Technical Data

Insert Grade Information

ALP-XL
(K10 - K25)
Extremely smooth self lubricating surface coupled with the latest coating technology ensures frictionless chip removal resulting in long tool life. Use in materials with less than 10% silicon content. Also may be used in titanium.

HMF
(HW - K15)
Excellent edge strength and the ability to hold a sharp edge makes this grade a perfect choice for machining non-ferrous materials.

MPS
(HC - K25)
PVD TiAlN coating holds up well in high heat applications. This grade is used for machining tough materials such as stainless and hardened steel.

MPX
(HC - K15)
Excellent choice for machining dies molds and difficult to machine materials such as titanium and nickel alloys. Ideal for high speed and dry machining applications.

PDC
(DP - N25)
Polycrystalline, carbide reinforced diamond of fine grit size, good cutting edge sharpness and low cutting pressure allowing close tolerances. Increased flank wear resistance and toughness.

PDC-L
(DP - N10)
Polycrystalline, carbide reinforced diamond of ultrafine grit size, high cutting edge sharpness, minimal cutting pressure allowing close tolerances. Good flank wear resistance and toughness.

PDC-S
(DP - N35)
Polycrystalline carbide reinforced diamond of coarse grit size, good edge sharpness and low cutting pressure allowing close tolerances. Best performances for milling. High flank wear resistance and toughness.

RK20C
(K05 - K20)
Tough carbide substrate layered with ceramic coating gives unsurpassed performance in grey and nodular cast iron applications. The ceramic based coating allows for high speeds and dry cutting.

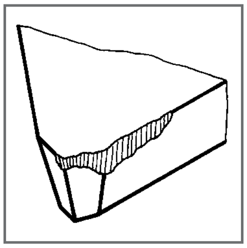
RK150
(HC-K15)
Coated grade for milling cast iron materials. Extremely high wear resistance and edge strength provides for long tool life in abrasive materials. Heat resistant coating allows this grade to be used in dry machining applications.

RM352
(HC - M35 - P35)
TiAlN PVD coating on a tough substrate makes this grade an excellent choice for applications in a broad range of materials where good toughness is needed, including stainless steel and aerospace alloys.

RP15K
(P10 - P25, M10 - M25)
Heat resistant Al_2O_3 coating allows for higher cutting speeds and long tool life in a wide range of materials and applications. Four layers of coating are interlocked for excellent adhesion to the insert. Use in semifinishing to finishing of steel and stainless steel. Can be used in moderate interrupted cut applications.

RP25K *(P15 - P30, M15 - M25)*	Universal turning grade with good toughness and excellent wear resistance. Particularly suited for rough to semifinishing of all steels and stainless steels. May be used in cast iron as well. First choice for an all purpose grade of carbide.
RP35K *(P25 - P45, M25 - M45)*	The toughest of RTC's steel turning family. The tough carbide substrate with the MT-CVD coating guarantees maximum performance in heavily interrupted cutting of steel and stainless steel.
RP35 *(HW - TTR)*	Tough uncoated grade for milling steel and cast steel under unfavorable cutting conditions. Low cutting speeds and heavy chip loads, excellent for rough milling.
RP350 *(HC - K25, M35, P35)*	CVD coated grade allows for all around successful machining in all the materials groups. Runs at higher surface footages and exhibits excellent toughness. First grade choice for most applications.
RP354 *(HC - M35, P35)*	High resistance to oxidation makes this wear resistant grade an excellent choice for milling applications where long tool life is required at higher surface footages.
SLK *(HC - K25, M25, P25)*	AlTiN coated grade runs at high speed for semi roughing and finishing applications. Excellent choice for aerospace materials and 300 series stainless steel too.
SLX *(HC - P35)*	General machining of steel . Excellent impact and wear resistance for use in finishing to roughing of all steels.
TK10M *(HW - K10)*	Uncoated K10/C2 wear resistant grade, suited for machining of non-ferrous materials, high temp. alloys as well as synthetic materials including fibreglass, graphite and plastic. Recommended to run with coolant only when materials require wet machining.
TK10MP *(HC - K10)*	TiAlN coating. Recommended grade for high speed machining of aluminum and non-ferrous materials. Good wear resistance. Designed to be used with coolant.
TK10TB	PVD diamond film coating offering greatly extended tool life over conventional carbide. Recommended specifically for synthetic materials such as graphite.
TK20 *(HW - K20)*	Micrograin carbide with excellent edge strength allos these tools to have extremely sharp cutting edges. Excellent for use in aluminum alloys and plastic materials. Usually polished to prevent edge build up.
TP30MC *(HC - P30)*	Good balance of toughness and wear resistance makes this a perfect choice for milling of steel at high surface footages especially when good toughness is required.

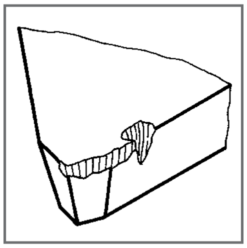
Troubleshooting



Flank Wear

General criteria for the end of tool life, characterized by an admissible amount of flank wear. (Figures usually relate to a tool life of T=15min.)

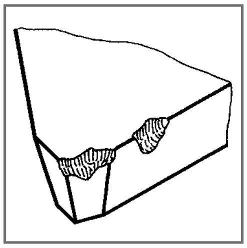
Remedy:
- select more wear-resistant grade
- reduce cutting speed



Notch Wear

Occurs locally in the area of the primary cutting edge where it contacts the workpiece surface. Caused by hard surface layers and work-hardened burrs, especially on stainless austenitic steels. Danger of breakage!

Remedy:
- strengthen cutting edge
- select smaller cutting edge angle (45°)
- reduce feed

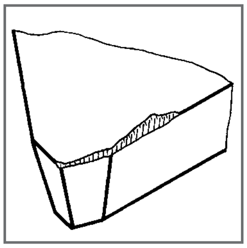


Edge Chipping

Minor chipping along the cutting edge, usually accompanied by flank wear and therefore not always identifiable. Danger of breakage! Edge chipping outside the cutting area is the result of chip impact due to unfavourable chip removal.

Remedy:
- select tougher grade
- use insert with stronger cutting edge geometry
- reduce feed when starting the cut

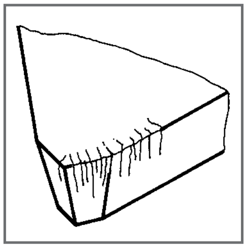
In the case of damage due to chip impact:
- vary feed
- change chipbreaker geometry
- change cutting edge angle



Built-Up Edges

Edge build-up occurs on the rake face as a result of work material welding together with the cutting material, especially when cutting difficult-to-machine materials. From time to time, the built-up edge will break off and may cause damage to the cutting edge. Also, built-up edges produce poor surface finishes.

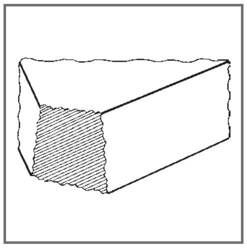
Remedy:
- increase cutting speed
- use coated hardmetals or cermets
- select positive cutting edge geometry
- use cutting fluid



Thermal Cracks

Small cracks running across the cutting edge, caused by thermal shock loads in interrupted cutting operations, particularly in milling. Danger of breakage!

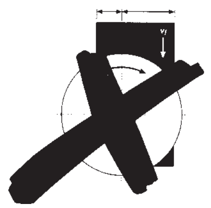
Remedy:
- use grade with greater resistance to thermal shock
- check use of cutting fluid; cutting fluid should not generally be used for milling, except with special grades for wet milling, e.g. TN450, aluminum, titanium alloys and high-temperature materials
- use compressed air to remove chips in slot milling



Insert Breakage

Insert breakage usually means damage to tool and workpiece. The causes are varied and also depend on machine and workpiece. This often originates in notches or other excessive types of wear.

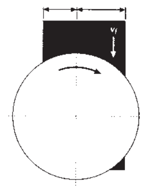
Remedy:
- select tougher grade
- reduce feed and possibly also depth of cut
- select chip breaker geometry for heavier chip sections



Burring

Chipping of the workpiece edge when cutter leaves the cut (mainly in cast iron).

Remedy:
- select smaller cutting edge angle for the tool
- select more positive cutting edge geometry
- change cutter position relative to workpiece



Workpiece Vibrations

Remedy:
- clamp workpiece more rigidly
- change cutter position relative to workpiece
- select a cutter with a different cutting edge angle

Cutter Vibration

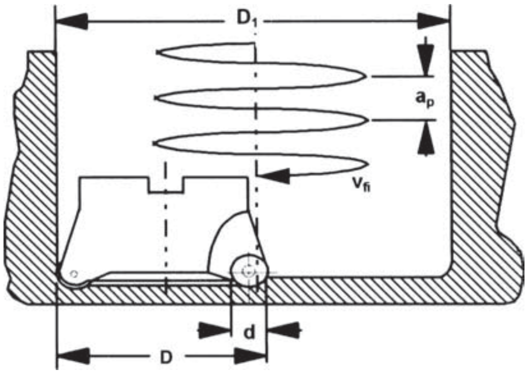
Remedy:
- minimize cutter overhang
- increase feed
- reduce cutting speed

Use of cutting fluids in milling

Remedy:
- cutting fluid should preferably not be used
- if cutting fluid is essential, then in copious amounts at low pressure with TN450 as the primary grade selection

Technical Info.

Circular and Helical Interpolation:



Circular and Helical Interpolation is an application where the cutter rotates on its own axis together in an orbiting motion around the workpiece (either internally or externally), while at the same time plunging to the required depth of cut. In order to accomplish this application, a machine with three-axis control capabilities is required.

Calculating feed rate: Unlike linear milling applications (face milling) where the tools cutting edge and centerline is identical, circular and helical interpolation feed rate is based only on the tools centerline (Vfi).The following formulas should be used to obtain the optimal running conditions.

Definitions

D	=	cutter diameter
d	=	insert diameter
D1	=	workpiece bore diameter
ap	=	depth of cut
fz	=	feed per tooth
fzkor	=	correction feed per tooth
Vfi	=	feed rate at cutters centerline
T	=	number of cutting teeth
rpm	=	revolutions per minute

Milling Cutter Diameter Selection Calculation:

Note: all values should be in inch

Minimum Cutter Diameter: $D_{min} = \frac{D_1}{2}$

Optimum / maximum Cutter Diameter: $D_{opt/max} = \frac{D1 + d}{2} - 1$

Calculating Feed Rate:

Note: all values should be in inch

Feed Rate Correction for Drill Milling with Round Inserts: $f_{zkor} = fz \times \frac{d}{ap} \times \frac{1}{135}$ inv cos* $\left(1 - \frac{1.5 \times ap}{d}\right)$

Depth of Cut (ap):
max. $ap \leq 0.5 \times d$ **opt.** $ap = 0.25 \times d$ * inv cos = $\cos^{-1}$

Feed Rate at Centerline of Tool when Drill Milling (V_{fi}) $Vfi = \left(1 - \frac{D}{D1}\right) \times rpm \times f_{zkor} \times T$

or approximately: $V_{fi} = .008 \times rpm \times f_{zkor} \times T$

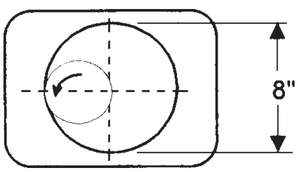
Example:

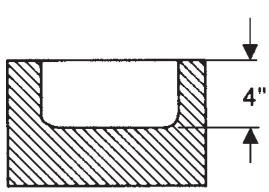
Cutter Data:

Cutter description: ..... **R360 Face Mill**
Diameter (D): .... 4″
Insert Diameter: .... .6299 (16mm)
Insert grade: TN5515
No. of teeth (T): 8

Recommended Machining Conditions:

Surface feet/minute (sfm): 533
Spindle speed (rpm): 509
Feed per tooth (fz): .... .008″
Depth of Cut (ap): .... .157″ (opt. ap = .25 x .6299)



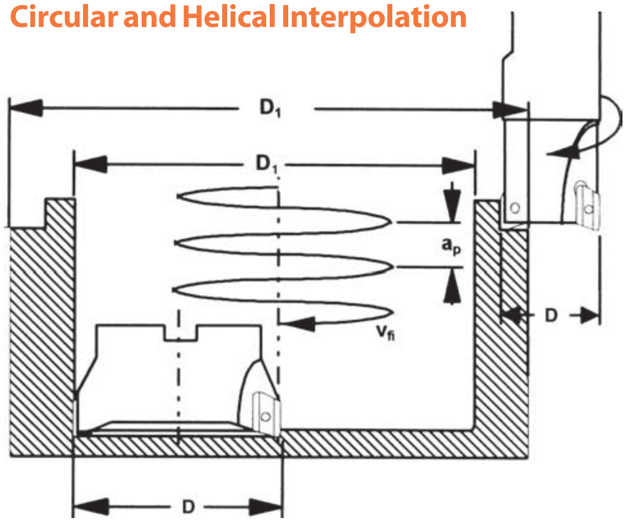


$f_{zkor} = .008 \times \frac{.6299}{.157} \times$ inv cos $\left(1 - \frac{1.5 \times .157}{.6299}\right) = 0.0122$

$V_{fi} = \left(1 - \frac{4}{8}\right) \times .509 \times 0.122 \times 8 + 24.798$ or 25 ipm

Machining Programming:
In order to maintain the recommended .008" feed per tooth (fz) for this insert size and application, the machine tool should be programmed for a feed of 25" per minute (ipm).

Circular and Helical Interpolation



Circular and Helical Interpolation is an application where the cutter rotates on its own axis together in an orbiting motion around the workpiece (either internally or externally), while at the same time plunging to the required depth of cut. In order to accomplish this application, a machine with three-axis control capabilities is required.

Calculating feed rate: Unlike linear milling applications (face milling) where the tools cutting edge and centerline is identical, circular and helical interpolation feed rate is based only on the tools centerline (Vfi). The following formulas should be used to obtain the optimal running conditions.

Definitions

D	=	cutter diameter
d	=	insert diameter
D1	=	workpiece bore diameter
ap	=	depth of cut
fz	=	feed per tooth
fzkor	=	correction feed per tooth
Vfi	=	feed rate at cutters centerline
T	=	number of cutting teeth
rpm	=	revolutions per minute

Milling Cutter Diameter Selection Calculation

Note: all values should be in inch

Minimum Cutter Diameter: $D_{min} = \frac{D_1}{2}$

Optimum / Maximum cutter Diameter: $D_{opt/max} = \frac{D1 + d}{2} - 1$

Calculating Feed Rate:

Note: all values should be in inch

Feed Rate at the Cutting Edge (V_f) Inches per Minute: $V_f = f_z \times rpm \times T$

Feed Rate at Centerline of Tool when Drill Milling (V_{fi}):

Internal Milling Applications:

$$V_{fi} = \frac{V_f \times (D_1 - D)}{D_1}$$

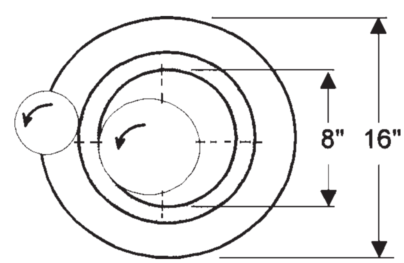
External Milling Applications:

$$V_{fi} = \frac{V_f \times (D_1 - D)}{D_1}$$

Example:

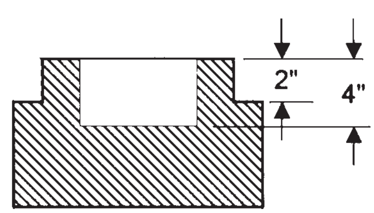
Cutter Data:

Cutter description:	**AP90 Face Mill**	**AP90 End Mill**
Diameter (D):	4"	1.5"
Insert number:	222.79.**400**	222.79.**400**
Insert grade:	TN7525	TN7525
No. of teeth (T):	8	4



ID: Face Mill $\mathbf{V_f = .008 \times 10 \times 358 = 28.6ipm}$

OD: End Mill $\mathbf{V_f = .004 \times 4 \times 1082 = 17.3ipm}$



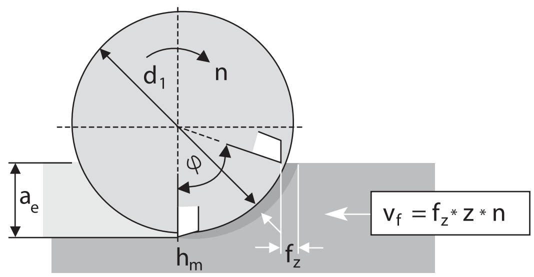
Machining Programming:

Based on the above OD and ID milling calculations, you must program the machine at the appropriate feed rate (Vfi) for each tools centerline.

Technical Info.

Cutting Ratios and Undeformed Chip Thickness in Milling

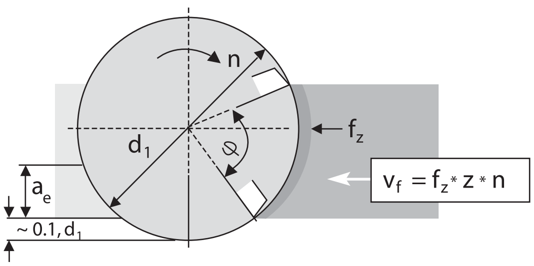
Valid for $a_e < 0.3\ d_1$



$$f_z = h_m * \sqrt{\frac{d_1}{a_e}} \qquad h_m = f_z * \sqrt{\frac{a_e}{d_1}}$$

At least 2 cutting edges in the working area of the feed motion angle φ

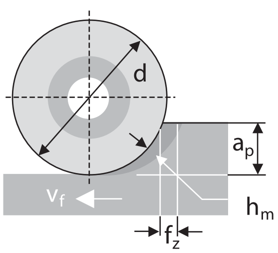
Valid for $a_p < 0.3\ d_1$



min. cutter diameter $d_1 \simeq 1.25 * a_e$

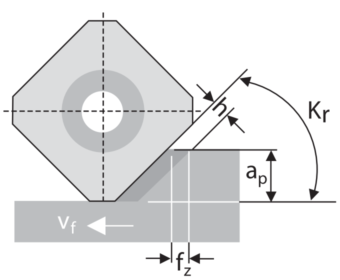
max. width of cut $a_e \simeq 0.8 * d_1$

Valid for $a_p < 0.3$



$$f_z = h_m * \sqrt{\frac{d}{a_p}}$$

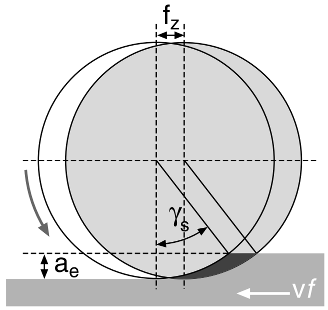
$$h_m = f_z * \sqrt{\frac{a_p}{d}}$$

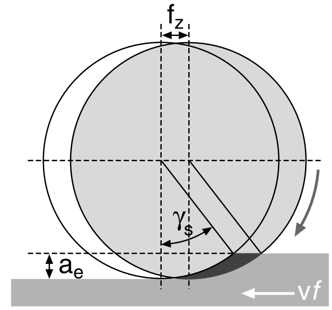


$$f_z = h : \sin \chi_r$$

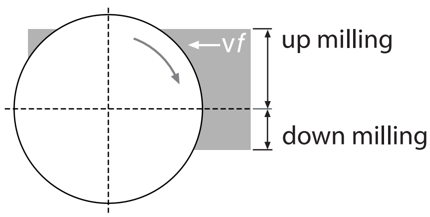
$$h = f_z * \sin \chi_r$$

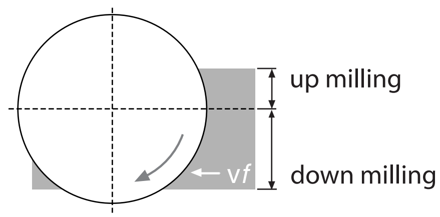
Up Milling / Down Milling with Square Shoulder and Side Face Mills



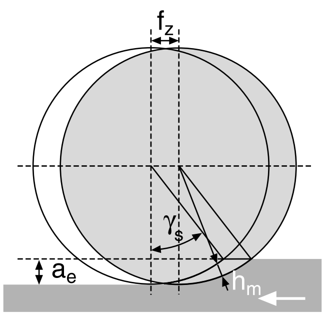


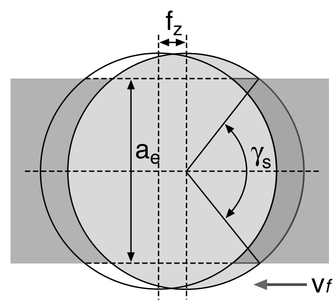
Up Milling / Down Milling with Face Mills





Average Chip Thickness h_m

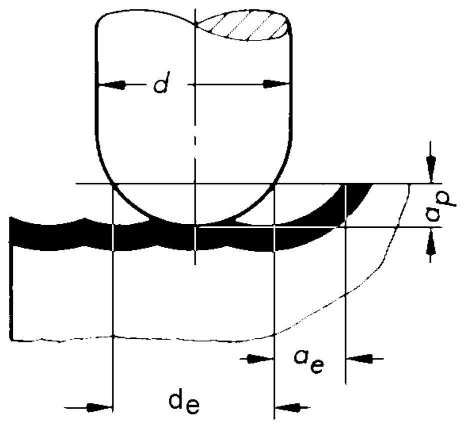




Approximate Formula

$$a_e \le \frac{D}{4} : h_m \approx \sqrt{\frac{a_e}{D}} * f_z * \sin \chi_r \qquad h_m \approx f_z * \sin \chi_r$$

Formulas:



Legend:

- **p** = 3.1416
- **a_e** = Width of cut
- **a_p** = Depth of cut
- **d** = Diameter of milling cutter, in inches
- **d_e** = Effective diameter
- **f_z** = Feed, inches per tooth
- **h** = Scallop height
- **ipm** = Feed, inches per minute
- **ipr** = Inches per revolution
- **mrr** = Metal removal rate in cubic inches
- **rpm** = Revolutions per minute
- **s** = Stepover value between two cutting passes, in inches
- **sfm** = Surface feet per minute
- **z** = Number of effective teeth

To calculate effective diameter of ball nose tool

$$d_e = 2 * \sqrt{\left(\frac{d}{2}\right)^2 - \left(\frac{d}{2} - a_p\right)^2}$$

To calculate sfm when rpm is known

$$sfm = .262 * d * rpm$$

To calculate rpm when sfm is known

$$rpm = \frac{sfm * 3.82}{d}$$

To calculate scallop height (cusp height)

$$h = \frac{d}{2} - \sqrt{\left(\frac{d}{2}\right)^2 - \left(\frac{s}{2}\right)^2}$$

To calculate inches per minute (table feed)

$$ipm = f_z * z * rpm$$

To calculate inches per revolution

$$ipr = \frac{ipm}{rpm}$$

To calculate f_z when ipm, rpm & z are known

$$f_z = \frac{ipm}{z * rpm}$$

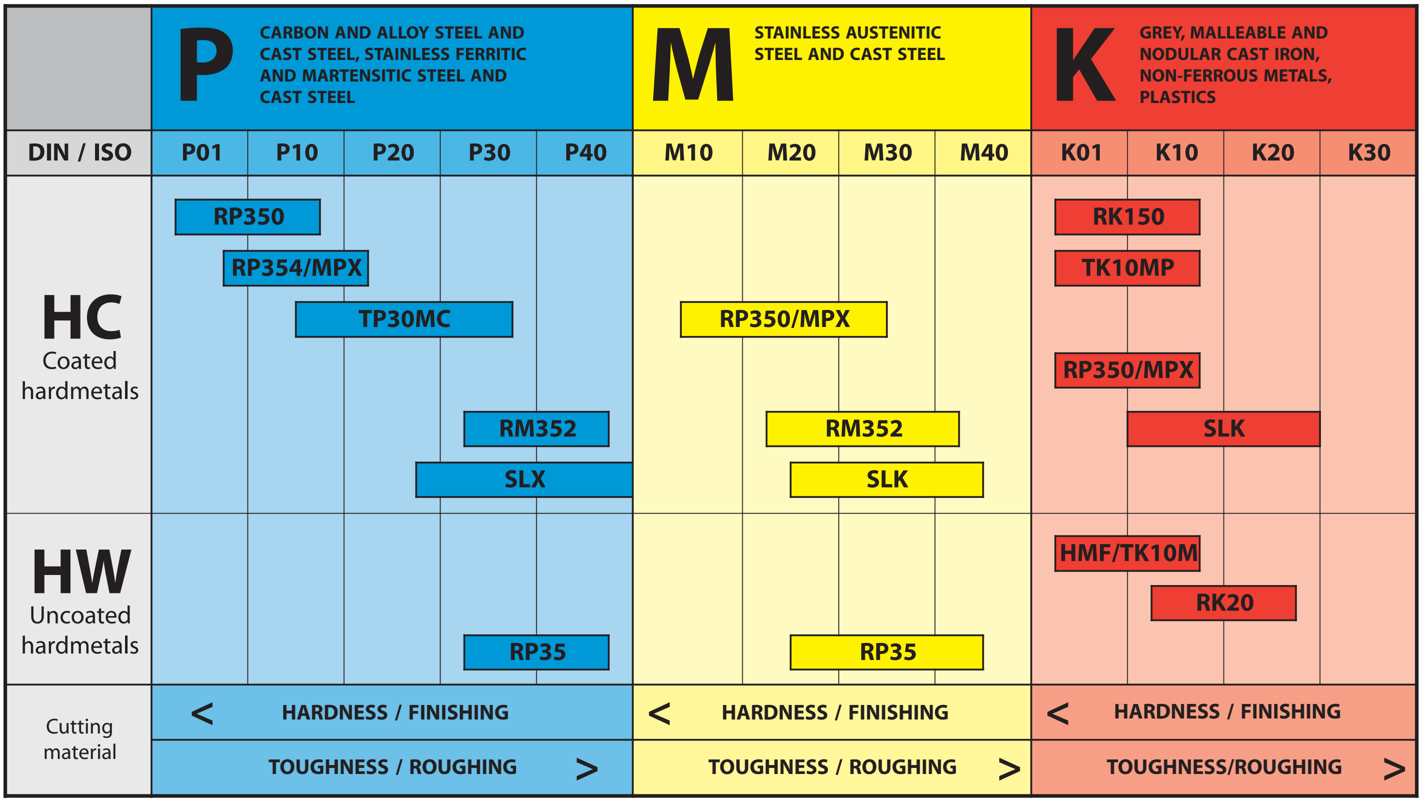
To calculate f_z when ipr & z are known

$$f_z = \frac{ipr}{z}$$

To calculate metal removal rate

$$mrr = a_p * a_e * ipm$$

ISO / ANSI Grade Chart• Cutting Materials



Hardmetals

Sintered hardmetals are made by powder metallurgy and in the most simple case consist of Tungsten Carbide (WC) as a source of hardness, and Cobalt (CO), which is primarily responsible for toughness. Titanium Carbide and/or tantalum carbide or niobium carbide are added to improve high-temperature properties. This applies particularly to oxidation resistance, hot hardness, elevated-temperature strength and diffusion resistance in the presence of iron-base alloys. Hardmetals attain their final properties at sintering temperatures of approximantly 1500° C.

Coated Hardmetals (ISO group HC)

Highest wear resistance and good toughness can be combined by appropriate coating techniques. The preferred process for hardmetal is Chemical Vapour Deposition. In the CVD process, extremely hard thin layers of coating material (e.g. TiC, TiN, Al203) are deposited on tougher hardmetal substrates at temperatur.lower temperature, 850°C instead of 1000°C.The chemical vapour disposition rates are much higher, thereby reducing the time required for completion. MT-CVD offers minimal diffusion of the substrate and a minimal loss of toughness properties.

The much longer life and higher cutting speeds attainable through coating, boost cost-efficiency and productivity. Inventory requirements are also reduced, thanks to the wider range of applications for coated grades.

Uncoated Hardmetals (ISO group HW)

The conventional uncoated hardmetals comprise a variety of mature grades. They are still employed frequently in milling but to a relatively small extent in turning and drilling. Their applications mainly include operations involving light cuts requiring sharp cutting edges and operations demanding very high toughness. Uncoated hardmetal grades are also used on nonferrous metals and nonmetallic materials.

In most steel and cast iron applications, coated hardmetals are preferred because they offer much longer life and/or higher cutting speeds and thus permit more cost effective production.

Cutting Data

for A90, HA90, AP75 End & Face Mills

CUTTING DATA FOR SQUARE SHOULDER MILLS

ISO 513: P — Coated: RP350 / RP354 TP30MC, RM352; Uncoated: RP35

Cutter	Max. a_p	Carbide Insert	RP350 / RP354 TP30MC			RM352			RP35		
			Feed fz inches per tooth [1]								
A90 [1]	.33	ADHT-1003..	---	.002	.004	---	.003	.005	---	.002	.004
A90 [1]	.55	APHT / APNT / APNX-1604..	.003	.006	.009	.003	.007	.010	.003	.006	.009

Work Material		Condition	Hardness HB	Mat. Gr.	RP350 / RP354 TP30MC			RM352			RP35		
					Cutting Speeds in SFPM								
Carbon steel, Unalloyed steel, cast steel and free cutting steel	< 0.25% C	annealed	125	1	1073	813	683	618	536	504	553	488	455
	≥ 0.25% C	annealed	190	2	813	634	553	455	374	358	390	325	293
	< 0.55% C	heat-treated	250	3	683	520	471	374	325	293	325	260	228
	≥ 0.55% C	annealed	220	4	699	553	471	390	358	325	358	276	260
		heat-treated	300	5	601	423	374	325	276	260	276	228	195
Low alloy steel and cast steel		annealed	200	6	780	601	488	455	374	358	390	325	293
		heat-treated	275	7	601	471	390	358	293	276	293	260	228
		heat-treated	300	8	520	390	341	293	260	228	260	195	179
		heat-treated	350	9	471	341	---	260	179	--	228	163	---
High alloy steel, cast steel & tool steel		annealed	200	10	601	471	423	390	341	293	358	276	260
		heat-treated	325	11	390	309	---	260	179	---	228	163	---

ISO 513: M

Cutter	Max. a_p	Carbide Insert	RP350 / RP354 TP30MC			RM352			RP35		
			Feed fz as inches per tooth [1]								
A90 [1]	.33	ADHT-1003..	---	.002	.004	---	.002	.004	---	.002	.004
A90 [1]	.55	APHT / APNT / APNX-1604..	.003	.006	.009	.003	.006	.009	.003	.006	.009

Work Material	Condition	Hardness HB	Mat. Gr.	RP350 / RP354 TP30MC			RM352			RP35		
				Cutting Speeds in SFPM								
400 series Stainless & cast steel	ferrit./mart.	200	12	764	569	488	585	439	374	374	293	276
	martensitic	240	13	666	471	390	504	358	293	325	260	228
300 series Stainless & cast steel	austenitic	180	14	683	423	---	520	325	---	325	195	---

CUTTING DATA FOR SQUARE SHOULDER MILLS

ISO 513: K — Coated: RK150, RP350

Cutter	Max. a_p	Carbide Insert	RK150			RP350		
			Feed fz inches per tooth [1]					
A90 [1]	.33	ADHT-1003..	---	.003	.005	---	.004	.006
A90 [1]	.55	APHT / XPNT / XPNX-1604..	.004	.007	.010	.004	.009	.012

Work Material	Condition	Hardness HB	Mat. Gr.	RK150			RP350		
				Cutting Speeds in SFPM					
Grey cast iron	ferrit./pearl.	180	15	959	699	601	439	325	276
	pearlitic	260	16	731	553	471	325	260	228
Nodular cast iron	ferritic	160	17	813	601	488	390	293	244
	pearlitic	250	18	601	358	---	276	195	---
Malleable cast iron	ferritic	130	19	829	488	---	390	244	---
	pearlitic	230	20	634	406	---	309	195	---

CUTTING DATA FOR SQUARE SHOULDER MILLS

ISO 513: N — Coated: RM352, ALP-XL

Cutter	Max. a_p	Carbide Insert	RM352			ALP-XL		
			Feed fz inches per tooth [1]					
A90 [1]	.33	ADHT-1003..	---	---	---	---	.004	.006
A90 [1]	.55	APHT / APHT / APNT / APNX-1604...	---	---	---	.004	.009	.012

Work Material	Condition	Hardness HB	Mat. Gr.	RM352			ALP-XL		
				Cutting Speeds in SFPM					
Cast aluminium alloys	≤ 12% Si	75	23	---	---	---	2763	1983	1658
	age-hardened	90	24	---	---	---	2210	1625	1381
	> 12% Si heat resistant	130	25	---	---	---	1381	894	683
Copper & copper alloys	Red Brass, brass	90	27	---	---	---	1105	683	0
	Bronze	100	28	---	---	---	829	504	0

CUTTING DATA FOR SQUARE SHOULDER MILLS

ISO 513: S — Coated: RP350, RM352

Cutter	Max. a_p	Carbide Insert	RP350			RM352		
			Feed fz inches per tooth [1]					
A90 [1]	.33	ADHT-1003..	---	.002	.003	---	.002	.003
A90 [1]	.55	APHT / APNT / APNX-1604..	.003	.005	.006	.003	.005	.006

Work Material	Condition	Hardness HB	Mat. Gr.	RP350			RM352		
				Cutting Speeds in SFPM					
High-temperature alloys	age-hardened	280	32	104	78	65	75	59	49
Ni- or Co- based	annealed	250	33	81	59	49	59	49	39
	age-hardened	350	34	65	49	39	49	39	33
Titanium alloys	age-hardened	310	37	---	---	---	---	---	---

1) The cutting data given is valid for slot milling with full width of cut ae = 100% of the cutter diameter.

For peripheral and shoulder milling with the A90 end mill, the figures in the table should be converted using the following correction factors:

Ratio $a_e : d_1$	*f_z factor*	*SFPM factor*
2%	3.5	1.6
5%	3	1.5
10%	2	1.4
20%	1.5	1.3
≥ 40%	1	1.1

CUTTING DATA FOR ROUND INSERT MILLING CUTTERS — P

ISO 513	MILLING CUTTER / MATERIAL				Coated RP350			Coated RP354			Coated RP352			Uncoated RP35		
	Cutter	Max. a_p	Carbide Insert		Feed fz inches per tooth [1]											
P	R360 [1]	.157 / .197	RD..-0802MOT / RD..-1003MOT		.003	.006	.008	.003	.006	.008	.003	.006	.008	.003	.006	.008
P	R360 [1]	.236	RD..-1204MOT-X		.004	.009	.012	.004	.009	.012	.004	.009	.012	.004	.009	.012
P	R360 [1]	.315	RCMT-1606MOT-X		.005	.010	.014	.005	.010	.014	.005	.010	.014	.005	.010	.014
	Work Material	Condition	Hardness HB	Mat. Gr.	Cutting Speeds in SFPM											
P	Carbon steel, Unalloyed steel, cast steel and free cutting steel < 0.25% C	annealed	125	1	1333	1056	910	1170	910	780	813	699	650	715	634	585
P	≥ 0.25% C	annealed	190	2	1056	813	699	813	618	536	585	488	455	520	423	390
P	< 0.55% C	heat-treated	250	3	894	683	601	683	520	455	488	423	390	423	325	293
P	≥ 0.55% C	annealed	220	4	910	699	601	699	536	455	520	455	423	455	358	325
P		heat-treated	300	5	764	553	---	585	423	---	423	358	---	358	293	---
P	Low alloy steel and cast steel	annealed	200	6	1024	764	634	780	585	488	585	488	455	520	423	390
P		heat-treated	275	7	764	601	520	585	455	390	455	390	358	390	325	293
P		heat-treated	300	8	683	520	---	520	390	---	390	325	---	325	260	---
P		heat-treated	350	9	601	423	---	455	325	---	325	228	---	293	195	---
P	High alloy steel, cast steel & tool steel	annealed	200	10	764	618	553	585	471	423	520	439	390	455	358	325
P		heat-treated	325	11	520	390	---	390	293	---	325	228	---	293	195	---

M

ISO 513	Cutter	Max. a_p	Carbide Insert		RP350			RP354			RP352			RP35		
					Feed fz as inches per tooth [1]											
M	R360 [1]	.157 / .197	RD..-0802MOT / RD..-1003MOT		.003	.006	.007	---	---	---	.003	.006	.007	.003	.006	.007
M	R360 [1]	.236	RD..-1204MOT-X		.004	.008	.011	.004	.008	.011	.004	.008	.011	.004	.008	.011
M	R360 [1]	.315	RCMT-1606MOT-X / RD..-1605MOT-X		.005	.009	.013	.005	.009	.013	.005	.009	.013	.005	.010	.013
	Work Material	Condition	Hardness HB	Mat. Gr.	Cutting Speeds in SFPM											
M	400 series Stainless & cast steel	ferrit./mart.	200	12	975	910	634	748	569	488	553	488	455	488	390	358
M		martensitic	240	13	845	618	520	650	471	390	455	390	358	423	325	293
M	300 series Stainless & cast steel	austenitic	180	14	423	260	---	325	195	---	228	130	---	195	130	---

CUTTING DATA FOR ROUND INSERT MILLING CUTTERS — K

ISO 513	MILLING CUTTER / MATERIAL				Coated RP350					
	Cutter	Max. a_p	Carbide Insert		Feed fz inches per tooth [1]					
K	R360 [1]	.157 / .197	RD..-0802MOT / RD..-1003MOT		.003	.006	.008	---	---	---
K	R360 [1]	.236	RD..-1204MOT-X		.004	.009	.012	---	---	---
K	R360 [1]	.315	RCMT-1606MOT-X / RD..-1605MOT-X		.005	.010	.014	---	---	---
	Work Material	Condition	Hardness HB	Mat. Gr.	Cutting Speeds in SFPM					
K	Grey cast iron	ferrit./pearl.	180	15	1235	910	764	---	---	---
K		pearlitic	260	16	943	699	601	---	---	---
K	Nodular cast iron	ferritic	160	17	1056	764	634	---	---	---
K		pearlitic	250	18	764	471	---	---	---	---
K	Malleable cast iron	ferritic	130	19	1056	634	---	---	---	---
K		pearlitic	230	20	945	520	---	---	---	---

CUTTING DATA FOR ROUND INSERT MILLING CUTTERS — N

ISO 513	MILLING CUTTER / MATERIAL				Coated ALP-XL			Uncoated TK20		
	Cutter	Max. a_p	Carbide Insert		Feed fz inches per tooth [1]					
N	R360 [1]	.157 / .197	RD..-0802MOT / RD..-1003MOT		.003	.006	.008	.003	.006	.008
N	R360 [1]	.236	RD..-1204MOT-X		.004	.009	.012	.004	.009	.012
N	R360 [1]	.315	RCMT-1606MOT-X / RD..-1605MOT-X		.005	.010	.014	.005	.010	.014
	Work Material	Condition	Hardness HB	Mat. Gr.	Cutting Speeds in SFPM					
N	Cast aluminium alloys	≤ 12% Si	75	23	3250	2340	1950	3250	2340	1950
N		age-hardened	90	24	2600	1918	1625	2600	1918	1625
N		> 12% Si heat resistant	130	25	1625	1056	813	1625	1056	813
N	Copper & copper alloys	Red Brass, brass	90	27	1300	813	---	1300	813	---
N		Bronze	100	28	975	585	---	975	585	---

CUTTING DATA FOR ROUND INSERT MILLING CUTTERS — S

ISO 513	MILLING CUTTER / MATERIAL				Coated RP350					
	Cutter	Max. a_p	Carbide Insert		Feed fz inches per tooth [1]					
S	R360 [1]	.157 / .197	RD..-0802MOT / RD..-1003MOT		.003	.005	.006	---	---	---
S	R360 [1]	.236	RD..-1204MOT-X		.004	.006	.007	---	---	---
S	R360 [1]	.315	RCMT-1606MOT-X / RD..-1605MOT-X		.005	.007	.009	---	---	---
	Work Material	Condition	Hardness HB	Mat. Gr.	Cutting Speeds in SFPM					
S	High-temperature alloys Ni- or Co- based	age-hardened	280	32	130	98	81	---	---	---
S		annealed	250	33	104	78	65	---	---	---
S		age-hardened	350	34	85	62	52	---	---	---
S	Titanium alloys	age-hardened	310	37	---	---	---	---	---	---

1) The feeds per tooth fz are valid for face milling with width of cut ae > 40% of the cutter diameter and max. depth of cut ap. For smaller widths and depths of cut, the figures in the tables should be converted using correction factors tables below. (d = diameter of insert, d1 = cutter diameter).

The axial feed in plunge milling should be reduced by approx. 40%.

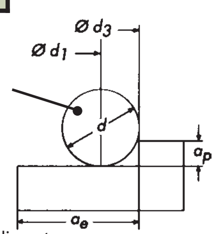
f_z factors for ratio $a_e : d_1$

Depth of cut a_p	$a_e : d_1$ 5%	10%	20%	≥40%
5% of d	9	6.3	4.3	3.2
10% of d	6.3	4.3	3.2	2.2
20% of d	4.3	3.2	2.2	1.6
40% of d	3.2	2.2	1.6	1.1

SFPM factors for various f_z factors

f_z factor	SFPM factor
9	1.6
6.3	1.5
4.3	1.4
3.2	1.3
2.2	1.2
1.6	1.1
1.1	1

R360 Insert



Legend:
ae - width of cut
ap - depth of cut
d - insert diameter
Ød1 - effective cutter diameter
Ød3 - nominal cutter diameter

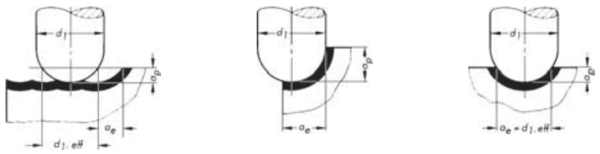
Cutting Data

for BNK Milling Cutters

TABLE A: CUTTING DATA FOR BNK BALL NOSE MILLING CUTTERS			
Material Application	**Grade**	**SFPM**	**FEED (IPR)**
Carbon, Alloy and Tool Steels	SLX	350-600	.006" - .016"
Cast Steel	SLX	400-700	.006" - .020"
Steels, Irons and Graphite	MPX	600-1200	.005" - .020"
Stainless Steels and Refractory Alloys	MPX / MPS	400-800	.003" - .010"
Aluminum, Titanium and Copper Alloys	MPX	500-1000	.010" - .020"

TABLE B: EFFECTIVE CUTTING DIAMETERS							
Depth of cut	Effective cutter diameter d_1 eff for cutter nominal diameter d_1						
a_p	**.312**	**.375**	**.500**	**.625**	**.750**	**1.000**	**1.250**
.010"	.110	.121	.140	.157	.172	.199	.223
.020"	.153	.169	.196	.220	.242	.280	.314
.035"	.197	.218	.255	.287	.316	.368	.412
.050"	.229	.255	.300	.339	.374	.436	.490
.075"	.267	.300	.357	.406	.450	.527	.594
.100"	.292	.332	.400	.458	.510	.600	.678
.125"	.306	.354	.433	.500	.559	.661	.750
.156"	.312	.370	.464	.541	.609	.726	.827
.188"	---	.375	.484	.573	.650	.781	.893
.250"	---	---	.500	.612	.707	.886	1.000
.312"	---	---	---	.625	.734	.927	1.082
.375"	---	---	---	---	.750	.968	1.146
.500"	---	---	---	---	---	1.000	1.225
.625"	---	---	---	---	---	---	1.250

TABLE C: FEED RATE ADJUSTMENT FACTOR							
Depth of cut	For cutter nominal diameter d1						
ap	**.312**	**.375**	**.500**	**.625**	**.750**	**1.000**	**1.250**
.010"	2.80	3.10	3.60	4.00	4.40	5.00	5.60
.020"	2.04	2.22	2.56	2.86	3.13	3.57	4.00
.035"	1.71	1.85	2.11	2.36	2.57	2.92	3.28
.050"	1.37	1.47	1.66	1.85	2.00	2.27	2.56
.075"	1.18	1.25	1.41	1.54	1.66	1.89	2.13
.100"	1.08	1.14	1.25	1.37	1.47	1.66	1.85
.125"	1.02	1.06	1.15	1.25	1.33	1.52	1.67
.156"	1.00	1.01	1.08	1.15	1.23	1.37	1.52
.188"	---	1.00	1.03	1.09	1.15	1.28	1.41
.250"	---	---	1.00	1.02	1.06	1.15	1.25
.312"	---	---	---	1.00	1.01	1.08	1.15
.375"	---	---	---	---	1.00	1.03	1.09
.500"	---	---	---	---	---	1.00	1.02
.625"	---	---	---	---	---	---	1.00



Cutting Data Compensation

1. Select the diameter of the tool to be used
2. Determine the Depth of Cut (a_p) to be used
3. Refer to Table B to determine the Effective Cutting Diameter d_1-eff
4. Refer to Table A to determine the Surface Footage (SFPM) and Feed per Revolution (IPR)
5. Calculate the RPM = (SFPM x 3.82) / d_1-eff
6. Refer to Table C to determine the Feed Rate Adjustment Factor IPRADJ = IPR x Feed Rate Adjustment Factor
7. Calculate the IPM (Inches per Minute)
   IPM = RPM x IPRADJ

Technical Considerations

- Always ensure that insert pockets are clean and free of debris or burrs
- Utilize holders that are stable and in good condition
- Clean and recoat screw with anti-seize lubricant during each index
- For optimum results, replace holders after 100 inserts
- Hold the insert in place during the locking process; check for interference or damage
- Do not use a pipe or other extensions to tighten the locking screw
- Generally speaking, drivers supplied with the tools provide proper torque
- If the torque wrench is available, follow the recommended torque specifications

Cutting Data

for PC, S45, S45F, & TC90 Milling Cutters

CUTTING DATA FOR PC, S45, S45F & TC90											
ISO 513	Material	TC90 End Mills			S45 End Mills			SF45 Face Mills			
		MILLING	SFPM		MILLING	SFPM		MILLING	SFPM		
		Feed 1)	Coated	Uncoated	Feed 1)	Coated	Uncoated	Feed 1)	CVDCoated	PVD Coated	Uncoated
P	Steel, unalloyed low carbon	.004 - .012	325 - 731	260 - 585	.004 - .012	325 - 731	260 - 585	.004 - .020	400 - 1100	350 - 900	---
	Steel, unalloyed or low-alloy	.004 - .012	284 - 650	228 - 520	.004 - .012	284 - 650	228 - 520	.003 - .013	300 - 900	300 - 700	---
	Steel alloy and tool steels	.004 - .010	244 - 569	195 - 455	.004 - .012	244 - 569	195 - 455	.003 - .014	250 - 650	175 - 400	---
	High tensile steels	.004 - .008	244 - 488	195 - 390	.004 - .010	244 - 488	195 - 390	.003 - .006	---	300 - 500	---
M		MILLING	SFPM		MILLING	SFPM		MILLING	SFPM		
		Feed 1)	Coated	Uncoated	Feed 1)	Coated	Uncoated	Feed 1)	CVDCoated	PVD Coated	Uncoated
	Corrosion-resistant steel	.004 - .008	203 - 569	163 - 455	.004 - .010	203 - 569	163 - 455	.003 - .012	250 - 650	200 - 600	---
	Cast steel, medium strength	.004 - .008	244 - 488	195 - 390	.004 - .012	244 - 488	195 - 390	.003 - .009	300 - 600	250 - 550	---
K		MILLING	SFPM		MILLING	SFPM		MILLING	SFPM		
		Feed 1)	Coated	Uncoated	Feed 1)	Coated	Uncoated	Feed 1)	CVDCoated	PVD Coated	Uncoated
	Grey cast iron, medium hardness	.004 - .010	284 - 488	228 - 390	.004 - .016	284 - 488	228 - 390	.003 - .009	---	300 - 900	250 - 750
N		MILLING	SFPM		MILLING	SFPM		MILLING	SFPM		
		Feed 1)	Coated	Uncoated	Feed 1)	Coated	Uncoated	Feed 1)	CVDCoated	PVD Coated	Uncoated
	Brass	.004 - .010	406 - 731	325 - 585	.004 - .010	406 - 731	325 - 585	.004 - .015	---	---	700 - 2000
	Mg-alloyed	.004 - .006	1219 - 3250	975 - 2600	.004 - .006	1219 - 3250	975 - 2600	.004 - .015	---	---	700 - 2000
	Si-alloyed	.002 - .006	1016 - 2438	813 - 1950	.002 - .006	1016 - 2438	813 - 1950	.004 - .015	---	---	700 - 2000
	Al-alloyed, hypo-eutectic	.004 - .008	1219 - 4063	975 - 3250	.004 - .008	1219 - 4063	975 - 3250	.003 - .012	---	---	700 - 1500
	Al-alloyed, hyper-eutectic Si>12%	.004 - .008	1219 - 2031	975 - 1625	.004 - .008	1219 - 2031	975 - 1625	.003 - .012	---	---	700 - 1500

Cutting Data

for CP90 Face Mills

Materials	Conditions of chip removal	Range of application N01 - N40		
		N01-N20 (HSC)	N20-N30 (HSC)	N25-N40 (HSC+HPC)
	High-speed milling	100µin - 200µin	100µin - 200µin	100µin - 200µin
N Nonferrous metals Aluminum alloys without silicon	unstable (varied depth)	PDC-S	PDC-S	PDC-S
		2600-14625	2600-13000	2600-8125
	continuous	PDC-S	PDC-S	PDC-S
		2600-14625	2600-13000	2600-8125
	heavily + slightly interrupted	PDC-S	PDC-S	PDC-S
		2600-14625	2600-13000	2600-8125
N Nonferrous metals Aluminum alloys with less than 12% silicon	unstable (varied depth)	PDC-S	PDC-S	PDC-S
		2600-13000	2600-11375	2600-8775
	continuous	PDC-S	PDC-S	PDC-S
		2600-13000	2600-11375	2600-8775
	heavily + slightly interrupted	PDC-S	PDC-S	PDC-S
		2600-13000	2600-11375	2600-8775
N Nonferrous metals Copper and copper alloys brass, bronze, precious metals	unstable (varied depth)	PDC-S	PDC-S	PDC-S
		2600-9750	2600-8125	2275-7150
	continuous	PDC-S	PDC-S	PDC-S
		2600-9750	2600-8125	2275-7150
	heavily + slightly interrupted	PDC-S	PDC-S	PDC-S
		2600-9750	2600-8125	2275-7150
Coolant: flood or through coolant				

CUTTING DATA FOR T45V END MILLS AND FACE MILLS

ISO 513	MILLING CUTTER / MATERIAL					Coated SLK	Coated SLX	Coated SLP	Uncoated SP25	Uncoated SK35
P	**Cutter**	**Max. a_p**	**Carbide Insert**			**Feed fz inches per tooth 2)**				
	T45VE/VF	.140	OECX/RECX 43			---	.003 - .010	.003 - .010	.003 - .010	---
	T45VE/VF	.170	OECX/RECX 53			---	.003 - .012	.003 - .012	.003 - .012	---
	T45VE/VF	.210	OECX/RECX 63			---	.003 - .015	.003 - .015	.003 - .015	---
	Work Material		**Condition**	**Hardness HB**	**Mat. Gr.**	**Cutting Speeds in SFPM**				
	Carbon steel,	< 0.25% C	annealed	125	1	---	800 - 1350	700 - 1000	350 - 700	---
	Unalloyed steel,	≥ 0.25% C	annealed	190	2	---	800 - 1350	700 - 1000	350 - 700	---
	cast steel and free	< 0.55% C	heat-treated	250	3	---	700 - 1100	630 - 950	330 - 675	---
	cutting steel	≥ 0.55% C	annealed	220	4	---	800 - 1350	700 - 1000	350 - 700	---
			heat-treated	300	5	---	700 - 1100	630 - 950	330 - 675	---
	Low alloy steel		annealed	200	6	---	800 - 1350	700 - 1000	350 - 700	---
	and cast steel		heat-treated	275	7	---	700 - 1100	630 - 950	330 - 675	---
			heat-treated	300	8	---	650 - 1000	620 - 900	300 - 650	---
			heat-treated	350	9	---	600 - 950	580 - 580	300 - 650	---
	High alloy steel,		annealed	200	10	---	800 - 1150	700 - 950	350 - 650	---
	cast steel & tool steel		heat-treated	325	11	---	700 -1000	650 - 900	300 - 600	---
M	**Cutter**	**Max. a_p**	**Carbide Insert**			**Feed fz as inches per tooth 2)**				
	T45VE/VF	.140	OECX/RECX 43			.003 - .006	.003 - .006	.003 - .006	.003 - .006	.003 - .006
	T45VE/VF	.170	OECX/RECX 53			.003 - .008	.003 - .008	.003 - .008	.003 - .008	.003 - .008
	T45VE/VF	.210	OECX/RECX 63			.003 - .012	.003 - .012	.003 - .012	.003 - .012	.003 - .012
	Work Material		**Condition**	**Hardness HB**	**Mat. Gr.**	**Cutting Speeds in SFPM**				
	400 series Stainless & cast steel		ferrit./mart.	200	12	---	850 - 1200	560 - 900	265 - 535	---
			martensitic	240	13	---	580 - 950	540 - 850	245 - 500	---
	300 series Stainless & cast steel		austenitic	180	14	800 - 1100	---	---	---	400 - 600

CUTTING DATA FOR RT45V END MILLS AND FACE MILLS

ISO 513	MILLING CUTTER / MATERIAL					Coated SLK	Uncoated SK35
K	**Cutter**	**Max. a_p**	**Carbide Insert**			**Feed fz inches per tooth 2)**	
	T45VE/VF	.140	OECX/RECX 43			.003 - .010	.003 - .010
	T45VE/VF	.170	OECX/RECX 53			.003 - .012	.003 - .012
	T45VE/VF	.210	OECX/RECX 63			.003 - .015	.003 - .015
	Work Material		**Condition**	**Hardness HB**	**Mat. Gr.**	**Cutting Speeds in SFPM**	
	Grey cast iron		ferrit./pearl.	180	15	550 - 1000	230 - 465
			pearlitic	260	16	500 - 900	230 - 465
	Nodular cast iron		ferritic	160	17	500 - 1000	230 - 465
			pearlitic	250	18	450 - 850	230 - 465
	Malleable cast iron		ferritic	130	19	550 - 1100	250 - 500
			pearlitic	230	20	500 - 900	230 - 465
N	**Cutter**	**Max. a_p**	**Carbide Insert**			**Feed fz inches per tooth 2)**	
	T45VE/VF	.140	OECX/RECX 43			---	.003 - .015
	T45VE/VF	.170	OECX/RECX 53			---	.003 - .018
	T45VE/VF	.210	OECX/RECX 63			---	.003 - .020
	Work Material		**Condition**	**Hardness HB**	**Mat. Gr.**	**Cutting Speeds in SFPM**	
	Cast aluminium		≤ 12% Si	75	23	---	1600 - 4000
	alloys		age-hardened	90	24	---	1200 - 3800
			> 12% Si heat resistant	130	25	---	1100 - 2800
	Copper & copper		Red Brass, brass	90	27	---	600 - 1000
	alloys		Bronze	100	28	---	600 - 1000
S	**Cutter**	**Max. a_p**	**Carbide Insert**			**Feed fz inches per tooth 2)**	
	T45VE/VF	.140	OECX/RECX 43			.002 - .004	.002 - .004
	T45VE/VF	.170	OECX/RECX 53			.002 - .004	.002 - .004
	T45VE/VF	.210	OECX/RECX 63			.002 - .004	.002 - .004
	Work Material		**Condition**	**Hardness HB**	**Mat. Gr.**	**Cutting Speeds in SFPM**	
	High-temperature alloys		age-hardened	280	32	50 - 110	50 - 100
	Ni- or Co- based		annealed	250	33	70 - 150	50 - 110
			age-hardened	350	34	50 - 110	50 - 100
	Titanium alloys		age-hardened	310	37	105 - 190	80 - 120

FOR USE WITH RECX INSERTS

1) The feeds per tooth fz are valid for face milling with width of cut ae > 40% of the cutter diameter and max. depth of cut ap.

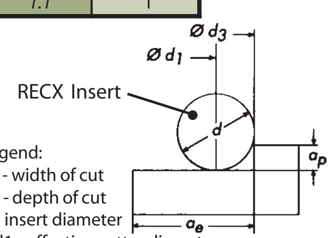
For smaller widths and depths of cut, the figures in the tables should be converted using correction factors tables below. (d = diameter of insert, d1 = cutter diameter).

f_z factors for ratio $a_e : d_1$

Depth of cut a_p	$a_e : d_1$ 5%	10%	20%	≥40%
5% of d	9	6.3	4.3	3.2
10% of d	6.3	4.3	3.2	2.2
20% of d	4.3	3.2	2.2	1.6
40% of d	3.2	2.2	1.6	1.1

SFPM factors for various f_z factors

f_z factor	SFPM factor
9	1.6
6.3	1.5
4.3	1.4
3.2	1.3
2.2	1.2
1.6	1.1
1.1	1



Legend:
ae - width of cut
ap - depth of cut
d - insert diameter
Ød1 - effective cutter diameter
Ød3 - nominal cutter diameter

Cutting Data

for STRATUS & VEGA End Mills

Cutting Data for STRATUS End Mills										
Material	SFM	Feed (Inches per tooth)					Maximum Depth of Cut			
		1/8	1/4	1/2	3/4	1	Slotting Axial	Profiling Axial	Profiling Radial	Profiling Feed Adj.
Steel - Low Carbon	400 - 500	.0010	.0020	.0040	.0050	.0060	1 x D	1 x D	.5 x D	+ 20%
Steel - Medium Carbon	275 - 400	.0007	.0015	.0035	.0045	.0060	1 x D	1 x D	.5 x D	+ 20%
Tool Steel <38 Rc	250 - 350	.0005	.0012	.0030	.0040	.0055	1 x D	1 x D	.5 x D	+ 15%
Cast Iron - Gray	450 - 550	.001	.0025	.0035	.0045	.0060	1 x D	1 x D	.5 x D	+ 20%
Cast Iron Ductile	300 - 400	.0007	.0012	.0025	.0040	.0055	1 x D	1 x D	.5 x D	+ 20%
Cast Iron Malleable	250 - 300	.0005	.0010	.0020	.0030	.0040	1 x D	1 x D	.5 x D	+ 15%
300 Series Stainless	250 - 350	.0004	.0010	.0020	.0030	.0040	1 x D	1 x D	.5 x D	+ 15%
400 Series Stainless	225 - 300	.0004	.0010	.0020	.0030	.0040	1 x D	1 x D	.5 x D	+ 15%
PH Series Stainless	200 - 275	.0003	.0008	.0015	.0025	.0030	1 x D	1 x D	.5 x D	+ 15%
Titanium	120 - 200	.0004	.0010	.0020	.0025	.0030	1 x D	1 x D	.5 x D	+ 15%
High Temp. Alloys	60 - 110	.0005	.0010	.0018	.0025	.0030	1 x D	1 x D	.5 x D	+ 10%

Cutting Data for VEGA End Mills						D= Tool Diameter Reduce feed rates by 20% when using long length tools						
	Type of Cut	Axial DOC	Radial DOC	No. of Flutes	Speed SFM	Feed (Inches per tooth)						
						1/8	1/4	3/8	1/2	5/8	3/4	1
Carbon & Tool Steels >38 Rc	Slotting	.5 x D	1 x D	6	275	.0003	.0007	.0010	.0015	.0019	.0024	.0030
	Rough	1 x D	.5 x D	6	325	.0005	.0010	.0015	.0020	.0025	.0030	.0040
	Finish	1.5 x D	.01 x D	6	400	.0006	.0012	.0018	.0025	.0031	.0037	.0050
	HSM	.1 x D	.1 x D	6	800	.0015	.0030	.0045	.0060	.0075	.0090	.0120
Carbon & Tool Steels 39 Rc to 48 Rc	Slotting	.5 x D	1 x D	6	200	.0002	.0005	.0007	.0010	.0013	.0016	.0020
	Rough	1 x D	.5 x D	6	250	.0004	.0007	.0011	.0015	.0019	.0024	.0030
	Finish	1.5 x D	.01 x D	6	325	.0004	.0009	.0013	.0018	.0022	.0027	.0036
	HSM	.1 x D	.1 x D	6	600	.0011	.0022	.0033	.0045	.0056	.0068	.0090
Titanium Alloys	Slotting	.25 x D	1 x D	6	225	.0002	.0005	.0007	.0010	.0013	.0016	.0020
	Rough	1 x D	.25 x D	6	250	.0003	.0006	.0009	.0013	.0016	.0020	.0026
	Finish	1.5 x D	.01 x D	6	350	.0005	.0010	.0015	.0020	.0025	.0030	.0040
High Temp. Alloys, Inconel, Haynes, Stellite, Hastalloy, Waspalloy	Slotting	.25 x D	1 x D	6	70	.0003	.0007	.0011	.0014	.0017	.0022	.0028
	Rough	1 x D	.25 x D	6	95	.0004	.0009	.0013	.0017	.0022	.0026	.0034
	Finish	1.5 x D	.01 x D	6	110	.0005	.0009	.0014	.0019	.0023	.0028	.0038
Carbon & Tool Steels 49 Rc to 57 Rc	Slotting	.25 x D	1 x D	6	150	.0002	.0005	.0007	.0010	.0012	.0015	.0020
	Rough	1 x D	25 x D	6	200	.0003	.0007	.0011	.0015	.0018	.0022	.0030
	Finish	1.5 x D	.01 x D	6	275	.0003	.0007	.0011	.0015	.0018	.0022	.0030
	HSM	.1 x D	.1 x D	6	500	.0006	.0012	.0017	.0023	.0028	.0034	.0046
Carbon & Tool Steels 58 Rc to 62Rc	Slotting	.20 x D	1 x D	6	45	.0002	.0005	.0007	.0010	.0013	.0016	.0020
	Rough	1 x D	.20 x D	6	65	.0004	.0007	.0011	.0015	.0019	.0024	.0030
	Finish	1.5 x D	.01 x D	6	100	.0004	.0007	.0011	.0015	.0019	.0024	.0030
	HSM	.1 x D	.1 x D	6	400	.0005	.0010	.0015	.0020	.0025	.0030	.0040

Cutting Data for ORION 2 & 3 Flute End Mills																				
Material	**Type of Cut**	**Axial DOC**	**Radial DOC**	**No. of flutes**	**Speed (SFM)**	**Feed (Inches per tooth)**							**Speed (m/min)**	**Feed (mm per tooth)**						
						1/8	**1/4**	**3/8**	**1/2**	**5/8**	**3/4**	**1**		**3.0**	**6.0**	**9.0**	**12.0**	**16.0**	**19.0**	**25.0**
Aluminum Alloys 2024, 6061, 7075	Slot	1 x D	1 x D	2	800	.0020	.0040	.0060	.0080	.0100	.0120	.0160	244	.0508	.1016	.1524	.2032	.2540	.3048	.4064
	Rough	1 x D	.75 x D	3	1000	.0020	.0050	.0075	.0100	.0120	.0150	.0200	305	.0508	.1270	.1905	.2540	.3048	.3810	.5080
	Finish	1.5 x D	.01 x D	3	1200	.0030	.0060	.0090	.0120	.0160	.0200	.0250	366	.0762	.1524	.2286	.3048	.4064	.5080	.6350
High Silicon Aluminum A380, A390	Slot	.5 x D	1 x D	3	400	.0010	.0020	.0030	.0040	.0050	.0060	.0080	122	.0254	.0508	.0762	.1016	.1270	.1524	.2032
	Rough	1 x D	.5 x D	3	600	.0015	.0030	.0045	.0060	.0075	.0090	.0120	183	.0381	.0762	.1143	.1524	.1905	.2286	.3048
	Finish	1.5 x D	.01 x D	3	800	.0018	.0035	.0055	.0070	.0090	.0110	.0140	244	.0457	.0889	.1397	.1778	.2286	.2794	.3556
Magnesium Alloys	Slot	1 x D	1 x D	2	800	.0020	.0040	.0060	.0080	.0100	.0120	.0160	244	.0508	.1016	.1524	.2032	.2540	.3048	.4064
	Rough	1 x D	.75 x D	3	1000	.0020	.0050	.0075	.0100	.0120	.0150	.0200	305	.0508	.1270	.1905	.2540	.3048	.3810	.5080
	Finish	1.5 x D	.01 x D	3	1200	.0030	.0060	.0090	.0120	.0160	.0200	.0250	366	.0762	.1524	.2286	.3048	.4064	.5080	.6350
Copper Alloys Brass, Bronze	Slot	.75 x D	1 x D	2	400	.0010	.0020	.0030	.0040	.0050	.0060	.0080	122	.0254	.0508	.0762	.1016	.1270	.1524	.2032
	Rough	1 x D	.75 x D	3	475	.0012	.0025	.0034	.0050	.0063	.0075	.0100	145	.0305	.0635	.0940	.1270	.1600	.1905	.2540
	Finish	1.5 x D	.01 x D	3	550	.0015	.0030	.0045	.0060	.0075	.0090	.0120	168	.0381	.0762	.1143	.1524	.1905	.2286	.3048
Composites Plastics, Fiberglass	Slot	1 x D	1 x D	3	400	.0010	.0020	.0030	.0040	.0050	.0060	.0080	122	.0254	.0508	.0762	.1016	.1270	.1524	.2032
	Rough	1 x D	.75 x D	3	600	.0015	.0030	.0045	.0060	.0075	.0090	.0120	183	.0381	.0762	.1143	.1524	.1905	.2286	.3048
	Finish	1.5 x D	.01 x D	3	800	.0018	.0035	.0055	.0070	.0090	.0110	.0140	244	.0457	.0889	.1397	.1778	.2286	.2794	.3556

D= tool diameter. Reduce feed rates by 20% when using long length tools. Starting parameters shown.