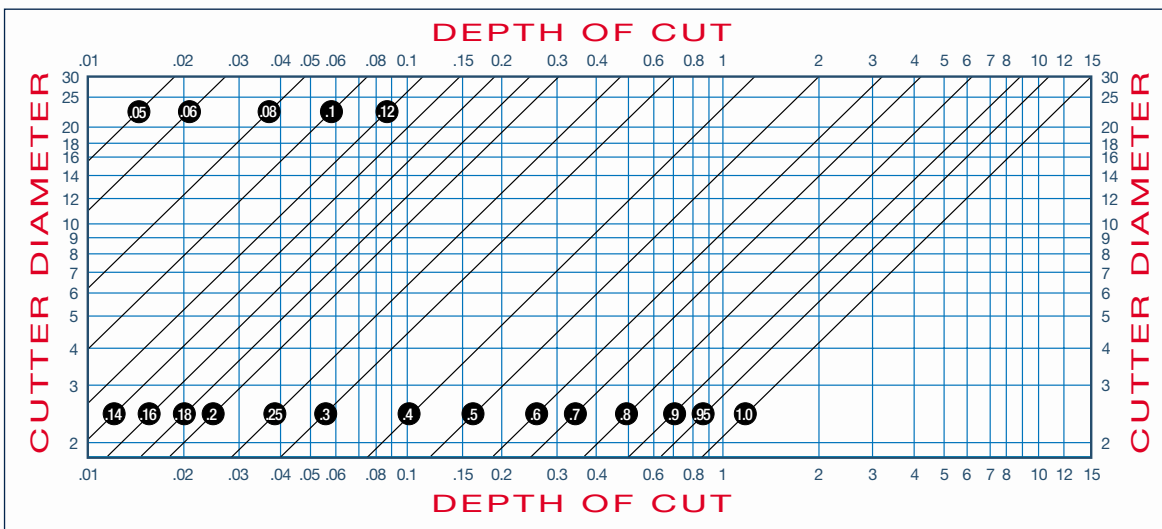


Chip Thinning • Operating Parameters

CHIP THINNING (SLOTING)



To find the Radial Chip Thinning Factor for a slotting cut:

1. Find the Depth of Cut on the horizontal scale.
2. Locate the nominal diameter of the cutter on the vertical axis.
3. Cross-reference the two figures.
4. Locate the diagonal line closest to the intersection of the vertical and horizontal axes.
The value of this diagonal is the Radial Chip Thinning Factor for your specific application.
5. Multiply this radial chip thinning factor with the calculated chip thickness to get the actual chip thickness.

VOMAX™ OPERATING PARAMETERS

Material		Brinell Hardness	SFM	Feed per Insert	Grades*							Coolant	
					INV530	ING515	INV2015/INV2010	INV2030	INV2040	INV2005	INV15K (Polished)		INV70N
Aluminum	6061-T6, 7075-T6, 2024	-	1500-3000	.004-.015								1	Yes
Cast Iron	Gray	150-280	400-750	.005-.012	2	1							No
	Nodular		300-650	.004-.007									
			1500+	.004-.007									
Steel	Low Carbon 1018, 8620	150-250	250-500	.005-.010									No
	High Carbon F-6180, Nitr alloy 52100	250-400	200-350	.005-.008									
	Alloyed Steel 4140, 4340, 6150	150-300	250-400	.005-.010			2	1	3				
	Tool Steel A-6, D-1, D-2, P-20	Up to 300											
Stainless Steel	300 Series, 304, 316	-	250-400	.003-.006	1		2	3	3				May not be required at high speeds
	400 Series, 15-5 PH, 17-4 PH	Up to 320	300-600										
	13-8 PH	-	200-250										
Nickel Alloys	Inconel 600, 706, 718, 903, Hastelloy, Waspalloy	-	75-120	.003-.006	1		3		2				Yes
Titanium	6AL-4V	-	100-150	.003-.006	2		3		1				Yes

*In order of preference.

Operating Parameters



INSERT SERIES: DPM314/DPM324

Material	Brinell Hardness	SFM	Feed per Insert	Grades*			Coolant
				IN2015	IN2040	IN2005	
Cast Iron	Gray	150-280	400-750	1	2		No
	Nodular		300-650				
Steel	Low Carbon 1018, 8620	150-250	250-500	1	2		No
	High Carbon F-6180 Nitr alloy 52100	250-400	200-350				
	Alloyed Steel 4140, 4340, 6150	150-300	250-400				
	Tool Steel A-6, D-1, D-2, P-20	Up to 300					
Stainless Steel	300 Series 304, 316	-	250-400	2	1		May not be required at high speeds
	400 series, 15-5 PH, 17-4 PH	Up to 300	300-600				
	13-8 PH	-	200-250				Yes
Nickel Alloys	Inconel 600, 706, 718 903, Hastelloy, Waspalloy	-	75-120	2	1		Yes
Titanium	6AL-4V	-	100-150	2	1		Yes



INSERT SERIES: DPM424/DPM434

Material	Brinell Hardness	SFM	Feed per Insert	Grades*					Coolant
				IN2015	IN2040	IN2005	IN1530	IN16515	
Cast Iron	Gray	150-280	400-750	1	3	2		No	
	Nodular		300-650						
Steel	Low Carbon 1018, 8620	150-250	250-500	1	2	3		No	
	High Carbon F-6180 Nitr alloy 52100	250-400	200-350						
	Alloyed Steel 4140, 4340, 6150	150-300	250-400						
	Tool Steel A-6, D-1, D-2, P-20	Up to 300							
Stainless Steel	300 Series 304, 316	-	250-400	2	1		May not be required at high speeds		
	400 series, 15-5 PH, 17-4 PH	Up to 300	300-600						
	13-8 PH	-	200-250				Yes		
Nickel Alloys	Inconel 600, 706, 718 903, Hastelloy, Waspalloy	-	75-120		2	1		Yes	
Titanium	6AL-4V	-	100-150		1	2		Yes	

Grade and Carbide Selection

CHOOSING A GRADE

Grade	Material
IN2015 / IN2010	Grey, ductile, nodular iron dry or wet, low to medium cutting speed, low to medium chip thickness.
IN6515	Grey, ductile, nodular iron dry, medium to high cutting speed, medium to high chip thickness. Heavily interrupted cuts.
IN1530	General purpose mild steel, hi-temp alloys, or stainless steel. Interrupted cuts. Wet.
IN2030 / IN2005	Hi-temp alloys. Poor set-up rigidity. Wet or dry.
IN2040	General purpose mild steel and steel alloys, ductile and nodular iron (dry only), when set-up rigidity is good.
IN6542 / IN6510	Grey, ductile, nodular iron dry or wet, non-interrupted milling, low to medium cutting speed, medium to high chip thickness.
IN15K (w/polish)	Non-ferrous materials. Wet.
IN70N	Grey, ductile, nodular iron dry only, very high speed, low to medium chip thickness.

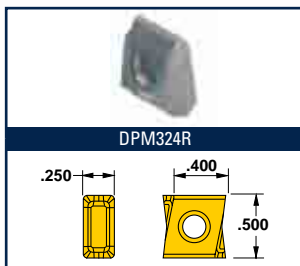
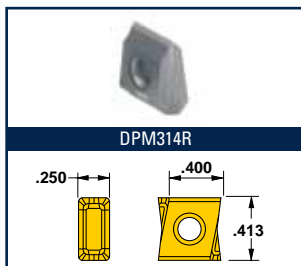
CARBIDE SELECTION GUIDE

Direction of Use	Wear Resistance →											Wear Resistance →					Wear Resistance →									
	← Toughness											← Toughness					← Toughness									
Material	← Increase Feed											← Increase Feed					← Increase Feed									
	→ Increase Speed											→ Increase Speed					→ Increase Speed									
Material		Short Chipping Malleable Iron, Non-Ferrous Metal, Hardened Iron, Chilled Iron, Cast Iron											High-Temp Alloys, Alloy Iron, Steel Casting, Manganese					Free Cutting Steels, Malleable Iron, Steel Casting, Steel								
New CL	Coating	C1			C2			C3		C4								C5		C6		C7		C8		
		K50	K45	K40	K35	K30	K25	K20	K15	K10	K05	K01	M50	M40	M30	M20	M10	P50	P45	P40	P35	P30	P25	P20	P15	P10
IN15K	Uncoated	IN15K																								
IN6510	CVD	IN6510																								
IN6515	CVD	IN6515																IN6515								
IN1530	PVD	IN1530											IN1530					IN1530								
IN2005	PVD												IN2005					IN2005								
IN2010	PVD	IN2010																								
IN2015	PVD	IN2015											IN2015					IN2015								
IN2030	PVD	IN2030											IN2030					IN2030								
IN2040	PVD																	IN2040								
IN70N	Non-Carbide	IN70N																								



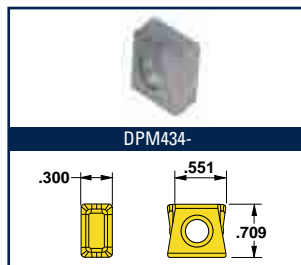
Standard Inserts for Special Steel

INSERTS: 0° LEAD RH ONLY



Insert Color Code	Insert Number	Corner	IN	Grades		
				2015	2040	2005
	DPM314R001	.031		■	■	■
	DPM324R001	.031		■	■	■
	DPM424R001	.031		■	■	■

INSERTS: SLOTTING RH/LH



Insert Color Code	Insert Number	Corner	IN	Grades			
				2015	2040	2005	1530
	DPM434-001	.031		■	■	■	■
	DPM434-002	.062		■	■	■	

General Application Information

APPLYING BASIC PRINCIPLES OF MACHINING WITH INDEXABLES CAN IMPROVE PERFORMANCE

The following information is directed toward indexable carbide tools but it can be applied to many other cutting tools, as well. It provides some basic guidelines designed to serve as a starting point for safe and reliable performance. Contact your Ingersoll Cutting Tool Company sales engineer or distributor for specific application assistance.

Rigidity. Use the most rigid cutter possible. This usually means the cutter with the largest diameter and shortest length. Use the best adaption possible. Integral tapers, such as a 50 V-flange, are better than straight shanks. When selecting straight shank tools, use a cutter with the largest diameter shank possible and a holder with the shortest length possible.

Effective cutting edges. When calculating feed rate, use the effective number of inserts. In extended flute cutters, the effective number of inserts is not the number of rows. Use the effective number listed with the specifications for each series of tools.

Chip load. Carbide cutting tools have to take a "bite" to cut. Be sure to cut with an adequate chip load. Light chip loads can contribute to chatter, causing a cutter to "rub" instead of "bite." This can also result in poor tool life. As a general rule, chip loads should not be less than .004". Also, be sure to use Radial Chip Thinning Factors (RCTF) when calculating feed rates.

Chip recutting. Unlike HSS, carbide cutting tools cannot recut chips. Recutting chips will damage carbide. To evacuate chips, use air or coolant depending on the material being cut.

Coolant. Generous amounts of coolant are required when low thermal conductivity, work hardening, and chip welding tendencies are evident.

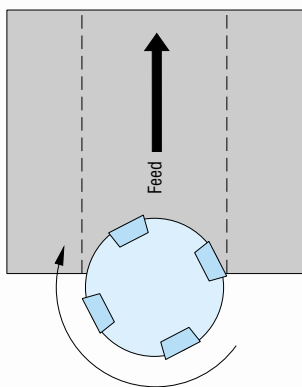
Use coolant only when necessary. Some materials cut better dry. In some applications, coolant causes thermal cracking of inserts and poor tool life.

Feed rates. Reduce feed rates by 50 percent when entering or exiting a cut. Since fewer inserts are engaged in the work, pounding can occur. Reducing feed rates will reduce the shock of the interrupted cut and contribute to longer tool life.

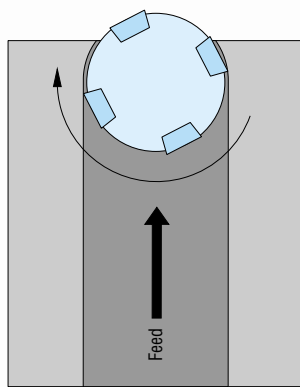
When entering a corner during pocket milling, a larger portion of the cutter's diameter is engaged. Power requirements and tool deflection increase. To compensate, program a reduced interpolated feed rate. Alternately, drill or plunge the corner prior to milling.

Cutter rotation. Climb cut whenever possible. Carbide is designed for climb milling and will not generally perform as well when conventional cutting.

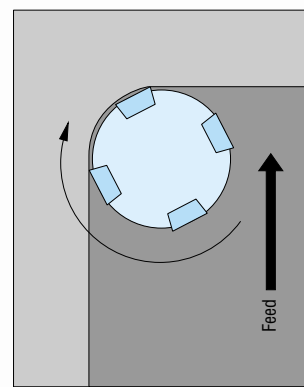
Conventional cutting may be employed on older machines to minimize backlash. It can also extend tool life in sandy, scaly, or torch-cut surfaces as the cutting edge enters into cleaner, softer material.



Entering a Cut



Exiting a Cut



Corner Cutting

Reduce feed rates by 50% when entering a cut, exiting a cut, or entering a corner. This reduces pounding and cutting forces and can extend the life of your indexable carbide tool.

Standard Milling Formulas

Surface Speed per Minute

$$SFM = .26 \times \text{Diameter} \times \text{RPM}$$

Revolutions per Minute

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

Feed per Revolution

$$\text{FPR} = \frac{\text{IPM}}{\text{RPM}}$$

Inches per Minute

$$\text{IPM} = \text{RPM} \times \text{FPR}$$

Feed per Insert

$$\text{FPI} = \frac{\text{FPR}}{\text{No. Eff. Insert}}$$

Horsepower equals Material Removal Rate divided by the "K" Factor

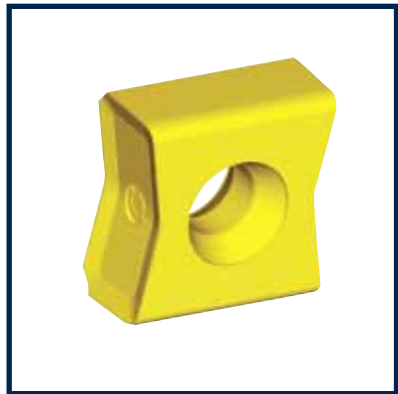
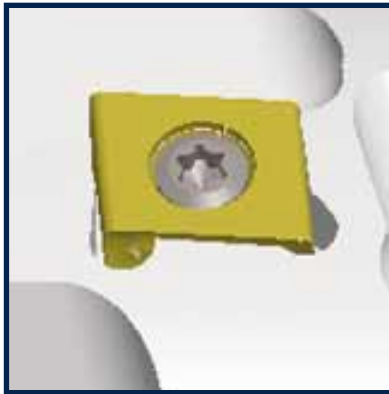
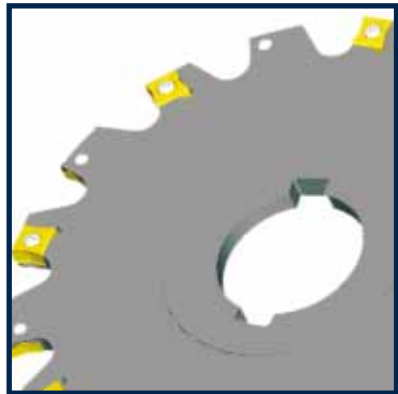
Horsepower

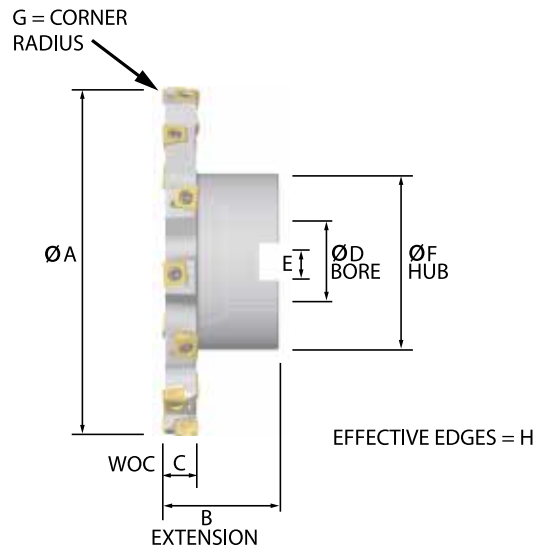
$$\text{HP} = \frac{\text{WOC} \times \text{DOC} \times \text{IPM}}{\text{K}}$$

Material	"K" Factors
Aluminum	3.0 - 4.0
Brass-Soft	3.0
Brass-Hard	2.0
Bronze-Hard	1.4
Bronze-VH	.5 - .7
Cast Iron 200 Bhn	1.5 - 2.0
Cast Iron > 200 Bhn	1.3 - 1.8
Steel 100 Bhn	1.5
Steel 150 Bhn	.9
Steel 200 Bhn	.7
Steel 250 Bhn	.6
Steel 400 Bhn	.5
Stainless Steel	.5 - 1.0
High Temp Alloys	.3 - .8



*MODIFIED STANDARDS AND SPECIALS
PRODUCT WORKSHEETS
- APPENDIX -*





SUGGESTED DIAMETER 4.00" +

VARIABLE FEATURES

A: _____

B: _____

C: _____

D: _____

E: _____

F: _____

G: _____

H: _____

SLOTting/SLABBING AND T-SLOTting

APPLICATION DATA

WORKPIECE MATERIAL _____

AVG. RADIAL DOC _____

RPM _____

FEED RATE _____

MACHINE TYPE _____

MACHINE H.P. _____

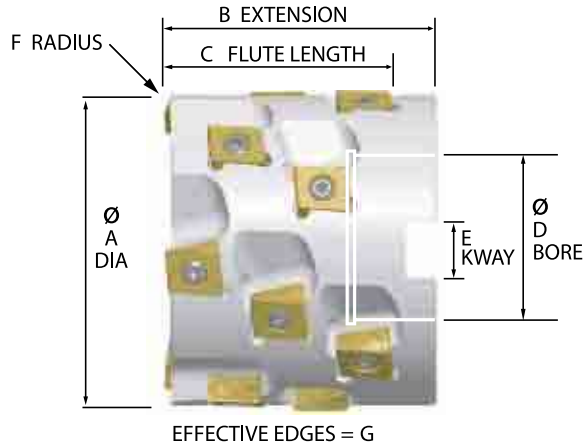
MAX. TOOL ASSY. WEIGHT _____

REMARKS

MEASUREMENT UNITS USED

INCH

MM



SUGGESTED DIAMETER 2.00" +

VARIABLE FEATURES

A: _____

B: _____

C: _____

D: _____

E: _____

F: _____

G: _____

HEAVY-DUTY SHELL MILL

COOLANT THRU: YES NO

APPLICATION DATA

WORKPIECE MATERIAL _____

AVG. RADIAL DOC _____

RPM _____

FEED RATE _____

MACHINE TYPE _____

MACHINE H.P. _____

MAX. TOOL ASSY. WEIGHT _____

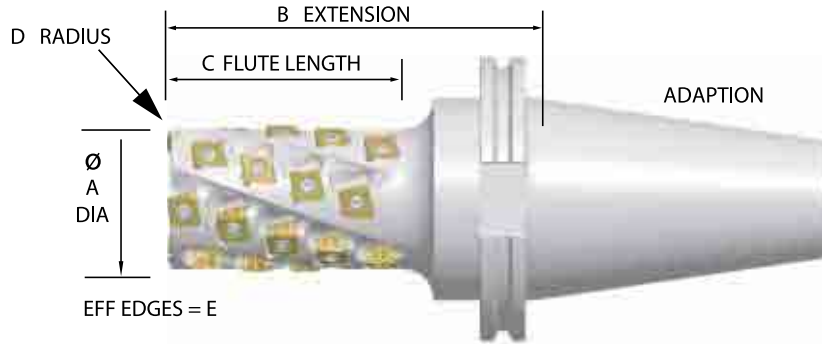
REMARKS

MEASUREMENT UNITS USED

INCH

MM

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SUGGESTED DIAMETER 1.50"+

VARIABLE FEATURES

A: _____
B: _____
C: _____
D: _____
E: _____

HEAVY-DUTY ENDMILLING

COOLANT THRU: YES NO
ADAPTION STYLE: _____

APPLICATION DATA

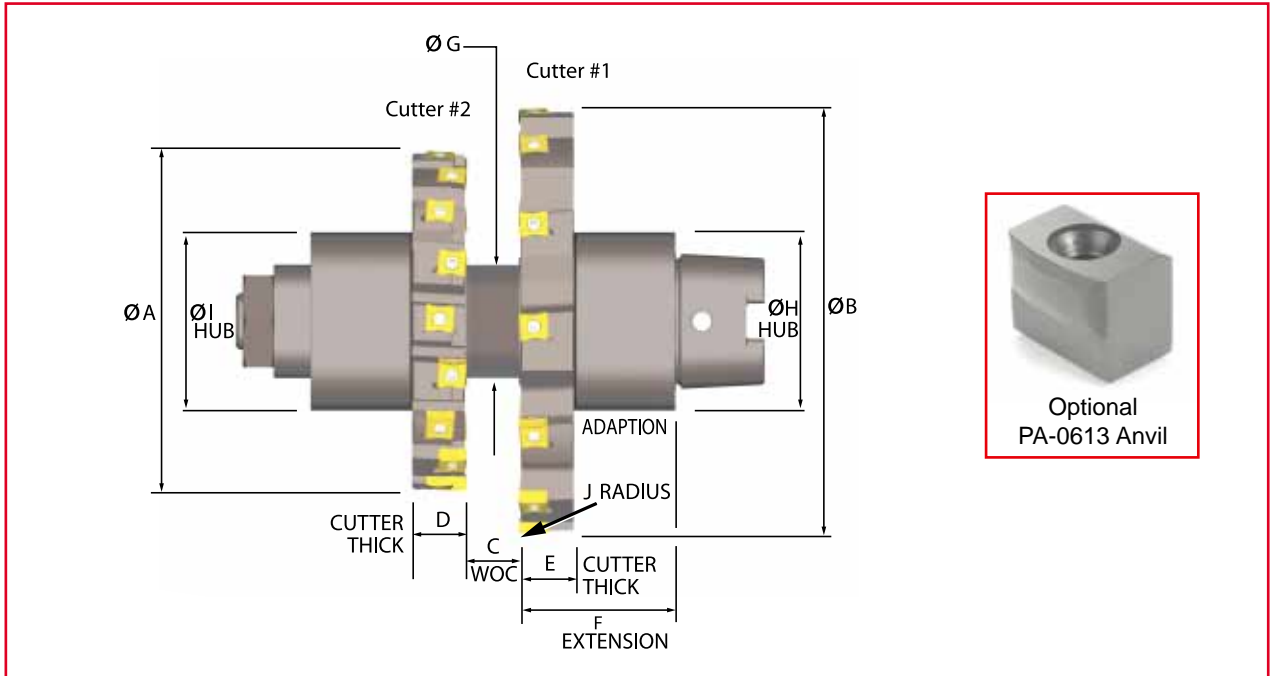
WORKPIECE MATERIAL
AVG. RADIAL DOC
RPM
FEED RATE
MACHINE TYPE
MACHINE H.P.
MAX. TOOL ASSY. WEIGHT

REMARKS

MEASUREMENT UNITS USED
[] INCH [] MM

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VARIABLE FEATURES

- A: _____
- B: _____
- C: _____
- D: _____
- E: _____
- F: _____
- G: _____
- H: _____
- I: _____
- J: _____

MEASUREMENT UNITS USED
 INCH MM

**STRADDLE MILLING
 FULL SIDE MILLING**

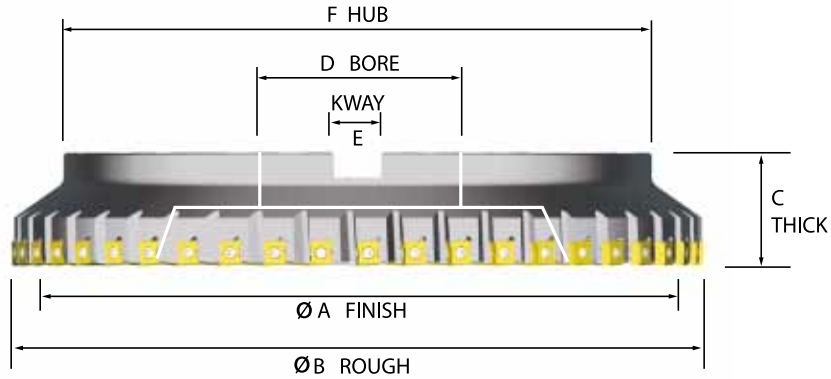
CUTTER # 1 QUANTITY OF INSERTS: _____
 CUTTER # 2 QUANTITY OF INSERTS: _____
 ADAPTION STYLE: _____

APPLICATION DATA

WORKPIECE MATERIAL _____
 AVG. AXIAL DOC _____
 RPM _____
 FEED RATE _____
 MACHINE TYPE _____
 MACHINE H.P. _____
 MAX. TOOL ASSY. WEIGHT _____

REMARKS

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VARIABLE FEATURES

- A: _____
- B: _____
- C: _____
- D: _____
- E: _____
- F: _____

COMBINATION FINISH FACE MILL

PROPOSED QUANTITY OF ROUGHER INSERTS: _____

PROPOSED QUANTITY OF FINISHER INSERTS: _____

ROUGHER L-NEST PROTECTION/ ADJUSTMENT REQUESTED: YES NO

COOLANT MANIFOLD REQUESTED: . . YES NO

APPLICATION DATA

WORKPIECE MATERIAL _____

AVG. AXIAL DOC _____

RPM _____

FEED RATE _____

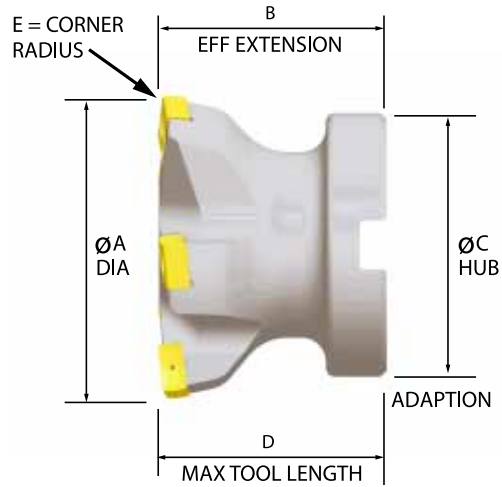
MACHINE TYPE _____

MACHINE H.P. _____

MAX. TOOL ASSY. WEIGHT _____

REMARKS

MEASUREMENT UNITS USED
 INCH MM



OPTIONAL
PAR0615/PAL0615
NEST

SUGGESTED DIAMETER 2.50" +

VARIABLE FEATURES

A: _____

B: _____

C: _____

D: _____

E: _____

BORING

QUANTITY OF INSERTS: _____

ADAPTION STYLE: _____

COOLANT THRU: YES NO

L-NEST POCKET PROTECTION/
ADJUSTMENT REQUESTED YES NO

APPLICATION DATA

WORKPIECE MATERIAL _____

AVG. RADIAL DOC _____

RPM _____

FEED RATE _____

MACHINE TYPE _____

MACHINE H.P. _____

MAX. TOOL ASSY. WEIGHT _____

REMARKS

MEASUREMENT UNITS USED
 INCH MM

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