

# MACHINING DATA NITRONIC® 60 Annealed

Based on 1" Dia Annealed (RB 95) 5 hour form tool life using high-speed tools. Carbide tools are suggested, for rates better than 50% of Type 304. These rates are for carbide tools, Type C-2 for roughing, drilling and reaming. Type C-3 for finishing. Suggested starting rates are:

## Single Point turning :

**Roughing** - 0.15" depth, 0.015"/rev feed - 175 SFM

**Finishing** - 0.025" depth, 0.007"/rev feed - 200 SFM

## Drilling :

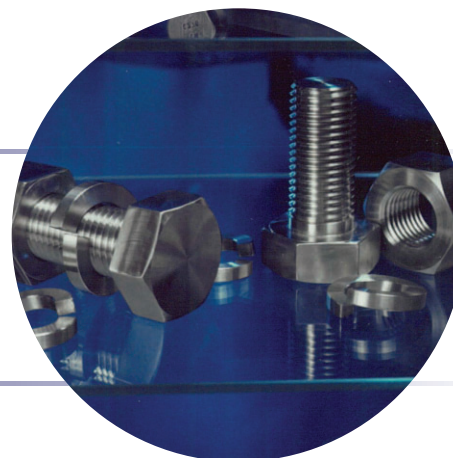
**1/4" Dia hole** - 0.004"/rev feed - 60 SFM

**1/2" Dia hole** - 0.007"/rev feed - 60 SFM

**3/4" Dia hole** - 0.010"/rev feed - 60 SFM

## Reaming :

**Feed** - same as drilling - 100 SFM



## Side and Slot Milling :

**Roughing** - 0.25" depth - 0.007"/tooth feed - 125 SFM

**Finishing** - 0.050" depth - 0.005"/tooth feed - 140 SFM

| MACHINABILITY RATINGS         |                     |                  |
|-------------------------------|---------------------|------------------|
| Material                      | Speed Surface ft/mm | Speed % of B1112 |
| AISI B1112                    | 165                 | 100              |
| Nitronic 30 Annealed          | 30                  | 18               |
| Nitronic 40 Annealed          | 40                  | 24               |
| Nitronic 50 Annealed          | 35                  | 21               |
| Nitronic 50 Grade A / Level 1 | 34                  | 21               |
| Nitronic 50 Grade B / Level 2 | 32                  | 19               |
| Nitronic 50 Grade C / Level 3 | 30                  | 18               |
| Nitronic 50 Grade D / Level 4 | 28                  | 17               |
| Nitronic 50 Grade E / Level 5 | 25                  | 15               |
| Nitronic 60 Annealed          | 40                  | 24               |
| Nitronic 60 Grade A / Level 1 | 38                  | 23               |
| Nitronic 60 Grade B / Level 2 | 36                  | 22               |
| Nitronic 60 Grade C / Level 3 | 32                  | 19               |
| Nitronic 60 Grade D / Level 4 | 28                  | 17               |
| Nitronic 60 Grade E / Level 5 | 25                  | 15               |
| 17-4 PH soln treated          | 75                  | 45               |
| 17-4 PH aged                  | 60                  | 36               |

These machinability ratios must be recognized as approximate values. They are a reasonable guide to relative tool life and lower required for cutting. It is obvious, however, that variables of speed, cutting oil, feed and depth of cut will significantly affect these ratios.

| MACHINABILITY RATINGS  |                      |                  | MACHINABILITY RATINGS   |                      |                  |
|------------------------|----------------------|------------------|-------------------------|----------------------|------------------|
| Material               | Speed Surface ft/min | Speed % of B1112 | Material                | Speed Surface ft/min | Speed % of B1112 |
| AISI B1112             | 165                  | 100              | Nitronic 50 Annealed    | 35                   | 21               |
| Hast X                 | 30                   | 18               | Nitronic 50 HS Lvl 1    | 34                   | 21               |
| C-276                  | 40                   | 18               | Nitronic 50 HS Lvl 2    | 32                   | 19               |
| B-2                    | 35                   | 21               | Nitronic 50 HS Lvl 3    | 30                   | 18               |
| C-22 TM                | 50                   | 30               | Nitronic 50 HS Lvl 4    | 28                   | 17               |
| HR-120 TM              | 40                   | 25               | Nitronic 50 HS Lvl 5    | 25                   | 15               |
| 20Cb-3 TM              | 65                   | 40               | Nitronic 60 Annealed    | 40                   | 24               |
| AL6XN TM               | 65                   | 40               | Nitronic 60 HS Lvl 1    | 38                   | 23               |
| A-286 Annealed         | 54                   | 32               | Nitronic 60 HS Lvl 2    | 36                   | 22               |
| A-286 Aged             | 30                   | 18               | Nitronic 60 HS Lvl 3    | 32                   | 19               |
| Nickel 200 Annealed    | 65                   | 40               | Nitronic 60 HS Lvl 4    | 28                   | 17               |
| Nickel 200 Cold Drawn  | 110                  | 66               | Nitronic 60 HS Lvl 5    | 25                   | 15               |
| Monel 400 Annealed/SR  | 60                   | 36               | Nitronic 30             | 30                   | 18               |
| Monel 400 Cold Drawn   | 80                   | 48               | Nitronic 40             | 40                   | 24               |
| Monel R405 Annealed/SR | 60                   | 36               | Ti 6Al-4V soln annealed | 40                   | 25               |
| Monel R405 Cold Drawn  | 80                   | 48               | Ti 6Al-4V aged          | 30                   | 18               |
| Monel K500 CW/HW       | 50                   | 30               | 309                     | 70                   | 42               |
| Monel K500 Annealed    | 60                   | 36               | 310                     | 70                   | 42               |
| Monel K500 Aged        | 40                   | 25               | 304                     | 75                   | 45               |
| 600 Annealed           | 50                   | 22               | 316                     | 75                   | 36               |
| 600 Cold Drawn         | 65                   | 39               | 321                     | 75                   | 45               |
| 625                    | 40                   | 24               | 446                     | 75                   | 45               |
| 718 Annealed           | 40                   | 24               | 303                     | 100                  | 60               |
| 718 Aged               | 20                   | 12               | 416                     | 145                  | 88               |
| 825                    | 20                   | 12               | 17-4 PH soln treated    | 75                   | 45               |
| X-750 Equalized        | 40                   | 24               | 17-4 PH aged            | 60                   | 36               |
| X-750 Aged             | 20                   | 12               | Rene 41                 | 12                   | 7                |
| 25 (L-605)             | 35                   | 21               | HAYNES TM 188           | 15                   | 9                |
| L605 Cold Worked       | 15                   | 9                | Waspaloy Annealed       | 45                   | 20               |
| MP 35N CW              | 45                   | 20               | Waspaloy Aged           | 20                   | 12               |
| MP 35N CW & Aged       | 20                   | 12               | MP 159                  | 45                   | 20               |

These machinability ratios must be recognized as approximate values. They are a reasonable guide to relative tool life and lower required for cutting. It is obvious, however, that variables of speed, cutting oil, feed and depth of cut will significantly affect these ratios.

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***The speeds are for single point turning operations using high speed steel tools. This information is provided as a guide to relative machinability. Higher speeds are used with carbide tooling.***

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***The alloys described here work harden rapidly during machining and require more power to cut than do the plain carbon steels. The metal is 'gummy,' with chips that tend to be stringy and tough. Machine tools should be rigid and used to no more than 75% of their rated capacity. Both work piece and tool should be held rigidly; tool overhang should be minimized. Rigidity is particularly important when machining titanium, as titanium has a much lower modulus of elasticity than either steel or nickel alloys. Slender work pieces of titanium tend to deflect under tool pressures causing chatter, tool rubbing and tolerance problems.***

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***Make sure that tools are always sharp. Change to sharpened tools at regular intervals rather than out of necessity. Titanium chips in particular tend to gall and weld to the tool cutting edges, speeding up tool wear and failure. Remember- cutting edges, particularly throw-away inserts, are expendable. Don't trade dollars in machine time for pennies in tool cost.***

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***Feed rate should be high enough to ensure that the tool cutting edge is getting under the previous cut thus avoiding work-hardened zones. Slow speeds are generally required with heavy cuts. Sulfur chlorinated petroleum oil lubricants are suggested for all alloys except titanium. Such lubricants may be thinned with paraffin oil for finish cuts at higher speeds. The tool should not ride on the work piece as this will work harden the material and result in early tool dulling or breakage. Use an air jet directed on the tool when dry cutting, to significantly increase tool life.***

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***Lubricants or cutting fluids for titanium should be carefully selected. Do not use fluids containing chlorine or other halogens (fluorine, bromine or iodine) in order to avoid risk of corrosion problems and contamination.***

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## **BAND-SAW CUTTING AND GRINDING**

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*When band sawing these alloys, the more economical high speed steel blades can be utilized. The machine must be set up to cut at much slower speeds to use the high speed steels. Some equipment does not have the capability to slow as much as needed. Blades that are 1.5-2" wide or wider are recommended to provide a rigid set up. Tungsten carbide blades can be utilized and can cut much faster, the trade off will be the number of cuts per hour vs. the higher cost of the blade.*

*Grinding should be performed submerged or flooded with water soluble coolant. Soft materials may be gummy and may cause the need for the wheel to be dressed more often. Some aerospace grades do not allow grinding, as it can alter the properties of the material. Many of our materials are austenitic, and some are only slightly ferro-magnetic. When utilizing magnetic hold downs, be aware that other holding methods may be needed.*

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