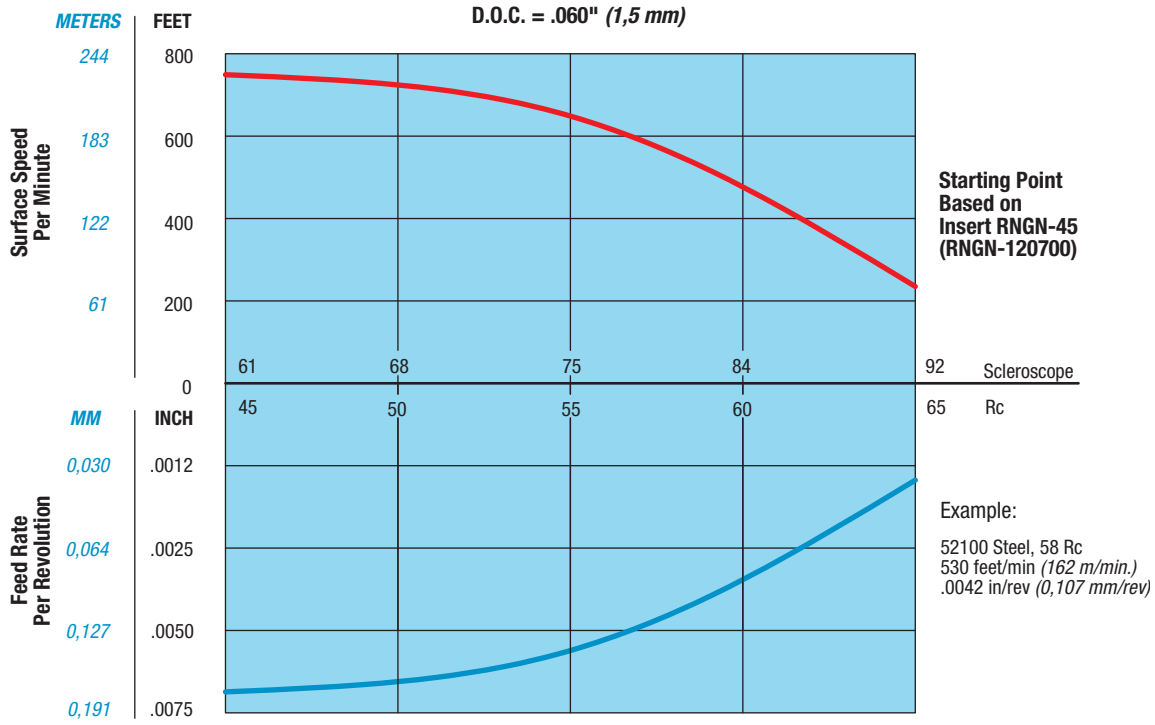
Turning Hard Materials 45-65 Rc

Figure 72 – WG-300 Machining Recommendations for Hardened Materials



WG-300 is successfully used for the turning of hard materials other than Nickel-based alloys in the range of 45-65 Rc. The outstanding hardness, combined with the high strength imparted by the reinforcing silicon carbide whiskers, makes possible the machining of many materials previously workable only by grinding. Some areas where the greatest savings have been shown are in the heat treated alloy steels, die steel, weld overlays, hard facings and hard irons.

As in Nickel-based alloys, speeds can be increased up to 8x those used for uncoated tungsten carbide tools and 4x those of coated carbide tools.

The above graph *(Figure 72)* gives starting points for speeds and feeds based upon material hardness. In hard turning the use of a light hone on the insert such as edge preparation T1A may help reduce chipping. ***Coolant should not be used.*** In this application we also recommend the use of an "ANSI" toolholder system which inherently has a five-degree double-negative rake.

If your job is in the 45 to 65 Rc range, chances are that Greenleaf WG-300 can increase productivity and cut machining costs substantially.

Milling of Nickel-Based Alloys

Milling can be compared to interrupted machining in turning. Since each insert is in and out of the cut during each revolution, the desirable temperature ahead of the tool is not easily achieved and calls for increased surface speed, reduced feed per tooth or a combination of both. It can be surprising how much extra speed is needed in some operations to get the heat back compared to machining the same material continuously as in turning. The increase can be many times the turning speed.

If a cutter designed for carbide is employed, new problems can arise. Often carbide insert milling cutter designs do not incorporate safety features to prevent components from dislodging at high speeds.

The use of coolants is not recommended.

With milling, unlike turning, the chip can be generated from thin to thick as in conventional or "up" milling or thick to thin as in "climb" or "down" milling. It is highly recommended to use the climb milling technique to avoid high heat in a thin section of the chip which encourages chip welding and re-cutting of the chips which reduces tool life.

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To summarize, when milling with WG-300:

1. Increase the speed from the turning recommendations in *Figure 13* according to the width of cut.
2. Reduce the feed rate recommended for turning in *Figure 13* by about 50%. **Remember, this is feed per tooth, not per revolution of the milling cutter.**
3. Be sure to use a Greenleaf high-velocity milling cutter or a cutter designed specifically for use with ceramics at high surface speeds.

Recommended Speed Increase for Milling with Various Declining Widths of Cut

In a milling operation the width of cut has a direct bearing upon the temperature generated ahead of the inserts. As the width is decreased, so is the temperature since each insert now passes through air for a longer time than it actually cuts material.

Figure 73 shows the percentage of increase to the speeds given in the graph *(Figure 13)* for various declining widths of cut. The widths are also expressed as percentages of the cutter diameter so the chart can be applied to all cutter sizes.

At the very best, a milling insert can only be cutting 50% of each revolution if the path of cut is equal to the cutter diameter. For this reason, it will always be necessary to increase speed and reduce feed compared to the turning recommendations in *Figure 13* to achieve the same temperature range.

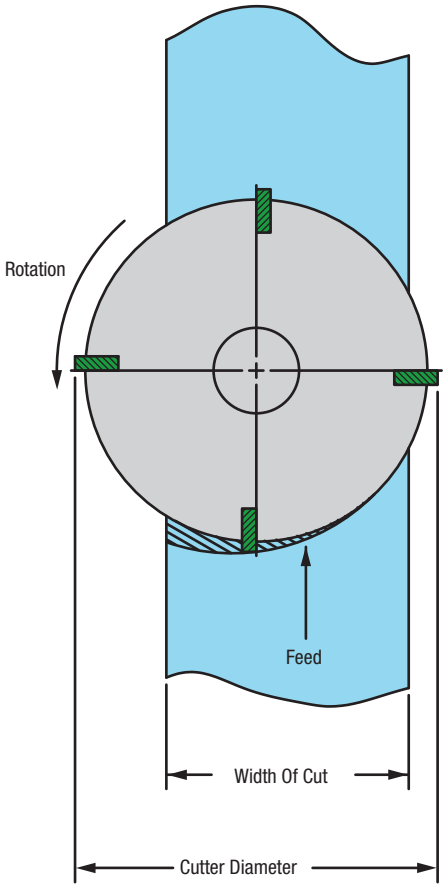
Example of a Ceramic Milling Application

The following data indicates outstanding success with a ceramic milling application:

Material . . . . . *Waspaloy*
Condition . . . . . *Forging*
Hardness . . . . . *41 Rc*
Operation . . . . . *Rough and Finish Milling*
Cutter Diameter . . . . . *3" (76 mm) WSRN-60003*
Number of Inserts *4*
Depth of cut (rough) . . . . *0.050" (1,27 mm)*
Depth of cut (finish) . . . . *0.025" (0,64 mm)*
Insert . . . . . *RNGN 45 T2 (120700)*
Grade *WG-300*
Speed . . . . . *3144 SFM (958 m/min)*
Feed . . . . . *64 ipm (1,6 m/min)*
Feed per tooth . . . . . *0.004" (0,1 mm)*

This application resulted in an 80-to-1 reduction in the cutting time cycle over carbide.

Figure 73 – Recommended Speed Increase for Milling with Various Declining Widths of Cut



Width of Cut in Percentage of Cutter Diameter Engaged in Workpiece	Surface Speed in Percentage of Graph (Figure 13)
100%	125%
90%	150%
80%	220%
70%	280%
60%	340%
50%	400%
40%	460%
30%	540%
20%	660%
10%	780%