MOLDINO
The Edge To Innovation

High Feed Radius End Mill for Hardened Steel

EHHRE-TH3

Epoch High Hard Radius

MOLDINO Tool Engineering, Ltd.

New Product News | No. H2006A-1 | 2020-10

Utilize the high-feed indexable cutter design on a solid end mill. High feed cutting is also possible in high hardness steels.

Lineup of Φ 1 ~ Φ 12

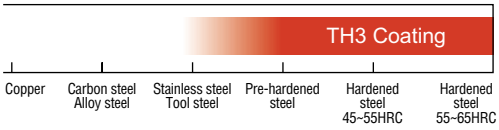
This multi-flute end mill allows for high efficiency machining on small precision molds.

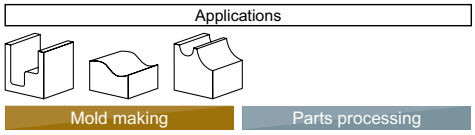
Features of EHHRE-TH3

01 Approximate radius creates a much thinner chip than a standard full radius.

02 Vibration-free peripheral clearance geometry

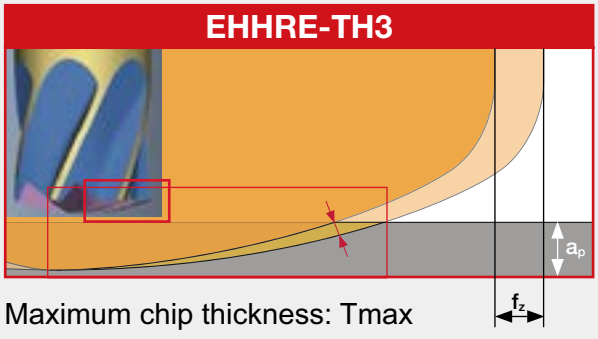
03 Newly developed "TH3" coating for hardened steel machining.



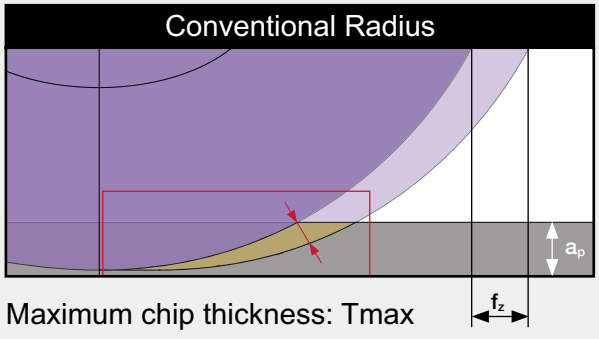


EHHRE-TH3
ϕ1～ϕ12 [13 Items]

Features 01 New Cutting Edge Geometry - Approximate radius creates a much thinner chip than a standard full radius.

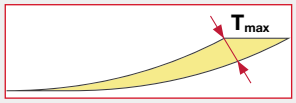


Maximum chip thickness: Tmax



Maximum chip thickness: Tmax

Thinner removed chip

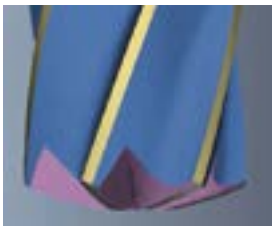


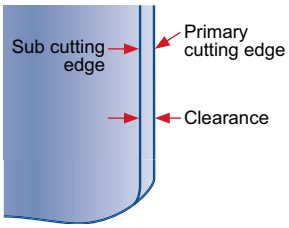
Effect

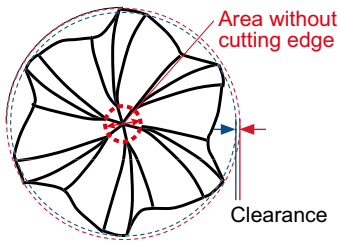
Composite R geometry on the bottom cutting edge creates a thinner chip than a conventional radius, which leads to reduced cutting forces. Furthermore, the bottom edge has a high helix shape, which improves the chip flow and achieves excellent chip removal performance.

Features 02 Peripheral clearance geometry to reduce vibration

Vibration-free peripheral clearance geometry



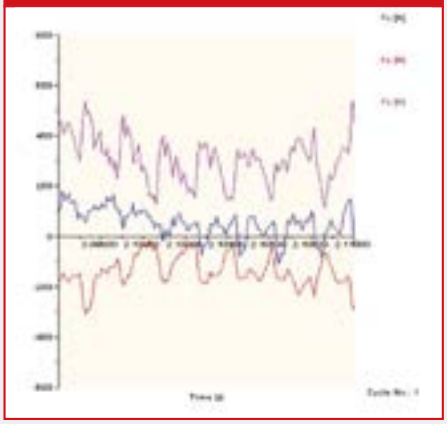




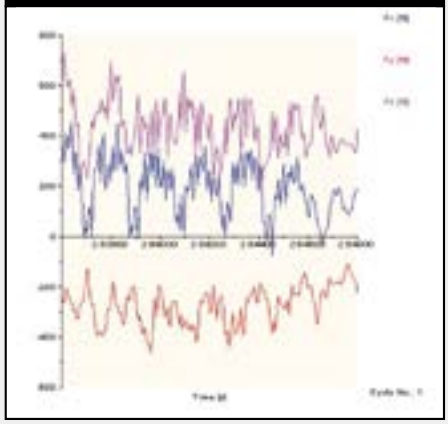
Vibrations are reduced when milling into corners.

Work material：H13Ⓗ 49HRC　Machine：Vertical MC (HSK-A63)　Tool：EHHRE6100-TH3
Cutting conditions：n=6,000min^{-1}(v_c=188m/min)　v_f=1,800mm/min (f_z=0.05mm/t)
Cutting amount：0.3mm,　Dry with air blow

EHHRE-TH3



Conventional



Effect

Chatter and vibrations are reduced when high speed machining internal corners. This prevents unexpected tool chipping and failure when machining the corners.

90 degree corner milling

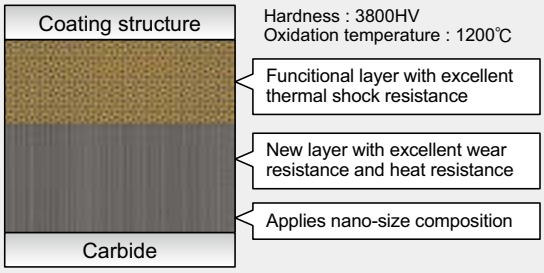
Features 03 Newly developed "TH3" coating for hardened steel machining.

Features and performance

- High hardness coating with excellent wear resistance and heat resistance
- Has excellent thermal shock resistance which reduces the risk of rapid tool chipping.
- Long tool life when cutting high-hardness materials (50HRC or higher) such as hardened steel

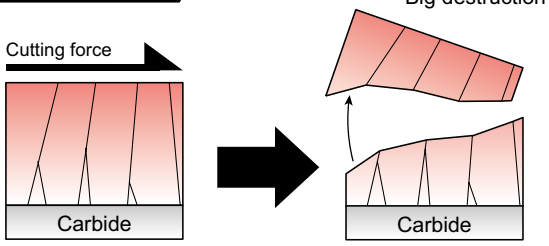
Target steel grade

- TH3 coating utilizes nano-size composition to reduce large chipping of the coating.

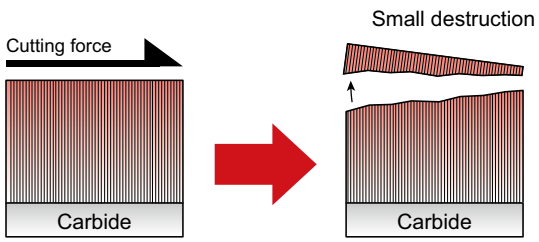


! Point TH3 coating utilizes nano-size composition to reduce large chipping of the coating.

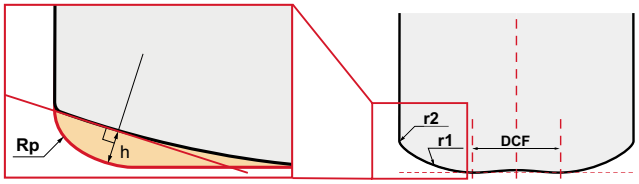
Conventional coating

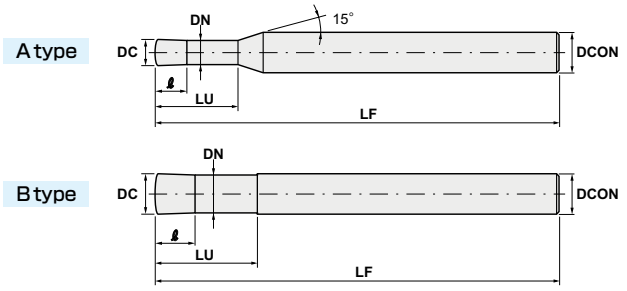


TH3 coating



Line Up





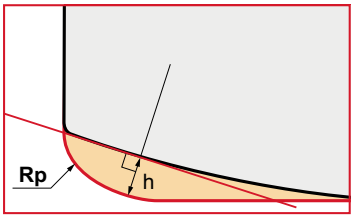
EHHRE○○○○(-S○)-TH3

Roughing | Carbide | 72 HRC | TH3 Coated | 0 -0.02 | Helix 20° | h5 | 4 Flutes | 6 Flutes

Order Number	Stock	Size (mm)										No. of flutes	Type
		Tool dia. **DC**	Approx radius **Rp**	Lowest point diameter **DCF**	End R **r1**	Corner radius **r2**	Under Neck length **LU**	Flute length **ℓ**	Neck dia. **DN**	Overall Length **LF**	Shank dia. **DCON**		
EHHRE4010-S4-TH3	●	1	0.134	0.28	1.1	0.1	3	1	0.95	50	4	4	A
EHHRE4010-S6-TH3	●							1	0.95	50	6	4	A
EHHRE4020-S4-TH3	●	2	0.194	0.56	2.2	0.1	6	2	1.9	50	4	4	A
EHHRE4020-S6-TH3	●							2	1.9	50	6	4	A
EHHRE4030-S4-TH3	●	3	0.328	0.84	3.3	0.2	9	3	2.9	60	4	4	A
EHHRE4030-S6-TH3	●							3	2.9	60	6	4	A
EHHRE6040-S4-TH3	●	4	0.387	1.12	4.4	0.2	12	4	3.9	60	4	6	B
EHHRE6040-S6-TH3	●							4	3.9	60	6	6	A
EHHRE6050-TH3	●	5	0.521	1.4	5.5	0.3	15	5	4.7	60	6	6	A
EHHRE6060-TH3	●	6	0.581	1.68	6.6	0.3	18	6	5.7	60	6	6	B
EHHRE6080-TH3	●	8	0.849	2.24	8.8	0.5	24	8	7.6	75	8	6	B
EHHRE6100-TH3	●	10	0.968	2.8	11	0.5	30	10	9.5	80	10	6	B
EHHRE6120-TH3	●	12	1.088	3.36	13.2	0.5	36	12	11.5	100	12	6	B

● : Stocked items.

Precaution for creating machining program



- When entering the corner radius into your CAM software, please use the approximate radius (RE1) in the table.
- If your CAM can utilize the exact tool geometry, please download the DXF data from our "TOOL SEARCH" website.

Tool Dia. **DC**	Approx radius and maximum remains at CAM input		Ramping angle	Possible helical hole dia.
	Approx radius **Rp**	Max remains h	θ	D
Φ1	0.134	0.026	0.5° or less	1.3～1.9
Φ2	0.194	0.068		2.6～3.8
Φ3	0.328	0.094		3.9～5.7
Φ4	0.387	0.136		5.2～7.6
Φ5	0.521	0.162		6.4～9.5
Φ6	0.581	0.204		7.7～11.4
Φ8	0.849	0.255		10.3～15.2
Φ10	0.968	0.34		12.8～19.0
Φ12	1.088	0.424		15.4～22.8

Recommended Cutting Conditions

General cutting conditions (Emphasis on tool life)

Work material		Hardened steel (50～55HRC) ※1					Hardened steel (55～62HRC)				
Tool dia. DC (mm)	No. of flutes	Cutting speed vc=80m/min					Cutting speed vc=60m/min				
		n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)
1	4	25,500	3,670	145	0.040	0.55	19,100	1,720	68	0.023	0.55
2	4	12,700	3,660	144	0.080	1.1	9,600	1,730	68	0.046	1.1
3	4	8,500	3,840	151	0.120	1.65	6,400	1,800	71	0.069	1.65
4	6	6,400	5,840	230	0.160	2.2	4,800	2,740	108	0.092	2.2
5	6	5,100	5,940	234	0.200	2.75	3,800	2,760	109	0.115	2.75
6	6	4,200	5,870	231	0.240	3.3	3,200	2,790	110	0.138	3.3
8	6	3,200	6,140	242	0.320	4.4	2,400	2,880	113	0.184	4.4
10	6	2,500	6,000	236	0.400	5.5	1,900	2,850	112	0.230	5.5
12	6	2,100	5,750	226	0.480	6.6	1,600	2,740	108	0.276	6.6

Work material		Hardened steel (62～66HRC)					Hardened steel (66～72HRC)				
Tool dia. DC (mm)	No. of flutes	Cutting speed vc=50m/min					Cutting speed vc=40m/min				
		n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)
1	4	15,900	1,070	42	0.019	0.55	12,700	570	22	0.013	0.5
2	4	8,000	1,080	43	0.038	1.1	6,400	580	23	0.026	1
3	4	5,300	1,120	44	0.057	1.65	4,200	590	23	0.039	1.5
4	6	4,000	1,710	67	0.076	2.2	3,200	910	36	0.052	2
5	6	3,200	1,750	69	0.095	2.75	2,500	910	36	0.065	2.5
6	6	2,700	1,770	70	0.114	3.3	2,100	920	36	0.078	3
8	6	2,000	1,800	71	0.152	4.4	1,600	960	38	0.104	4
10	6	1,600	1,800	71	0.190	5.5	1,300	980	39	0.130	5
12	6	1,300	1,670	66	0.228	6.6	1,100	940	37	0.156	6

Cutting conditions for high-efficiency cutting (Emphasis on efficiency)

Work material		Hardened steel (50～55HRC) ※1					Hardened steel (55～62HRC)				
Tool dia. DC (mm)	No. of flutes	Cutting speed vc=100m/min					Cutting speed vc=70m/min				
		n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)
1	4	31,880	4,730	186	0.038	0.7	22,280	2,070	82	0.022	0.7
2	4	15,880	4,710	185	0.076	1.4	11,200	2,080	82	0.044	1.4
3	4	10,630	4,940	195	0.114	2.1	7,470	2,170	85	0.066	2.1
4	6	8,000	7,510	296	0.152	2.8	5,600	3,290	130	0.087	2.8
5	6	6,380	7,650	301	0.190	3.5	4,430	3,320	131	0.109	3.5
6	6	5,250	7,550	297	0.228	4.2	3,730	3,350	132	0.131	4.2
8	6	4,000	7,910	311	0.304	5.6	2,800	3,460	136	0.175	5.6
10	6	3,130	7,740	305	0.380	7	2,220	3,430	135	0.219	7
12	6	2,630	7,410	292	0.456	8.4	1,870	3,290	130	0.262	8.4

Work material		Hardened steel (62～66HRC)					Hardened steel (66～72HRC)				
Tool dia. DC (mm)	No. of flutes	Cutting speed vc=60m/min					Cutting speed vc=50m/min				
		n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	IPM	ap (mm)	ae (mm)
1	4	19,080	1,330	52	0.018	0.7	15,880	740	29	0.012	0.6
2	4	9,600	1,330	52	0.036	1.4	8,000	740	29	0.025	1.2
3	4	6,360	1,390	55	0.054	2.1	5,250	760	30	0.037	1.8
4	6	4,800	2,110	83	0.072	2.8	4,000	1,170	46	0.049	2.4
5	6	3,840	2,160	85	0.090	3.5	3,130	1,170	46	0.062	3
6	6	3,240	2,190	86	0.108	4.2	2,630	1,180	47	0.074	3.6
8	6	2,400	2,220	87	0.144	5.6	2,000	1,240	49	0.099	4.8
10	6	1,920	2,220	87	0.181	7	1,630	1,260	50	0.124	6
12	6	1,560	2,060	81	0.217	8.4	1,380	1,220	48	0.148	7.2

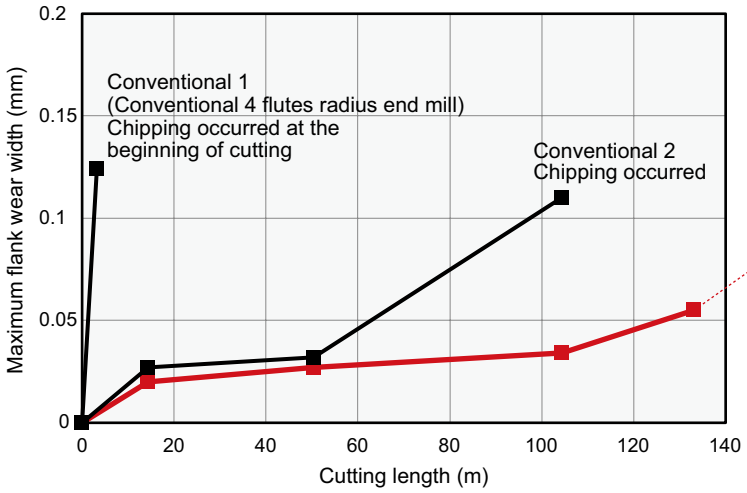
【Note】
① Use the appropriate coolant for the work material and machining shape.
② Use the most accurate and rigid machine as possible.
③ These Recommended Cutting Conditions are standard parameters. When machining, these parameters should be adjusted according to the machining shape and the machine capabilities.
④ If the RPM available is lower than the recommended RPM, please reduce the feed rate by the same ratio.
⑤ **Please use for contouring process.**
⑥ **If you set the pick feed (*ae*) larger than the lowest point diameter of the tool, then a cusp will remain on part.**

※1 **This EHHRE-TH3 utilizes cutting edge geometry for high hardness steel cutting. It is not recommended for sticky hard material such as hot forging die material (H13).**
EMBE-ATH is recommended for those sticky materials.

Field data

Tool life evaluation of cutting D2Ⓗ

Tool size：ϕ10×6 flutes　Work material：D2Ⓗ（60HRC）　Machine：Vertical MC (HSK-F63)
Cutting conditions：n=1,900min^{-1} (v_c=60m/min)　v_f=2,850mm/min (f_z=0.25mm/t)　a_p 0.2mm　a_e 5.5mm
OH＝30mm　Coolant：Air-blow

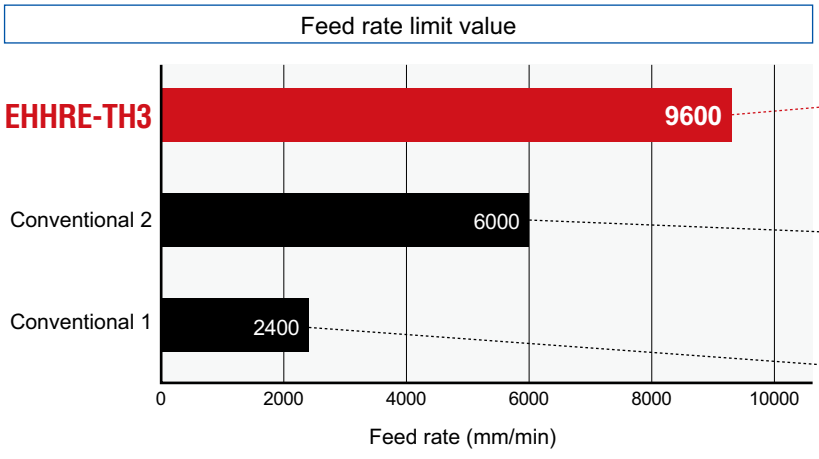


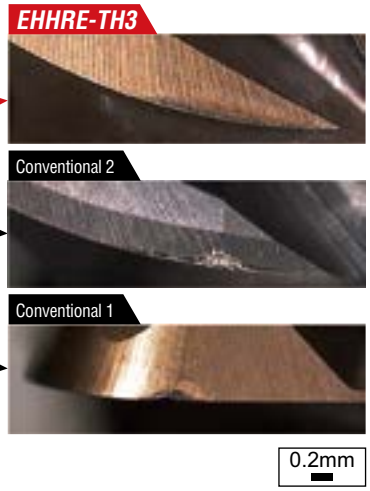
EHHRE-TH3 achieves more than twice the tool life of conventional products

High feed cutting of high hardness steel which was difficult with conventional radius geometry was realized.

Marginal test to evaluate feed limit for cutting powder high-speed steel

Tool size：ϕ10×6 flutes　Work material：Powdered HSS (65HRC)　Machine：Vertical MC (HSK-F63)
Cutting conditions：n=2,000min^{-1}(v_c=63m/min)　v_f=Refer to below table　a_p 0.15mm　a_e 3mm　OH＝30mm　Coolant：Air-blow





High feed cutting of high hardness steel is possible by synergistic effect of low cutting force radius geometry and TH3 coating.

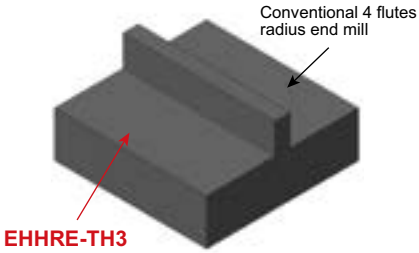
After roughing by EHHRE-TH3, recommended semi-finishing and finishing with the following tool.
Epoch High Hard Ball (EHHB-ATH), Epoch Deep Ball Evolution Hard -TH3 (EPDBEH-TH3)

Example of high-efficiency roughing of matrix high-speed steel

Work size：100×100mm
Work material：Matrix HSS (58HRC)
Machine：Vertical MC(BT40)
Coolant：Air-blow

Tool	Tool Dia. [mm]	R [mm]	Revolution [min^{-1}]	Cutting speed [m/min]	Feed rate [mm/min]	Feed per tooth [mm/t]	a_p [mm]	a_e [mm]	Chip removal volume [cm^3/min]	Machining time
EHHRE6100-TH3	10	0.968	2,200	69	4,000	0.3	0.2	6	4.8	24 min
Conventional (4 flutes radius)	10	2	2,100	66	2,000	0.24	0.15	3	0.9	1hr.25min.

Work shape：100×45×Depth10mm



Wear condition after cutting

Micro wear, possible to use continuously

Chipping occured on R edge

EHHRE achieved 5 times the cutting efficiency than the conventional tool. Tool wear was minimal enough to continue using.

High-efficiency cutting example of powder high-speed steel

Work size：50×50mm　Work material：Powdered HSS (65HRC)　Machine：Vertical MC(HSK-F63)

Process	Tool	Tool Dia. [mm]	R [mm]	Revolution [min^{-1}]	Cutting speed [m/min]	Feed rate [mm/min]	Feed per tooth [mm/t]	a_p [mm]	a_e [mm]	Removal stock [mm]	Coolant	Machining time
Contour roughing ❶	EHHRE4030-S6-TH3	3	0.328	6,360	60	1,390	0.055	0.054	2	0.05	Air-blow	1hr. 3min.
Contour roughing ❷	EHHRE4030-S6-TH3	3	0.328	6,360	60	1,390	0.055	0.054	2	0.05	Air-blow	1hr. 3min.

Figure　Work model

Cubic shape size：5×5×6mm, Space 5mm

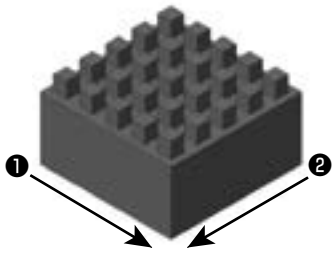


Figure　Work after cutting

Figure　Wear condition after roughing

Normal wear even after 1 hour cutting

EHHRE can perform high-efficiency machining even for small work-piece of high hardness steel

⚠ Safety notes

1. Cautions regarding handling
   (1) When removing the tool from its case (packaging), be careful that the tool does not pop out or is dropped. Be particularly careful regarding contact with the tool flutes.
   (2) When handling tools with sharp cutting flutes, be careful not to touch the cutting flutes directly with your bare hands.
2. Cautions regarding mounting
   (1) Before use, check the outside appearance of the tool for scratches, cracks, etc. and that it is firmly mounted in the collet chuck, etc.
   (2) If abnormal chattering, etc. occurs during use, stop the machine immediately and remove the cause of the chattering.
3. Cautions during use
   (1) Before use, confirm the dimensions and direction of rotation of the tool and milling work material.
   (2) The numerical values in the standard cutting conditions table should be used as criteria when starting new work. The cutting conditions should be adjusted as appropriate when the cutting depth is large, the rigidity of the machine being used is low, or according to the conditions of the work material.
   (3) Cutting tools are made of a hard material. During use, they may break and fly off. In addition, cutting chips may also fly off. Since there is a danger of injury to workers, fire, or eye damage from such flying pieces, a safety cover should be attached when work is performed and safety equipment such as safety goggles should be worn to create a safe environment for work.
   (4) There is a risk of fire or inflammation due to sparks, heat due to breakage, and cutting chips. Do not use where there is a risk of fire or explosion. **Please caution of fire while using oil base coolant, fire prevention is necessary.**
   (5) Do not use the tool for any purpose other than that for which it is intended.
4. Cautions regarding regrinding
   (1) If regrinding is not performed at the proper time, there is a risk of the tool breaking. Replace the tool with one in good condition, or perform regrinding.
   (2) Grinding dust will be created when regrinding a tool. When regrinding, be sure to attach a safety cover over the work area and wear safety clothes such as safety goggles, etc.
   (3) This product contains the specified chemical substance cobalt and its inorganic compounds. When performing regrinding or similar processing, be sure to handle the processing in accordance with thelocal laws and regulations regarding prevention of hazards due to specified chemical substances.

MITSUBISHI MATERIALS U.S.A.

Product Brands Crafted by Mitsubishi Materials U.S.A.

DIA EDGE MOLDINO The Edge To Innovation

California Office [Headquarters]

3535 Hyland Avenue, Suite 200
Costa Mesa, CA 92626
Customer Service: 800.523.0800
Technical Service: 800.486.2341

Detroit Office [MOLDINO Products Customer Service]

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Novi, MI 48375
Main: 248.308.2620
Fax: 248.308.2627
Email: rfqHTdiv@mmus.com (MOLDINO Product & Techinical Inquiry)

Toronto Office [Canada Branch]

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Units 15 & 16
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Main: 905.814.0240
Fax: 905.814.0245

MMC Metal de Mexico, S.A. DE C.V.

Av. La Cañada No.16,
Parque Industrial Bernardo
Quintana, El Marques,
Queretaro C.P. 76246 MEXICO
Main: +52.442.221.61.36
Fax: +52.442.221.61.34

Chicago Office [Engineering]

1314B North Plum Grove Road
Schaumburg, IL 60173
Main: 847.252.6300
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North Carolina-MTEC [Marketing & Technical Center]

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