.0041	0.0055
Cast Iron	Peripheral - HEM*	3 x D	.05 x D	5	390	0.002	0.003	0.004	0.005	0.006	0.007	0.0081	0.0101	0.0121	0.0161
	Finish	2 x D	.015 x D	5	350	0.0007	0.001	0.0014	0.0017	0.0021	0.0024	0.0028	0.0035	0.0042	0.0056
	Slotting	.5 x D	1 x D	5	325	0.0007	0.0011	0.0014	0.0018	0.0021	0.0025	0.0028	0.0035	0.0042	0.0056
Low Carbon Steels ≤ 38 Rc	Peripheral - Rough	1.25 x D	.3 x D	5	400	0.001	0.0014	0.0019	0.0024	0.0029	0.0033	0.0038	0.0048	0.0057	0.0076
	Peripheral - HEM*	3 x D	.07 x D	5	450	0.0028	0.0042	0.0056	0.007	0.0084	0.0098	0.0112	0.014	0.0168	0.0224
	Finish	2 x D	.015 x D	5	400	0.001	0.0015	0.0019	0.0024	0.0029	0.0034	0.0039	0.0049	0.0058	0.0078
Medium Carbon Steels ≤ 48 HRC	Slotting	.5 x D	1 x D	5	300	0.0006	0.001	0.0013	0.0016	0.0019	0.0022	0.0026	0.0032	0.0038	0.0051
	Peripheral - Rough	1.25 x D	.3 x D	5	375	0.0009	0.0013	0.0017	0.0022	0.0026	0.0031	0.0035	0.0044	0.0052	0.007
	Peripheral - HEM*	3 x D	.05 x D	5	415	0.0026	0.0039	0.0052	0.0065	0.0077	0.009	0.0103	0.0129	0.0155	0.0207
1045, 4140, 4340, 5140	Finish	2 x D	.015 x D	5	375	0.0009	0.0013	0.0018	0.0022	0.0027	0.0031	0.0036	0.0044	0.0053	0.0071
	Slotting	.5 x D	1 x D	5	275	0.0005	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0027	0.0032	0.0043
	Peripheral - Rough	1.25 x D	.3 x D	5	350	0.0007	0.0011	0.0015	0.0018	0.0022	0.0026	0.0029	0.0037	0.0044	0.0059
Tool and Die Steels ≤ 48 Rc	Peripheral - HEM*	3 x D	.05 x D	5	390	0.0022	0.0032	0.0043	0.0054	0.0065	0.0076	0.0087	0.0108	0.013	0.0173
	Finish	2 x D	.015 x D	5	350	0.0007	0.0011	0.0015	0.0019	0.0022	0.0026	0.003	0.0037	0.0045	0.006
	Slotting	.5 x D	1 x D	5	300	0.0006	0.001	0.0013	0.0016	0.0019	0.0022	0.0026	0.0032	0.0038	0.0051
Martensitic & Ferritic Stainless Steels	Peripheral - Rough	1.25 x D	.3 x D	5	375	0.0009	0.0013	0.0017	0.0022	0.0026	0.0031	0.0035	0.0044	0.0052	0.007
	Peripheral - HEM*	3 x D	.05 x D	5	415	0.0026	0.0039	0.0052	0.0065	0.0077	0.009	0.0103	0.0129	0.0155	0.0207
	Finish	2 x D	.015 x D	5	375	0.0009	0.0013	0.0018	0.0022	0.0027	0.0031	0.0036	0.0044	0.0053	0.0071
410, 416, 440	Slotting	.5 x D	1 x D	5	275	0.0006	0.0009	0.0012	0.0015	0.0018	0.0021	0.0024	0.003	0.0036	0.0048
	Peripheral - Rough	1.25 x D	.3 x D	5	350	0.0008	0.0012	0.0016	0.002	0.0025	0.0029	0.0033	0.0041	0.0049	0.0065
	Peripheral - HEM*	3 x D	.05 x D	5	390	0.0025	0.0037	0.0049	0.0062	0.0074	0.0086	0.0099	0.0123	0.0148	0.0198
303, 304, 316, Invar, Kovar	Finish	2 x D	.015 x D	5	350	0.0008	0.0012	0.0017	0.0021	0.0025	0.0029	0.0033	0.0042	0.005	0.0067
	Slotting	.5 x D	1 x D	5	250	0.0005	0.0008	0.001	0.0013	0.0015	0.0018	0.002	0.0025	0.003	0.004
	Peripheral - Rough	1.25 x D	.3 x D	5	325	0.0007	0.001	0.0014	0.0017	0.002	0.0024	0.0027	0.0034	0.0041	0.0055
Precipitation Hardening Stainless Steels	Peripheral - HEM*	3 x D	.05 x D	5	360	0.002	0.003	0.004	0.0049	0.0059	0.0069	0.0079	0.0099	0.0119	0.0158
	Finish	1.5 x D	.015 x D	5	325	0.0007	0.001	0.0014	0.0017	0.0021	0.0024	0.0028	0.0035	0.0042	0.0056
	Slotting	.5 x D	1 x D	5	250	0.0005	0.0007	0.0009	0.0012	0.0014	0.0016	0.0018	0.0023	0.0028	0.0037
Titanium Alloys	Peripheral - Rough	1 x D	.3 x D	5	300	0.0006	0.0009	0.0013	0.0016	0.0019	0.0022	0.0025	0.0031	0.0038	0.005
	Peripheral - HEM*	3 x D	.05 x D	5	330	0.0018	0.0027	0.0036	0.0046	0.0055	0.0064	0.0073	0.0091	0.0109	0.0146
	Finish	1.5 x D	.015 x D	5	300	0.0006	0.001	0.0013	0.0016	0.0019	0.0022	0.0026	0.0032	0.0038	0.0051
Difficult-to- Machine Titanium Alloys	Slotting	.25 x D	1 x D	5	200	0.0003	0.0005	0.0007	0.0009	0.001	0.0012	0.0014	0.0017	0.002	0.0027
	Peripheral - Rough	1 x D	.25 x D	5	250	0.0005	0.0007	0.001	0.0012	0.0015	0.0017	0.002	0.0025	0.0029	0.0039
	Peripheral - HEM*	3 x D	.05 x D	5	275	0.0015	0.0022	0.003	0.0037	0.0045	0.0052	0.0059	0.0074	0.0089	0.0119
10-2-3 Precipitation Hardening Stainless Steels	Finish	1.5 x D	.01 x D	5	250	0.0006	0.0009	0.0012	0.0014	0.0017	0.002	0.0023	0.0029	0.0035	0.0046

- Speed and feed recommendations are for **profile milling** (side cut) operations up to 20% of the cutter diameter
- Decrease values by 20% for **slotting operations**
- Rates based on **HIGH** values are for optimum working conditions

SPEEDS & FEEDS

PX SERIES

PX Series Application Guide - Speeds & Feeds (Inch)

Material Information					Feed (Inches per tooth)									
Work Material	Type of Cut	Axial DOC	Radial DOC	Speed SPM	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	1"
Cast Iron	Slotting	0.5 x D	1 x D	300	.0006	.0009	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
ASTM-A48 Class 20, 25, 30, 35 & 40	Peripheral - Rough	1.25 x D	.3 x D	375	.0008	.0012	.0016	.0025	0.0026	.0029	.0033	.0041	.0049	.0065
	Finish	2 x D	.015 x D	375	.0008	.0012	.0017	.0025	0.0027	.0029	.0033	.0042	.0050	.0067
	Slotting	0.5 x D	1 x D	275	.0005	.0008	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
Cast Iron	Peripheral - Rough	1.25 x D	.3 x D	350	.0007	.0010	.0014	.0017	.0020	.0024	.0027	.0034	.0034	.0055
Malleable	Peripheral - HEM*	3 x D	.05 x D	390	.0020	.0030	.0040	.0050	.0060	.0070	.0081	.0101	.0121	.0161
	Slotting	2 x D	.015 x D	350	.0007	.0010	.0014	.0017	.0021	.0024	.0028	.0035	.0042	.0056
	Slotting	0.5 x D	1 x D	325	.0007	.0011	.0014	.0018	.0021	.0025	.0028	.0035	.0042	.0056
Low Carbon Steels ≤ 38 Rc	Peripheral - Rough	1.25 x D	.3 x D	400	.0010	.0014	.0019	.0024	.0029	.0033	.0038	.0048	.0057	.0076
1018, 1020, 12L14, 5120, 8620	Peripheral - HEM*	3 x D	.07 x D	450	.0028	.0042	.0056	.0070	.0084	.0098	.0112	.0140	.0168	.0224
	Finish	2 x D	.015 x D	400	.0010	.0015	.0019	.0024	.0029	.0034	.0039	.0049	.0058	.0078
	Slotting	0.5 x D	1 x D	300	.0006	.0010	.0013	.0016	.0019	.0022	.0026	.0032	.0038	.0051
Medium Carbon Steels ≤ 48 HRC	Peripheral - Rough	1 x D	.3 x D	375	.0009	.0013	.0017	.0022	.0026	.0031	.0035	.0044	.0052	.0070
1045, 4140, 4340, 5140	Peripheral - HEM*	3 x D	.05 x D	415	.0026	.0039	.0052	.0065	.0077	.0090	.0103	.0129	.0155	.0207
	Finish	2 x D	.015 x D	375	.0009	.0013	.0018	.0022	.0027	.0031	.0036	.0044	.0053	.0071
	Slotting	0.5 x D	1 x D	275	.0005	.0008	.0011	.0014	.0016	.0019	.0022	.0027	.0032	.0043
Tool and Die Steels ≤ 48 Rc	Peripheral - Rough	1.25 x D	.3 x D	350	.0007	.0011	.0015	.0018	.0022	.0026	.0029	.0037	.0044	.0059
A2, D2, O1, S7, P20, H13	Peripheral - HEM*	3 x D	.05 x D	390	.0022	.0032	.0043	.0054	.0065	.0076	.0087	.0108	.0130	.0173
	Finish	2 x D	.015 x D	350	.0007	.0011	.0015	.0019	.0022	.0026	.0030	.0037	.0045	.0060
	Slotting	0.5 x D	1 x D	300	.0006	.0010	.0013	.0016	.0019	.0022	.0026	.0032	.0038	.0051
Martensitic & Ferritic Stainless Steels	Peripheral - Rough	1.25 x D	.3 x D	375	.0009	.0013	.0017	.0022	.0026	.0031	.0035	.0044	.0052	.0070
410, 416, 440	Peripheral - HEM*	3 x D	.05 x D	415	.0026	.0039	.0052	.0065	.0077	.0090	.0103	.0129	.0155	.0207
	Slotting	2 x D	.015 x D	375	.0009	.0013	.0018	.0022	.0027	.0031	.0036	.0044	.0053	.0071
	Slotting	0.5 x D	1 x D	275	.0006	.0009	.0012	.0015	.0018	.0021	.0024	.0030	.0036	.0048
Austenitic Stainless Steels, FeNi Alloys	Peripheral - Rough	1.25 x D	.3 x D	350	.0008	.0012	.0016	.0020	.0025	.0029	.0033	.0041	.0049	.0065
303, 304, 316, Invar, Kovar	Peripheral - HEM*	3 x D	.05 x D	390	.0025	.0037	.0049	.0062	.0074	.0086	.0099	.0123	.0148	.0198
	Finish	2 x D	.015 x D	350	.0008	.0012	.0017	.0021	.0025	.0029	.0033	.0042	.0050	.0067
	Slotting	0.5 x D	1 x D	250	.0005	.0008	.0010	.0013	.0015	.0018	.0020	.0025	.0030	.0040
Precipitation Hardening Stainless Steels	Peripheral - Rough	1.25 x D	.3 x D	325	.0007	.0010	.0014	.0017	.0020	.0024	.0027	.0034	.0041	.0055
17-4, 15-5	Peripheral - HEM*	3 x D	.05 x D	360	.0020	.0030	.0040	.0049	.0059	.0069	.0079	.0099	.0119	.0158
	Slotting	1.5 x D	.015 x D	325	.0007	.0010	.0014	.0017	.0021	.0024	.0028	.0035	.0042	.0056
	Slotting	0.5 x D	1 x D	250	.0005	.0007	.0009	.0012	.0014	.0016	.0018	.0023	.0028	.0037
Titanium Alloys	Peripheral - Rough	1 x D	.3 x D	300	.0006	.0009	.0013	.0016	.0019	.0022	.0025	.0031	.0038	.0050
6Al-4V, 6-2-4	Peripheral - HEM*	3 x D	.05 x D	330	.0018	.0027	.0036	.0046	.0055	.0064	.0073	.0091	.0109	.0146
	Finish	1.5 x D	.015 x D	300	.0006	.0010	.0013	.0016	.0019	.0022	.0026	.0032	.0038	.0051
	Slotting	0.25 x D	1 x D	200	.0003	.0005	.0007	.0009	.0010	.0012	.0014	.0017	.0020	.0027
Difficult-to-Machine Titanium Alloys	Peripheral - Rough	1 x D	.25 x D	250	.0005	.0007	.0010	.0012	.0015	.0017	.0020	.0025	.0029	.0039
10-2-3	Peripheral - Rough	1 x D	.25 x D	250	.0005	.0007	.0010	.0012	.0015	.0017	.0020	.0025	.0029	.0039
Precipitation Hardening Stainless Steels	Peripheral - HEM*	3 x D	.05 x D	275	.0015	.0022	.0030	.0037	.0045	.0052	.0059	.0074	.0089	.0119
13-8	Slotting	1.5 x D	.01 x D	250	.0006	.0009	.0012	.0014	.0017	.0020	.0023	.0029	.0035	.0046

*** For 5 & 7 Flute HEM applications, please refer to standard RDOC chip thinning practices ***

Recommended Speeds and Feeds For MX Series End Mills with 4 & 6 Flutes											
CUTTING SPEEDS		1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	1"	
Work Material	SFM	ipt	ipt	ipt	ipt	ipt	ipt	ipt	ipt	ipt	
Titanium Alloys											
	HIGH	250	0.0004	0.0004	0.0005	0.0008	0.001	0.0013	0.0014	0.0021	0.0025
	LOW	212	0.0005	0.0005	0.0006	0.0009	0.0011	0.0014	0.0015	0.0022	0.0026
High Temp Alloys											
	HIGH	125	0.0003	0.0003	0.0006	0.001	0.001	0.0016	0.0018	0.0023	0.0023
	LOW	106	0.0004	0.0004	0.0007	0.0011	0.0011	0.0017	0.0019	0.0024	0.0024
Alloy Steels											
4140-4340	HIGH	575	0.0005	0.0009	0.0015	0.0019	0.0024	0.003	0.0034	0.0036	0.0039
Below 36Rc	LOW	450	0.0006	0.001	0.0016	0.002	0.0025	0.0031	0.0035	0.0037	0.004
4140-4340	HIGH	387	0.0005	0.0009	0.0015	0.0019	0.0024	0.003	0.0034	0.0036	0.0039
Above 36Rc	LOW	325	0.0006	0.001	0.0016	0.002	0.0025	0.0031	0.0035	0.0037	0.004
Grey Cast Iron											
	HIGH	700	0.0007	0.0007	0.0007	0.0011	0.0011	0.0017	0.0019	0.0023	0.0027
	LOW	575	0.0008	0.0008	0.0008	0.0012	0.0012	0.0018	0.002	0.0024	0.0028
Tool Steels											
Below 36Rc	HIGH	575	0.0004	0.0006	0.0013	0.0018	0.0019	0.0024	0.003	0.0031	0.0034
	LOW	450	0.0005	0.0007	0.0014	0.0019	0.002	0.0025	0.0031	0.0032	0.0035
Above 36Rc	HIGH	262	0.0004	0.0006	0.0013	0.0018	0.0019	0.0024	0.003	0.0031	0.0034
	LOW	211	0.0005	0.0007	0.0014	0.0019	0.002	0.0025	0.0031	0.0032	0.0035
Stainless Steels											
Hard to Machine	HIGH	362	0.0003	0.0003	0.0005	0.0009	0.0009	0.0015	0.0017	0.0021	0.0021
	LOW	325	0.0004	0.0004	0.0006	0.001	0.001	0.0016	0.0018	0.0022	0.0022
Mild to Machine	HIGH	375	0.0004	0.0004	0.0006	0.001	0.001	0.0016	0.0018	0.0022	0.0022
	LOW	337	0.0005	0.0005	0.0007	0.0011	0.0011	0.0017	0.0019	0.0023	0.0023
Easy to Machine	HIGH	487	0.0005	0.0005	0.0007	0.0011	0.0011	0.0017	0.0019	0.0023	0.0023
	LOW	387	0.0006	0.0006	0.0008	0.0012	0.0012	0.0018	0.002	0.0024	0.0024
Soft Steels											
	HIGH	762	0.0005	0.0007	0.0007	0.0011	0.0011	0.0017	0.0019	0.0023	0.0027
	LOW	637	0.0006	0.0008	0.0008	0.0012	0.0012	0.0018	0.002	0.0024	0.0028
Die Steels											
Below 37Rc	HIGH	387	0.0005	0.0009	0.0015	0.0019	0.0024	0.003	0.0034	0.0036	0.0039
	LOW	325	0.0006	0.001	0.0016	0.002	0.0025	0.0031	0.0035	0.0037	0.004

- Speed and feed recommendations are for *profile milling* (side cut) operations up to 20% of the cutter diameter
- Decrease values by 20% for *slotting operations*
- Rates based on **HIGH** values are for optimum working conditions

SPEEDS & FEEDS

HX SERIES

HX Series Application Guide - Speeds & Feeds (Inch)

Material Information					Feed (Inches per tooth)									
Work Material	Type of Cut	Axial DOC	Radial DOC	Speed SPM	1/8"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	1"
	Slotting	0.5 x D	1 x D	300	0.0006	0.001	0.0013	0.0016	0.0019	0.0022	0.0026	0.0032	0.0038	0.0051
Martensitic & Ferritic Stainless Steels	Peripheral - Rough	1.25 x D	.3 x D	375	0.0009	0.0013	0.0017	0.0022	0.0026	0.0031	0.0035	0.0044	0.0052	0.007
410, 416, 440	Peripheral - HEM*	3 x D	.05 x D	415	0.0026	0.0039	0.0052	0.0065	0.0077	0.009	0.0103	0.0129	0.0155	0.0207
	Finish	2 x D	.015 x D	375	0.0009	0.0013	0.0018	0.0022	0.0027	0.0031	0.0036	0.0044	0.0053	0.0071
	Slotting	0.5 x D	1 x D	275	0.0006	0.0009	0.0012	0.0015	0.0018	0.0021	0.0024	0.003	0.0036	0.0048
Austenitic Stainless Steels, FeNi Alloys	Peripheral - Rough	1.25 x D	.3 x D	350	0.0008	0.0012	0.0016	0.002	0.0025	0.0029	0.0033	0.0041	0.0049	0.0065
303, 304, 316, Invar, Kovar	Peripheral - HEM*	3 x D	.05 x D	390	0.0025	0.0037	0.0049	0.0062	0.0074	0.086	0.0099	0.0123	0.0148	0.0198
	Slotting	2 x D	.015 x D	350	0.0008	0.0012	0.0017	0.0021	0.0025	0.0029	0.0033	0.0042	0.005	0.0067
	Slotting	0.5 x D	1 x D	250	0.0005	0.0008	0.001	0.0013	0.0015	0.0018	0.002	0.0025	0.003	0.004
Precipitation Hardening Stainless Steels	Peripheral - Rough	1.25 x D	.3 x D	325	0.0007	0.001	0.0014	0.0017	0.002	0.0024	0.0027	0.0034	0.0041	0.0055
17-4, 15-5	Peripheral - HEM*	3 x D	.05 x D	360	0.002	0.003	0.004	0.0059	0.0055	0.0069	0.0079	0.0099	0.0119	0.0158
	Finish	1.5 x D	.015 x D	325	0.0007	0.001	0.0014	0.0021	0.0019	0.0024	0.0028	0.0035	0.0042	0.0056
	Slotting	0.5 x D	1 x D	250	0.0005	0.0007	0.0009	0.0012	0.0014	0.0016	0.0018	0.0023	0.0028	0.0037
Titanium Alloys	Peripheral - Rough	1 x D	.3 x D	300	0.0006	0.0009	0.0013	0.0016	0.0019	0.0022	0.0025	0.0031	0.0038	0.005
6Al-4V, 6-2-4	Peripheral - HEM*	3 x D	.05 x D	330	0.0018	0.0027	0.0036	0.0046	0.0055	0.0064	0.0073	0.0091	0.0109	0.0146
	Finish	1.5 x D	.015 x D	300	0.0006	0.001	0.0013	0.0016	0.0019	0.0022	0.0026	0.0032	0.0038	0.0051
Difficult to Machine Titanium Alloys	Slotting	0.25 x D	1 x D	200	0.0003	0.0005	0.0007	0.0009	0.001	0.0012	0.0014	0.0017	0.002	0.0027
10-2-3	Peripheral - Rough	1 x D	.25 x D	250	0.0005	0.0007	0.001	0.0012	0.0015	0.0017	0.002	0.0025	0.0029	0.0039
Precipitation Hardening Stainless Steels	Peripheral - HEM*	3 x D	.05 x D	275	0.0015	0.0022	0.003	0.0037	0.0045	0.0052	0.0059	0.0074	0.0089	0.0119
13-8	Finish	1.5 x D	.01 x D	250	0.0006	0.009	0.0012	0.0014	0.0017	0.002	0.0023	0.0029	0.0035	0.0046
	Slotting	0.5 x D	1 x D	275	0.0005	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0027	0.0032	0.0043
Tool & Die Steels < 48 Rc	Peripheral - Rough	1.25 x D	.3 x D	350	0.0007	0.0011	0.0015	0.0018	0.0022	0.0026	0.0029	0.0037	0.0044	0.0059
c A2, D2, O1, S7, P20, H13	Peripheral - HEM*	3 x D	.05 x D	390	0.0022	0.0032	0.0043	0.0054	0.0065	0.0076	0.0087	0.0108	0.013	0.0173
	Slotting	2 x D	.015 x D	350	0.0007	0.0011	0.0015	0.0019	0.0022	0.0026	0.003	0.0037	0.0045	0.006
	Slotting	0.5 x D	1 x D	325	0.0007	0.0011	0.0018	0.0021	0.001	0.0025	0.0028	0.0035	0.0042	0.0056
Low Carbon Steels < 38 Rc	Peripheral - Rough	1.25 x D	.3 x D	400	0.001	0.0019	0.0024	0.0029	0.0015	0.0033	0.0038	0.0048	0.0057	0.0076
1018, 1020, 12L14, 5120, 8620	Peripheral - HEM*	3 x D	.07 x D	450	0.0028	0.0056	0.007	0.0084	0.0045	0.0098	0.0112	0.014	0.0168	0.0224
	Finish	2 x D	.015 x D	400	0.001	0.0019	0.0024	0.0029	0.0017	0.0034	0.0039	0.0049	0.0058	0.0078
	Slotting	0.5 x D	1 x D	300	0.0006	0.001	0.0013	0.0016	0.0019	0.0022	0.0026	0.0032	0.0038	0.0051
Medium Carbon Steels < 48 Rc	Peripheral - Rough	1.25 x D	.3 x D	375	0.0009	0.0013	0.0017	0.0022	0.0026	0.0031	0.0035	0.0044	0.0052	0.007
1045, 4140, 4340, 5140	Peripheral - HEM*	3 x D	.05 x D	415	0.0026	0.0039	0.0052	0.0065	0.0077	0.009	0.0103	0.0129	0.0155	0.0207
	Slotting	2 x D	.015 x D	375	0.0009	0.0013	0.0018	0.0022	0.0027	0.0031	0.0036	0.0044	0.0053	0.0071

- Speed and feed recommendations are for **profile milling** (side cut) operations up to 20% of the cutter diameter
- Decrease values by 20% for **slotting operations**
- Rates based on **HIGH** values are for optimum working conditions