

CNC  
**Award**

**TAPERED END MILLS**

***SUPER HIGH SPEED STEEL***

***COBALT HIGH SPEED STEEL***

***OVER 1200 STOCKED STANDARD SIZES***

**TOLL FREE 1-888-531-0430**  
**TOLL FREE FAX 1-888-531-3240**



Award Cutter Company, Inc. 5577 Crippen Ave. S.W. Grand Rapids, MI 49548

Phone: (616) 531-0430/ (616) 531-0431/(616) 532-9985

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# AWARD

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**AWARD  
TAPERED  
END  
MILLS**



**THE AWARD CUTTER COMPANY  
WARRANTY AND LIMITATION  
OF LIABILITY**

The Award Cutter Company warrants each new product manufactured and sold by it or one of its authorized dealers only against defects in workmanship and/or materials under normal service, proper installation and use. This warranty is limited to repair or replacement of verified defective products and excludes and all implied warranty or merchantability and all risks and liability whatsoever resulting from any use of said products, including incidental and consequential damages. The provisions of this warranty and limitation of liability shall not be modified in any respect except by written document signed by an officer of The Award Cutter Company.

**IMPORTANT:** Cutting tools can shatter/break under improper or severe use. Wear safety equipment and particularly eye protection at all times in the vicinity of their use.

# Award

**ALL END MILLS ARE END CUTTING**

**ALL END MILLS ARE GUARANTEED**

**ALL TOOLS SUPER HIGH SPEED**

**CONSTANT SPIRAL, FREE CUTTING  
LESS BREAKAGE**

**LONGER CUTTING LIFE**

**FINEST MATERIALS AVAILABLE**

**IMMEDIATE SHIPMENTS**

**ALL TOOLS MFG IN USA**

MANUFACTURERS OF TAPERED END MILLS • COMPLETE RESHARPENING SERVICE

*Award Cutter Company*

## **AWARD CUTTER COMPANY, INC. SINCE 1959**

Through the years, Award Cutter Company has been a trusted partner of major manufacturers and industrial tool distributors throughout the world in producing tapered end mills of the highest quality.

We have kept pace with industry's ever increasing demand for greater product reliability and complete technology.

Using the very latest technology in the manufacturing process, you can be assured that we are providing industry with a product that out-performs all others.

We wish to extend our sincere thanks to all of our customers, who have enabled us to grow and expand to the point we are today. Some of you have been loyal customers since our beginning in 1959, and for this, we are very grateful. You can be assured that we will continue to provide you with a quality product as well as very personalized service.

Again, we thank you.

**Award Cutter Co., Inc.**

## **AWARD TAPERED END MILL DATA**

### **SIZES:**

Standard sizes are available in a complete range all popular sizes, 1/2 degree through 45 degree in various flute lengths. All standard sizes are right hand cut, right hand spiral. The spiral is constant.

### **MATERIAL:**

All tapered end mills are produced from a premium grade high speed steel capable of heat treatment throughout to obtain a combination of hardness and high wear resistance, yet remain a remarkably high impact resistance with a Rockwell of 65 and above. This means longer cutting life with less breakage.

### **HEAT TREATMENT:**

Award tapered end mills are very carefully hardened and given a series of multiple draws, some of which are many hours duration. This process assures tools full hardness yet maximum freedom from residual stresses, which so often cause breakage. We believe our method of heat treating provides the ultimate in high hardness necessary for good cutting action and long life, coupled with maximum shock resistance to prevent breakage.

### **GRINDING:**

All flutes are hollow ground with double clearance angles. The flute face is also hollow ground and polished to assure free cutting actions with minimum of heat generation. All tools have end cutting teeth. Special grinding procedures and equipment assures a high degree of concentricity between shank and cutting flutes.

### **TOLERANCES:**

Taper angles constant to +/- .001 per inch of flute length.  
Tip diameter tolerances are held at +/- .002.  
Shank diameter tolerances are -.0002 to -.0005.



# AWARD TAPERED END MILL DATA

## Calculating Ball End Diameters

P/S Taper Angle	Ball End Multiplier
1/2 deg per side	0.99131
1 deg per side	0.98269
1-1/2 deg per side	0.97415
2 deg per side	0.96568
3 deg per side	0.94896
4 deg per side	0.93251
5 deg per side	0.91633
6 deg per side	0.90053
7 deg per side	0.88472
10 deg per side	0.83909
15 deg per side	0.76732
20 deg per side	0.70020
25 deg per side	0.63707
30 deg per side	0.57735
45 deg per side	0.41421



Formula for calculating a starting tip diameter on a flat end to achieve a specific tangent Ball Diameter:  
 $\text{Ball Diameter} \times \text{Multiplier} = \text{Starting Tip Diameter}$

## Large Diameter Multipliers

P/S Taper Angle	Large Diameter Multiplier
1/2 deg per side	0.01745
1 deg per side	0.03490
1-1/2 deg per side	0.05236
2 deg per side	0.06984
3 deg per side	0.10482
4 deg per side	0.13986
5 deg per side	0.17498
6 deg per side	0.21021
7 deg per side	0.24556
10 deg per side	0.35266
15 deg per side	0.53590
20 deg per side	0.72794
25 deg per side	0.93262
30 deg per side	1.15470
45 deg per side	2.00000



Formula for calculating Large Diameters:  
 $(\text{Large Diameter Multiplier} \times \text{Flute Length}) + \text{Tip Diameter} = \text{Large Diameter}$

**A**

# MINIATURE HIGH SPEED STEEL & COBALT Flat Ends

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	
<b>1/2 DEG</b>	M0-002	1/16	1/2	3/16	1 3/4	0.07123	
	M0-003	1/16	3/4	3/16	2	0.07559	
	M0-004	1/16	1	3/16	2 1/4	0.07995	
	M0-052	5/64	1/2	3/16	1 3/4	0.08685	
	M0-054	5/64	1	3/16	2 1/4	0.09558	
	M0-103	3/32	3/4	3/16	2	0.10684	
	M0-105	3/32	1 1/4	3/16	2 1/2	0.11556	
	M0-106	3/32	1 1/2	3/16	2 11/16	0.11993	
	M0-201	1/8	1/4	3/16	1 1/2	0.12936	
	M0-2015	1/8	3/8	3/16	1 5/8	0.13154	
	M0-203	1/8	3/4	3/16	2	0.13809	
	M0-204	1/8	1	3/16	2 1/4	0.14245	
	<b>1 DEG</b>	M1-002	1/16	1/2	3/16	1 3/4	0.07995
		M1-003	1/16	3/4	3/16	2	0.08868
M1-004		1/16	1	3/16	2 1/4	0.09740	
M1-052		5/64	1/2	3/16	1 3/4	0.09558	
M1-054		5/64	1	3/16	2 1/4	0.11303	
M1-103		3/32	3/4	3/16	2	0.11993	
M1-105		3/32	1 1/4	3/16	2 1/2	0.13738	
M1-106		3/32	1 1/2	3/16	2 11/16	0.14610	
M1-201		1/8	1/4	3/16	1 1/2	0.13373	
M1-2015		1/8	3/8	3/16	1 5/8	0.13809	
M1-203		1/8	3/4	3/16	2	0.15118	
M1-204		1/8	1	3/16	2 1/4	0.15990	

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
<b>1 1/2 DEG</b>	M15-003	1/16	3/4	3/16	2	0.10177
	M15-104	3/32	1	3/16	2 1/4	0.14611
	M15-105	3/32	1 1/4	3/16	2 1/2	0.15920
	M15-154	7/64	1	3/16	2 1/4	0.16174
	M15-203	1/8	3/4	3/16	2	0.16427
	M15-204	1/8	1	3/16	2 1/4	0.17736
<b>2 DEG</b>	M2-002	1/16	1/2	3/16	1 3/4	0.09742
	M2-004	1/16	1	3/16	2 1/4	0.13234
	M2-052	5/64	1/2	3/16	1 3/4	0.11305
	M2-054	5/64	1	3/16	2 1/4	0.14797
	M2-056	5/64	1 1/2	3/16	2 11/16	0.18289
	M2-103	3/32	3/4	3/16	2	0.14613
M2-105	3/32	1 1/4	3/16	2 1/2	0.18105	
M2-203	1/8	3/4	3/16	2	0.17738	

TO ORDER COBALT OR COATINGS,  
Add a suffix to the part number given above.  
for TIN Coated, add the suffix "TIN"  
for Cobalt, add the suffix "CO"  
for Cobalt TIN Coated, add the suffix "CO-TIN"  
If no suffix is given High Speed Steel will ship.

ALL SIZES ARE AVAILABLE  
SOME ARE AVAILABLE WITH EXTENDED SHANKS.  
CALL FOR AVAILABILITY 1-888-531-0430



• Four Flutes

# HIGH SPEED STEEL & COBALT

## Flat Ends

# A

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
1/2 DEG	KK-102	3/32	1/2	3/8	2 1/2	0.10248
	KK-103	3/32	3/4	3/8	2 5/8	0.10684
	KK-105	3/32	1 1/4	3/8	3 1/8	0.11556
	KK-201	1/8	1/4	3/8	2 1/2	0.12936
	KK-202	1/8	1/2	3/8	2 1/2	0.13373
	KK-203	1/8	3/4	3/8	2 1/2	0.13809
	KK-204	1/8	1	3/8	2 7/8	0.14245
	KK-205	1/8	1 1/4	3/8	3 1/8	0.14681
	KK-206	1/8	1 1/2	3/8	3 1/4	0.15118
	KK-303	3/16	3/4	3/8	2 1/2	0.20059
	KK-305	3/16	1 1/4	3/8	3 1/8	0.20931
	KK-307	3/16	1 3/4	3/8	3 7/8	0.21804
	KK-309	3/16	2 1/4	3/8	4 1/4	0.22676
	KK-313	3/16	3 1/4	3/8	5 1/2	0.24421
	KK-403	1/4	3/4	3/8	2 1/2	0.26309
	KK-405	1/4	1 1/4	3/8	3	0.27181
	KK-409	1/4	2 1/4	1/2	4 1/4	0.28926
	KK-409A	1/4	2 1/4	3/8	4 1/4	0.28926
	KK-413	1/4	3 1/4	1/2	5 1/2	0.30671
	KK-605	3/8	1 1/4	1/2	3 1/8	0.39681
	KK-609	3/8	2 1/4	1/2	4 1/4	0.41426
	KK-613	3/8	3 1/4	1/2	5 1/2	0.43171
	KK-805	1/2	1 1/4	1/2	3 1/4	0.52181
	KK-809	1/2	2 1/4	1/2	4 1/4	0.53926
	KK-813	1/2	3 1/4	1/2	5 1/2	0.55671
	KK-1009	5/8	2 1/4	5/8	4 1/2	0.66426
	KK-1013	5/8	3 1/4	5/8	5 1/2	0.68171
	KK-1017	5/8	4 1/4	5/8	6 1/2	0.69916
	KK-1209	3/4	2 1/4	3/4	4 3/4	0.78926
	KK-1213	3/4	3 1/4	3/4	5 3/4	0.80671
	KK-1217	3/4	4 1/4	3/4	6 3/4	0.82416
	KK-1221	3/4	5 1/4	3/4	7 3/4	0.84161
KK-1624	• 1	6	1	8 1/2	1.10470	

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
1 DEG	K-102	3/32	1/2	3/8	2 1/2	0.11120
	K-103	3/32	3/4	3/8	2 1/2	0.11993
	K-105	3/32	1 1/4	3/8	3 1/8	0.13738
	K-201	1/8	1/4	3/8	2 1/2	0.13373
	K-202	1/8	1/2	3/8	2 1/2	0.14245
	K-203	1/8	3/4	3/8	2 1/2	0.15118
	K-204	1/8	1	3/8	2 7/8	0.15990
	K-205	1/8	1 1/4	3/8	3 1/8	0.16863
	K-206	1/8	1 1/2	3/8	3 1/4	0.17735
	K-208	1/8	2	3/8	3 7/8	0.19480
	K-303	3/16	3/4	3/8	2 1/2	0.21368
	K-305	3/16	1 1/4	3/8	3 1/8	0.23113
	K-308	3/16	2	3/8	3 7/8	0.25730
	K-309	3/16	2 1/4	3/8	4 1/4	0.26603
	K-310	3/16	2 1/2	3/8	4 1/2	0.27475
	K-313	3/16	3 1/4	3/8	5 1/2	0.30093
	K-403	1/4	3/4	3/8	2 1/2	0.27618
	K-405	1/4	1 1/4	3/8	3	0.29363
	K-406	1/4	1 1/2	3/8	3 1/4	0.30235
	K-409	1/4	2 1/4	1/2	4 1/4	0.32853
	K-413	1/4	3 1/4	1/2	5 1/2	0.36343
	K-605	3/8	1 1/4	1/2	3 1/4	0.41863
	K-609	3/8	2 1/4	1/2	4 1/4	0.45353
	K-613	3/8	3 1/4	1/2	5 1/4	0.48843
	K-805	1/2	1 1/4	1/2	3 1/4	0.54363
	K-809	1/2	2 1/4	1/2	4 1/4	0.57853
	K-813	1/2	3 1/4	5/8	5 3/8	0.61343
	K-813A	1/2	3 1/4	1/2	5 3/8	0.61343
	K-1009	5/8	2 1/4	5/8	4 1/2	0.70353
	K-1013	5/8	3 1/4	5/8	5 1/2	0.73843
	K-1017	5/8	4 1/4	5/8	6 1/2	0.77333
	K-1209	3/4	2 1/4	3/4	4 3/4	0.82853
K-1213	3/4	3 1/4	3/4	5 3/4	0.86343	
K-1217	3/4	4 1/4	3/4	6 3/4	0.89833	
K-1221	3/4	5 1/4	3/4	7 3/4	0.93323	
K-1624	• 1	6	1	8 1/2	1.20940	

TO ORDER COBALT OR COATINGS,  
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for Cobalt, add the suffix "CO"  
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If no suffix is given High Speed Steel will ship.



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SOME ARE AVAILABLE WITH EXTENDED SHANKS.  
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• Four Flutes

**A**

# HIGH SPEED STEEL & COBALT

## Flat Ends

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
1 1/2 DEG	KX-102	3/32	1/2	3/8	2 1/2	0.11993	2 DEG	L-002	1/16	1/2	3/8	2 5/8	0.09742
	KX-103	3/32	3/4	3/8	2 1/2	0.13302		L-004	1/16	1	3/8	2 7/8	0.13234
	KX-104	3/32	1	3/8	2 7/8	0.14611		L-102	3/32	1/2	3/8	2 1/2	0.12867
	KX-105	3/32	1 1/4	3/8	3 1/8	0.15920		L-103	3/32	3/4	3/8	2 1/2	0.14613
	KX-106	3/32	1 1/2	3/8	3 1/4	0.17229		L-105	3/32	1 1/4	3/8	3 1/8	0.18105
	KX-110	3/32	2 1/2	3/8	4 1/2	0.22465		L-202	1/8	1/2	3/8	2 1/2	0.15992
	KX-154	7/64	1	3/8	2 7/8	0.16174		L-203	1/8	3/4	3/8	2 1/2	0.17738
	KX-155	7/64	1 1/4	3/8	3 1/8	0.17483		L-204	1/8	1	3/8	2 7/8	0.19484
	KX-156	7/64	1 1/2	3/8	3 1/4	0.18792		L-205	1/8	1 1/4	3/8	3 1/8	0.21230
	KX-202	1/8	1/2	3/8	2 1/2	0.15118		L-206	1/8	1 1/2	3/8	3 1/4	0.22976
	KX-203	1/8	3/4	3/8	2 1/2	0.16427		L-208	1/8	2	3/8	3 7/8	0.26468
	KX-204	1/8	1	3/8	2 7/8	0.17736		L-210	1/8	2 1/2	3/8	4 1/2	0.29960
	KX-205	1/8	1 1/4	3/8	3 1/8	0.19045		L-303	3/16	3/4	3/8	2 1/2	0.23988
	KX-206	1/8	1 1/2	3/8	3 1/4	0.20354		L-305	3/16	1 1/4	3/8	3 1/8	0.27480
	KX-208	1/8	2	3/8	3 7/8	0.22972		L-309	3/16	2 1/4	1/2	4 1/4	0.34464
	KX-209	1/8	2 1/4	3/8	4 1/4	0.24281		L-313	3/16	3 1/4	1/2	5 1/2	0.41448
	KX-212	1/8	3	3/8	5	0.28208		L-403	1/4	3/4	3/8	2 1/2	0.30238
	KX-254	5/32	1	3/8	2 7/8	0.20861		L-405	1/4	1 1/4	3/8	3	0.33730
	KX-255	5/32	1 1/4	3/8	3 1/8	0.22170		L-409	1/4	2 1/4	1/2	4 3/8	0.40714
	KX-256	5/32	1 1/2	3/8	3 1/4	0.23479		L-413	1/4	3 1/4	1/2	5 1/4	0.47698
	KX-258	5/32	2	3/8	3 7/8	0.26097		L-505	5/16	1 1/4	1/2	3 1/4	0.39980
	KX-303	3/16	3/4	3/8	2 1/2	0.22677		L-605	3/8	1 1/4	1/2	3 1/4	0.46230
	KX-305	3/16	1 1/4	3/8	3 1/8	0.25295		L-609	3/8	2 1/4	1/2	4 1/4	0.53214
	KX-309	3/16	2 1/4	3/8	4	0.30531		L-613	3/8	3 1/4	1/2	5 1/2	0.60198
	KX-313	3/16	3 1/4	3/8	5 1/2	0.35767		L-613B	3/8	3 1/4	5/8	5 1/2	0.60198
	KX-403	1/4	3/4	3/8	2 1/2	0.28927		L-805	1/2	1 1/4	1/2	3 1/4	0.58730
	KX-405	1/4	1 1/4	3/8	3	0.31545		L-809	1/2	2 1/4	5/8	4 3/8	0.65714
	KX-409	1/4	2 1/4	1/2	4 1/4	0.36781		L-809A	1/2	2 1/4	1/2	4 3/8	0.65714
	KX-413	1/4	3 1/4	1/2	5 1/2	0.42017		L-813	1/2	3 1/4	3/4	5 1/2	0.72698
	KX-605	3/8	1 1/4	1/2	3 1/8	0.44045		L-813B	1/2	3 1/4	5/8	5 1/2	0.72698
	KX-609	3/8	2 1/4	1/2	4 1/4	0.49281		L-1009	5/8	2 1/4	3/4	4 1/2	0.78214
	KX-613	3/8	3 1/4	1/2	5 1/2	0.54517		L-1013	5/8	3 1/4	3/4	5 1/2	0.85198
KX-805	1/2	1 1/4	1/2	3 1/4	0.56545	L-1017	5/8	4 1/4	3/4	6 1/2	0.92182		
KX-809	1/2	2 1/4	5/8	4 1/2	0.61781	L-1209	3/4	2 1/4	3/4	4 1/2	0.90714		
KX-813	1/2	3 1/4	5/8	5 1/2	0.67017	L-1213	3/4	3 1/4	3/4	5 3/4	0.97698		
KX-1009	5/8	2 1/4	3/4	4 1/2	0.74281	L-1221	3/4	5 1/4	1	7 3/4	1.11666		
KX-1013	5/8	3 1/4	3/4	5 1/2	0.79517	L-1624	• 1	6	1 1/4	8 1/2	1.41904		
KX-1017	5/8	4 1/4	3/4	6 1/2	0.84753								
KX-1209	3/4	2 1/4	3/4	4 3/4	0.86781								
KX-1221	3/4	5 1/4	1	7 3/4	1.02489								
KX-1624	• 1	6	1 1/4	8 1/2	1.31416								

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for Cobalt, add the suffix "CO"  
for Cobalt TIN Coated, add the suffix "CO-TIN"  
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# HIGH SPEED STEEL & COBALT

## Flat Ends



Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
3 DEG	M-002	1/16	1/2	3/8	2 5/8	0.11491
	M-003	1/16	3/4	3/8	2 3/4	0.14112
	M-004	1/16	1	3/8	2 7/8	0.16732
	M-005	1/16	1 1/4	3/8	3 1/8	0.19353
	M-006	1/16	1 1/2	3/8	3 1/4	0.21973
	M-103	3/32	3/4	3/8	2 1/2	0.17237
	M-104	3/32	1	3/8	2 7/8	0.19857
	M-105	3/32	1 1/4	3/8	3 1/8	0.22478
	M-106	3/32	1 1/2	3/8	3 1/4	0.25098
	M-108	3/32	2	3/8	3 3/4	0.30339
	M-110	3/32	2 1/2	1/2	4 1/2	0.35580
	M-154	7/64	1	3/8	2 7/8	0.21420
	M-155	7/64	1 1/4	3/8	3 1/8	0.24040
	M-156	7/64	1 1/2	3/8	3 1/4	0.26661
	M-158	7/64	2	3/8	3 3/4	0.31902
	M-203	1/8	3/4	3/8	2 5/8	0.20362
	M-204	1/8	1	3/8	2 7/8	0.22982
	M-205	1/8	1 1/4	3/8	3 1/8	0.25603
	M-206	1/8	1 1/2	3/8	3 1/4	0.28223
	M-208	1/8	2	3/8	3 3/4	0.33464
	M-210	1/8	2 1/2	1/2	4 1/2	0.38705
	M-210A	1/8	2 1/2	3/8	4 1/2	0.38705
	M-212	1/8	3	1/2	5	0.43946
	M-216	1/8	4	1/2	6 1/2	0.54428
	M-2525	5/32	5/8	3/8	2 1/2	0.22176
	M-253	5/32	3/4	3/8	2 1/2	0.23487
	M-254	5/32	1	3/8	2 7/8	0.26107
	M-255	5/32	1 1/4	3/8	3 1/8	0.28728
	M-256	5/32	1 1/2	3/8	3 1/4	0.31348
	M-258	5/32	2	3/8	3 7/8	0.36589
	M-303	3/16	3/4	3/8	2 5/8	0.26612
	M-304	3/16	1	3/8	2 7/8	0.29232
M-305	3/16	1 1/4	3/8	3 1/8	0.31853	
M-306	3/16	1 1/2	3/8	3 1/8	0.34473	
M-308	3/16	2	1/2	4	0.39714	
M-310	3/16	2 1/2	1/2	4 1/2	0.44955	
M-312	3/16	3	1/2	5	0.50196	
M-313	3/16	3 1/4	1/2	5 1/2	0.52817	
M-316	3/16	4	5/8	6 1/8	0.60678	
M-320	3/16	5	3/4	7 1/4	0.71160	
M-322	3/16	5 1/2	3/4	7 3/4	0.76401	

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
3 DEG	M-403	1/4	3/4	3/8	2 1/2	0.32862
	M-404	1/4	1	3/8	2 3/4	0.35482
	M-405	1/4	1 1/4	3/8	3 1/8	0.37500
	M-406	1/4	1 1/2	3/8	3 1/4	0.40723
	M-409	1/4	2 1/4	1/2	4 1/4	0.48585
	M-410	1/4	2 1/2	1/2	4 1/2	0.51205
	M-413	1/4	3 1/4	1/2	5 1/2	0.59067
	M-416	1/4	4	3/4	6 1/4	0.66928
	M-416A	1/4	4	5/8	6 1/4	0.66928
	M-420	1/4	5	3/4	7 3/8	0.77410
	M-504	5/16	1	1/2	3 1/8	0.41732
	M-507	5/16	1 3/4	1/2	3 7/8	0.49594
	M-605	3/8	1 1/4	1/2	3 1/4	0.50000
	M-609	3/8	2 1/4	5/8	4 3/8	0.61085
	M-609A	3/8	2 1/4	1/2	4 3/8	0.61085
	M-613	3/8	3 1/4	5/8	5 3/8	0.71567
	M-613A	3/8	3 1/4	3/4	5 3/8	0.71567
	M-616	3/8	4	3/4	6 1/2	0.79428
	M-620	3/8	5	3/4	7 1/2	0.89910
	M-624	3/8	6	1	8 1/2	1.00392
	M-805	1/2	1 1/4	1/2	3 1/4	0.63103
	M-809	1/2	2 1/4	3/4	4 1/2	0.73585
	M-809A	1/2	2 1/4	1/2	4 1/8	0.73585
	M-809B	1/2	2 1/4	5/8	4 1/4	0.73585
	M-813	1/2	3 1/4	3/4	5 1/2	0.84067
	M-816	1/2	4	3/4	6 3/8	0.91928
	M-820	1/2	5	1	7 1/2	1.02410
	M-824	1/2	6	1	8 1/2	1.12892
	M-1009	5/8	2 1/4	3/4	4 1/2	0.86085
	M-1013	5/8	3 1/4	3/4	5 1/2	0.96567
	M-1016	5/8	4	1	6 1/2	1.04428
	M-1020	5/8	5	1	7 1/2	1.14910
M-1209	3/4	2 1/4	1	4 3/4	0.98585	
M-1213	3/4	3 1/4	1	5 3/4	1.09067	
M-1216	• 3/4	4	1	6 1/2	1.16928	
M-1220	• 3/4	5	1	7 1/2	1.27410	
M-1224	• 3/4	6	1 1/4	8 1/2	1.37892	
M-1624	• 1	6	1 1/4	8 1/2	1.62892	

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for Cobalt TIN Coated, add the suffix "CO-TIN"  
If no suffix is given High Speed Steel will ship.

# A

## HIGH SPEED STEEL & COBALT Flat Ends

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
4 DEG	N-004	1/16	1	3/8	2 7/8	0.20236
	N-006	1/16	1 1/2	3/8	3 1/4	0.27229
	N-103	3/32	3/4	3/8	2 5/8	0.19865
	N-104	3/32	1	3/8	2 7/8	0.23361
	N-203	1/8	3/4	3/8	2 5/8	0.22990
	N-204	1/8	1	3/8	2 7/8	0.26486
	N-206	1/8	1 1/2	3/8	3 1/4	0.33479
	N-208	1/8	2	1/2	3 7/8	0.40472
	N-210	1/8	2 1/2	1/2	4 1/2	0.47465
	N-303	3/16	3/4	3/8	2 5/8	0.29240
	N-305	3/16	1 1/4	3/8	3 1/8	0.36233
	N-310	3/16	2 1/2	1/2	4 1/2	0.53715
	N-313	3/16	3 1/4	5/8	5 1/2	0.64205
	N-316	3/16	4	3/4	6 1/2	0.74694
	N-403	1/4	3/4	3/8	2 1/2	0.35490
	N-405	1/4	1 1/4	1/2	3 1/4	0.42483
	N-409	1/4	2 1/4	5/8	4 3/8	0.56469
	N-413	1/4	3 1/4	3/4	5 1/2	0.70455
	N-416	1/4	4	3/4	6 1/2	0.80944
	N-605	3/8	1 1/4	1/2	3 1/4	0.54983
	N-609	3/8	2 1/4	5/8	4 3/8	0.68969
	N-613	3/8	3 1/4	3/4	5 1/2	0.82955
	N-616	3/8	4	3/4	6 1/2	0.93444
	N-805	1/2	1 1/4	1/2	3 1/4	0.67483
N-809	1/2	2 1/4	3/4	4 1/2	0.81469	
N-813	1/2	3 1/4	3/4	6 1/2	0.95455	
N-816	1/2	4	1	6 1/2	1.05944	
N-820	1/2	5	1	7 1/2	1.19930	

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
5 DEG	O-0002	1/32	1/2	3/16	2 5/8	0.11874
	O-0003	1/32	3/4	3/16	2 5/8	0.16249
	O-002	1/16	1/2	3/8	2 5/8	0.14999
	O-003	1/16	3/4	3/8	2 5/8	0.19374
	O-004	1/16	1	3/8	2 7/8	0.23748
	O-005	1/16	1 1/4	3/8	3 1/8	0.28123
	O-006	1/16	1 1/2	3/8	3 1/4	0.32497
	O-102	3/32	1/2	3/8	2 5/8	0.18124
	O-103	3/32	3/4	3/8	2 5/8	0.22499
	O-104	3/32	1	3/8	2 7/8	0.26873
	O-105	3/32	1 1/4	3/8	3 1/8	0.31248
	O-106	3/32	1 1/2	3/8	3 1/4	0.35622
	O-108	3/32	2	1/2	4	0.44371
	O-108A	3/32	2	3/8	3 7/8	0.44371
	O-110	3/32	2 1/2	1/2	4 1/2	0.53120
	O-114	3/32	3 1/2	3/4	5 7/8	0.66244
	O-154	7/64	1	3/8	2 7/8	0.28436
	O-155	7/64	1 1/4	3/8	3 1/8	0.32810
	O-156	7/64	1 1/2	3/8	3 5/16	0.37185
	O-158	7/64	2	1/2	4	0.45934
	O-203	1/8	3/4	3/8	2 5/8	0.25000
	O-204	1/8	1	3/8	2 7/8	0.29998
	O-205	1/8	1 1/4	3/8	3 1/8	0.34373
	O-206	1/8	1 1/2	3/8	3 1/4	0.37500
	O-208	1/8	2	1/2	4	0.47496
	O-208A	1/8	2	3/8	3 7/8	0.47496
	O-210	1/8	2 1/2	5/8	4 1/2	0.56245
	O-210A	1/8	2 1/2	1/2	4 1/2	0.56245
	O-212	1/8	3	3/4	5 1/4	0.64994
	O-212A	1/8	3	1/2	5 1/4	0.64994
	O-222	1/8	5 1/2	1/2	7 1/2	1.08739
	O-254	5/32	1	3/8	2 7/8	0.33123
	O-255	5/32	1 1/4	3/8	3 1/8	0.37498
	O-256	5/32	1 1/2	1/2	3 5/8	0.41872
	O-258	5/32	2	1/2	3 7/8	0.50000
	O-303	3/16	3/4	3/8	2 9/16	0.31874
	O-304	3/16	1	1/2	3	0.36248
	O-305	3/16	1 1/4	1/2	3 3/8	0.40623
	O-305S	7/32	1 1/4	1/2	3 3/8	0.43748
	O-306	3/16	1 1/2	1/2	3 1/2	0.44997
	O-308	3/16	2	1/2	4 1/8	0.53746
	O-310	3/16	2 1/2	5/8	4 5/8	0.62495
	O-310A	3/16	2 1/2	1/2	4 1/2	0.62495
	O-312	3/16	3	3/4	5 1/4	0.71244
	O-312A	3/16	3	1/2	5 1/4	0.71244
	O-313	3/16	3 1/4	3/4	5 1/2	0.75619
	O-313A	3/16	3 1/4	1/2	5 1/2	0.74619

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# HIGH SPEED STEEL & COBALT

## Flat Ends



Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
5	O-316	3/16	4	3/4	6 1/4	0.88742	7 DEG	R-0004	1/32	1	3/8	2 3/4	0.27681
	O-320	3/16	5	1	7 1/2	1.06240		R-003	1/16	3/4	3/8	2 5/8	0.24667
	O-324	3/16	6	1	8 1/2	1.23738		R-004	1/16	1	3/8	2 7/8	0.30806
	O-403	1/4	3/4	3/8	2 1/2	0.38124		R-006	1/16	1 1/2	1/2	3 1/4	0.43084
	O-404	1/4	1	1/2	3	0.42498		R-0254	.070	1	3/8	2 7/8	0.31556
	O-405	1/4	1 1/4	1/2	3 1/4	0.46873		R-054	5/64	1	3/8	2 7/8	0.32369
	O-406	1/4	1 1/2	1/2	3 1/2	0.51247		R-103	3/32	3/4	3/8	2 1/2	0.27792
	O-409	1/4	2 1/4	5/8	4 3/8	0.64371		R-104	3/32	1	3/8	2 3/4	0.33931
	O-409A	1/4	2 1/4	1/2	4 1/4	0.64371		R-105	3/32	1 1/4	1/2	3 1/8	0.40070
	O-410	1/4	2 1/2	5/8	4 1/2	0.68745		R-106	3/32	1 1/2	1/2	3 1/2	0.46209
	O-413	1/4	3 1/4	3/4	5 1/2	0.81869		R-203	1/8	3/4	3/8	2 9/16	0.30917
	O-416	1/4	4	3/4	6 1/4	0.94992		R-204	1/8	1	3/8	2 3/4	0.37056
	O-424	1/4	6	1	8 1/2	1.29988		R-206	1/8	1 1/2	1/2	3 1/2	0.49334
	O-509	5/16	2 1/4	5/8	4 1/4	0.70621		R-208	1/8	2	5/8	3 7/8	0.61612
	O-605	3/8	1 1/4	1/2	3 1/4	0.59373		R-212	1/8	3	3/4	5 1/4	0.86168
	O-609	3/8	2 1/4	3/4	4 1/2	0.76871		R-305	3/16	1 1/4	1/2	3 1/4	0.49445
	O-613	3/8	3 1/4	3/4	5 1/2	0.94369		R-312	3/16	3	3/4	5 3/8	0.92418
	O-616	3/8	4	1	6 1/2	1.07492		R-403	1/4	3/4	1/2	2 1/2	0.43417
	O-620	3/8	5	1 1/4	7 1/2	1.24990		R-405	1/4	1 1/4	1/2	3 1/4	0.55695
	O-624	3/8	6	1 1/4	8 1/2	1.42488		R-409	1/4	2 1/4	3/4	4 1/2	0.80251
	O-805	1/2	1 1/4	1/2	3 1/4	0.71873		R-413	1/4	3 1/4	1	5 3/8	1.04807
	O-809	1/2	2 1/4	3/4	4 1/2	0.89371		R-416	1/4	4	1	6 1/2	1.23224
	O-813	1/2	3 1/4	3/4	5 5/8	1.06869		R-513	5/16	3 1/4	1	5 3/4	1.11057
	O-816	1/2	4	1	6 1/2	1.19992		R-605	3/8	1 1/4	5/8	3 1/4	0.68195
	O-820	1/2	5	1 1/4	7 1/2	1.37490		R-609	3/8	2 1/4	3/4	4 1/2	0.92751
	O-824	1/2	6	1 1/4	8 1/2	1.54988		R-613	3/8	3 1/4	1	5 5/8	1.17307
	O-1009	5/8	2 1/4	3/4	4 1/4	1.01871		R-616	3/8	4	1 1/4	6 1/2	1.35724
	O-1020	• 5/8	5	1 1/4	7 1/2	1.49990		R-624	• 3/8	6	1 1/4	8 1/2	1.84836
	O-1209	3/4	2 1/4	3/4	4 3/4	1.14371		R-805	1/2	1 1/4	3/4	3 1/2	0.80695
	O-1216	• 3/4	4	1 1/4	6 1/2	1.44992		R-805A	1/2	1 1/4	5/8	3 3/8	0.80695
	O-1220	• 3/4	5	1 1/4	7 1/2	1.62490		R-809	1/2	2 1/4	1	4 5/8	1.05251
	O-1224	• 3/4	6	1 1/4	8 1/2	1.79988		R-813	• 1/2	3 1/4	1 1/4	5 3/4	1.29807
O-1620	• 1	5	1 1/4	7 1/2	1.87490	R-816	• 1/2	4	1 1/4	6 1/2	1.48224		
O-1624	• 1	6	2	9 1/2	2.04988	R-824	• 1/2	6	1 1/4	8 1/2	1.97336		
6 DEG	P-004	1/16	1	3/8	2 7/8	0.27271	R-1016	• 5/8	4	1 1/4	6 1/2	1.60724	
	P-104	3/32	1	3/8	2 7/8	0.30396	R-1020	• 5/8	5	1 1/4	7 1/2	1.85280	
	P-204	1/8	1	3/8	2 7/8	0.33521	R-1213	• 3/4	3 1/4	1 1/4	5 3/4	1.54807	
	P-206	1/8	1 1/2		3 1/4	0.44032	R-1216	• 3/4	4	1 1/4	6 1/2	1.73224	
	P-306	3/16	1 1/2	1/2	3 1/4	0.50282	R-1224	• 3/4	6	2	9 1/2	2.22336	
	P-406	1/4	1 1/2	5/8	3 1/2	0.56532	R-1624	• 1	6	2	9 1/2	2.47336	
	P-605	3/8	1 1/4	5/8	3 1/4	0.63776							
	P-805	1/2	1 1/4	3/4	3 1/4	0.76276							

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**A**

# HIGH SPEED STEEL & COBALT

## Flat Ends

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
<b>10 DEG</b>	T-0003	1/32	3/4	3/8	2 3/4	0.29575
	T-002	1/16	1/2	3/8	2 3/8	0.23883
	T-003	1/16	3/4	3/8	2 5/8	0.32700
	T-004	1/16	1	1/2	2 7/8	0.41516
	T-102	3/32	1/2	3/8	2 3/8	0.27008
	T-103	3/32	3/4	3/8	2 5/8	0.35825
	T-106	3/32	1 1/2	1/2	3 1/2	0.62274
	T-203	1/8	3/4	3/8	2 5/8	0.38950
	T-205	1/8	1 1/4	1/2	3 1/4	0.56583
	T-206	1/8	1 1/2	1/2	3 1/2	0.65399
	T-254	5/32	1	1/2	3	0.50000
	T-258	5/32	2	3/4	4 1/4	0.86157
	T-305	3/16	1 1/4	1/2	3 3/8	0.62500
	T-309	3/16	2 1/4	3/4	4 1/2	0.98099
	T-403	1/4	3/4	1/2	2 3/4	0.51450
	T-405	1/4	1 1/4	1/2	3 1/4	0.69083
	T-409	1/4	2 1/4	3/4	4 1/2	1.04349
	T-409A	1/4	2 1/4	1/2	4 1/2	1.04349
	T-413	1/4	3 1/4	1	5 5/8	1.39615
	T-605	3/8	1 1/4	5/8	3 1/2	0.81583
	T-609	3/8	2 1/4	1	4 5/8	1.16849
T-613	• 3/8	3 1/4	1 1/4	5 3/4	1.52115	
T-805	1/2	1 1/4	3/4	3 1/2	0.94083	
T-809	1/2	2 1/4	1	4 3/4	1.29349	
T-813	• 1/2	3 1/4	1 1/4	5 3/4	1.64615	
T-816	• 1/2	4	1 1/4	6 3/8	1.91064	

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
<b>15 DEG</b>	V-0003	1/32	3/4	1/2	2 3/4	0.43318
	V-003	1/16	3/4	1/2	2 3/4	0.46443
	V-102	3/32	1/2	3/8	2 3/8	0.36170
	V-103	3/32	3/4	1/2	2 7/8	0.49568
	V-104	3/32	1	1/2	3	0.62965
	V-106	3/32	1 1/2	3/4	3 3/4	0.89760
	V-106A	3/32	1 1/2	1/2	3 3/4	0.89760
	V-202	1/8	1/2	1/2	2 5/8	0.39295
	V-202A	1/8	1/2	3/8	2 5/8	0.39295
	V-203	1/8	3/4	1/2	2 7/8	0.52693
	V-204	1/8	1	1/2	3 1/8	0.66090
	V-205	1/8	1 1/4	5/8	3 1/2	0.79488
	V-205A	1/8	1 1/4	1/2	3 1/2	0.79488
	V-206A	1/8	1 1/2	1/2	3 5/8	0.92885
	V-304	3/16	1	1/2	3 1/8	0.72340
	V-305	3/16	1 1/4	3/4	3 1/2	0.85738
	V-305A	3/16	1 1/4	1/2	3 1/2	0.85738
	V-308	3/16	2	1	4 1/2	1.25930
	V-404	1/4	1	1/2	3 1/8	0.78590
	V-405	1/4	1 1/4	3/4	3 1/2	0.91988
	V-405A	1/4	1 1/4	1/2	3 1/2	0.91988
	V-406	1/4	1 1/2	3/4	3 3/4	1.05385
	V-408	1/4	2	3/4	4 1/2	1.32180
	V-409	1/4	2 1/4	1	4 3/4	1.45578
	V-413	• 1/4	3 1/4	1 1/4	5 3/4	1.99168
	V-504	5/16	1	3/4	3 1/4	0.84840
	V-506	5/16	1 1/2	3/4	3 7/8	1.11635
	V-509	• 5/16	2 1/4	1	4 7/8	1.51828
	V-605	3/8	1 1/4	3/4	3 5/8	1.04488
	V-609	• 3/8	2 1/4	1 1/4	4 3/4	1.51828
	V-613	• 3/8	3 1/4	1 1/4	5 3/4	2.05418
	V-804	1/2	1	3/4	3 1/4	1.03590
V-805	1/2	1 1/4	3/4	3 5/8	1.16988	
V-807	• 1/2	1 3/4	1	4 1/4	1.43783	
V-809	• 1/2	2 1/4	1 1/4	4 7/8	1.70578	
V-812	• 1/2	3	1 1/4	5 1/2	2.10770	
V-813	• 1/2	3 1/4	1 1/4	6	2.24168	



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# HIGH SPEED STEEL & COBALT

## Flat Ends

# A

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	
20 DEG	W-002	1/16	1/2	3/8	2 1/2	0.42647	
	W-103	3/32	3/4	1/2	2 3/4	0.63971	
	W-202	1/8	1/2	3/8	2 1/2	0.48897	
	W-204	• 1/8	1	1/2	3 1/8	0.85294	
	W-304	• 3/16	1	1/2	4	0.91544	
	W-306	• 3/16	1 1/2	3/4	3 1/4	1.27941	
	W-404	• 1/4	1	1/2	3 1/8	0.97794	
	W-406	• 1/4	1 1/2	3/4	4	1.34191	
	W-504	• 5/16	1	3/4	3 1/4	1.04044	
	W-506	• 5/16	1 1/2	3/4	3 7/8	1.40441	
	W-606	• 3/8	1 1/2	3/4	3 7/8	1.46691	
	W-608	• 3/8	2	1	4 1/2	1.83088	
	W-809	• 1/2	2 1/4	1 1/4	4 7/8	2.13787	
25 DEG	X-103	3/32	3/4	1/2	3	0.79322	
	X-202	1/8	1/2	1/2	2 1/2	0.59131	
	X-204A	1/8	1	1/2	3 1/8	1.05762	
	X-204B	1/8	1	5/8	3 1/8	1.05762	
	X-204C	1/8	1	3/4	3 1/8	1.05762	
	X-404	• 1/4	1	5/8	3 1/4	1.18262	
	X-406	• 1/4	1 1/2	3/4	4 1/8	1.64893	
	X-503	• 5/16	3/4	5/8	3	1.01197	
	X-504	• 5/16	1	3/4	3 3/8	1.24512	
	X-506	• 5/16	1 1/2	1	4 1/8	1.71143	
	X-603	• 3/8	3/4	5/8	3	1.07447	
	X-604	• 3/8	1	3/4	3 1/4	1.30762	
	X-606	• 3/8	1 1/2	1	4 1/8	1.77393	
	X-805	• 1/2	1 1/4	1	3 3/4	1.66578	
	30 DEG	Z-002	1/16	1/2	1/2	2 1/2	0.63985
		Z-103	3/32	3/4	1/2	3	0.95978
Z-202		• 1/8	1/2	1/2	2 5/8	0.70235	
Z-204		• 1/8	1	1/2	3 1/8	1.27970	
Z-404		• 1/4	1	3/4	3 3/8	1.40470	
Z-406		• 1/4	1 1/2	1	4 1/8	1.98205	
Z-605		• 3/8	1 1/4	1	3 7/8	1.81838	
Z-606		• 3/8	1 1/2	1	4 1/4	2.10705	
Z-805		• 1/2	1 1/4	1	3 3/4	1.94338	
Z-806		• 1/2	1 1/2	1	4 1/4	2.23205	

Taper Per Side	Tool No.	Tip Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
45 DEG	45-2015	• 1/8	5/16	1/2	2 1/2	0.75000
	45-202	• 1/8	1/2	1/2	2 5/8	1.12500
	45-203	• 1/8	3/4	5/8	3 1/4	1.62500
	45-204	• 1/8	1	1	3 3/4	2.12500
	45-303	• 3/16	3/4	3/4	3 1/4	1.68750
	45-304	• 3/16	1	1	4	2.17850
	45-305	• 3/16	1 1/4	1 1/4	4 1/4	2.68750
	45-403	• 1/4	3/4	3/4	3 1/4	1.75000
	45-404	• 1/4	1	1	4	2.25000
	45-405	• 1/4	1 1/4	1 1/4	4 1/4	2.75000
	45-406	• 1/4	1 1/2	1 1/4	4 1/2	3.25000
	45-603	• 3/8	3/4	3/4	3 1/4	1.87500
	45-604	• 3/8	1	1	4	2.37500
	45-605	• 3/8	1 1/4	1 1/4	4 1/4	2.87500
	45-606	• 3/8	1 1/2	1 1/4	4 1/2	3.37500
	45-803	• 1/2	3/4	3/4	3 1/4	2.00000
	45-804	• 1/2	1	1	4	2.50000
	45-805	• 1/2	1 1/4	1 1/4	4 1/4	3.00000
	45-806	• 1/2	1 1/2	1 1/4	4 5/8	3.50000



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**A**

# MINIATURE HIGH SPEED STEEL & COBALT Ball Ends

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	
<b>1/2 DEG</b>	BM0-002	1/16	1/2	3/16	1 3/4	0.07123	
	BM0-003	1/16	3/4	3/16	2	0.07559	
	BM0-004	1/16	1	3/16	2 1/4	0.07995	
	BM0-052	5/64	1/2	3/16	1 3/4	0.08685	
	BM0-054	5/64	1	3/16	2 1/4	0.09558	
	BM0-103	3/32	3/4	3/16	2	0.10684	
	BM0-105	3/32	1 1/4	3/16	2 1/2	0.11556	
	BM0-106	3/32	1 1/2	3/16	2	0.11993	
	BM0-201	1/8	1/4	3/16	1 1/2	0.12936	
	BM0-2015	1/8	3/8	3/16	1 5/8	0.13154	
	BM0-203	1/8	3/4	3/16	2	0.13809	
	BM0-204	1/8	1	3/16	2 1/4	0.14245	
	<b>1 DEG</b>	BM1-002	1/16	1/2	3/16	1 3/4	0.07995
		BM1-003	1/16	3/4	3/16	2	0.08868
BM1-003		1/16	1	3/16	2 1/4	0.09740	
BM1-052		5/64	1/2	3/16	1 3/4	0.09558	
BM1-054		5/64	1	3/16	2 1/4	0.11303	
BM1-103		3/32	3/4	3/16	2	0.11993	
BM1-105		3/32	1 1/4	3/16	2 1/2	0.13738	
BM1-106		3/32	1 1/2	3/16	2 11/16	0.14610	
BM1-201		1/8	1/4	3/16	1 1/2	0.13373	
BM1-2015		1/8	3/8	3/16	1 5/8	0.13809	
BM1-203		1/8	3/4	3/16	2	0.15118	
BM1-204		1/8	1	3/16	2 1/4	0.15990	

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
<b>1 1/2 DEG</b>	BM15-003	1/16	3/4	3/16	2	0.10177
	BM15-104	3/32	1	3/16	2 1/4	0.14611
	BM15-105	3/32	1 1/4	3/16	2 1/2	0.15920
	BM15-154	7/64	1	3/16	2 1/4	0.16174
	BM15-203	1/8	3/4	3/16	2	0.16427
	BM15-204	1/8	1	3/16	2 1/4	0.17736
<b>2 DEG</b>	BM2-002	1/16	1/2	3/16	1 3/4	0.09742
	BM2-004	1/16	1	3/16	2 1/4	0.13234
	BM2-052	5/64	1/2	3/16	1 3/4	0.11305
	BM2-054	5/64	1	3/16	2 1/4	0.14797
	BM2-056	5/64	1 1/2	3/16	2 11/16	0.18289
	BM2-103	3/32	3/4	3/16	2	0.14613
	BM2-105	3/32	1 1/4	3/16	2 1/2	0.18105
BM2-203	1/8	3/4	3/16	2	0.17738	

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• Four Flutes

# HIGH SPEED STEEL & COBALT

## Ball Ends

# A

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
1/2 DEG	BKK-102	3/32	1/2	3/8	2 1/2	0.10248
	BKK-103	3/32	3/4	3/8	2 5/8	0.10684
	BKK-105	3/32	1 1/4	3/8	3 1/8	0.11556
	BKK-201	1/8	1/4	3/8	2 1/2	0.12936
	BKK-202	1/8	1/2	3/8	2 1/2	0.13373
	BKK-203	1/8	3/4	3/8	2 1/2	0.13809
	BKK-204	1/8	1	3/8	2 7/8	0.14245
	BKK-205	1/8	1 1/4	3/8	3 1/8	0.14681
	BKK-206	1/8	1 1/2	3/8	3 1/4	0.15118
	BKK-303	3/16	3/4	3/8	2 1/2	0.20059
	BKK-305	3/16	1 1/4	3/8	3 1/8	0.20931
	BKK-307	3/16	1 1/4	3/8	3 7/8	0.21804
	BKK-309	3/16	2 1/4	3/8	4 1/4	0.22676
	BKK-313	3/16	3 1/4	3/8	5 1/2	0.24421
	BKK-403	1/4	3/4	3/8	2 1/2	0.26309
	BKK-405	1/4	1 1/4	3/8	3	0.27181
	BKK-409	1/4	2 1/4	1/2	4 1/4	0.28926
	BKK-409A	1/4	2 1/4	3/8	4 1/4	0.28926
	BKK-413	1/4	3 1/4	1/2	5 1/2	0.30671
	BKK-605	3/8	1 1/4	1/2	3 1/8	0.39681
	BKK-609	3/8	2 1/4	1/2	4 1/4	0.41426
	BKK-613	3/8	3 1/4	1/2	5 1/2	0.43171
	BKK-805	1/2	1 1/4	1/2	3 1/4	0.52181
	BKK-809	1/2	2 1/4	1/2	4 1/4	0.53926
	BKK-813	1/2	3 1/4	1/2	5 1/2	0.55671
	BKK-1009	5/8	2 1/4	5/8	4 1/2	0.66426
	BKK-1013	5/8	3 1/4	5/8	5 1/2	0.68171
	BKK-1017	5/8	4 1/4	5/8	6 1/2	0.69916
	BKK-1209	3/4	2 1/4	3/4	4 3/4	0.78926
	BKK-1213	3/4	3 1/4	3/4	5 3/4	0.80671
	BKK-1217	3/4	4 1/4	3/4	6 3/4	0.82416
	BKK-1221	3/4	5 1/4	3/4	7 3/4	0.84161
BKK-1624	• 1	6	1	8 1/2	1.10470	

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
1 DEG	BK-102	3/32	1/2	3/8	2 1/2	0.11120
	BK-103	3/32	3/4	3/8	2 1/2	0.11993
	BK-105	3/32	1 1/4	3/8	3 1/8	0.13738
	BK-201	1/8	1/4	3/8	2 1/2	0.13373
	BK-202	1/8	1/2	3/8	2 1/2	0.14245
	BK-203	1/8	3/4	3/8	2 1/2	0.15118
	BK-204	1/8	1	3/8	2 7/8	0.15990
	BK-205	1/8	1 1/4	3/8	3 1/8	0.16863
	BK-206	1/8	1 1/2	3/8	3 1/4	0.17735
	BK-208	1/8	2	3/8	3 7/8	0.19480
	BK-303	3/16	3/4	3/8	2 1/2	0.21368
	BK-305	3/16	1 1/4	3/8	3 1/8	0.23113
	BK-308	3/16	2	3/8	3 7/8	0.25730
	BK-309	3/16	2 1/4	3/8	4 1/4	0.26603
	BK-310	3/16	2 1/2	3/8	4 1/2	0.27475
	BK-313	3/16	3 1/4	3/8	5 1/2	0.30093
	BK-403	1/4	3/4	3/8	2 1/2	0.27618
	BK-405	1/4	1 1/4	3/8	3	0.29363
	BK-406	1/4	1 1/2	3/8	3 1/4	0.30235
	BK-409	1/4	2 1/4	1/2	4 1/4	0.32853
	BK-413	1/4	3 1/4	1/2	5 1/2	0.36343
	BK-605	3/8	1 1/4	1/2	3 1/4	0.41863
	BK-609	3/8	2 1/4	1/2	4 1/4	0.45353
	BK-613	3/8	3 1/4	1/2	5 1/4	0.48843
	BK-805	1/2	1 1/4	1/2	3 1/4	0.54363
	BK-809	1/2	2 1/4	1/2	4 1/4	0.57853
	BK-813	1/2	3 1/4	5/8	5 3/8	0.61343
	BK-813A	1/2	3 1/4	1/2	5 3/8	0.61343
	BK-1009	5/8	2 1/4	5/8	4 1/2	0.70353
	BK-1013	5/8	3 1/4	5/8	5 1/2	0.73843
	BK-1017	5/8	4 1/4	5/8	6 1/2	0.77333
	BK-1209	3/4	2 1/4	3/4	4 3/4	0.82853
BK-1213	3/4	3 1/4	3/4	5 3/4	0.86343	
BK-1217	3/4	4 1/4	3/4	6 3/4	0.89833	
BK-1221	3/4	5 1/4	3/4	7 3/4	0.93323	
BK-1624	• 1	6	1	8 1/2	1.20940	

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**A**

# HIGH SPEED STEEL & COBALT

## Ball Ends

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
1 1/2 DEG	BKX-102	3/32	1/2	3/8	2 1/2	0.11993	2 DEG	BL-002	1/16	1/2	3/8	2 5/8	0.09742
	BKX-103	3/32	3/4	3/8	2 1/2	0.13302		BL-004	1/16	1	3/8	2 7/8	0.13234
	BKX-104	3/32	1	3/8	2 7/8	0.14611		BL-102	3/32	1/2	3/8	2 1/2	0.12867
	BKX-105	3/32	1 1/4	3/8	3 1/8	0.15920		BL-103	3/32	3/4	3/8	2 1/2	0.14613
	BKX-106	3/32	1 1/2	3/8	3 1/4	0.17229		BL-105	3/32	1 1/4	3/8	3 1/8	0.18105
	BKX-110	3/32	2 1/2	3/8	4 1/2	0.22465		BL-202	1/8	1/2	3/8	2 1/2	0.15992
	BKX-154	7/64	1	3/8	2 7/8	0.16174		BL-203	1/8	3/4	3/8	2 1/2	0.17738
	BKX-155	7/64	1 1/4	3/8	3 1/8	0.17483		BL-204	1/8	1	3/8	2 7/8	0.19484
	BKX-156	7/64	1 1/2	3/8	3 1/4	0.18792		BL-205	1/8	1 1/4	3/8	3 1/8	0.21230
	BKX-202	1/8	1/2	3/8	2 1/2	0.15118		BL-206	1/8	1 1/2	3/8	3 1/4	0.22976
	BKX-203	1/8	3/4	3/8	2 1/2	0.16427		BL-208	1/8	2	3/8	3 7/8	0.26468
	BKX-204	1/8	1	3/8	2 7/8	0.17736		BL-210	1/8	2 1/2	3/8	4 1/2	0.29960
	BKX-205	1/8	1 1/4	3/8	3 1/8	0.19045		BL-303	3/16	3/4	3/8	2 1/2	0.23988
	BKX-206	1/8	1 1/2	3/8	3 1/4	0.20354		BL-305	3/16	1 1/4	3/8	3 1/8	0.27480
	BKX-208	1/8	2	3/8	3 7/8	0.22972		BL-309	3/16	2 1/4	1/2	4 1/4	0.34464
	BKX-209	1/8	2 1/4	3/8	4 1/4	0.24281		BL-313	3/16	3 1/4	1/2	5 1/2	0.41448
	BKX-212	1/8	3	3/8	5	0.28208		BL-403	1/4	3/4	3/8	2 1/2	0.30238
	BKX-254	5/32	1	3/8	2 7/8	0.20861		BL-405	1/4	1 1/4	3/8	3	0.33730
	BKX-255	5/32	1 1/4	3/8	3 1/8	0.22170		BL-409	1/4	2 1/4	1/2	4 3/8	0.40714
	BKX-256	5/32	1 1/2	3/8	3 1/4	0.23479		BL-413	1/4	3 1/4	1/2	5 1/4	0.47698
	BKX-258	5/32	2	3/8	3 7/8	0.26097		BL-505	5/16	1 1/4	1/2	3 1/4	0.39980
	BKX-303	3/16	3/4	3/8	2.125	0.22677		BL-605	3/8	1 1/4	1/2	3 1/4	0.46230
	BKX-305	3/16	1 1/4	3/8	3 1/8	0.25295		BL-609	3/8	2 1/4	1/2	4 1/4	0.53214
	BKX-309	3/16	2 1/4	3/8	4	0.30531		BL-613	3/8	3 1/4	1/2	5 1/2	0.60198
	BKX-313	3/16	3 1/4	3/8	5 1/2	0.35767		BL-613B	3/8	3 1/4	5/8	5 1/2	0.60198
	BKX-403	1/4	3/4	3/8	2 1/2	0.28927		BL-805	1/2	1 1/4	1/2	3 1/4	0.58730
	BKX-405	1/4	1 1/4	3/8	3	0.31545		BL-809	1/2	2 1/4	5/8	4 3/8	0.65714
	BKX-409	1/4	2 1/4	1/2	4 1/4	0.36781		BL-809A	1/2	2 1/4	1/2	4 3/8	0.65714
	BKX-413	1/4	3 1/4	1/2	5 1/2	0.42017		BL-813	1/2	3 1/4	3/4	5 1/2	0.72698
	BKX-605	3/8	1 1/4	1/2	3 1/8	0.44045		BL-813B	1/2	3 1/4	5/8	5 1/2	0.72698
	BKX-609	3/8	2 1/4	1/2	4 1/4	0.49281		BL-1009	5/8	2 1/4	3/4	4 1/2	0.78214
	BKX-613	3/8	3 1/4	1/2	5 1/2	.054517		BL-1013	5/8	3 1/4	3/4	5 1/2	0.85198
BKX-805	1/2	1 1/4	1/2	3 1/4	0.56545	BL-1017	5/8	4 1/4	3/4	6 1/2	0.92182		
BKX-809	1/2	2 1/4	0	4 1/2	0.61781	BL-1209	3/4	2 1/4	3/4	4 1/2	0.90714		
BKX-813	1/2	3 1/4	0	5 1/2	0.67017	BL-1213	3/4	3 1/4	3/4	5 3/4	0.97698		
BKX-1009	5/8	2 1/4	0	4 1/2	0.74281	BL-1221	3/4	5 1/4	1	7 3/4	1.11666		
BKX-1013	5/8	3 1/4	0	5 1/2	0.79517	BL-1624	• 1	6	1 1/4	8 1/2	1.41904		
BKX-1017	5/8	4 1/4	0	6 1/2	0.84753								
BKX-1209	3/4	2 1/4	0	4 3/4	0.86781								
BKX-1221	3/4	5 1/4	1	7 3/4	1.02489								
BKX-1624	• 1	6	1 1/4	8 1/2	1.31416								

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• Four Flutes

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for Cobalt, add the suffix "CO"  
for Cobalt TIN Coated, add the suffix "CO-TIN"  
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# HIGH SPEED STEEL & COBALT

## Ball Ends



Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
3 DEG	BM-002	1/16	1/2	3/8	2 5/8	0.11491
	BM-003	1/16	3/4	3/8	2 3/4	0.14112
	BM-004	1/16	1	3/8	2 7/8	0.16732
	BM-005	1/16	1 1/4	3/8	3 1/8	0.19353
	BM-006	1/16	1 1/2	3/8	3 1/4	0.21973
	BM-103	3/32	3/4	3/8	2 1/2	0.17237
	BM-104	3/32	1	3/8	2 7/8	0.19857
	BM-105	3/32	1 1/4	3/8	3 1/8	0.22478
	BM-106	3/32	1 1/2	3/8	3 1/4	0.25098
	BM-108	3/32	2	3/8	3 3/4	0.30339
	BM-110	3/32	2 1/2	1/2	4 1/2	0.35580
	BM-154	7/64	1	3/8	2 7/8	0.21420
	BM-155	7/64	1 1/4	3/8	3 1/8	0.24040
	BM-156	7/64	1 1/2	3/8	3 1/4	0.26661
	BM-158	7/64	2	3/8	3 3/4	0.31902
	BM-203	1/8	3/4	3/8	2 5/8	0.20362
	BM-204	1/8	1	3/8	2 7/8	0.22982
	BM-205	1/8	1 1/4	3/8	3 1/8	0.25603
	BM-206	1/8	1 1/2	3/8	3 1/4	0.28223
	BM-208	1/8	2	3/8	3 3/4	0.33464
	BM-210	1/8	2 1/2	1/2	4 1/2	0.38705
	BM-210A	1/8	2 1/2	3/8	4 1/2	0.38705
	BM-212	1/8	3	1/2	5	0.43946
	BM-216	1/8	4	1/2	6 1/2	0.54428
	BM-2525	5/32	5/8	3/8	2 1/2	0.22176
	BM-253	5/32	3/4	3/8	2 1/2	0.23487
	BM-254	5/32	1	3/8	2 7/8	0.26107
	BM-255	5/32	1 1/4	3/8	3 1/8	0.28728
	BM-256	5/32	1 1/2	3/8	3 1/4	0.31348
	BM-258	5/32	2	3/8	3 7/8	0.36589
	BM-303	3/16	3/4	3/8	2 5/8	0.26612
	BM-304	3/16	1	3/8	2 7/8	0.29232
BM-305	3/16	1 1/4	3/8	3 1/8	0.31853	
BM-306	3/16	1 1/2	3/8	3 1/8	0.34473	
BM-308	3/16	2	1/2	4	0.39714	
BM-310	3/16	2 1/2	1/2	4 1/2	0.44955	
BM-312	3/16	3	1/2	5	0.50196	
BM-313	3/16	3 1/4	1/2	5 1/2	0.52817	
BM-316	3/16	4	5/8	6 1/8	0.60678	
BM-320	3/16	5	3/4	7 1/4	0.71160	
BM-322	3/16	5 1/2	3/4	7 3/4	0.76401	

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
3 DEG	BM-403	1/4	3/4	3/8	2 1/2	0.32862
	BM-404	1/4	1	3/8	2 3/4	0.35482
	BM-405	1/4	1 1/4	3/8	3 1/8	0.37500
	BM-406	1/4	1 1/2	3/8	3 1/4	0.40723
	BM-409	1/4	2 1/4	1/2	4 1/4	0.48585
	BM-410	1/4	2 1/2	1/2	4 1/2	0.51205
	BM-413	1/4	3 1/4	1/2	5 1/2	0.59067
	BM-416	1/4	4	3/4	6 1/4	0.66928
	BM-416A	1/4	4	5/8	6 1/4	0.66928
	BM-420	1/4	5	3/4	7 3/8	0.77410
	BM-504	5/16	1	1/2	3 1/8	0.41732
	BM-507	5/16	1 3/4	1/2	3 7/8	0.49594
	BM-605	3/8	1 1/4	1/2	3 1/4	0.50000
	BM-609	3/8	2 1/4	5/8	4 3/8	0.61085
	BM-609A	3/8	2 1/4	1/2	4 3/8	0.61085
	BM-613	3/8	3 1/4	5/8	5 3/8	0.71567
	BM-613A	3/8	3 1/4	3/4	5 3/8	0.71567
	BM-616	3/8	4	3/4	6 1/2	0.79428
	BM-620	3/8	5	3/4	7 1/2	0.89910
	BM-624	3/8	6	1	8 1/2	1.00392
	BM-805	1/2	1 1/4	1/2	3 1/4	0.63103
	BM-809	1/2	2 1/4	3/4	4 1/2	0.73585
	BM-809A	1/2	2 1/4	1/2	4 1/8	0.73585
	BM-809B	1/2	2 1/4	5/8	4 1/4	0.73585
	BM-813	1/2	3 1/4	3/4	5 1/2	0.84067
	BM-816	1/2	4	3/4	6 3/8	0.91928
	BM-820	1/2	5	1	7 1/2	1.02410
	BM-824	1/2	6	1	8 1/2	1.12892
	BM-1009	5/8	2 1/4	3/4	4 1/2	0.86085
	BM-1013	5/8	3 1/4	3/4	5 1/2	0.96567
	BM-1016	5/8	4	1	6 1/2	1.04428
	BM-1020	5/8	5	1	7 1/2	1.14910
BM-1209	3/4	2 1/4	1	4 3/4	0.98585	
BM-1213	3/4	3 1/4	1	5 3/4	1.09067	
BM-1216	• 3/4	4	1	6 1/2	1.16928	
BM-1220	• 3/4	5	1	7 1/2	1.27410	
BM-1224	• 3/4	6	1 1/4	8 1/2	1.37892	
BM-1624	• 1	6	1 1/4	8 1/2	1.62892	

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# A

## HIGH SPEED STEEL & COBALT Ball Ends

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
4 DEG	BN-004	1/16	1	3/8	2 7/8	0.20236
	BN-006	1/16	1 1/2	3/8	3 1/4	0.27229
	BN-103	3/32	3/4	3/8	2 5/8	0.19865
	BN-104	3/32	1	3/8	2 7/8	0.23361
	BN-203	1/8	3/4	3/8	2 5/8	0.22990
	BN-204	1/8	1	3/8	2 7/8	0.26486
	BN-206	1/8	1 1/2	3/8	3 1/4	0.33479
	BN-208	1/8	2	1/2	3 7/8	0.40472
	BN-210	1/8	2 1/2	1/2	4 1/2	0.47465
	BN-303	3/16	3/4	3/8	2 5/8	0.29240
	BN-305	3/16	1 1/4	3/8	3 1/8	0.36233
	BN-310	3/16	2 1/2	1/2	4 1/2	0.53715
	BN-313	3/16	3 1/4	5/8	5 1/2	0.64205
	BN-316	3/16	4	3/4	6 1/2	0.74694
	BN-403	1/4	3/4	3/8	2 1/2	0.35490
	BN-405	1/4	1 1/4	1/2	3 1/4	0.42483
	BN-409	1/4	2 1/4	5/8	4 3/8	0.56469
	BN-413	1/4	3 1/4	3/4	5 1/2	0.70455
	BN-416	1/4	4	3/4	6 1/2	0.80944
	BN-605	3/8	1 1/4	1/2	3 1/4	0.54983
	BN-609	3/8	2 1/4	5/8	4 3/8	0.68969
	BN-613	3/8	3 1/4	3/4	5 1/2	0.82955
	BN-616	3/8	4	3/4	6 1/2	0.93444
	BN-805	1/2	1 1/4	1/2	3 1/4	0.67483
	BN-809	1/2	2 1/4	3/4	4 1/2	0.81469
	BN-813	1/2	3 1/4	3/4	6 1/2	0.95455
	BN-816	1/2	4	1	6 1/2	1.05944
	BN-820	1/2	5	1	7 1/2	1.19930

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
5 DEG	BO-002	1/32	1/2	3/16	2 5/8	0.11874
	BO-003	1/32	3/4	3/16	2 5/8	0.16249
	BO-002	1/16	1/2	3/8	2 5/8	0.14999
	BO-003	1/16	3/4	3/8	2 5/8	0.19374
	BO-004	1/16	1	3/8	2 7/8	0.23748
	BO-005	1/16	1 1/4	3/8	3 1/8	0.28123
	BO-006	1/16	1 1/2	3/8	3 1/4	0.32497
	BO-102	3/32	1/2	3/8	2 5/8	0.18124
	BO-103	3/32	3/4	3/8	2 5/8	0.22499
	BO-104	3/32	1	3/8	2 7/8	0.26873
	BO-105	3/32	1 1/4	3/8	3 1/8	0.31248
	BO-106	3/32	1 1/2	3/8	3 1/4	0.35622
	BO-108	3/32	2	1/2	4	0.44371
	BO-108A	3/32	2	3/8	3 7/8	0.44371
	BO-110	3/32	2 1/2	1/2	4 1/2	0.53120
	BO-114	3/32	3 1/2	3/4	5 7/8	0.66244
	BO-154	7/64	1	3/8	2 7/8	0.28436
	BO-155	7/64	1 1/4	3/8	3 1/8	0.32810
	BO-156	7/64	1 1/2	3/8	3 5/16	0.37185
	BO-158	7/64	2	1/2	4	0.45934
	BO-203	1/8	3/4	3/8	2 5/8	0.25000
	BO-204	1/8	1	3/8	2 7/8	0.29998
	BO-205	1/8	1 1/4	3/8	3 1/8	0.34373
	BO-206	1/8	1 1/2	3/8	3 1/4	0.37500
	BO-208	1/8	2	1/2	4	0.47496
	BO-208A	1/8	2	3/8	3 7/8	0.47496
	BO-210	1/8	2 1/2	5/8	4 1/2	0.56245
	BO-210A	1/8	2 1/2	1/2	4 1/2	0.56245
	BO-212	1/8	3	3/4	5 1/4	0.64994
	BO-212A	1/8	3	1/2	5 1/4	0.64994
	BO-222	1/8	5 1/2	1/2	7 1/2	1.08739
	BO-254	5/32	1	3/8	2 7/8	0.33123
	BO-255	5/32	1 1/4	3/8	3 1/8	0.37498
	BO-256	5/32	1 1/2	1/2	3 5/8	0.41872
	BO-258	5/32	2	1/2	3 7/8	0.50000
	BO-303	3/16	3/4	3/8	2 9/16	0.31874
	BO-304	3/16	1	1/2	3	0.36248
	BO-305	3/16	1 1/4	1/2	3 3/8	0.40623
	BO-305S	7/32	1 1/4	1/2	3 3/8	0.43748
	BO-306	3/16	1 1/2	1/2	3 1/2	0.44997
	BO-308	3/16	2	1/2	4 1/8	0.53746
	BO-310	3/16	2 1/2	5/8	4 5/8	0.62495
	BO-310A	3/16	2 1/2	1/2	4 1/2	0.62495
	BO-312	3/16	3	3/4	5 1/4	0.71244
	BO-312A	3/16	3	1/2	5 1/4	0.71244
	BO-313	3/16	3 1/4	3/4	5 1/2	0.75619
	BO-313A	3/16	3 1/4	1/2	5 1/2	0.74619

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# HIGH SPEED STEEL & COBALT

## Ball Ends



Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.	Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
5	BO-316	3/16	4	3/4	6 1/4	0.88742	7 DEG	BR-0004	1/32	1	3/8	2 3/4	0.27681
	BO-320	3/16	5	1	7 1/2	1.06240		BR-003	1/16	3/4	3/8	2 5/8	0.24667
	BO-324	3/16	6	1	8 1/2	1.23738		BR-004	1/16	1	3/8	2 7/8	0.30806
	BO-403	1/4	3/4	3/8	2 1/2	0.38124		BR-006	1/16	1 1/2	1/2	3 1/4	0.43084
	BO-404	1/4	1	1/2	3	0.42498		BR-0254	.070	1	3/8	2 7/8	0.31556
	BO-405	1/4	1 1/4	1/2	3 1/4	0.46873		BR-054	5/64	1	3/8	2 7/8	0.32369
	BO-406	1/4	1 1/2	1/2	3 1/2	0.51247		BR-103	3/32	3/4	3/8	2 1/2	0.27792
	BO-409	1/4	2 1/4	5/8	4 3/8	0.64371		BR-104	3/32	1	3/8	2 3/4	0.33931
	BO-409A	1/4	2 1/4	1/2	4 1/4	0.64371		BR-105	3/32	1 1/4	1/2	3 1/8	0.40070
	BO-410	1/4	2 1/2	5/8	4 1/2	0.68745		BR-106	3/32	1 1/2	1/2	3 1/2	0.46209
	BO-413	1/4	3 1/4	3/4	5 1/2	0.81869		BR-203	1/8	3/4	3/8	2 9/16	0.30917
	BO-416	1/4	4	3/4	6 1/4	0.94992		BR-204	1/8	1	3/8	2 3/4	0.37056
	BO-424	1/4	6	1	8 1/2	1.29988		BR-206	1/8	1 1/2	1/2	3 1/2	0.49334
	BO-509	5/16	2 1/4	5/8	4 1/4	0.70621		BR-208	1/8	2	5/8	3 7/8	0.61612
	BO-605	3/8	1 1/4	1/2	3 1/4	0.59373		BR-212	1/8	3	3/4	5 1/4	0.86168
	BO-609	3/8	2 1/4	3/4	4 1/2	0.76871		BR-305	3/16	1 1/4	1/2	3 1/4	0.49445
	BO-613	3/8	3 1/4	3/4	5 1/2	0.94369		BR-312	3/16	3	3/4	5 3/8	0.92418
	BO-616	3/8	4	1	6 1/2	1.07492		BR-403	1/4	3/4	1/2	2 1/2	0.43417
	BO-620	3/8	5	1 1/4	7 1/2	1.24990		BR-405	1/4	1 1/4	1/2	3 1/4	0.55695
	BO-624	3/8	6	1 1/4	8 1/2	1.42488		BR-409	1/4	2 1/4	3/4	4 1/2	0.80251
	BO-805	1/2	1 1/4	1/2	3 1/4	0.71873		BR-413	1/4	3 1/4	1	5 3/8	1.04807
	BO-809	1/2	2 1/4	3/4	4 1/2	0.89371		BR-416	1/4	4	1	6 1/2	1.23224
	BO-813	1/2	3 1/4	3/4	5 5/8	1.06869		BR-513	5/16	3 1/4	1	5 3/4	1.11057
	BO-816	1/2	4	1	6 1/2	1.19992		BR-605	3/8	1 1/4	5/8	3 1/4	0.68195
	BO-820	1/2	5	1 1/4	7 1/2	1.37490		BR-609	3/8	2 1/4	3/4	4 1/2	0.92751
	BO-824	1/2	6	1 1/4	8 1/2	1.54988		BR-613	3/8	3 1/4	1	5 5/8	1.17307
	BO-1009	5/8	2 1/4	3/4	4 1/4	1.01871		BR-616	3/8	4	1 1/4	6 1/2	1.35724
	BO-1020	• 5/8	5	1 1/4	7 1/2	1.49990		BR-624	• 3/8	6	1 1/4	8 1/2	1.84836
	BO-1209	3/4	2 1/4	3/4	4 3/4	1.14371		BR-805	1/2	1 1/4	3/4	3 1/2	0.80695
	BO-1216	• 3/4	4	1 1/4	6 1/2	1.44992		BR-805A	1/2	1 1/4	5/8	3 3/8	0.80695
	BO-1220	• 3/4	5	1 1/4	7 1/2	1.62490		BR-809	1/2	2 1/4	1	4 5/8	1.05251
	BO-1224	• 3/4	6	1 1/4	8 1/2	1.79988		BR-813	• 1/2	3 1/4	1 1/4	5 3/4	1.29807
BO-1620	• 1	5	1 1/4	7 1/2	1.87490	BR-816	• 1/2	4	1 1/4	6 1/2	1.48224		
BO-1624	• 1	6	2	9 1/2	2.04988	BR-824	• 1/2	6	1 1/4	8 1/2	1.97336		
6 DEG	BP-004	1/16	1	3/8	2 7/8	0.27271	BR-1016	• 5/8	4	1 1/4	6 1/2	1.60724	
	BP-104	3/32	1	3/8	2 7/8	0.30396	BR-1020	• 5/8	5	1 1/4	7 1/2	1.85280	
	BP-204	1/8	1	3/8	2 7/8	0.33521	BR-1213	• 3/4	3 1/4	1 1/4	5 3/4	1.54807	
	BP-206	1/8	1 1/2	1/2	3 1/4	0.44032	BR-1216	• 3/4	4	1 1/4	6 1/2	1.73224	
	BP-306	3/16	1 1/2	1/2	3 1/4	0.50282	BR-1224	• 3/4	6	2	9 1/2	2.22336	
	BP-406	1/4	1 1/2	5/8	3 1/2	0.56532	BR-1624	• 1	6	2	9 1/2	2.47336	
	BP-605	3/8	1 1/4	5/8	3 1/4	0.63776							
	BP-805	1/2	1 1/4	3/4	3 1/4	0.76276							

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**A**

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## Ball Ends

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
<b>10 DEG</b>	BT-0003	1/32	3/4	3/8	2 3/4	0.29575
	BT-002	1/16	1/2	3/8	2 3/8	0.23883
	BT-003	1/16	3/4	3/8	2 5/8	0.32700
	BT-004	1/16	1	1/2	2 7/8	0.41516
	BT-102	3/32	1/2	3/8	2 3/8	0.27008
	BT-103	3/32	3/4	3/8	2 5/8	0.35825
	BT-106	3/32	1 1/2	1/2	3 1/2	0.62274
	BT-203	1/8	3/4	3/8	2 5/8	0.38950
	BT-205	1/8	1 1/4	1/2	3 1/4	0.56583
	BT-206	1/8	1 1/2	1/2	3 1/2	0.65399
	BT-254	5/32	1	1/2	3	0.50000
	BT-258	5/32	2	3/4	4 1/4	0.86157
	BT-305	3/16	1 1/4	1/2	3 3/8	0.62500
	BT-309	3/16	2 1/4	3/4	4 1/2	0.98099
	BT-403	1/4	3/4	1/2	2 3/4	0.51450
	BT-405	1/4	1 1/4	1/2	3 1/4	0.69083
	BT-409	1/4	2 1/4	3/4	4 1/2	1.04349
	BT-409A	1/4	2 1/4	1/2	4 1/2	1.04349
	BT-413	1/4	3 1/4	1	5 5/8	1.39615
	BT-605	3/8	1 1/4	5/8	3 1/2	0.81583
	BT-609	3/8	2 1/4	1	4 5/8	1.16849
	BT-613	• 3/8	3 1/4	1 1/4	5 3/4	1.52115
	BT-805	1/2	1 1/4	3/4	3 1/2	0.94083
	BT-809	1/2	2 1/4	1	4 3/4	1.29349
BT-813	• 1/2	3 1/4	1 1/4	5 3/4	1.64615	
BT-816	• 1/2	4	1 1/4	6 3/8	1.91064	

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
<b>15 DEG</b>	BV-0003	1/32	3/4	1/2	2 3/4	0.43318
	BV-003	1/16	3/4	1/2	2 3/4	0.46443
	BV-102	3/32	1/2	3/8	2 3/8	0.36170
	BV-103	3/32	3/4	1/2	2 7/8	0.49568
	BV-104	3/32	1	1/2	3	0.62965
	BV-106	3/32	1 1/2	3/4	3 3/4	0.89760
	BV-106A	3/32	1 1/2	1/2	3 3/4	0.89760
	BV-202	1/8	1/2	1/2	2 5/8	0.39295
	BV-202A	1/8	1/2	3/8	2 5/8	0.39295
	BV-203	1/8	3/4	1/2	2 7/8	0.52693
	BV-204	1/8	1	1/2	3 1/8	0.66090
	BV-205	1/8	1 1/4	5/8	3 1/2	0.79488
	BV-205A	1/8	1 1/4	1/2	3 1/2	0.79488
	BV-206A	1/8	1 1/2	1/2	3 5/8	0.92885
	BV-304	3/16	1	1/2	3 1/8	0.72340
	BV-305	3/16	1 1/4	3/4	3 1/2	0.85738
	BV-305A	3/16	1 1/4	1/2	3 1/2	0.85738
	BV-308	3/16	2	1	4 1/2	1.25930
	BV-404	1/4	1	1/2	3 1/8	0.78590
	BV-405	1/4	1 1/4	3/4	3 1/2	0.91988
	BV-405A	1/4	1 1/4	1/2	3 1/2	0.91988
	BV-406	1/4	1 1/2	3/4	3 3/4	1.05385
	BV-408	1/4	2	3/4	4 1/2	1.32180
	BV-409	1/4	2 1/4	1	4 3/4	1.45578
	BV-413	• 1/4	3 1/4	1 1/4	5 3/4	1.99168
	BV-504	5/16	1	3/4	3 1/4	0.84840
	BV-506	5/16	1 1/2	3/4	3 7/8	1.11635
	BV-509	• 5/16	2 1/4	1	4 7/8	1.51828
	BV-605	3/8	1 1/4	3/4	3 5/8	1.04488
	BV-609	• 3/8	2 1/4	1 1/4	4 3/4	1.51828
	BV-613	• 3/8	3 1/4	1 1/4	5 3/4	2.05418
	BV-804	1/2	1	3/4	3 1/4	1.03590
	BV-805	1/2	1 1/4	3/4	3 5/8	1.16988
	BV-807	• 1/2	1 3/4	1	4 1/4	1.43783
BV-809	• 1/2	2 1/4	1 1/4	4 7/8	1.70578	
BV-812	• 1/2	3	1 1/4	5 1/2	2.10770	
BV-813	• 1/2	3 1/4	1 1/4	6	2.24168	



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for Cobalt, add the suffix "CO"  
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• Four Flutes

ALL SIZES ARE AVAILABLE  
SOME ARE AVAILABLE WITH EXTENDED SHANKS.  
CALL FOR AVAILABILITY 1-888-531-0430



# HIGH SPEED STEEL & COBALT

## Ball Ends

# A

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
20 DEG	BW-002	1/16	1/2	3/8	2 1/2	0.42647
	BW-103	3/32	3/4	1/2	2 3/4	0.63971
	BW-202	1/8	1/2	3/8	2 1/2	0.48897
	BW-204	• 1/8	1	1/2	3 1/8	0.85294
	BW-304	• 3/16	1	1/2	4	0.91544
	BW-306	• 3/16	1 1/2	3/4	3 1/4	1.27941
	BW-404	• 1/4	1	1/2	3 1/8	0.97794
	BW-406	• 1/4	1 1/2	3/4	4	1.34191
	BW-504	• 5/16	1	3/4	3 1/4	1.04044
	BW-506	• 5/16	1 1/2	3/4	3 7/8	1.40441
	BW-606	• 3/8	1 1/2	3/4	3 7/8	1.46691
	BW-608	• 3/8	2	1	4 1/2	1.83088
	BW-809	• 1/2	2 1/4	1 1/4	4 7/8	2.13787
	25 DEG	BX-103	3/32	3/4	1/2	3
BX-202		1/8	1/2	1/2	2 1/2	0.59131
BX-204A		1/8	1	1/2	3 1/8	1.05762
BX-204B		1/8	1	5/8	3 1/8	1.05762
BX-204C		1/8	1	3/4	3 1/8	1.05762
BX-404		• 1/4	1	5/8	3 1/4	1.18262
BX-406		• 1/4	1 1/2	3/4	4 1/8	1.64893
BX-503		• 5/16	3/4	5/8	3	1.01197
BX-504		• 5/16	1	3/4	3 3/8	1.24512
BX-506		• 5/16	1 1/2	1	4 1/8	1.71143
BX-603		• 3/8	3/4	5/8	3	1.07447
BX-604		• 3/8	1	3/4	3 1/4	1.30762
BX-606		• 3/8	1 1/2	1	4 1/8	1.77393
BX-805		• 1/2	1 1/4	1	3 3/4	1.66578
30 DEG	BZ-002	1/16	1/2	1/2	2 1/2	0.63985
	BZ-103	3/32	3/4	1/2	3	0.95978
	BZ-202	• 1/8	1/2	1/2	2 5/8	0.70235
	BZ-204	• 1/8	1	1/2	3 1/8	1.27970
	BZ-404	• 1/4	1	3/4	3 3/8	1.40470
	BZ-406	• 1/4	1 1/2	1	4 1/8	1.98205
	BZ-605	• 3/8	1 1/4	1	3 7/8	1.81838
	BZ-606	• 3/8	1 1/2	1	4 1/4	2.10705
	BZ-805	• 1/2	1 1/4	1	3 3/4	1.94338
	BZ-806	• 1/2	1 1/2	1	4 1/4	2.23205

Taper Per Side	Tool No.	Ball Dia.	Flt. Lgth	Shk Dia.	OAL	Large Dia.
45 DEG	B45-2015	• 1/8	5/16	1/2	2 1/2	0.75000
	B45-202	• 1/8	1/2	1/2	2 5/8	1.12500
	B45-203	• 1/8	3/4	5/8	3 1/4	1.62500
	B45-204	• 1/8	1	1	3 3/4	2.12500
	B45-303	• 3/16	3/4	3/4	3 1/4	1.68750
	B45-304	• 3/16	1	1	4	2.17850
	B45-305	• 3/16	1 1/4	1 1/4	4 1/4	2.68750
	B45-403	• 1/4	3/4	3/4	3 1/4	1.75000
	B45-404	• 1/4	1	1	4	2.25000
	B45-405	• 1/4	1 1/4	1 1/4	4 1/4	2.75000
	B45-406	• 1/4	1 1/2	1 1/4	4 1/2	3.25000
	B45-603	• 3/8	3/4	3/4	3 1/4	1.87500
	B45-604	• 3/8	1	1	4	2.37500
	B45-605	• 3/8	1 1/4	1 1/4	4 1/4	2.87500
	B45-606	• 3/8	1 1/2	1 1/4	4 1/2	3.37500
	B45-803	• 1/2	3/4	3/4	3 1/4	2.00000
	B45-804	• 1/2	1	1	4	2.50000
	B45-805	• 1/2	1 1/4	1 1/4	4 1/4	3.00000
B45-806	• 1/2	1 1/2	1 1/4	4 5/8	3.50000	



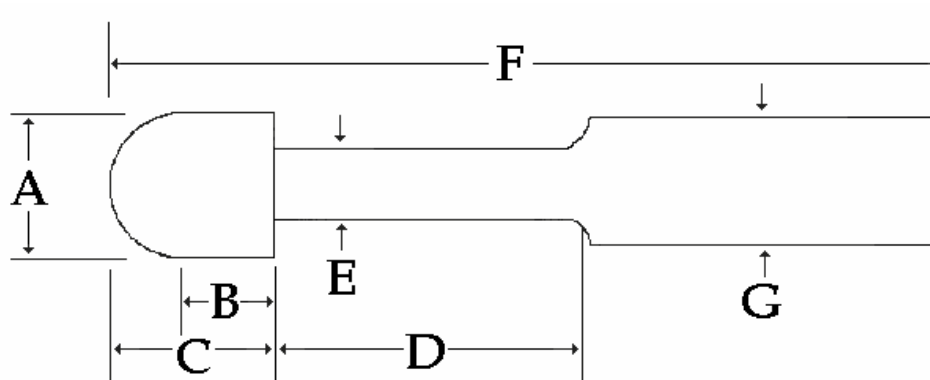
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• Four Flutes

# A

## UNDERCUTTING TOOLS



### HIGH SPEED STEEL & COBALT

ORDER NO.	A	B	C	D	E	F	G
SE-61S	3/8	1/4	3/8	1-1/8	0.250	3-1/2	3/8
SE-61L	3/8	1/4	3/8	1-5/8	0.250	4	3/8
SE-81S	1/2	1/4	1/2	1-1/4	0.310	3-5/8	1/2
SE-81L	1/2	1/4	1/2	1-3/4	0.310	4-1/2	1/2
SE-101S	5/8	1/4	1/2	1-1/8	0.400	3-3/4	5/8
SE-101L	5/8	1/4	1/2	2-1/8	0.400	5-1/8	5/8
SE-121S	3/4	1/4	5/8	1-1/4	0.490	4-1/8	3/4
SE-121L	3/4	1/4	5/8	2-1/8	0.490	5-1/2	3/4

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# Trouble Shooting Guide For Problems With End Mills



Problem/ Cause	Solution
<b>Chip Packing</b> Cut too heavy Not enough chip clearance Not enough coolant	<ul style="list-style-type: none"> <li>• Decrease width and depth of cut</li> <li>• Use end mill with less flutes</li> <li>• Use higher coolant pressure and reposition nozzle to point of cut or use air pressure</li> </ul>
<b>Chipped Cutting Edge</b> Feed rate too heavy Feed too heavy on first cut Lack of rigidity (machine & holder) Lack of rigidity (tool) Tool cutting corner too sharp	<ul style="list-style-type: none"> <li>• Reduce feed rate</li> <li>• Reduce feed rate on first cut</li> <li>• Use better machine or tool holder or change parameters</li> <li>• Use shorter tool, hold shank deeper, try climb milling</li> <li>• Decrease primary relief and cutting angle, reduce radial width-of cut</li> </ul>
<b>Excessive Wear</b> Speed is too fast Hard work material Improper feed and speed (too slow) Improper helix angle Primary relief angle is too large Recutting chips	<ul style="list-style-type: none"> <li>• Decrease spindle speed, use another coolant</li> <li>• Use coatings (TiN, TiCN, TiAlN, TiAlN+, etc.)</li> <li>• Increase feed and speed</li> <li>• Change to correct helix angle</li> <li>• Change to smaller relief angle</li> <li>• Change feed &amp; speed, Change chip size or clear chips with more coolant or air pressure</li> </ul>
<b>No Dimensional Accuracy</b> Cut is too heavy Lack of accuracy (machine & holder) Rigidity is not enough (machine & holder) Too few flutes	<ul style="list-style-type: none"> <li>• Decrease width and depth of cut</li> <li>• Repair machine or holder</li> <li>• Change machine or holder or change parameters</li> <li>• Use mult flute end mills, use end mill with higher rigidity</li> </ul>
<b>Reduced Tool Life</b> Cutting friction is too much Hard work material Improper helix & relief angle	<ul style="list-style-type: none"> <li>• Regrind at earlier stage</li> <li>• Use coatings (TiN, TiCN, TiAlN, TiAlN+, etc.)</li> <li>• Change to correct helix angle and primary relief</li> </ul>
<b>Rough Surface Finish</b> Feed rate too heavy Cutting speed is too slow Wear is too much No end tooth concavity Recutting chips	<ul style="list-style-type: none"> <li>• Reduce feed rate</li> <li>• Increase RPM</li> <li>• Regrind at earlier stage</li> <li>• Grind concave angle on bottom of teeth</li> <li>• Change feed &amp; speed, change chip size or clear chips with coolant or air pressure</li> </ul>
<b>Side Wall Taper in Work Piece</b> Feed rate too heavy Overhang of tool is too much Too few flutes	<ul style="list-style-type: none"> <li>• Reduce feed rate</li> <li>• Hold shank deeper, use shorter end mill</li> <li>• Use mult flute end mills, use end mill with higher rigidity</li> </ul>
<b>Squeal and Chattering</b> Feed and speed too fast Lack of rigidity (machine & holder) Poor set up Cut is too heavy Overhang of tool is too much Lack of relief	<ul style="list-style-type: none"> <li>• Correct feed and speed</li> <li>• Use better machine or tool holder or change parameter</li> <li>• Improve clamping rigidity</li> <li>• Decrease width and depth of cut</li> <li>• Hold shank deeper, use shorter end mill</li> <li>• Decrease relief angle, make margin; hone primary with oil stone</li> </ul>
<b>Tool Breakage</b> Feed is too heavy Cut is too heavy Overhang of tool is too much Wear is too much	<ul style="list-style-type: none"> <li>• Reduce feed rate</li> <li>• Decrease width and depth-of-cut</li> <li>• Hold shank deeper, use shorter end mill</li> <li>• Regrind at earlier stage</li> </ul>
<b>Work Piece Burrs</b> Wear on primary relief is too much Incorrect feed and speed Improper helix angle	<ul style="list-style-type: none"> <li>• Regrind at earlier stage</li> <li>• Correct cutting parameters</li> <li>• Change to correct cutting angle</li> </ul>

# A

## FINISHING & ROUGHING FEEDS & SPEEDS FOR HIGH SPEED STEEL

### Instructions

1. Locate SFM & FPT for material, (Table A)
2. Find RPM at Intersection of SFM line & Diameter Column, (Table B)
3. Calculate Feed IPM = FPT X (No. of Flutes) X RPM

### Explanation of Symbols:

SFM = Surface Feet Per Minute (Cutting Speed)  
 RPM = Revolutions Per Minute (Spindle Speed)  
 FPT = Feed Per Tooth  
 IPM = Inches Per Minute

HIGH SPEED STEEL								
MATERIAL TO BE CUT	CONDITION	FEED PER TOOTH						SFM
		1/8" & under	1/4"	3/8"	1/2"	3/4"	1"	
Aluminum 2024, 6061, 7075	150 Bhn	.0006	.0012	.0020	.0040	.0064	.0080	400-800
Magnesium AM60A	90 Bhn	.0007	.0014	.0023	.0045	.0072	.0090	500-1000
Bronze / Brass	81RF	.0004	.0008	.0013	.0025	.0040	.0050	75-120
Copper 834, 934, 978	150 Bhn	.0005	.0009	.0015	.0030	.0048	.0060	275-450
Inconel 625, 718	300 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	10-20
Hastelloy Alloy B	220 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	15-30
Stainless Steel 304	185 Bhn	.0004	.0008	.0013	.0025	.0040	.0050	60-110
Stainless Steel 17-4PH	375 Bhn	.0002	.0003	.0005	.0010	.0016	.0020	45-80
Steel 4140 / 4340	350 Bhn	.0003	.0006	.0010	.0020	.0032	.0040	40-70
Steel 1020	150 Bhn	.0004	.0008	.0013	.0025	.0040	.0050	100-165
Tool Steel A2	250 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	50-90
Tool Steel D2	250 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	35-65
Tool Steel H13	200 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	60-100
Titanium 6Al-4V	325 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	30-90
Titanium 6Al-6V-2Sn	370 Bhn	.0002	.0005	.0008	.0015	.0024	.0030	30-90
Cast Iron (Ductile)	190 Bhn	.0005	.0009	.0015	.0030	.0048	.0060	75-125
Cast Iron (Gray)	220 Bhn	.0003	.0006	.0010	.0020	.0032	.0040	75-125

These are based on a RADIAL Depth of Cut equal to the Tool Diameter divided by 4.

These Starting Points are Based on Maximum Axial Depth of 1.5 X the Cutting Diameter.

Speeds May be Increased When Using: TiN +25% TiCN +30% TiAlN +35%.

When Slotting Reduce Feed per Tooth 20% and if the Slot Depth is Greater than 1/2 of the Tool Diameter Reduce by 50%

Roughing End Mills Increase Feed per Tooth by 20%.

RPM SELECTOR																			B
Surface Feet Per Minute (SFM)	20	30	40	50	60	70	80	90	100	125	150	200	300	400	500	600	800	1000	
Diameter Inches	REVOLUTIONS PER MINUTE (RPM)																		
1/16	122	1833	2445	3056	3667	4278	4889	5500	6112	7639	9167								
1/8	611	917	1222	1528	1833	2139	2445	2750	3056	3820	4584	6112	9167						
3/16	407	611	815	1019	1222	1426	1630	1833	2037	2546	3056	4074	6112	8149					
1/4	306	458	611	764	917	1070	1222	1375	1528	1910	2292	3056	4584	6112	7639	9167			
5/16	244	367	489	611	733	856	978	1100	1222	1528	1833	2445	3667	4889	6112	7334	9778		
3/8	204	306	407	509	611	713	815	917	1019	1273	1528	2037	3056	4074	5093	6112	8149		
7/16	175	262	349	437	524	611	698	786	873	1091	1310	1746	2619	3492	4365	5238	6985	8731	
1/2	153	229	306	382	458	535	611	688	764	955	1146	1528	2292	3056	3820	4584	6112	7639	
5/8	122	183	244	306	367	428	489	550	611	764	917	1222	1833	2445	3056	3667	4889	6112	
3/4	102	153	204	255	306	257	407	458	509	637	764	1019	1528	2037	2546	3056	4074	5093	
7/8	87	131	175	218	262	306	349	393	437	546	655	873	1310	1746	2183	2619	3492	4365	
1	76	115	153	191	229	267	306	344	382	477	573	764	1146	1528	1910	2292	3056	3820	
1-1/8	68	102	136	170	204	238	272	306	340	424	509	679	1019	1358	1698	2037	2716	3395	
1-1/4	61	92	122	153	183	214	244	275	306	382	458	611	917	1222	1528	1833	2445	3056	
1-3/8	56	83	111	139	167	194	222	250	278	347	417	556	833	1111	1389	1667	2222	2778	
1-1/2	51	76	102	127	153	178	204	229	255	318	382	509	764	1019	1273	1528	2037	2546	
1-5/8	47	71	94	118	141	165	188	212	235	294	353	470	705	940	1175	1410	1880	2351	
1-3/4	44	66	87	109	131	153	175	196	218	273	327	437	655	873	1091	1310	1746	2183	
1-7/8	41	61	82	102	122	143	163	183	204	255	306	407	611	815	1019	1222	1630	2037	
2	38	57	76	96	115	134	153	172	191	239	286	382	573	764	955	1446	1528	1910	
2-1/2	31	46	61	76	92	107	122	138	153	191	229	306	458	611	764	917	1222	1528	

# Award

**TAPERED END MILLS™**

**SUPERIOR SERVICE SINCE 1959**

**HEAT TREATED FOR MAXIMUM CUTTING  
SPEED AND ABRASION RESISTANCE**

**HIGHLY ACCURATE - TOOL AFTER TOOL  
LATEST MANUFACTURING TECHNOLOGY  
KNOWN WORLDWIDE FOR PRODUCT RELIABILITY**

**FEWER CHANGES, LASTS MANY  
TIMES LONGER THAN ORDINARY  
HIGH SPEED STEEL END MILLS**

**MANUFACTURED FROM SUPERIOR  
HIGH SPEED STEELS**

# METRIC CONVERSION TABLE

## LINEAR MEASURE

1 kilometer = 0.6214 mile	1 mile = 1.609 kilometers
39.37 inches	1 yard = 0.9144 meter
1 meter = 3.2808 feet	1 foot = 0.3048 meter
1.0936 yards	1 foot = 304.8 millimeters
1 centimeter = 0.3937 inch	1 inch = 2.54 centimeters
1 millimeter = 0.03937 inch	1 inch = 25.4 millimeters
1 micrometer ( $\mu\text{m}$ )	1 micromin = 0.025 $\mu\text{m}$
(0.001 millimeter) = 0.00004 inch	

## SQUARE MEASURE

1 square kilometer = 0.3861 square mile = 247.1 acres
1 hectare = 2.471 acres = 107,640 square feet
1 are = 0.0247 acre = 1076.4 square feet
1 square meter = 10.764 square feet = 1.196 square yards
1 square centimeter = 0.155 square inch
1 square millimeter = 0.00155 square inch
1 square mile = 2.5899 square kilometer
1 acre = 0.4047 hectare = 40.47 ares
1 square yard = 0.0929 square meter = 929 square centimeters
1 square inch = 6.452 square centimeters = 645.2 square millimeters

## CUBIC MEASURE

1 cubic meter = 35.31 cubic feet = 1.308 cubic yards
1 cubic meter = 264.2 US gallons = 219.969 Imperial gallons
1 cubic centimeter = 0.062 cubic inch
1 liter (cubic decimeter) = 0.0353 cubic foot = 61.023 cubic inches
1 liter = 0.2642 US gallons = 1.0567 US quarts = 0.2200 Imperial gallons
1 cubic yard = 0.7646 cubic meter
1 cubic foot = 0.02832 cubic meter = 28.317 liters
1 cubic inch = 16.38706 cubic centimeters
1 Imperial gallon = 4.546 liters
1 Imperial quart = 1.136 liters
1 US gallon = 3.785 liters
1 US quart = 0.946 liter

## WEIGHT

1 metric ton = 0.9842 ton (of 2240 pounds) = 2204.6 pounds
1 kilogram = 2.2046 pounds = 35.274 ounces avoirdupois
1 gram = 0.03215 ounces troy = 0.03527 ounces avoirdupois
1 gram = 15.432 grains
1 ton (of 2240 pounds) = 1.016 metric tons = 1016 kilograms
1 pound = 0.4536 kilograms = 453.6 grams
1 ounce avoirdupois = 28.35 grams
1 ounce troy = 31.103 grams
1 grain = 0.0648 gram
1 kilogram per square millimeter = 1422.32 pounds per sq. in.
1 kilogram per square centimeter = 14.2232 pounds per sq. in.
1 kilogram/meter = 7.233 foot/pounds
1 pound per square inch = 0.0703 kilogram per square centimeter
1 calorie (kilogram calorie) = 3.968 Btu (British Thermal Units)
1 international table calorie = 4.1868 joules
1 kilojoules = 0.948 Btu
1 kilo pound (kp) = 1 kilogram-force



