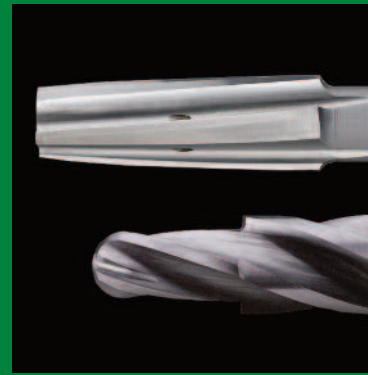
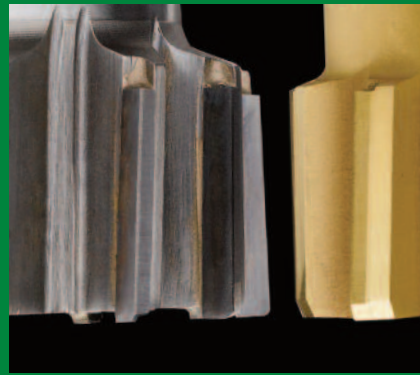




# HOLEMAKING & HOLE FINISHING

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As an innovator for more than 80 years, the WIDIA Products Group has been designing and manufacturing metalcutting products that make customer machining processes more efficient and effective.

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# HOLEMAKING & HOLE FINISHING

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## Metcut spade blades give you the edge!

- Highest performance in the industry
- Faster penetration rates – 35% to 100% higher "in-feed" rates than competitors' blades
- More holes per blade – 25% to 50% wear-life improvement over competitors' blades
- Less down time
- Interchangeable with other conventional spade blades
- Improved surface finish – elimination of secondary operations
- Complete standard and specials drill body / holder offering.
- Lower variability

### Premium blade construction:

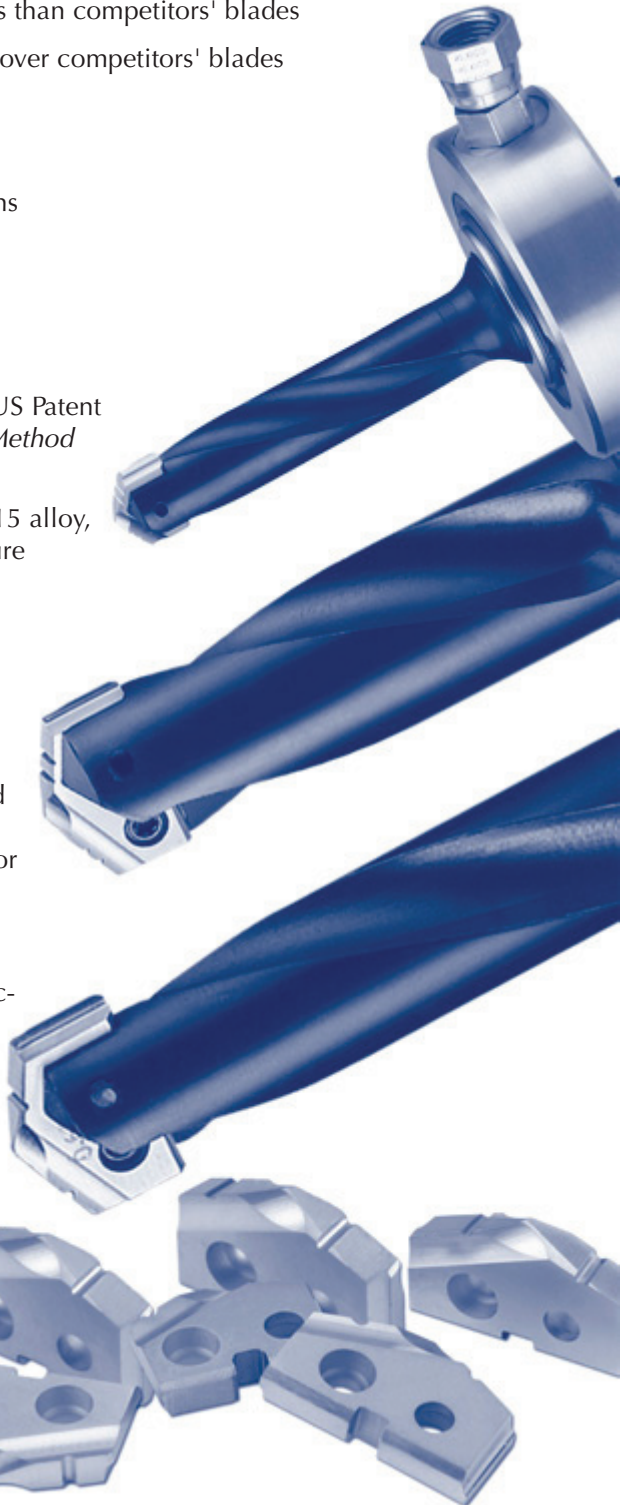
- Unique cutting geometry protected under Kennametal Inc. US Patent Number 63701702 (April 16, 2002) "*Spade Blade Drill and Method of Making*".
- Fabricated from a pressed and HIP sintered powder metal T-15 alloy, yielding a more uniform and consistent metallurgical structure provides lower variability than competing blades.

### Premium service and support:

- A specials program that delivers custom engineered spade blade and spade blade holder sizes and geometries to fulfill every customer requirement.
- A complete line of straight and helical fluted holders offered with both straight and taper shank styles; all holders are engineered to accommodate the option of a coolant gland for use where coolant through the spindle is lacking.

### Premium Coatings:

- **TiN** (Titanium Nitride) gives longer tool life and added lubricity, while allowing more aggressive machining of steels.
- **TiCN** (Titanium Carbonitride) is a general purpose coating well suited to machining of mild steel, ductile cast iron and nonferrous materials such as aluminum and copper alloys. TiCN is superior in preventing excessive BUE (built-up edge).
- **"G"** is comprised of more than 20 layers of TiCN and TiAlN with an overcoat of TiN optimized for drilling mild steel and ductile cast iron.
- **TiAlN** (Titanium Aluminum Nitride) a multilayer, mixed phase coating designed for high-speed machining in alloy steels, high temp alloys, gray cast iron and titanium. Performance advantages require TiAlN coated tools to be operated at relatively high speeds, typically 50% greater than other PVD coatings such as TiN.
- **CX-H** is a proprietary coating designed for optimal drilling of abrasive, short chipping nonferrous alloys (e.g. red brass, Al-Si alloys).
- **Diamond** coating is designed for abrasive nonferrous alloys.





## Application Information

**T-15 HSS spade blades** are recommended:

- For replacing steel twist drills resulting in 2X to 3X higher penetration rates and up to 4X to 5X longer wearlife.
- For providing straighter and more consistent holes with superior surface finishes than can be produced using either HSS twist drills or carbide indexable drills.
- When rigidity of the machine or the fixture requires a more forgiving, durable and tougher tool; T-15 steel possesses a higher transverse rupture strength and is more impact-resistant than comparable carbide spade blades and/or carbide indexable drills.
- In applications requiring hole depths up through 15X to 20X diameter; pecking may be required for depths above 7X diameter for some materials.
- As a more cost effective alternative to carbide indexable drills since T-15 steel spade blades operate at comparable penetration rates to single-effective indexable drills in materials <35 Rc, and one spade blade holder accommodates multiple diameter blades.

**Carbide spade blades** are recommended:

- For high productivity applications in which wearlife must be maximized; typically limited to hole depths less than 5X diameter.
- For use in highly abrasive materials such as cast iron, cast aluminum, etc.; or in harder steel alloys, typically 30 to 45 Rc.
- To exceed the performance of single-effective indexable drills by 20% to 50% in materials <45 Rc.
- To get improved productivity in contrast to T-15 steel spade blades by allowing 50% to 100% higher speeds; operational parameters of carbide blades recommend hole depths < 5X diameter, rigid set-ups, and 50% to 100% higher coolant pressures.

**Spade blade holders** generally can accommodate a range of blade sizes up to 1.30 to 1.35 times the smallest blade size. It is therefore possible to cover the entire range of hole sizes with just a few spade drill holders. Contrast this with the inventories required for indexable drills and steel taper shank drills.

**Straight fluted spade blade holders** are recommended for horizontal machining center applications to maximize chip evacuation given their inherent open flute construction.

**Helical fluted spade blade holders** may be necessary for vertical machining center applications to break chips, enhancing chip removal.

**R-8 (Bridgeport) holders** and blades are used in Bridgeport machines that require a R-8 taper holder.

**Through coolant** via the spindle cooling is preferable for optimal drilling with spade blades. However, if spindle cooling is unavailable, then coolant glands or inducers should be used to provide through coolant capability. All METCUT spade blade holders are manufactured with both the option of through the spindle cooling or with a rotary coolant gland. Flood coolant is not recommended, but can be used for very short hole depths, less than one diameter. Through coolant *must* be used with spade drill depths greater than one diameter.

**Half-size spade blade holders** (see pages 16–20) may be required where the penetration rate (in-feed) exceeds the recommended values by more than 25%. They are also recommended for use in gummy materials (e.g., aluminum, copper alloys) where torque forces can exceed the yield strength of the spade blade holder, typically where the spade blade diameter exceeds the spade blade body diameter by more than 25%. Without half-size holders, the spade blade's excessive overhang can expose it to premature failure and the holder to potential catastrophic break-up.

Series 0, 1 and 2 spade blade diameters have both full size and half size holders that provide proper support to the blade under most circumstances. Standard full-size holders can accommodate the full diameter range for a given spade blade series. Half-size holders should be used only for blade diameters that exceed the half-size spade blade holder body diameter by at least 0.010".



## Upgrade your tool crib with METCUT Spade Blade Holders

You've heard about the performance advantages of METCUT spade blades and you want to try them. But you've got an investment in tool holders. How can you make a cost effective switch? Let us prove the value of genuine METCUT spade blades and holders.

**Why settle for universal-style toolholders?**

**UPGRADE TO METCUT!**

*Superior hole making solutions by design.™*

### METCUT spade blade inserts:

- Increase average wear life by up to 2.5 times over coated universal-style blades
- Increase productivity (ipm) by as much as 50% over universal-style blades
- Cost up to 50% less than same substrate material universal-style blades

### Universal-style spade blade inserts:

- Lower wear life which means costly tool change-outs and machine down time
- Lower ipm which gives fewer parts per machine-hour, less productivity
- Higher investment costs in blade inventory without higher return on investment

## Spade Blade Holder Cross-Reference

### Taper Shank, Straight Flute Holders

| Universal Type Series | METCUT Blade Series | Blade Diameter Range | Morse Taper No. | Short Length     |       |               | Standard Length  |       |                   | Long Length      |       |               |
|-----------------------|---------------------|----------------------|-----------------|------------------|-------|---------------|------------------|-------|-------------------|------------------|-------|---------------|
|                       |                     |                      |                 | Max. Drill Depth | OAL   | METCUT Holder | Max. Drill Depth | OAL   | METCUT Holder     | Max. Drill Depth | OAL   | METCUT Holder |
| A                     | 2                   | 31/32"-1-3/8"        | 3               | 3.07             | 9.44  | <b>7S2S</b>   | 7.82             | 14.19 | <b>7S2L</b>       | 10.89            | 17.26 | <b>7S2E</b>   |
| AA                    | 2                   | 1-1/8"-1-3/8"        | 3               | 2.88             | 9.44  | <b>7S2.5S</b> | 7.63             | 15.19 | <b>*7S2.5L-4M</b> | —                | —     | —             |
| B                     | 3                   | 1-3/8"-1-7/8"        | 4               | 4.33             | 12.13 | <b>7S3S</b>   | 8.43             | 16.13 | <b>7S3M</b>       | 13.18            | 20.38 | <b>7S3L</b>   |
| C,D                   | 4                   | 1-7/8"-2-9/16"       | 4               | 5.90             | 13.62 | <b>7S4S</b>   | 9.90             | 17.63 | <b>7S4M</b>       | 16.02            | 23.75 | <b>7S4L</b>   |
| E,F                   | 5,6                 | 2-1/2"-3-1/2"        | 5               | 6.24             | 15.38 | <b>7S5S</b>   | 11.99            | 21.13 | <b>7S5M</b>       | 17.74            | 26.88 | <b>7S5L</b>   |
| G                     | 7,8                 | 3-1/2"-4-1/2"        | 5               | 6.88             | 16.28 | <b>7S7S</b>   | 12.25            | 22.28 | <b>7S7M</b>       | 19.45            | 30.53 | <b>7S7L</b>   |

\*#4 Morse Taper

### Straight Shank, Straight Flute Holders

| Universal Type Series | METCUT Blade Series | Blade Diameter Range | Shank Dia. | Short Length     |       |                | Standard Length  |       |                | Long Length      |       |               |
|-----------------------|---------------------|----------------------|------------|------------------|-------|----------------|------------------|-------|----------------|------------------|-------|---------------|
|                       |                     |                      |            | Max. Drill Depth | OAL   | METCUT Holder  | Max. Drill Depth | OAL   | METCUT Holder  | Max. Drill Depth | OAL   | METCUT Holder |
| A                     | 2                   | 31/32"-1-3/8"        | 1.25       | 3.07             | 8.00  | <b>7S2SS</b>   | 7.82             | 12.75 | <b>7S2SL</b>   | 10.89            | 15.92 | <b>7S2SE</b>  |
| AA                    | 2                   | 1-1/8"-1-3/8"        | 1.25       | 2.88             | 8.00  | <b>7S2.5SS</b> | 7.63             | 12.75 | <b>7S2.5SL</b> | —                | —     | —             |
| B                     | 3                   | 1-3/8"-1-7/8"        | 1.50       | 4.33             | 9.88  | <b>7S3SS</b>   | 8.43             | 13.88 | <b>7S3SM</b>   | 13.18            | 18.63 | <b>7S3SL</b>  |
| C,D                   | 4                   | 1-7/8"-2-9/16"       | 1.50       | 5.90             | 11.38 | <b>7S4SS</b>   | 9.90             | 15.38 | <b>7S4SM</b>   | 16.02            | 21.50 | <b>7S4SL</b>  |
| E,F                   | 5,6                 | 2-1/2"-3-1/2"        | 2.00       | 6.24             | 12.50 | <b>7S5SS</b>   | 11.99            | 18.25 | <b>7S5SM</b>   | 17.74            | 24.00 | <b>7S5SL</b>  |
| G                     | 7,8                 | 3-1/2"-4-1/2"        | 3.00       | 6.88             | 15.25 | <b>7S7SS</b>   | 12.25            | 21.25 | <b>7S7SM</b>   | 19.45            | 29.50 | <b>7S7SL</b>  |



## Minimum Coolant Volumetric Flow Rate and Coolant Pressure for T-15 HSS and Carbide Spade Blades

Note: These flow rates and coolant pressures are general recommendations for water-based coolants. They are guidelines for achieving maximum tool life and chip evacuation at the recommended speeds and feeds.

The table recommends adjusted flow and pressure rates for blade size, blade material, and holder length (short, medium, long, extended length). Since carbide blades are normally used in applications 5 x diameter or less, the long and extended length holders are not listed.

| Holder*<br>Length                                |     | X & Z<br>.375"-508" |       | 0<br>.509"-.690" |       | 1<br>.691"-.960" |       | 2<br>.961"-1.380" |       | 3<br>1.381"-1.879" |       | 4 & 5<br>1.880"-3.000" |      | 6, 7 & 8<br>3.001"-4.500" |      |
|--------------------------------------------------|-----|---------------------|-------|------------------|-------|------------------|-------|-------------------|-------|--------------------|-------|------------------------|------|---------------------------|------|
|                                                  |     | Low                 | High  | Low              | High  | Low              | High  | Low               | High  | Low                | High  | Low                    | High | Low                       | High |
| Low Carbon Steel 1010, 1020, 1025, 1522, etc.    |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| T-15 HSS                                         |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.4                 | 2.6   | 2.4              | 2.6   | 3.7              | 4.2   | 6.0               | 7.0   | 11.0               | 12.0  | 26.0                   | 30.0 | 36.0                      | 40.0 |
|                                                  | L   | 2.8                 | 3.0   | 2.8              | 3.0   | 4.3              | 4.8   | 6.9               | 8.1   | 12.7               | 13.8  | 29.9                   | 34.5 | 41.4                      | 46.0 |
|                                                  | E   | 3.1                 | 3.4   | 3.1              | 3.4   | 4.8              | 5.5   | 7.8               | 9.1   | 14.3               | 15.6  | 33.8                   | 39.0 | 46.8                      | 52.0 |
| Pressure (PSI)                                   | S/M | 160.0               | 170.0 | 75.0             | 90.0  | 75.0             | 95.0  | 60.0              | 80.0  | 55.0               | 75.0  | 30.0                   | 40.0 | >50.0                     |      |
|                                                  | L   | 184.0               | 195.5 | 86.3             | 103.5 | 86.3             | 109.3 | 69.0              | 92.0  | 63.3               | 86.3  | 34.5                   | 46.0 | >57.5                     |      |
|                                                  | E   | 208.0               | 221.0 | 97.5             | 117.0 | 97.5             | 123.5 | 78.0              | 104.0 | 71.5               | 97.5  | 39.0                   | 52.0 | >65.0                     |      |
| Carbide                                          |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.6                 | 2.9   | 2.9              | 3.1   | 4.4              | 5.0   | 7.5               | 8.8   | 15.4               | 16.8  |                        |      |                           |      |
| Pressure (PSI)                                   | S/M | 200.0               | 212.5 | 105.0            | 126.0 | 105.0            | 133.0 | 96.0              | 128.0 | 104.5              | 142.5 |                        |      |                           |      |
| Free Machining Steel 1118, 1215, 12L14, etc.     |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| T-15 HSS                                         |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.5                 | 2.7   | 2.8              | 3.0   | 4.4              | 5.2   | 7.0               | 8.0   | 12.0               | 14.0  | 30.0                   | 33.0 | 37.0                      | 41.0 |
|                                                  | L   | 2.9                 | 3.1   | 3.2              | 3.5   | 5.1              | 6.0   | 8.1               | 9.2   | 13.8               | 16.1  | 34.5                   | 38.0 | 42.6                      | 47.2 |
|                                                  | E   | 3.3                 | 3.5   | 3.6              | 3.9   | 5.7              | 6.8   | 9.1               | 10.4  | 15.6               | 18.2  | 39.0                   | 42.9 | 48.1                      | 53.3 |
| Pressure (PSI)                                   | S/M | 175.0               | 185.0 | 100.0            | 120.0 | 105.0            | 140.0 | 80.0              | 115.0 | 75.0               | 100.0 | 40.0                   | 50.0 | >60.0                     |      |
|                                                  | L   | 201.3               | 212.8 | 115.0            | 138.0 | 120.8            | 161.0 | 92.0              | 132.3 | 86.3               | 115.0 | 46.0                   | 57.5 | >69.0                     |      |
|                                                  | E   | 227.5               | 240.5 | 130.0            | 156.0 | 136.5            | 182.0 | 104.0             | 149.5 | 97.5               | 130.0 | 52.0                   | 65.0 | >78.0                     |      |
| Carbide                                          |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.8                 | 3.0   | 3.4              | 3.6   | 5.3              | 6.2   | 8.8               | 10.0  | 16.8               | 19.6  |                        |      |                           |      |
| Pressure (PSI)                                   | S/M | 218.8               | 231.3 | 140.0            | 168.0 | 147.0            | 196.0 | 128.0             | 184.0 | 142.5              | 190.0 |                        |      |                           |      |
| Medium Carbon Steel 1040, 1050, 1527, 1144, etc. |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| T-15 HSS                                         |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.3                 | 2.5   | 2.3              | 2.6   | 3.6              | 4.1   | 5.0               | 6.0   | 10.0               | 12.0  | 26.0                   | 30.0 | 36.0                      | 40.0 |
|                                                  | L   | 2.6                 | 2.9   | 2.6              | 3.0   | 4.1              | 4.7   | 5.8               | 6.9   | 11.5               | 13.8  | 29.9                   | 34.5 | 41.4                      | 46.0 |
|                                                  | E   | 3.0                 | 3.3   | 3.0              | 3.4   | 4.7              | 5.3   | 6.5               | 7.8   | 13.0               | 15.6  | 33.8                   | 39.0 | 46.8                      | 52.0 |
| Pressure (PSI)                                   | S/M | 155.0               | 165.0 | 70.0             | 85.0  | 70.0             | 90.0  | 55.0              | 75.0  | 50.0               | 70.0  | 30.0                   | 40.0 | >50.0                     |      |
|                                                  | L   | 178.3               | 189.8 | 80.5             | 97.8  | 80.5             | 103.5 | 63.3              | 86.3  | 57.5               | 80.5  | 34.5                   | 46.0 | >57.5                     |      |
|                                                  | E   | 201.5               | 214.5 | 91.0             | 110.5 | 91.0             | 117.0 | 71.5              | 97.5  | 65.0               | 91.0  | 39.0                   | 52.0 | >65.0                     |      |
| Carbide                                          |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.5                 | 2.8   | 2.8              | 3.1   | 4.3              | 4.9   | 6.3               | 7.5   | 14.0               | 16.8  |                        |      |                           |      |
| Pressure (PSI)                                   | S/M | 193.8               | 206.3 | 98.0             | 119.0 | 98.0             | 126.0 | 88.0              | 120.0 | 95.0               | 133.0 |                        |      |                           |      |
| Alloy Steel 4140, 5140, 8640, etc.               |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| T-15 HSS                                         |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.2                 | 2.4   | 2.2              | 2.4   | 3.5              | 3.9   | 5.0               | 6.0   | 10.0               | 11.0  | 26.0                   | 28.0 | 31.0                      | 36.0 |
|                                                  | L   | 2.5                 | 2.8   | 2.5              | 2.8   | 4.0              | 4.5   | 5.8               | 6.9   | 11.5               | 12.7  | 29.9                   | 32.2 | 35.7                      | 41.4 |
|                                                  | E   | 2.9                 | 3.1   | 2.9              | 3.1   | 4.6              | 5.1   | 6.5               | 7.8   | 13.0               | 14.3  | 33.8                   | 36.4 | 40.3                      | 46.8 |
| Pressure (PSI)                                   | S/M | 155.0               | 165.0 | 65.0             | 75.0  | 65.0             | 80.0  | 50.0              | 70.0  | 45.0               | 60.0  | 30.0                   | 35.0 | >40.0                     |      |
|                                                  | L   | 178.3               | 189.8 | 74.8             | 86.3  | 74.8             | 92.0  | 57.5              | 80.5  | 51.8               | 69.0  | 34.5                   | 40.3 | >46.0                     |      |
|                                                  | E   | 201.5               | 214.5 | 84.5             | 97.5  | 84.5             | 104.0 | 65.0              | 91.0  | 58.5               | 78.0  | 39.0                   | 45.5 | >52.0                     |      |
| Carbide                                          |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.4                 | 2.6   | 2.6              | 2.9   | 4.2              | 4.7   | 6.3               | 7.5   | 14.0               | 15.4  |                        |      |                           |      |
| Pressure (PSI)                                   | S/M | 193.8               | 206.3 | 91.0             | 105.0 | 91.0             | 112.0 | 80.0              | 112.0 | 85.5               | 114.0 |                        |      |                           |      |
| High Strength Alloy 4340, 4330V, 300M, etc.      |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| T-15 HSS                                         |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.2                 | 2.4   | 2.2              | 2.4   | 2.9              | 3.1   | 4.0               | 5.0   | 7.0                | 8.0   | 21.0                   | 23.0 | 27.0                      | 30.0 |
|                                                  | L   | 2.5                 | 2.8   | 2.5              | 2.8   | 3.3              | 3.6   | 4.6               | 5.8   | 8.1                | 9.2   | 24.2                   | 26.5 | 31.1                      | 34.5 |
|                                                  | E   | 2.9                 | 3.1   | 2.9              | 3.1   | 3.8              | 4.0   | 5.2               | 6.5   | 9.1                | 10.4  | 27.3                   | 29.9 | 35.1                      | 39.0 |
| Pressure (PSI)                                   | S/M | 150.0               | 160.0 | 55.0             | 60.0  | 45.0             | 50.0  | 25.0              | 30.0  | 25.0               | 30.0  | 20.0                   | 25.0 | >30.0                     |      |
|                                                  | L   | 172.5               | 184.0 | 63.3             | 69.0  | 51.8             | 57.5  | 28.8              | 34.5  | 28.8               | 34.5  | 23.0                   | 28.8 | >34.5                     |      |
|                                                  | E   | 195.0               | 208.0 | 71.5             | 78.0  | 58.5             | 65.0  | 32.5              | 39.0  | 32.5               | 39.0  | 26.0                   | 32.5 | >39.0                     |      |
| Carbide                                          |     |                     |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                       | S/M | 2.4                 | 2.6   | 2.6              | 2.9   | 3.5              | 3.7   | 5.0               | 6.3   | 9.8                | 11.2  |                        |      |                           |      |
| Pressure (PSI)                                   | S/M | 187.5               | 200.0 | 77.0             | 84.0  | 63.0             | 70.0  | 40.0              | 48.0  | 47.5               | 57.0  |                        |      |                           |      |

\* See holder dimensions in holder listings pp 16-20



| Holder*<br>Length                                      |            | X & Z<br>.375"-.508" |       | 0<br>.509"-.690" |       | 1<br>.691"-.960" |       | 2<br>.961"-1.380" |       | 3<br>1.381"-1.879" |       | 4 & 5<br>1.880"-3.000" |      | 6, 7 & 8<br>3.001"-4.500" |      |
|--------------------------------------------------------|------------|----------------------|-------|------------------|-------|------------------|-------|-------------------|-------|--------------------|-------|------------------------|------|---------------------------|------|
|                                                        |            | Low                  | High  | Low              | High  | Low              | High  | Low               | High  | Low                | High  | Low                    | High | Low                       | High |
| <b>Structural Steel A36, A285, A516, etc.</b>          |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>T-15 HSS</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.3                  | 2.5   | 2.4              | 2.6   | 3.5              | 3.9   | 5.0               | 6.0   | 9.0                | 10.0  | 23.0                   | 26.0 | 31.0                      | 35.0 |
|                                                        | <b>L</b>   | 2.6                  | 2.9   | 2.8              | 3.0   | 4.0              | 4.5   | 5.8               | 6.9   | 10.4               | 11.5  | 26.5                   | 29.9 | 35.7                      | 40.3 |
|                                                        | <b>E</b>   | 3.0                  | 3.3   | 3.1              | 3.4   | 4.6              | 5.1   | 6.5               | 7.8   | 11.7               | 13.0  | 29.9                   | 33.8 | 40.3                      | 45.5 |
| Pressure (PSI)                                         | <b>S/M</b> | 155.0                | 165.0 | 75.0             | 85.0  | 65.0             | 80.0  | 40.0              | 55.0  | 40.0               | 50.0  | 25.0                   | 30.0 | >40.0                     |      |
|                                                        | <b>L</b>   | 178.3                | 189.8 | 86.3             | 97.8  | 74.8             | 92.0  | 46.0              | 63.3  | 46.0               | 57.5  | 28.8                   | 34.5 | >46.0                     |      |
|                                                        | <b>E</b>   | 201.5                | 214.5 | 97.5             | 110.5 | 84.5             | 104.0 | 52.0              | 71.5  | 52.0               | 65.0  | 32.5                   | 39.0 | >52.0                     |      |
| <b>Carbide</b>                                         |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.5                  | 2.8   | 2.9              | 3.1   | 4.2              | 4.7   | 6.3               | 7.5   | 12.6               | 14.0  |                        |      |                           |      |
|                                                        | <b>S/M</b> | 193.8                | 206.3 | 105.0            | 119.0 | 91.0             | 112.0 | 64.0              | 88.0  | 76.0               | 95.0  |                        |      |                           |      |
| <b>Pressure (PSI)</b>                                  |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>Tool Steel H-13, H-21, A-4, O-2, etc.</b>           |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>T-15 HSS</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.3                  | 2.5   | 2.3              | 2.5   | 2.9              | 3.1   | 4.0               | 5.0   | 7.0                | 8.0   | 21.0                   | 23.0 | 27.0                      | 30.0 |
|                                                        | <b>L</b>   | 2.6                  | 2.9   | 2.6              | 2.9   | 3.3              | 3.6   | 4.6               | 5.8   | 8.1                | 9.2   | 24.2                   | 26.5 | 31.1                      | 34.5 |
|                                                        | <b>E</b>   | 3.0                  | 3.3   | 3.0              | 3.3   | 3.8              | 4.0   | 5.2               | 6.5   | 9.1                | 10.4  | 27.3                   | 29.9 | 35.1                      | 39.0 |
| Pressure (PSI)                                         | <b>S/M</b> | 145.0                | 155.0 | 55.0             | 60.0  | 45.0             | 50.0  | 25.0              | 30.0  | 25.0               | 30.0  | 20.0                   | 25.0 | >30.0                     |      |
|                                                        | <b>L</b>   | 166.8                | 178.3 | 63.3             | 69.0  | 51.8             | 57.5  | 28.8              | 34.5  | 28.8               | 34.5  | 23.0                   | 28.8 | >34.5                     |      |
|                                                        | <b>E</b>   | 188.5                | 201.5 | 71.5             | 78.0  | 58.5             | 65.0  | 32.5              | 39.0  | 32.5               | 39.0  | 26.0                   | 32.5 | >39.0                     |      |
| <b>Carbide</b>                                         |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.5                  | 2.8   | 2.8              | 3.0   | 3.5              | 3.7   | 5.0               | 6.3   | 9.8                | 11.2  |                        |      |                           |      |
|                                                        | <b>S/M</b> | 181.3                | 193.8 | 77.0             | 84.0  | 63.0             | 70.0  | 40.0              | 48.0  | 47.5               | 57.0  |                        |      |                           |      |
| <b>Pressure (PSI)</b>                                  |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>Stainless Steel 303, 416, 420, 17-4PH, etc.</b>     |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>T-15 HSS</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.3                  | 2.5   | 2.3              | 2.6   | 3.5              | 3.7   | 5.0               | 6.0   | 9.0                | 10.0  | 23.0                   | 26.0 | 33.0                      | 37.0 |
|                                                        | <b>L</b>   | 2.6                  | 2.9   | 2.6              | 3.0   | 4.0              | 4.3   | 5.8               | 6.9   | 10.4               | 11.5  | 26.5                   | 29.9 | 38.0                      | 42.6 |
|                                                        | <b>E</b>   | 3.0                  | 3.3   | 3.0              | 3.4   | 4.6              | 4.8   | 6.5               | 7.8   | 11.7               | 13.0  | 29.9                   | 33.8 | 42.9                      | 48.1 |
| Pressure (PSI)                                         | <b>S/M</b> | 160.0                | 170.0 | 70.0             | 85.0  | 65.0             | 75.0  | 40.0              | 55.0  | 40.0               | 50.0  | 25.0                   | 30.0 | >35.0                     |      |
|                                                        | <b>L</b>   | 184.0                | 195.5 | 80.5             | 97.8  | 74.8             | 86.3  | 46.0              | 63.3  | 46.0               | 57.5  | 28.8                   | 34.5 | >40.3                     |      |
|                                                        | <b>E</b>   | 208.0                | 221.0 | 91.0             | 110.5 | 84.5             | 97.5  | 52.0              | 71.5  | 52.0               | 65.0  | 32.5                   | 39.0 | >45.5                     |      |
| <b>Carbide</b>                                         |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.5                  | 2.8   | 2.8              | 3.1   | 4.2              | 4.4   | 6.3               | 7.5   | 12.6               | 14.0  |                        |      |                           |      |
|                                                        | <b>S/M</b> | 200.0                | 212.5 | 98.0             | 119.0 | 91.0             | 105.0 | 64.0              | 88.0  | 76.0               | 95.0  |                        |      |                           |      |
| <b>Pressure (PSI)</b>                                  |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>Cast Iron Gray, Ductile, Nodular</b>                |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>T-15 HSS</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.2                  | 2.4   | 2.2              | 2.4   | 3.1              | 3.3   | 4.0               | 5.0   | 8.0                | 9.0   | 23.0                   | 26.0 | 27.0                      | 30.0 |
|                                                        | <b>L</b>   | 2.5                  | 2.8   | 2.5              | 2.8   | 3.6              | 3.8   | 4.6               | 5.8   | 9.2                | 10.4  | 26.5                   | 29.9 | 31.1                      | 34.5 |
|                                                        | <b>E</b>   | 2.9                  | 3.1   | 2.9              | 3.1   | 4.0              | 4.3   | 5.2               | 6.5   | 10.4               | 11.7  | 29.9                   | 33.8 | 35.1                      | 39.0 |
| Pressure (PSI)                                         | <b>S/M</b> | 155.0                | 165.0 | 60.0             | 65.0  | 50.0             | 60.0  | 30.0              | 40.0  | 30.0               | 35.0  | 25.0                   | 30.0 | >30.0                     |      |
|                                                        | <b>L</b>   | 178.3                | 189.8 | 69.0             | 74.8  | 57.5             | 69.0  | 34.5              | 46.0  | 34.5               | 40.3  | 28.8                   | 34.5 | >34.5                     |      |
|                                                        | <b>E</b>   | 201.5                | 214.5 | 78.0             | 84.5  | 65.0             | 78.0  | 39.0              | 52.0  | 39.0               | 45.5  | 32.5                   | 39.0 | >39.0                     |      |
| <b>Carbide</b>                                         |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.4                  | 2.6   | 2.6              | 2.9   | 3.7              | 4.0   | 5.0               | 6.3   | 11.2               | 12.6  |                        |      |                           |      |
|                                                        | <b>S/M</b> | 193.8                | 206.3 | 84.0             | 91.0  | 70.0             | 84.0  | 48.0              | 64.0  | 57.0               | 66.5  |                        |      |                           |      |
| <b>Pressure (PSI)</b>                                  |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>Aluminum</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>T-15 HSS</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.6                  | 2.8   | 3.3              | 3.7   | 5.3              | 6.1   | 8.0               | 9.0   | 14.0               | 16.0  | 30.0                   | 33.0 | 37.0                      | 41.0 |
|                                                        | <b>L</b>   | 3.0                  | 3.2   | 3.8              | 4.3   | 6.1              | 7.0   | 9.2               | 10.4  | 16.1               | 18.4  | 34.5                   | 38.0 | 42.6                      | 47.2 |
|                                                        | <b>E</b>   | 3.4                  | 3.6   | 4.3              | 4.8   | 6.9              | 7.9   | 10.4              | 11.7  | 18.2               | 20.8  | 39.0                   | 42.9 | 48.1                      | 53.3 |
| Pressure (PSI)                                         | <b>S/M</b> | 185.0                | 200.0 | 140.0            | 180.0 | 150.0            | 200.0 | 115.0             | 160.0 | 90.0               | 125.0 | 40.0                   | 50.0 | >60.0                     |      |
|                                                        | <b>L</b>   | 212.8                | 230.0 | 161.0            | 207.0 | 172.5            | 230.0 | 132.3             | 184.0 | 103.5              | 143.8 | 46.0                   | 57.5 | >69.0                     |      |
|                                                        | <b>E</b>   | 240.5                | 260.0 | 182.0            | 234.0 | 195.0            | 260.0 | 149.5             | 208.0 | 117.0              | 162.5 | 52.0                   | 65.0 | >78.0                     |      |
| <b>Carbide</b>                                         |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.9                  | 3.1   | 4.0              | 4.4   | 6.4              | 7.3   | 10.0              | 11.3  | 19.6               | 22.4  |                        |      |                           |      |
|                                                        | <b>S/M</b> | 231.3                | 250.0 | 196.0            | 252.0 | 210.0            | 280.0 | 184.0             | 256.0 | 171.0              | 237.5 |                        |      |                           |      |
| <b>Pressure (PSI)</b>                                  |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>High Temp. Alloy Hastelloy B, Inconel 600, etc.</b> |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| <b>T-15 HSS</b>                                        |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.2                  | 2.4   | 2.2              | 2.4   | 3.1              | 3.2   | 4.0               | 5.0   | 7.0                | 8.0   | 23.0                   | 26.0 | 27.0                      | 30.0 |
|                                                        | <b>L</b>   | 2.5                  | 2.8   | 2.5              | 2.8   | 3.6              | 3.7   | 4.6               | 5.8   | 8.1                | 9.2   | 26.5                   | 29.9 | 31.1                      | 34.5 |
|                                                        | <b>E</b>   | 2.9                  | 3.1   | 2.9              | 3.1   | 4.0              | 4.2   | 5.2               | 6.5   | 9.1                | 10.4  | 29.9                   | 33.8 | 35.1                      | 39.0 |
| Pressure (PSI)                                         | <b>S/M</b> | 150.0                | 160.0 | 60.0             | 65.0  | 50.0             | 55.0  | 30.0              | 35.0  | 25.0               | 30.0  | 25.0                   | 30.0 | >30.0                     |      |
|                                                        | <b>L</b>   | 172.5                | 184.0 | 69.0             | 74.8  | 57.5             | 63.3  | 34.5              | 40.3  | 28.8               | 34.5  | 28.8                   | 34.5 | >34.5                     |      |
|                                                        | <b>E</b>   | 195.0                | 208.0 | 78.0             | 84.5  | 65.0             | 71.5  | 39.0              | 45.5  | 32.5               | 39.0  | 32.5                   | 39.0 | >39.0                     |      |
| <b>Carbide</b>                                         |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |
| Flow (GPM)                                             | <b>S/M</b> | 2.4                  | 2.6   | 2.6              | 2.9   | 3.7              | 3.8   | 5.0               | 6.3   | 9.8                | 11.2  |                        |      |                           |      |
|                                                        | <b>S/M</b> | 187.5                | 200.0 | 84.0             | 91.0  | 70.0             | 77.0  | 48.0              | 56.0  | 47.5               | 57.0  |                        |      |                           |      |
| <b>Pressure (PSI)</b>                                  |            |                      |       |                  |       |                  |       |                   |       |                    |       |                        |      |                           |      |



## Recommended Starting Speeds (SFM) and Feeds (IPR) — T-15 HSS Blades

| MATERIAL                                                                 | Hardness  | SPEEDS (SFM) |             |       |      |         | FEED (IPR)               |                      |                      |                       |                        |                        |                        |                              |
|--------------------------------------------------------------------------|-----------|--------------|-------------|-------|------|---------|--------------------------|----------------------|----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------------|
|                                                                          |           | Coatings     |             |       |      |         | Series/Diameters         |                      |                      |                       |                        |                        |                        |                              |
|                                                                          |           | TiN          | TiCN or "G" | TiAlN | CX-H | Diamond | Y & Z<br>.375 to<br>.508 | 0<br>.509 to<br>.690 | 1<br>.691 to<br>.960 | 2<br>.961 to<br>1.380 | 3<br>1.381 to<br>1.879 | 4<br>1.880 to<br>2.570 | 5<br>2.571 to<br>3.000 | 6, 7, 8<br>3.001 to<br>4.500 |
| Low Carbon Steel<br>1010, 1020, 1025,<br>1522, etc.                      | 85 – 125  | 175          | 225         | NR    | 240  | NR      | .008                     | .011                 | .013                 | .016                  | .020                   | .023                   | .025                   | .028                         |
|                                                                          | 125 – 175 | 165          | 210         | NR    | 230  | NR      | .007                     | .010                 | .012                 | .016                  | .020                   | .022                   | .024                   | .027                         |
|                                                                          | 175 – 225 | 155          | 200         | NR    | 215  | NR      | .006                     | .009                 | .011                 | .015                  | .019                   | .021                   | .023                   | .026                         |
|                                                                          | 225 – 275 | 145          | 185         | 225   | NR   | NR      | .006                     | .008                 | .010                 | .014                  | .018                   | .021                   | .023                   | .025                         |
| Free Machining Steel<br>1118, 1215, 12L14, etc.                          | 100 – 150 | 200          | 260         | NR    | NR   | NR      | .008                     | .011                 | .014                 | .017                  | .021                   | .025                   | .026                   | .028                         |
|                                                                          | 150 – 200 | 180          | 240         | NR    | NR   | NR      | .007                     | .010                 | .013                 | .016                  | .020                   | .023                   | .024                   | .026                         |
|                                                                          | 200 – 250 | 160          | 220         | 250   | 230  | NR      | .006                     | .010                 | .013                 | .016                  | .020                   | .023                   | .024                   | .026                         |
| Medium Carbon Steel<br>1030, 1040, 1050, 1527,<br>1140, 1144, 1151, etc. | 125 – 175 | 165          | 210         | NR    | NR   | NR      | .007                     | .009                 | .012                 | .016                  | .020                   | .023                   | .025                   | .027                         |
|                                                                          | 175 – 225 | 155          | 190         | NR    | NR   | NR      | .006                     | .008                 | .011                 | .015                  | .019                   | .022                   | .023                   | .025                         |
|                                                                          | 225 – 275 | 145          | 170         | 215   | NR   | NR      | .006                     | .008                 | .010                 | .014                  | .018                   | .021                   | .022                   | .024                         |
|                                                                          | 275 – 325 | 135          | 160         | 200   | NR   | NR      | .005                     | .007                 | .009                 | .012                  | .016                   | .019                   | .021                   | .023                         |
| Alloy Steel<br>4140, 5140, 8640, etc.                                    | 125 – 175 | 150          | 195         | NR    | 200  | NR      | .007                     | .009                 | .011                 | .015                  | .018                   | .021                   | .023                   | .025                         |
|                                                                          | 175 – 225 | 140          | 180         | NR    | 185  | NR      | .007                     | .009                 | .010                 | .014                  | .017                   | .019                   | .021                   | .023                         |
|                                                                          | 225 – 275 | 130          | 165         | 185   | NR   | NR      | .006                     | .008                 | .010                 | .013                  | .016                   | .019                   | .020                   | .021                         |
|                                                                          | 275 – 325 | 120          | 150         | 170   | NR   | NR      | .005                     | .007                 | .009                 | .012                  | .015                   | .017                   | .018                   | .020                         |
|                                                                          | 325 – 375 | 110          | 140         | 155   | NR   | NR      | .004                     | .006                 | .009                 | .012                  | .015                   | .017                   | .018                   | .020                         |
| High Strength Alloy<br>4340, 4330V, etc.                                 | 225 – 300 | 90           | 105         | 130   | NR   | NR      | .006                     | .008                 | .010                 | .012                  | .015                   | .017                   | .019                   | .021                         |
|                                                                          | 300 – 350 | 70           | 85          | 100   | NR   | NR      | .005                     | .007                 | .009                 | .011                  | .014                   | .016                   | .018                   | .021                         |
|                                                                          | 350 – 400 | NR           | NR          | 80    | NR   | NR      | .004                     | .006                 | .008                 | .010                  | .012                   | .014                   | .016                   | .019                         |
| Structural Steel<br>A36, A285, A516, etc.                                | 100 – 150 | 150          | 180         | NR    | NR   | NR      | .007                     | .010                 | .012                 | .015                  | .018                   | .021                   | .023                   | .026                         |
|                                                                          | 150 – 250 | 125          | 160         | 190   | NR   | NR      | .006                     | .009                 | .011                 | .013                  | .016                   | .019                   | .021                   | .024                         |
|                                                                          | 250 – 350 | 100          | 135         | 160   | NR   | NR      | .005                     | .008                 | .009                 | .011                  | .014                   | .017                   | .019                   | .022                         |
| Tool Steel<br>H-13, H-21,<br>A-4, O-2, S-3, etc                          | 150 – 200 | 85           | 105         | NR    | NR   | NR      | .007                     | .008                 | .009                 | .011                  | .013                   | .015                   | .016                   | .018                         |
|                                                                          | 200 – 250 | 75           | 90          | 110   | NR   | NR      | .006                     | .007                 | .008                 | .011                  | .013                   | .015                   | .016                   | .018                         |
|                                                                          | 250 – 350 | 45           | NR          | 70    | NR   | NR      | .005                     | .006                 | .007                 | .009                  | .011                   | .013                   | .014                   | .016                         |
|                                                                          | 350 – 400 | NR           | NR          | 50    | NR   | NR      | .004                     | .005                 | .006                 | .007                  | .009                   | .012                   | .013                   | .014                         |
| Stainless Steel<br>416, 420, 17-4PH, etc.                                | 135 – 185 | 80           | 100         | 120   | 100  | NR      | .007                     | .008                 | .010                 | .012                  | .015                   | .017                   | .019                   | .021                         |
|                                                                          | 185 – 275 | NR           | 85          | 105   | 95   | NR      | .006                     | .007                 | .009                 | .011                  | .013                   | .015                   | .017                   | .019                         |
|                                                                          | 275 – 350 | NR           | 75          | 90    | 80   | NR      | .005                     | .006                 | .007                 | .009                  | .011                   | .013                   | .015                   | .017                         |
| Cast Iron<br>Gray, Ductile,<br>Nodular                                   | 120 – 150 | 180          | 225         | 270   | 250  | 225     | .008                     | .013                 | .017                 | .020                  | .024                   | .027                   | .029                   | .031                         |
|                                                                          | 150 – 200 | 160          | 200         | 240   | 220  | 200     | .007                     | .011                 | .014                 | .018                  | .022                   | .025                   | .027                   | .029                         |
|                                                                          | 200 – 220 | 140          | 175         | 210   | 190  | 175     | .006                     | .009                 | .012                 | .016                  | .018                   | .021                   | .023                   | .025                         |
|                                                                          | 220 – 260 | 120          | 150         | 180   | 165  | 150     | .005                     | .007                 | .010                 | .012                  | .014                   | .017                   | .019                   | .021                         |
|                                                                          | 260 – 320 | 100          | 125         | 150   | 135  | 125     | .004                     | .006                 | .007                 | .009                  | .012                   | .014                   | .016                   | .018                         |
| Aluminum - Wrought                                                       | —         | NR           | 700         | NR    | 750  | 750     | .007                     | .012                 | .015                 | .019                  | .021                   | .024                   | .025                   | .026                         |
| Cast                                                                     | —         | NR           | 400         | NR    | 500  | 500     | .008                     | .013                 | .016                 | .020                  | .022                   | .025                   | .026                   | .027                         |
| Copper Alloys                                                            | —         | NR           | 450         | NR    | 550  | 600     | .007                     | .012                 | .015                 | .019                  | .021                   | .024                   | .025                   | .026                         |
| High Temp. Alloy                                                         | 140 – 210 | NR           | 35          | 45    | NR   | NR      | .006                     | .007                 | .008                 | .010                  | .013                   | .015                   | .016                   | .017                         |
| Hastelloy B,                                                             | 210 – 280 | NR           | 30          | 40    | NR   | NR      | .005                     | .006                 | .007                 | .008                  | .010                   | .012                   | .013                   | .014                         |
| Inconel 600, etc.                                                        | 280 – 340 | NR           | 25          | 35    | NR   | NR      | .004                     | .006                 | .007                 | .008                  | .009                   | .011                   | .012                   | .013                         |
| Titanium Alloys                                                          | —         | NR           | 40          | 50    | 45   | NR      | .005                     | .007                 | .008                 | .010                  | .012                   | .015                   | .016                   | .017                         |

NR = Not Recommended

Formulas:  $IPM = RPM \times IPR$  ★  $SFM = .262 \times RPM \times Diameter$  ★  $RPM = SFM \times 3.82 \div Diameter$

## Premium Coatings:

- **TiN** (Titanium Nitride) gives longer tool life and added lubricity, while allowing more aggressive machining of steels.
- **TiCN** (Titanium Carbonitride) is a general purpose coating well suited to machining of mild steel, ductile cast iron and nonferrous materials such as aluminum and copper alloys. TiCN is superior in preventing excessive BUE (built-up edge).
- **"G"** is comprised of more than 20 layers of TiCN and TiAlN with an overcoat of TiN optimized for drilling mild steel and ductile cast iron.
- **TiAlN** (Titanium Aluminum Nitride) a multilayer, mixed phase coating designed for high-speed machining in alloy steels, high temp alloys, gray cast iron and titanium. Performance advantages require TiAlN coated tools to be operated at relatively high speeds, typically 50% greater than other PVD coatings such as TiN.
- **CX-H** is a proprietary coating designed for optimal drilling of abrasive, short chipping nonferrous alloys (e.g. red brass, Al-Si alloys).
- **Diamond** coating is designed for abrasive nonferrous alloys.



| Decimal Size                         | Inch Size | Metric Size | TiN Coated EDP Number | TiCN Coated EDP Number | TiAlN Coated EDP Number |
|--------------------------------------|-----------|-------------|-----------------------|------------------------|-------------------------|
| <b>Series X: .375" through .436"</b> |           |             |                       |                        |                         |
| .3740                                | —         | 9,5         | 7FX-0374T             | 7FX-0374N              | 7FX-0374A               |
| .3750                                | 3/8       | —           | 7FX-0375T             | 7FX-0375N              | 7FX-0375A               |
| .3860                                | W         | —           | 7FX-0386T             | 7FX-0386N              | 7FX-0386A               |
| .3890                                | SAE #4    | —           | 7FX-0389T             | 7FX-0389N              | 7FX-0389A               |
| .3906                                | 25/64     | —           | 7FX-0391T             | 7FX-0391N              | 7FX-0391A               |
| .3937                                | —         | 10,0        | 7FX-0394T             | 7FX-0394N              | 7FX-0394A               |
| .4016                                | —         | 10,2        | 7FX-0402T             | 7FX-0402N              | 7FX-0402A               |
| .4063                                | 13/32     | —           | 7FX-0406T             | 7FX-0406N              | 7FX-0406A               |
| .4134                                | —         | 10,5        | 7FX-0413T             | 7FX-0413N              | 7FX-0413A               |
| .4219                                | 27/64     | —           | 7FX-0422T             | 7FX-0422N              | 7FX-0422A               |
| .4252                                | —         | 10,8        | 7FX-0425T             | 7FX-0425N              | 7FX-0425A               |
| .4331                                | —         | 11,0        | 7FX-0433T             | 7FX-0433N              | 7FX-0433A               |
| <b>Series Z: .437" through .508"</b> |           |             |                       |                        |                         |
| .4375                                | 7/16      | —           | 7FZ-0438T             | 7FZ-0438N              | 7FZ-0438A               |
| .4520                                | SAE #5    | —           | 7FZ-0452T             | 7FZ-0452N              | 7FZ-0452A               |
| .4531                                | 29/64     | —           | 7FZ-0453T             | 7FZ-0453N              | 7FZ-0453A               |
| .4646                                | —         | 11,8        | 7FZ-0465T             | 7FZ-0465N              | 7FZ-0465A               |
| .4688                                | 15/32     | —           | 7FZ-0469T             | 7FZ-0469N              | 7FZ-0469A               |
| .4724                                | —         | 12,0        | 7FZ-0472T             | 7FZ-0472N              | 7FZ-0472A               |
| .4844                                | 31/64     | —           | 7FZ-0484T             | 7FZ-0484N              | 7FZ-0484A               |
| .4921                                | —         | 12,5        | 7FZ-0492T             | 7FZ-0492N              | 7FZ-0492A               |
| .5000                                | 1/2       | —           | 7FZ-0500T             | 7FZ-0500N              | 7FZ-0500A               |
| <b>Series 0: .509" through .690"</b> |           |             |                       |                        |                         |
| .5090                                | SAE #6    | —           | 7F0-0509T             | 7F0-0509N              | 7F0-0509A               |
| .5118                                | —         | 13,0        | 7F0-0512T             | 7F0-0512N              | 7F0-0512A               |
| .5156                                | 33/64     | —           | 7F0-0516T             | 7F0-0516N              | 7F0-0516A               |
| .5313                                | 17/32     | —           | 7F0-0531T             | 7F0-0531N              | 7F0-0531A               |
| .5469                                | 35/64     | —           | 7F0-0547T             | 7F0-0547N              | 7F0-0547A               |
| .5512                                | —         | 14,0        | 7F0-0551T             | 7F0-0551N              | 7F0-0551A               |
| .5625                                | 9/16      | —           | 7F0-0563T             | 7F0-0563N              | 7F0-0563A               |
| .5709                                | —         | 14,5        | 7F0-0571T             | 7F0-0571N              | 7F0-0571A               |
| .5781                                | 37/64     | —           | 7F0-0578T             | 7F0-0578N              | 7F0-0578A               |
| .5906                                | —         | 15,0        | 7F0-0591T             | 7F0-0591N              | 7F0-0591A               |
| .5938                                | 19/32     | —           | 7F0-0594T             | 7F0-0594N              | 7F0-0594A               |
| .6094                                | 39/64     | —           | 7F0-0609T             | 7F0-0609N              | 7F0-0609A               |
| .6102                                | —         | 15,5        | 7F0-0610T             | 7F0-0610N              | 7F0-0610A               |
| .6250                                | 5/8       | —           | 7F0-0625T             | 7F0-0625N              | 7F0-0625A               |
| .6299                                | —         | 16,0        | 7F0-0630T             | 7F0-0630N              | 7F0-0630A               |
| .6406                                | 41/64     | —           | 7F0-0641T             | 7F0-0641N              | 7F0-0641A               |
| .6496                                | —         | 16,5        | 7F0-0650T             | 7F0-0650N              | 7F0-0650A               |
| .6563                                | 21/32     | —           | 7F0-0656T             | 7F0-0656N              | 7F0-0656A               |
| .6611                                | —         | 16,8        | 7F0-0661T             | 7F0-0661N              | 7F0-0661A               |
| .6693                                | —         | 17,0        | 7F0-0669T             | 7F0-0669N              | 7F0-0669A               |
| .6719                                | 43/64     | —           | 7F0-0672T             | 7F0-0672N              | 7F0-0672A               |
| .6875                                | 11/16     | —           | 7F0-0688T             | 7F0-0688N              | 7F0-0688A               |
| .6890                                | SAE #8    | 17,5        | 7F0-0689T             | 7F0-0689N              | 7F0-0689A               |
| <b>Series 1: .691" through .960"</b> |           |             |                       |                        |                         |
| .7031                                | 45/64     | —           | 7F1-0703T             | 7F1-0703N              | 7F1-0703A               |
| .7087                                | —         | 18,0        | 7F1-0709T             | 7F1-0709N              | 7F1-0709A               |
| .7188                                | 23/32     | —           | 7F1-0719T             | 7F1-0719N              | 7F1-0719A               |
| .7283                                | —         | 18,5        | 7F1-0728T             | 7F1-0728N              | 7F1-0728A               |
| .7344                                | 47/64     | —           | 7F1-0734T             | 7F1-0734N              | 7F1-0734A               |
| .7480                                | —         | 19,0        | 7F1-0748T             | 7F1-0748N              | 7F1-0748A               |

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# T-15 HSS Spade Blades



| Decimal Size                                     | Inch Size | Metric Size | TiN Coated EDP Number | TiCN Coated EDP Number | TiAlN Coated EDP Number |
|--------------------------------------------------|-----------|-------------|-----------------------|------------------------|-------------------------|
| <b>(continued) Series 1: .691" through .960"</b> |           |             |                       |                        |                         |
| .7500                                            | 3/4       |             | 7F1-0750T             | 7F1-0750N              | 7F1-0750A               |
| .7580                                            | —         | 19,25       | 7F1-0758T             | 7F1-0758N              | 7F1-0758A               |
| .7656                                            | 49/64     | —           | 7F1-0766T             | 7F1-0766N              | 7F1-0766A               |
| .7677                                            | —         | 19,5        | 7F1-0768T             | 7F1-0768N              | 7F1-0768A               |
| .7813                                            | 25/32     | —           | 7F1-0781T             | 7F1-0781N              | 7F1-0781A               |
| .7874                                            | —         | 20,0        | 7F1-0787T             | 7F1-0787N              | 7F1-0787A               |
| .7969                                            | 51/64     | —           | 7F1-0797T             | 7F1-0797N              | 7F1-0797A               |
| .8060                                            | SAE #10   | —           | 7F1-0806T             | 7F1-0806N              | 7F1-0806A               |
| .8071                                            | —         | 20,5        | 7F1-0807T             | 7F1-0807N              | 7F1-0807A               |
| .8125                                            | 13/16     | —           | 7F1-0813T             | 7F1-0813N              | 7F1-0813A               |
| .8268                                            | —         | 21,0        | 7F1-0827T             | 7F1-0827N              | 7F1-0827A               |
| .8281                                            | 53/64     | —           | 7F1-0828T             | 7F1-0828N              | 7F1-0828A               |
| .8438                                            | 27/32     | —           | 7F1-0844T             | 7F1-0844N              | 7F1-0844A               |
| .8594                                            | 55/64     | —           | 7F1-0859T             | 7F1-0859N              | 7F1-0859A               |
| .8661                                            | —         | 22,0        | 7F1-0866T             | 7F1-0866N              | 7F1-0866A               |
| .8750                                            | 7/8       | —           | 7F1-0875T             | 7F1-0875N              | 7F1-0875A               |
| .8906                                            | 57/64     | —           | 7F1-0891T             | 7F1-0891N              | 7F1-0891A               |
| .9063                                            | 29/32     | —           | 7F1-0906T             | 7F1-0906N              | 7F1-0906A               |
| .9219                                            | 59/64     | —           | 7F1-0922T             | 7F1-0922N              | 7F1-0922A               |
| .9375                                            | 15/16     | —           | 7F1-0938T             | 7F1-0938N              | 7F1-0938A               |
| .9449                                            | —         | 24,0        | 7F1-0945T             | 7F1-0945N              | 7F1-0945A               |
| .9531                                            | 61/64     | —           | 7F1-0953T             | 7F1-0953N              | 7F1-0953A               |
| .9600                                            | —         | 24,4        | 7F1-0960T             | 7F1-0960N              | 7F1-0960A               |
| <b>Series 2: .961" through 1.380"</b>            |           |             |                       |                        |                         |
| .9688                                            | 31/32     | —           | 7F2-0969T             | 7F2-0969N              | 7F2-0969A               |
| .9810                                            | SAE #12   | —           | 7F2-0981T             | 7F2-0981N              | 7F2-0981A               |
| .9843                                            | —         | 25,0        | 7F2-0984T             | 7F2-0984N              | 7F2-0984A               |
| 1.0000                                           | 1         | —           | 7F2-1000T             | 7F2-1000N              | 7F2-1000A               |
| 1.0156                                           | 1-1/64    | —           | 7F2-1016T             | 7F2-1016N              | 7F2-1016A               |
| 1.0236                                           | —         | 26,0        | 7F2-1024T             | 7F2-1024N              | 7F2-1024A               |
| 1.0313                                           | 1-1/32    | —           | 7F2-1031T             | 7F2-1031N              | 7F2-1031A               |
| 1.0469                                           | 1-3/64    | —           | 7F2-1047T             | 7F2-1047N              | 7F2-1047A               |
| 1.0625                                           | 1-1/16    | —           | 7F2-1063T             | 7F2-1063N              | 7F2-1063A               |
| 1.0781                                           | 1-5/64    | —           | 7F2-1078T             | 7F2-1078N              | 7F2-1078A               |
| 1.0938                                           | 1-3/32    | —           | 7F2-1094T             | 7F2-1094N              | 7F2-1094A               |
| 1.1024                                           | —         | 28,0        | 7F2-1102T             | 7F2-1102N              | 7F2-1102A               |
| 1.1060                                           | SAE #14   | —           | 7F2-1106T             | 7F2-1106N              | 7F2-1106A               |
| 1.1094                                           | 1-7/64    | —           | 7F2-1109T             | 7F2-1109N              | 7F2-1109A               |
| 1.1250                                           | 1-1/8     | —           | 7F2-1125T             | 7F2-1125N              | 7F2-1125A               |
| 1.1310                                           | —         | —           | 7F2-1131T             | 7F2-1131N              | 7F2-1131A               |
| 1.1406                                           | 1-9/64    | —           | 7F2-1141T             | 7F2-1141N              | 7F2-1141A               |
| 1.1417                                           | —         | 29,0        | 7F2-1142T             | 7F2-1142N              | 7F2-1142A               |
| 1.1563                                           | 1-5/32    | —           | 7F2-1156T             | 7F2-1156N              | 7F2-1156A               |
| 1.1614                                           | —         | 29,5        | 7F2-1161T             | 7F2-1161N              | 7F2-1161A               |
| 1.1811                                           | —         | 30,0        | 7F2-1181T             | 7F2-1181N              | 7F2-1181A               |
| 1.1875                                           | 1-3/16    | —           | 7F2-1188T             | 7F2-1188N              | 7F2-1188A               |
| 1.1929                                           | —         | 30,3        | 7F2-1193T             | 7F2-1193N              | 7F2-1193A               |
| 1.2031                                           | 1-13/64   | —           | 7F2-1203T             | 7F2-1203N              | 7F2-1203A               |
| 1.2188                                           | 1-7/32    | —           | 7F2-1219T             | 7F2-1219N              | 7F2-1219A               |
| 1.2205                                           | —         | 31,0        | 7F2-1221T             | 7F2-1221N              | 7F2-1221A               |
| 1.2310                                           | SAE #16   | —           | 7F2-1231T             | 7F2-1231N              | 7F2-1231A               |
| 1.2344                                           | 1-15/64   | —           | 7F2-1234T             | 7F2-1234N              | 7F2-1234A               |
| 1.2500                                           | 1-1/4     | —           | 7F2-1250T             | 7F2-1250N              | 7F2-1250A               |
| 1.2598                                           | —         | 32,0        | 7F2-1260T             | 7F2-1260N              | 7F2-1260A               |

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| Decimal Size | Inch Size | Metric Size | TiN Coated EDP Number | TiCN Coated EDP Number | TiAlN Coated EDP Number |
|--------------|-----------|-------------|-----------------------|------------------------|-------------------------|
| 1.2656       | 1-17/64   | —           | 7F2-1266T             | 7F2-1266N              | 7F2-1266A               |
| 1.2813       | 1-9/32    | —           | 7F2-1281T             | 7F2-1281N              | 7F2-1281A               |
| 1.2992       | —         | 33,0        | 7F2-1299T             | 7F2-1299N              | 7F2-1299A               |
| 1.3125       | 1-5/16    | —           | 7F2-1313T             | 7F2-1313N              | 7F2-1313A               |
| 1.3281       | 1-21/64   | —           | 7F2-1328T             | 7F2-1328N              | 7F2-1328A               |
| 1.3386       | —         | 34,0        | 7F2-1339T             | 7F2-1339N              | 7F2-1339A               |
| 1.3438       | 1-11/32   | —           | 7F2-1344T             | 7F2-1344N              | 7F2-1344A               |
| 1.3594       | 1-23/64   | —           | 7F2-1359T             | 7F2-1359N              | 7F2-1359A               |
| 1.3750       | 1-3/8     | —           | 7F2-1375T             | 7F2-1375N              | 7F2-1375A               |
| 1.3780       | —         | 35,0        | 7F2-1378T             | 7F2-1378N              | 7F2-1378A               |

## Series 3: 1.381" through 1.879"

|        |         |       |           |           |           |
|--------|---------|-------|-----------|-----------|-----------|
| 1.3906 | 1-25/64 | —     | 7F3-1391T | 7F3-1391N | 7F3-1391A |
| 1.4063 | 1-13/32 | —     | 7F3-1406T | 7F3-1406N | 7F3-1406A |
| 1.4173 | —       | 36,0  | 7F3-1417T | 7F3-1417N | 7F3-1417A |
| 1.4375 | 1-7/16  | —     | 7F3-1438T | 7F3-1438N | 7F3-1438A |
| 1.4531 | 1-29/64 | —     | 7F3-1453T | 7F3-1453N | 7F3-1453A |
| 1.4567 | —       | 37,0  | 7F3-1457T | 7F3-1457N | 7F3-1457A |
| 1.4688 | 1-15/32 | —     | 7F3-1469T | 7F3-1469N | 7F3-1469A |
| 1.4844 | 1-31/64 | —     | 7F3-1484T | 7F3-1484N | 7F3-1484A |
| 1.4961 | —       | 38,0  | 7F3-1496T | 7F3-1496N | 7F3-1496A |
| 1.5000 | 1-1/2   | —     | 7F3-1500T | 7F3-1500N | 7F3-1500A |
| 1.5156 | 1-33/64 | —     | 7F3-1516T | 7F3-1516N | 7F3-1516A |
| 1.5250 | —       | 38,74 | 7F3-1525T | 7F3-1525N | 7F3-1525A |
| 1.5313 | 1-17/32 | —     | 7F3-1531T | 7F3-1531N | 7F3-1531A |
| 1.5354 | —       | 39,0  | 7F3-1535T | 7F3-1535N | 7F3-1535A |
| 1.5430 | SAE #20 | —     | 7F3-1543T | 7F3-1543N | 7F3-1543A |
| 1.5625 | 1-9/16  | —     | 7F3-1563T | 7F3-1563N | 7F3-1563A |
| 1.5748 | —       | 40,0  | 7F3-1575T | 7F3-1575N | 7F3-1575A |
| 1.5781 | 1-37/64 | —     | 7F3-1578T | 7F3-1578N | 7F3-1578A |
| 1.5938 | 1-19/32 | —     | 7F3-1594T | 7F3-1594N | 7F3-1594A |
| 1.6142 | —       | 41,0  | 7F3-1614T | 7F3-1614N | 7F3-1614A |
| 1.6250 | 1-5/8   | —     | 7F3-1625T | 7F3-1625N | 7F3-1625A |
| 1.6535 | —       | 42,0  | 7F3-1654T | 7F3-1654N | 7F3-1654A |
| 1.6563 | 1-21/32 | —     | 7F3-1656T | 7F3-1656N | 7F3-1656A |
| 1.6875 | 1-11/16 | —     | 7F3-1688T | 7F3-1688N | 7F3-1688A |
| 1.6929 | —       | 43,0  | 7F3-1693T | 7F3-1693N | 7F3-1693A |
| 1.7031 | 1-45/64 | —     | 7F3-1703T | 7F3-1703N | 7F3-1703A |
| 1.7188 | 1-23/32 | —     | 7F3-1719T | 7F3-1719N | 7F3-1719A |
| 1.7323 | —       | 44,0  | 7F3-1732T | 7F3-1732N | 7F3-1732A |
| 1.7500 | 1-3/4   | —     | 7F3-1750T | 7F3-1750N | 7F3-1750A |
| 1.7656 | 1-49/64 | —     | 7F3-1766T | 7F3-1766N | 7F3-1766A |
| 1.7717 | —       | 45,0  | 7F3-1772T | 7F3-1772N | 7F3-1772A |
| 1.7813 | 1-25/32 | —     | 7F3-1781T | 7F3-1781N | 7F3-1781A |
| 1.7930 | SAE #24 | —     | 7F3-1793T | 7F3-1793N | 7F3-1793A |
| 1.8110 | —       | 46,0  | 7F3-1811T | 7F3-1811N | 7F3-1811A |
| 1.8125 | 1-13/16 | —     | 7F3-1813T | 7F3-1813N | 7F3-1813A |
| 1.8281 | 1-53/64 | —     | 7F3-1828T | 7F3-1828N | 7F3-1828A |
| 1.8438 | 1-27/32 | —     | 7F3-1844T | 7F3-1844N | 7F3-1844A |
| 1.8504 | —       | 47,0  | 7F3-1850T | 7F3-1850N | 7F3-1850A |
| 1.8750 | 1-7/8   | —     | 7F3-1875T | 7F3-1875N | 7F3-1875A |

## Series 4: 1.880" through 2.570"

|        |         |      |           |           |           |
|--------|---------|------|-----------|-----------|-----------|
| 1.8800 | —       | —    | 7F4-1880T | 7F4-1880N | 7F4-1880A |
| 1.8898 | —       | 48,0 | 7F4-1890T | 7F4-1890N | 7F4-1890A |
| 1.9063 | 1-29/32 | —    | 7F4-1906T | 7F4-1906N | 7F4-1906A |
| 1.9291 | —       | 49,0 | 7F4-1929T | 7F4-1929N | 7F4-1929A |

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# T-15 HSS Spade Blades



| Decimal Size                                       | Inch Size | Metric Size | TiN Coated EDP Number | TiCN Coated EDP Number | TiAlN Coated EDP Number |
|----------------------------------------------------|-----------|-------------|-----------------------|------------------------|-------------------------|
| <b>(continued) Series 4: 1.880" through 2.570"</b> |           |             |                       |                        |                         |
| 1.9375                                             | 1-15/16   | —           | 7F4-1938T             | 7F4-1938N              | 7F4-1938A               |
| 1.9688                                             | 1-31/32   | —           | 7F4-1969T             | 7F4-1969N              | 7F4-1969A               |
| 2.0000                                             | 2         | —           | 7F4-2000T             | 7F4-2000N              | 7F4-2000A               |
| 2.0079                                             | —         | 51,0        | 7F4-2008T             | 7F4-2008N              | 7F4-2008A               |
| 2.0156                                             | 2-1/64    | —           | 7F4-2016T             | 7F4-2016N              | 7F4-2016A               |
| 2.0313                                             | 2-1/32    | —           | 7F4-2031T             | 7F4-2031N              | 7F4-2031A               |
| 2.0472                                             | —         | 52,0        | 7F4-2047T             | 7F4-2047N              | 7F4-2047A               |
| 2.0625                                             | 2-1/16    | —           | 7F4-2063T             | 7F4-2063N              | 7F4-2063A               |
| 2.0866                                             | —         | 53,0        | 7F4-2087T             | 7F4-2087N              | 7F4-2087A               |
| 2.0938                                             | 2-3/32    | —           | 7F4-2094T             | 7F4-2094N              | 7F4-2094A               |
| 2.1250                                             | 2-1/8     | —           | 7F4-2125T             | 7F4-2125N              | 7F4-2125A               |
| 2.1260                                             | —         | 54,0        | 7F4-2126T             | 7F4-2126N              | 7F4-2126A               |
| 2.1563                                             | 2-5/32    | —           | 7F4-2156T             | 7F4-2156N              | 7F4-2156A               |
| 2.1654                                             | —         | 55,0        | 7F4-2165T             | 7F4-2165N              | 7F4-2165A               |
| 2.1875                                             | 2-3/16    | —           | 7F4-2188T             | 7F4-2188N              | 7F4-2188A               |
| 2.2047                                             | —         | 56,0        | 7F4-2205T             | 7F4-2205N              | 7F4-2205A               |
| 2.2188                                             | 2-7/32    | —           | 7F4-2219T             | 7F4-2219N              | 7F4-2219A               |
| 2.2441                                             | —         | 57,0        | 7F4-2244T             | 7F4-2244N              | 7F4-2244A               |
| 2.2500                                             | 2-1/4     | —           | 7F4-2250T             | 7F4-2250N              | 7F4-2250A               |
| 2.2559                                             | —         | 57,3        | 7F4-2256T             | 7F4-2256N              | 7F4-2256A               |
| 2.2813                                             | 2-9/32    | —           | 7F4-2281T             | 7F4-2281N              | 7F4-2281A               |
| 2.2835                                             | —         | 58,0        | 7F4-2284T             | 7F4-2284N              | 7F4-2284A               |
| 2.3125                                             | 2-5/16    | —           | 7F4-2313T             | 7F4-2313N              | 7F4-2313A               |
| 2.3228                                             | —         | 59,0        | 7F4-2323T             | 7F4-2323N              | 7F4-2323A               |
| 2.3438                                             | 2-11/32   | —           | 7F4-2344T             | 7F4-2344N              | 7F4-2344A               |
| 2.3622                                             | —         | 60,0        | 7F4-2362T             | 7F4-2362N              | 7F4-2362A               |
| 2.3750                                             | 2-3/8     | —           | 7F4-2375T             | 7F4-2375N              | 7F4-2375A               |
| 2.3906                                             | 2-25/64   | —           | 7F4-2391T             | 7F4-2391N              | 7F4-2391A               |
| 2.4016                                             | —         | 61,0        | 7F4-2402T             | 7F4-2402N              | 7F4-2402A               |
| 2.4063                                             | 2-13/32   | —           | 7F4-2406T             | 7F4-2406N              | 7F4-2406A               |
| 2.4375                                             | 2-7/16    | —           | 7F4-2438T             | 7F4-2438N              | 7F4-2438A               |
| 2.4409                                             | —         | 62,0        | 7F4-2441T             | 7F4-2441N              | 7F4-2441A               |
| 2.4688                                             | 2-15/32   | —           | 7F4-2469T             | 7F4-2469N              | 7F4-2469A               |
| 2.4803                                             | —         | 63,0        | 7F4-2480T             | 7F4-2480N              | 7F4-2480A               |
| 2.5000                                             | 2-1/2     | —           | 7F4-2500T             | 7F4-2500N              | 7F4-2500A               |
| 2.5197                                             | —         | 64,0        | 7F4-2520T             | 7F4-2520N              | 7F4-2520A               |
| 2.5313                                             | 2-17/32   | —           | 7F4-2531T             | 7F4-2531N              | 7F4-2531A               |
| 2.5591                                             | —         | 65,0        | 7F4-2559T             | 7F4-2559N              | 7F4-2559A               |
| 2.5625                                             | 2-9/16    | —           | 7F4-2563T             | 7F4-2563N              | 7F4-2563A               |
| <b>Series 5: 2.500" through 3.000"</b>             |           |             |                       |                        |                         |
| 2.5000                                             | 2-1/2     | —           | 7F5-2500T             | 7F5-2500N              | 7F5-2500A               |
| 2.5197                                             | —         | 64,0        | 7F5-2520T             | 7F5-2520N              | 7F5-2520A               |
| 2.5313                                             | 2-17/32   | —           | 7F5-2531T             | 7F5-2531N              | 7F5-2531A               |
| 2.5625                                             | 2-9/16    | —           | 7F5-2563T             | 7F5-2563N              | 7F5-2563A               |
| 2.5984                                             | —         | 66,0        | 7F5-2598T             | 7F5-2598N              | 7F5-2598A               |
| 2.6250                                             | 2-5/8     | —           | 7F5-2625T             | 7F5-2625N              | 7F5-2625A               |
| 2.6563                                             | 2-21/32   | —           | 7F5-2656T             | 7F5-2656N              | 7F5-2656A               |
| 2.6772                                             | —         | 68,0        | 7F5-2677T             | 7F5-2677N              | 7F5-2677A               |
| 2.6875                                             | 2-11/16   | —           | 7F5-2688T             | 7F5-2688N              | 7F5-2688A               |
| 2.7188                                             | 2-23/32   | —           | 7F5-2719T             | 7F5-2719N              | 7F5-2719A               |
| 2.7500                                             | 2-3/4     | —           | 7F5-2750T             | 7F5-2750N              | 7F5-2750A               |
| 2.7559                                             | —         | 70,0        | 7F5-2756T             | 7F5-2756N              | 7F5-2756A               |
| 2.7813                                             | 2-25/32   | —           | 7F5-2781T             | 7F5-2781N              | 7F5-2781A               |
| 2.8125                                             | 2-13/16   | —           | 7F5-2813T             | 7F5-2813N              | 7F5-2813A               |

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| Decimal Size | Inch Size | Metric Size | TiN Coated EDP Number | TiCN Coated EDP Number | TiAlN Coated EDP Number |
|--------------|-----------|-------------|-----------------------|------------------------|-------------------------|
| 2.8346       | —         | 72,0        | 7F5-2835T             | 7F5-2835N              | 7F5-2835A               |
| 2.8438       | 2-27/32   | —           | 7F5-2844T             | 7F5-2844N              | 7F5-2844A               |
| 2.8750       | 2-7/8     | —           | 7F5-2875T             | 7F5-2875N              | 7F5-2875A               |
| 2.9063       | 2-29/32   | —           | 7F5-2906T             | 7F5-2906N              | 7F5-2906A               |
| 2.9134       | —         | 74,0        | 7F5-2913T             | 7F5-2913N              | 7F5-2913A               |
| 2.9375       | 2-15/16   | —           | 7F5-2938T             | 7F5-2938N              | 7F5-2938A               |
| 2.9688       | 2-31/32   | —           | 7F5-2969T             | 7F5-2969N              | 7F5-2969A               |
| 2.9921       | —         | 76,0        | 7F5-2992T             | 7F5-2992N              | 7F5-2992A               |
| 3.0000       | 3         | —           | 7F5-3000T             | 7F5-3000N              | 7F5-3000A               |

## Series 6: 3.001" through 3.500"

|        |        |      |           |           |           |
|--------|--------|------|-----------|-----------|-----------|
| 3.0625 | 3-1/16 | —    | 7F6-3063T | 7F6-3063N | 7F6-3063A |
| 3.0709 | —      | 78,0 | 7F6-3071T | 7F6-3071N | 7F6-3071A |
| 3.1250 | 3-1/8  | —    | 7F6-3125T | 7F6-3125N | 7F6-3125A |
| 3.1496 | —      | 80,0 | 7F6-3150T | 7F6-3150N | 7F6-3150A |
| 3.1875 | 3-3/16 | —    | 7F6-3188T | 7F6-3188N | 7F6-3188A |
| 3.2283 | —      | 82,0 | 7F6-3228T | 7F6-3228N | 7F6-3228A |
| 3.2500 | 3-1/4  | —    | 7F6-3250T | 7F6-3250N | 7F6-3250A |
| 3.3071 | —      | 84,0 | 7F6-3307T | 7F6-3307N | 7F6-3307A |
| 3.3125 | 3-5/16 | —    | 7F6-3313T | 7F6-3313N | 7F6-3313A |
| 3.3750 | 3-3/8  | —    | 7F6-3375T | 7F6-3375N | 7F6-3375A |
| 3.3858 | —      | 86,0 | 7F6-3386T | 7F6-3386N | 7F6-3386A |
| 3.4375 | 3-7/16 | —    | 7F6-3438T | 7F6-3438N | 7F6-3438A |
| 3.4646 | —      | 88,0 | 7F6-3465T | 7F6-3465N | 7F6-3465A |
| 3.5000 | 3-1/2  | —    | 7F6-3500T | 7F6-3500N | 7F6-3500A |

## Series 7: 3.501" through 4.000"

|        |         |      |           |           |           |
|--------|---------|------|-----------|-----------|-----------|
| 3.5433 | —       | 90,0 | 7F7-3543T | 7F7-3543N | 7F7-3543A |
| 3.5625 | 3-9/16  | —    | 7F7-3563T | 7F7-3563N | 7F7-3563A |
| 3.6250 | 3-5/8   | —    | 7F7-3625T | 7F7-3625N | 7F7-3625A |
| 3.6875 | 3-11/16 | —    | 7F7-3688T | 7F7-3688N | 7F7-3688A |
| 3.7008 | —       | 94,0 | 7F7-3701T | 7F7-3701N | 7F7-3701A |
| 3.7500 | 3-3/4   | —    | 7F7-3750T | 7F7-3750N | 7F7-3750A |
| 3.7795 | —       | 96,0 | 7F7-3780T | 7F7-3780N | 7F7-3780A |
| 3.8125 | 3-13/16 | —    | 7F7-3813T | 7F7-3813N | 7F7-3813A |
| 3.8583 | —       | 98,0 | 7F7-3858T | 7F7-3858N | 7F7-3858A |
| 3.8750 | 3-7/8   | —    | 7F7-3875T | 7F7-3875N | 7F7-3875A |
| 3.9375 | 3-15/16 | —    | 7F7-3938T | 7F7-3938N | 7F7-3938A |
| 4.0000 | 4       | —    | 7F7-4000T | 7F7-4000N | 7F7-4000A |

## Series 8: 4.001" through 4.500"

|        |        |       |           |           |           |
|--------|--------|-------|-----------|-----------|-----------|
| 4.0625 | 4-1/16 | —     | 7F8-4063T | 7F8-4063N | 7F8-4063A |
| 4.0945 | —      | 104,0 | 7F8-4095T | 7F8-4095N | 7F8-4095A |
| 4.1250 | 4-1/8  | —     | 7F8-4125T | 7F8-4125N | 7F8-4125A |
| 4.1875 | 4-3/16 | —     | 7F8-4188T | 7F8-4188N | 7F8-4188A |
| 4.2500 | 4-1/4  | —     | 7F8-4250T | 7F8-4250N | 7F8-4250A |
| 4.3125 | 4-5/16 | —     | 7F8-4313T | 7F8-4313N | 7F8-4313A |
| 4.3750 | 4-3/8  | —     | 7F8-4375T | 7F8-4375N | 7F8-4375A |
| 4.4094 | —      | 112,0 | 7F8-4409T | 7F8-4409N | 7F8-4409A |
| 4.4375 | 4-7/16 | —     | 7F8-4438T | 7F8-4438N | 7F8-4438A |
| 4.5000 | 4-1/2  | —     | 7F8-4500T | 7F8-4500N | 7F8-4500A |

## Blade Sets for R-8 (Bridgeport) Holders

- Series 0 TiN Coated Spade Blade Set C53100  
10 sizes: 33/64, 17/32, 35/64, 9/16, 37/64, 19/32, 39/64, 5/8, 21/32, 11/16
- Series 1 TiN Coated Spade Blade Set C53101  
10 sizes: 45/64, 23/32, 3/4, 49/64, 25/32, 13/16, 27/32, 7/8, 29/32, 15/16
- Series 2 TiN Coated Spade Blade Set C53102  
10 sizes: 31/32, 63/64, 1, 1-1/32, 1-1/16, 1-1/8, 1-5/32, 1-3/16, 1-1/4, 1-3/8





## Recommended Starting Speeds (SFM) and Feeds (IPR) — Carbide Blades

| MATERIAL                                                                 |           | SPEEDS (SFM)<br>Coatings |       |      |         |      | FEED (IPR)       |       |                      |                      |                      |                      |
|--------------------------------------------------------------------------|-----------|--------------------------|-------|------|---------|------|------------------|-------|----------------------|----------------------|----------------------|----------------------|
|                                                                          |           |                          |       |      |         |      | Series/Diameters |       |                      |                      |                      |                      |
|                                                                          |           | Hardness                 |       |      |         |      |                  | Y & Z | 0                    | 1                    | 2                    | 3                    |
|                                                                          |           |                          |       |      |         |      |                  |       | 0.375<br>to<br>0.508 | 0.509<br>to<br>0.690 | 0.691<br>to<br>0.960 | 0.961<br>to<br>1.380 |
| Bhn                                                                      | TiN       | TiCNor<br>TiN/TiCN       | TiAlN | CX-H | Diamond |      |                  |       |                      |                      |                      |                      |
| Low Carbon Steel<br>1010, 1020, 1025,<br>1522, etc.                      | 85 – 125  | 300                      | 375   | NR   | 375     | NR   | .009             | .011  | .014                 | .017                 | .020                 |                      |
|                                                                          | 125 – 175 | 275                      | 325   | NR   | 325     | NR   | .008             | .010  | .014                 | .016                 | .019                 |                      |
|                                                                          | 175 – 225 | 225                      | 275   | NR   | NR      | NR   | .007             | .010  | .013                 | .016                 | .018                 |                      |
|                                                                          | 225 – 275 | 190                      | 240   | 275  | NR      | NR   | .006             | .009  | .012                 | .014                 | .017                 |                      |
| Free Machining Steel<br>1118, 1215, 12L14, etc.                          | 100 – 150 | 325                      | 375   | NR   | NR      | NR   | .010             | .012  | .016                 | .019                 | .023                 |                      |
|                                                                          | 150 – 200 | 275                      | 350   | NR   | NR      | NR   | .009             | .011  | .014                 | .018                 | .021                 |                      |
|                                                                          | 200 – 250 | 250                      | 325   | NR   | NR      | NR   | .008             | .010  | .013                 | .017                 | .020                 |                      |
| Medium Carbon Steel<br>1030, 1040, 1050, 1527,<br>1140, 1144, 1151, etc. | 125 – 175 | 250                      | 300   | NR   | NR      | NR   | .008             | .010  | .013                 | .016                 | .019                 |                      |
|                                                                          | 175 – 225 | 210                      | 260   | NR   | NR      | NR   | .007             | .009  | .012                 | .015                 | .019                 |                      |
|                                                                          | 225 – 275 | 175                      | 230   | 275  | NR      | NR   | .007             | .009  | .011                 | .014                 | .018                 |                      |
|                                                                          | 275 – 325 | 150                      | 200   | 240  | NR      | NR   | .006             | .008  | .010                 | .013                 | .016                 |                      |
| Alloy Steel<br>4140, 5140, 8640, etc.                                    | 125 – 175 | 250                      | 275   | NR   | NR      | NR   | .008             | .009  | .012                 | .015                 | .018                 |                      |
|                                                                          | 175 – 225 | 225                      | 250   | NR   | NR      | NR   | .007             | .009  | .012                 | .014                 | .017                 |                      |
|                                                                          | 225 – 275 | 200                      | 230   | 275  | NR      | NR   | .006             | .008  | .011                 | .014                 | .016                 |                      |
|                                                                          | 275 – 325 | 190                      | 220   | 260  | NR      | NR   | .005             | .007  | .010                 | .013                 | .015                 |                      |
|                                                                          | 325 – 375 | 160                      | NR    | 225  | NR      | NR   | .005             | .007  | .009                 | .012                 | .015                 |                      |
| High Strength Alloy<br>4340, 4330V, etc.                                 | 225 – 300 | 150                      | 175   | 200  | NR      | NR   | .006             | .009  | .010                 | .012                 | .015                 |                      |
|                                                                          | 300 – 350 | 125                      | 150   | 175  | NR      | NR   | .005             | .008  | .009                 | .011                 | .014                 |                      |
|                                                                          | 350 – 400 | NR                       | NR    | 150  | NR      | NR   | .004             | .007  | .008                 | .010                 | .012                 |                      |
| Structural Steel<br>A36, A285, A516, etc.                                | 100 – 150 | 250                      | 275   | 325  | NR      | NR   | .008             | .011  | .013                 | .015                 | .018                 |                      |
|                                                                          | 150 – 250 | 200                      | 230   | 265  | NR      | NR   | .007             | .009  | .012                 | .013                 | .016                 |                      |
|                                                                          | 250 – 350 | 175                      | 200   | 225  | NR      | NR   | .006             | .008  | .010                 | .012                 | .014                 |                      |
| Tool Steel<br>H-13, H-21,<br>A-4, O-2, S-3, etc                          | 150 – 200 | 160                      | 190   | NR   | NR      | NR   | .007             | .008  | .009                 | .011                 | .013                 |                      |
|                                                                          | 200 – 250 | 110                      | 150   | 175  | NR      | NR   | .006             | .007  | .008                 | .011                 | .013                 |                      |
|                                                                          | 250 – 350 | 75                       | NR    | 135  | NR      | NR   | .005             | .006  | .007                 | .009                 | .011                 |                      |
|                                                                          | 350 – 400 | NR                       | NR    | 95   | NR      | NR   | .004             | .005  | .006                 | .007                 | .009                 |                      |
| Stainless Steel<br>416, 420, 17-4PH, etc.                                | 135 – 185 | 150                      | 175   | 250  | NR      | NR   | .009             | .010  | .013                 | .014                 | .016                 |                      |
|                                                                          | 185 – 275 | NR                       | 150   | 200  | NR      | NR   | .008             | .009  | .012                 | .013                 | .015                 |                      |
|                                                                          | 275 – 350 | NR                       | 100   | 150  | NR      | NR   | .007             | .008  | .011                 | .012                 | .014                 |                      |
| Cast Iron<br>Gray, Ductile,<br>Nodular                                   | 120 – 150 | 300                      | 400   | 450  | 400     | NR   | .009             | .013  | .017                 | .020                 | .024                 |                      |
|                                                                          | 150 – 200 | 275                      | 350   | 400  | 350     | NR   | .008             | .012  | .016                 | .019                 | .022                 |                      |
|                                                                          | 200 – 220 | 225                      | 300   | 350  | 300     | NR   | .008             | .011  | .014                 | .018                 | .020                 |                      |
|                                                                          | 220 – 260 | 200                      | 275   | 325  | 300     | NR   | .007             | .011  | .013                 | .016                 | .018                 |                      |
|                                                                          | 260 – 320 | 175                      | 225   | 275  | 250     | NR   | .006             | .009  | .011                 | .014                 | .016                 |                      |
| Aluminum - Wrought                                                       | —         | NR                       | 1300  | NR   | 1300    | 1450 | .010             | .014  | .018                 | .022                 | .024                 |                      |
| Cast                                                                     | —         | NR                       | 850   | NR   | 900     | 1000 | .008             | .013  | .016                 | .020                 | .022                 |                      |
| Copper Alloys                                                            | —         | NR                       | 750   | NR   | 900     | 800  | .009             | .012  | .015                 | .019                 | .021                 |                      |
| High Temp. Alloy                                                         | 140 – 210 | NR                       | 85    | 100  | 90      | NR   | .005             | .007  | .008                 | .010                 | .012                 |                      |
| Hastelloy B,                                                             | 210 – 280 | NR                       | 70    | 85   | NR      | NR   | .005             | .006  | .007                 | .010                 | .012                 |                      |
| Inconel 600, etc.                                                        | 280 – 340 | NR                       | 55    | 70   | NR      | NR   | .004             | .005  | .006                 | .008                 | .010                 |                      |

NR = Not Recommended

Formulas: IPM = RPM x IPR ★ SFM = .262 x RPM x Diameter ★ RPM = SFM x 3.82 ÷ Diameter

## Premium Coatings:

- **TiN** (Titanium Nitride) gives longer tool life and added lubricity, while allowing more aggressive machining of steels.
- **TiCN** (Titanium Carbonitride) is a general purpose coating well suited to machining of mild steel, ductile cast iron and nonferrous materials such as aluminum and copper alloys. TiCN is superior in preventing excessive BUE (built-up edge).
- **"G"** is comprised of more than 20 layers of TiCN and TiAlN with an overcoat of TiN optimized for drilling mild steel and ductile cast iron.
- **TiAlN** (Titanium Aluminum Nitride) a multilayer, mixed phase coating designed for high-speed machining in alloy steels, high temp alloys, gray cast iron and titanium. Performance advantages require TiAlN coated tools to be operated at relatively high speeds, typically 50% greater than other PVD coatings such as TiN.
- **CX-H** is a proprietary coating designed for optimal drilling of abrasive, short chipping nonferrous alloys (e.g. red brass, Al-Si alloys).
- **Diamond** coating is designed for abrasive nonferrous alloys.



| Decimal Size                       | Inch Size | Metric Size | TiN Coating EDP Number | TiCN Coating EDP Number | TiAlN Coating EDP Number |
|------------------------------------|-----------|-------------|------------------------|-------------------------|--------------------------|
| <b>Series Y: .375 through .436</b> |           |             |                        |                         |                          |
| .3740                              | —         | 9,50        | 9CY-0374T              | 9CY-0374N               | 9CY-0374A                |
| .3750                              | 3/8       | —           | 9CY-0375T              | 9CY-0375N               | 9CY-0375A                |
| .3860                              | W         | —           | 9CY-0386T              | 9CY-0386N               | 9CY-0386A                |
| .3890                              | SAE #4    | —           | 9CY-0389T              | 9CY-0389N               | 9CY-0389A                |
| .3906                              | 25/64     | —           | 9CY-0391T              | 9CY-0391N               | 9CY-0391A                |
| .3937                              | —         | 10,0        | 9CY-0394T              | 9CY-0394N               | 9CY-0394A                |
| .4016                              | —         | 10,2        | 9CY-0402T              | 9CY-0402N               | 9CY-0402A                |
| .4063                              | 13/32     | —           | 9CY-0406T              | 9CY-0406N               | 9CY-0406A                |
| .4134                              | —         | 10,5        | 9CY-0413T              | 9CY-0413N               | 9CY-0413A                |
| .4219                              | 27/64     | —           | 9CY-0422T              | 9CY-0422N               | 9CY-0422A                |
| .4252                              | —         | 10,8        | 9CY-0425T              | 9CY-0425N               | 9CY-0425A                |
| .4313                              | —         | 11,0        | 9CY-0433T              | 9CY-0433N               | 9CY-0433A                |
| <b>Series Z: .437 through .508</b> |           |             |                        |                         |                          |
| .4375                              | 7/16      | —           | 9CZ-0438T              | 9CZ-0438N               | 9CZ-0438A                |
| .4520                              | SAE #5    | —           | 9CZ-0452T              | 9CZ-0452N               | 9CZ-0452A                |
| .4531                              | 29/64     | —           | 9CZ-0453T              | 9CZ-0453N               | 9CZ-0453A                |
| .4688                              | 15/32     | —           | 9CZ-0469T              | 9CZ-0469N               | 9CZ-0469A                |
| .4724                              | —         | 12,0        | 9CZ-0472T              | 9CZ-0472N               | 9CZ-0472A                |
| .4844                              | 31/64     | —           | 9CZ-0484T              | 9CZ-0484N               | 9CZ-0484A                |
| .4921                              | —         | 12,5        | 9CZ-0492T              | 9CZ-0492N               | 9CZ-0492A                |
| .5000                              | 1/2       | —           | 9CZ-0500T              | 9CZ-0500N               | 9CZ-0500A                |
| <b>Series 0: .509 through .690</b> |           |             |                        |                         |                          |
| .5090                              | SAE #6    | —           | 9C0-0509T              | 9C0-0509N               | 9C0-0509A                |
| .5118                              | —         | 13,0        | 9C0-0512T              | 9C0-0512N               | 9C0-0512A                |
| .5156                              | 33/64     | —           | 9C0-0516T              | 9C0-0516N               | 9C0-0516A                |
| .5313                              | 17/32     | —           | 9C0-0531T              | 9C0-0531N               | 9C0-0531A                |
| .5469                              | 35/64     | —           | 9C0-0547T              | 9C0-0547N               | 9C0-0547A                |
| .5512                              | —         | 14,0        | 9C0-0551T              | 9C0-0551N               | 9C0-0551A                |
| .5625                              | 9/16      | —           | 9C0-0563T              | 9C0-0563N               | 9C0-0563A                |
| .5706                              | —         | 14,5        | 9C0-0571T              | 9C0-0571N               | 9C0-0571A                |
| .5781                              | 37/64     | —           | 9C0-0578T              | 9C0-0578N               | 9C0-0578A                |
| .5909                              | —         | 15,0        | 9C0-0591T              | 9C0-0591N               | 9C0-0591A                |
| .5938                              | 19/32     | —           | 9C0-0594T              | 9C0-0594N               | 9C0-0594A                |
| .6094                              | 39/64     | —           | 9C0-0609T              | 9C0-0609N               | 9C0-0609A                |
| .6102                              | —         | 15,5        | 9C0-0610T              | 9C0-0610N               | 9C0-0610A                |
| .6250                              | 5/8       | —           | 9C0-0625T              | 9C0-0625N               | 9C0-0625A                |
| .6299                              | —         | 16,0        | 9C0-0630T              | 9C0-0630N               | 9C0-0630A                |
| .6406                              | 41/64     | —           | 9C0-0641T              | 9C0-0641N               | 9C0-0641A                |
| .6496                              | —         | 16,5        | 9C0-0650T              | 9C0-0650N               | 9C0-0650A                |
| .6563                              | 21/32     | —           | 9C0-0656T              | 9C0-0656N               | 9C0-0656A                |
| .6693                              | —         | 17,0        | 9C0-0669T              | 9C0-0669N               | 9C0-0669A                |
| .6719                              | 43/64     | —           | 9C0-0672T              | 9C0-0672N               | 9C0-0672A                |
| .6875                              | 11/16     | —           | 9C0-0688T              | 9C0-0688N               | 9C0-0688A                |
| .6890                              | SAE #8    | 17,5        | 9C0-0689T              | 9C0-0689N               | 9C0-0689A                |
| <b>Series 1: .691 through .960</b> |           |             |                        |                         |                          |
| .7031                              | 45/64     | —           | 9C1-0703T              | 9C1-0703N               | 9C1-0703A                |
| .7087                              | —         | 18,0        | 9C1-0709T              | 9C1-0709N               | 9C1-0709A                |
| .7188                              | 23/32     | —           | 9C1-0719T              | 9C1-0719N               | 9C1-0719A                |
| .7283                              | —         | 18,5        | 9C1-0728T              | 9C1-0728N               | 9C1-0728A                |
| .7344                              | 47/64     | —           | 9C1-0734T              | 9C1-0734N               | 9C1-0734A                |
| .7480                              | —         | 19,0        | 9C1-0748T              | 9C1-0748N               | 9C1-0748A                |
| .7500                              | 3/4       | —           | 9C1-0750T              | 9C1-0750N               | 9C1-0750A                |
| .7656                              | 49/64     | —           | 9C1-0766T              | 9C1-0766N               | 9C1-0766A                |

continued on next page



# Carbide Spade Blades



| Decimal Size                                     | Inch Size | Metric Size | TiN Coating EDP Number | TiCN Coating EDP Number | TiAlN Coating EDP Number |
|--------------------------------------------------|-----------|-------------|------------------------|-------------------------|--------------------------|
| <b>(continued) Series 1: .691" through .960"</b> |           |             |                        |                         |                          |
| .7677                                            | —         | 19,5        | 9C1-0768T              | 9C1-0768N               | 9C1-0768A                |
| .7813                                            | 25/32     | —           | 9C1-0781T              | 9C1-0781N               | 9C1-0781A                |
| .7874                                            | —         | 20,0        | 9C1-0787T              | 9C1-0787N               | 9C1-0787A                |
| .7969                                            | 51/64     | —           | 9C1-0797T              | 9C1-0797N               | 9C1-0797A                |
| .8060                                            | SAE #10   | —           | 9C1-0806T              | 9C1-0806N               | 9C1-0806A                |
| .8071                                            | —         | 20,5        | 9C1-0807T              | 9C1-0807N               | 9C1-0807A                |
| .8125                                            | 13/16     | —           | 9C1-0813T              | 9C1-0813N               | 9C1-0813A                |
| .8268                                            | —         | 21,0        | 9C1-0827T              | 9C1-0827N               | 9C1-0827A                |
| .8438                                            | 27/32     | —           | 9C1-0844T              | 9C1-0844N               | 9C1-0844A                |
| .8594                                            | 55/64     | —           | 9C1-0859T              | 9C1-0859N               | 9C1-0859A                |
| .8661                                            | —         | 22,0        | 9C1-0866T              | 9C1-0866N               | 9C1-0866A                |
| .8750                                            | 7/8       | —           | 9C1-0875T              | 9C1-0875N               | 9C1-0875A                |
| .8906                                            | 57/64     | —           | 9C1-0891T              | 9C1-0891N               | 9C1-0891A                |
| .9063                                            | 29/32     | —           | 9C1-0906T              | 9C1-0906N               | 9C1-0906A                |
| .9219                                            | 59/64     | —           | 9C1-0922T              | 9C1-0922N               | 9C1-0922A                |
| .9375                                            | 15/16     | —           | 9C1-0938T              | 9C1-0938N               | 9C1-0938A                |
| .9449                                            | —         | 24,0        | 9C1-0945T              | 9C1-0945N               | 9C1-0945A                |
| <b>Series 2: .961" through 1.380"</b>            |           |             |                        |                         |                          |
| .9688                                            | 31/32     | —           | 9C2-0969T              | 9C2-0969N               | 9C2-0969A                |
| .9810                                            | SAE #12   | —           | 9C2-0981T              | 9C2-0981N               | 9C2-0981A                |
| .9843                                            | —         | 25,0        | 9C2-0984T              | 9C2-0984N               | 9C2-0984A                |
| 1.0000                                           | 1         | —           | 9C2-1000T              | 9C2-1000N               | 9C2-1000A                |
| 1.0156                                           | 1-1/64    | —           | 9C2-1016T              | 9C2-1016N               | 9C2-1016A                |
| 1.0236                                           | —         | 26,0        | 9C2-1024T              | 9C2-1024N               | 9C2-1024A                |
| 1.0313                                           | 1-1/32    | —           | 9C2-1031T              | 9C2-1031N               | 9C2-1031A                |
| 1.0625                                           | 1-1/16    | —           | 9C2-1063T              | 9C2-1063N               | 9C2-1063A                |
| 1.0938                                           | 1-3/32    | —           | 9C2-1094T              | 9C2-1094N               | 9C2-1094A                |
| 1.1024                                           | —         | 28,0        | 9C2-1102T              | 9C2-1102N               | 9C2-1102A                |
| 1.1060                                           | SAE #14   | —           | 9C2-1106T              | 9C2-1106N               | 9C2-1106A                |
| 1.1250                                           | 1-1/8     | —           | 9C2-1125T              | 9C2-1125N               | 9C2-1125A                |
| 1.1417                                           | —         | 29,0        | 9C2-1142T              | 9C2-1142N               | 9C2-1142A                |
| 1.1563                                           | 1-5/32    | —           | 9C2-1156T              | 9C2-1156N               | 9C2-1156A                |
| 1.1614                                           | —         | 29,5        | 9C2-1161T              | 9C2-1161N               | 9C2-1161A                |
| 1.1811                                           | —         | 30,0        | 9C2-1181T              | 9C2-1181N               | 9C2-1181A                |
| 1.1875                                           | 1-3/16    | —           | 9C2-1188T              | 9C2-1188N               | 9C2-1188A                |
| 1.2008                                           | —         | 30,5        | 9C2-1201T              | 9C2-1201N               | 9C2-1201A                |
| 1.2188                                           | 1-7/32    | —           | 9C2-1219T              | 9C2-1219N               | 9C2-1219A                |
| 1.2205                                           | —         | 31,0        | 9C2-1221T              | 9C2-1221N               | 9C2-1221A                |
| 1.2310                                           | SAE #16   | —           | 9C2-1231T              | 9C2-1231N               | 9C2-1231A                |
| 1.2500                                           | 1-1/4     | —           | 9C2-1250T              | 9C2-1250N               | 9C2-1250A                |
| 1.2598                                           | —         | 32,0        | 9C2-1260T              | 9C2-1260N               | 9C2-1260A                |
| 1.2813                                           | 1-9/32    | —           | 9C2-1281T              | 9C2-1281N               | 9C2-1281A                |
| 1.2992                                           | —         | 33,0        | 9C2-1299T              | 9C2-1299N               | 9C2-1299A                |
| 1.3125                                           | 1-5/16    | —           | 9C2-1313T              | 9C2-1313N               | 9C2-1313A                |
| 1.3386                                           | —         | 34,0        | 9C2-1339T              | 9C2-1339N               | 9C2-1339A                |
| 1.3438                                           | 1-11/32   | —           | 9C2-1344T              | 9C2-1344N               | 9C2-1344A                |
| 1.3750                                           | 1-3/8     | —           | 9C2-1375T              | 9C2-1375N               | 9C2-1375A                |
| 1.3780                                           | —         | 35,0        | 9C2-1378T              | 9C2-1378N               | 9C2-1378A                |
| <b>Series 3: 1.381" through 1.879"</b>           |           |             |                        |                         |                          |
| 1.5430                                           | SAE #20   | —           | 9C3-1543T              | 9C3-1543N               | 9C3-1543A                |
| 1.7930                                           | SAE #24   | —           | 9C3-1793T              | 9C3-1793N               | 9C3-1793A                |



| Max/<br>Drill Depth | Body<br>Length | Overall<br>Length | Shank<br>Diameter | Shank<br>Length | Pipe<br>Tap | Straight Flute<br>EDP Number | Helical Flute<br>EDP Number |
|---------------------|----------------|-------------------|-------------------|-----------------|-------------|------------------------------|-----------------------------|
|---------------------|----------------|-------------------|-------------------|-----------------|-------------|------------------------------|-----------------------------|

## Holdings with Straight Shanks



|                                          |       |       |      |       |     |         |         |
|------------------------------------------|-------|-------|------|-------|-----|---------|---------|
| <b>Series X: .375" through .436"</b>     |       |       |      |       |     |         |         |
| 1.09                                     | 1.59  | 3.97  | 0.75 | 2.375 | 1/8 | 7SXSS   | —       |
| 2.19                                     | 2.68  | 5.06  | 0.75 | 2.375 | 1/8 | 7SXSM   | —       |
| 4.38                                     | 4.87  | 7.25  | 0.75 | 2.375 | 1/8 | 7SXSE   | —       |
| <b>Series Z: .437" through .508"</b>     |       |       |      |       |     |         |         |
| 1.58                                     | 3.37  | 5.75  | 0.75 | 2.375 | 1/8 | 7SZSS   | 7HZSS   |
| 2.59                                     | 4.38  | 6.76  | 0.75 | 2.375 | 1/8 | 7SZSM   | 7HZSM   |
| 3.59                                     | 5.38  | 7.76  | 0.75 | 2.375 | 1/8 | 7SZSL   | 7HZSL   |
| 4.46                                     | 6.25  | 8.63  | 0.75 | 2.375 | 1/8 | 7SZSE   | 7HZSE   |
| <b>Series 0: .509" through .690"</b>     |       |       |      |       |     |         |         |
| 2.18                                     | 3.97  | 6.35  | 0.75 | 2.375 | 1/8 | 7S0SS   | 7H0SS   |
| 3.44                                     | 5.33  | 7.71  | 0.75 | 2.375 | 1/8 | 7S0SM   | 7H0SM   |
| 4.86                                     | 6.75  | 9.13  | 0.75 | 2.375 | 1/8 | 7S0SL   | 7H0SL   |
| 7.90                                     | 9.80  | 12.17 | 0.75 | 2.375 | 1/8 | 7S0SE   | 7H0SE   |
| <b>Series 0.5: .609" through .690"</b>   |       |       |      |       |     |         |         |
| 1.98                                     | 3.97  | 6.35  | 0.75 | 2.375 | 1/4 | 7S0.5SS | 7H0.5SS |
| 3.34                                     | 5.33  | 7.71  | 0.75 | 2.375 | 1/4 | 7S0.5SM | 7H0.5SM |
| 4.76                                     | 6.75  | 9.13  | 0.75 | 2.375 | 1/4 | 7S0.5SL | 7H0.5SL |
| 7.80                                     | 9.80  | 12.17 | 0.75 | 2.375 | 1/4 | 7S0.5SE | 7H0.5SE |
| <b>Series 1: .690" through .960"</b>     |       |       |      |       |     |         |         |
| 2.76                                     | 4.85  | 7.23  | 1.00 | 2.375 | 1/4 | 7S1SS   | 7H1SS   |
| 4.71                                     | 6.80  | 9.18  | 1.00 | 2.375 | 1/4 | 7S1SM   | 7H1SM   |
| 6.63                                     | 8.72  | 11.10 | 1.00 | 2.375 | 1/4 | 7S1SL   | 7H1SL   |
| 10.66                                    | 12.75 | 15.12 | 1.00 | 2.375 | 1/4 | 7S1SE   | 7H1SE   |
| <b>Series 1.5: .859" through .960"</b>   |       |       |      |       |     |         |         |
| 2.55                                     | 4.85  | 7.22  | 1.00 | 2.375 | 1/4 | 7S1.5SS | 7H1.5SS |
| 4.80                                     | 6.80  | 9.18  | 1.00 | 2.375 | 1/4 | 7S1.5SM | 7H1.5SM |
| 6.42                                     | 8.72  | 11.10 | 1.00 | 2.375 | 1/4 | 7S1.5SL | 7H1.5SL |
| 10.45                                    | 12.75 | 15.12 | 1.00 | 2.375 | 1/4 | 7S1.5SE | 7H1.5SE |
| <b>Series 2: .961" through 1.380"</b>    |       |       |      |       |     |         |         |
| 3.07                                     | 5.56  | 8.00  | 1.25 | 2.437 | 1/4 | 7S2SS   | 7H2SS   |
| 5.45                                     | 7.94  | 10.38 | 1.25 | 2.437 | 1/4 | 7S2SM   | 7H2SM   |
| 7.82                                     | 10.31 | 12.75 | 1.25 | 2.437 | 1/4 | 7S2SL   | 7H2SL   |
| 10.89                                    | 13.38 | 15.82 | 1.25 | 2.437 | 1/4 | 7S2SE   | 7H2SE   |
| <b>Series 2.5: 1.187" through 1.380"</b> |       |       |      |       |     |         |         |
| 2.88                                     | 5.56  | 8.00  | 1.25 | 2.437 | 1/4 | 7S2.5SS | 7H2.5SS |
| 5.26                                     | 5.56  | 8.00  | 1.25 | 2.437 | 1/4 | 7S2.5SM | 7H2.5SM |
| 7.63                                     | 10.31 | 12.75 | 1.25 | 2.437 | 1/4 | 7S2.5SL | 7H2.5SL |
| 10.70                                    | 13.38 | 15.82 | 1.25 | 2.437 | 1/4 | 7S2.5SE | 7H2.5SE |
| <b>Series 3: 1.381" through 1.879"</b>   |       |       |      |       |     |         |         |
| 4.43                                     | 7.25  | 9.88  | 1.50 | 2.625 | 1/4 | 7S3SS   | 7H3SS   |
| 8.43                                     | 11.25 | 13.88 | 1.50 | 2.625 | 1/4 | 7S3SM   | 7H3SM   |
| 13.18                                    | 16.00 | 18.63 | 1.50 | 2.625 | 1/4 | 7S3SL   | 7H3SL   |



| Max/<br>Drill Depth | Body<br>Length | Overall<br>Length | Shank<br>Diameter | Shank<br>Length | Pipe<br>Tap | Straight Flute<br>EDP Number | Helical Flute<br>EDP Number |
|---------------------|----------------|-------------------|-------------------|-----------------|-------------|------------------------------|-----------------------------|
|---------------------|----------------|-------------------|-------------------|-----------------|-------------|------------------------------|-----------------------------|

## Holdings with Straight Shanks (continued)



### Series 4: 1.880" through 2.570"

|       |       |       |      |       |     |       |       |
|-------|-------|-------|------|-------|-----|-------|-------|
| 5.90  | 8.75  | 11.38 | 1.50 | 2.625 | 1/4 | 7S4SS | 7H4SS |
| 9.90  | 12.75 | 15.38 | 1.50 | 2.625 | 1/4 | 7S4SM | 7H4SM |
| 16.02 | 18.87 | 21.50 | 1.50 | 2.625 | 1/4 | 7S4SL | 7H4SL |

### Series 5: 2.500" through 3.500" holds series 5 + series 6 blades

|       |       |       |      |       |     |       |       |
|-------|-------|-------|------|-------|-----|-------|-------|
| 6.24  | 9.25  | 12.50 | 2.00 | 3.250 | 1/4 | 7S5SS | —     |
| 11.99 | 15.00 | 18.25 | 2.00 | 3.250 | 1/4 | 7S5SM | 7H5SM |
| 17.74 | 20.75 | 24.00 | 2.00 | 3.250 | 1/4 | 7S5SL | 7H5SL |

### Series 7: 3.501 through 4.500" holds series 7 + series 8 blades

|       |       |       |      |       |     |       |   |
|-------|-------|-------|------|-------|-----|-------|---|
| 6.88  | 8.63  | 15.25 | 3.00 | 6.625 | 1/4 | 7S7SS | — |
| 12.25 | 14.63 | 21.25 | 3.00 | 6.625 | 1/4 | 7S7SM | — |
| 19.45 | 22.86 | 29.50 | 3.00 | 6.625 | 1/4 | 7S7SL | — |

## Metric Size Holdings with Straight Shanks

### Series Y: 9,50 through 11,07

|        |        |        |       |       |            |        |  |
|--------|--------|--------|-------|-------|------------|--------|--|
| 31,75  | 69,45  | 119,45 | 20,00 | 50,00 | 1/8-28 BSP | 8SYSS  |  |
| 60,33  | 98,03  | 148,03 | 20,00 | 50,00 | 1/8-28 BSP | 8SYSM  |  |
| 111,13 | 148,83 | 198,83 | 20,00 | 50,00 | 1/8-28 BSP | 8SYSLS |  |

### Series Z: 11,10 through 12,90

|        |        |        |       |       |            |       |  |
|--------|--------|--------|-------|-------|------------|-------|--|
| 31,75  | 69,45  | 119,45 | 20,00 | 50,00 | 1/8-28 BSP | 8SZSS |  |
| 60,33  | 98,03  | 148,03 | 20,00 | 50,00 | 1/8-28 BSP | 8SZSM |  |
| 111,13 | 148,83 | 198,83 | 20,00 | 50,00 | 1/8-28 BSP | 8SZSL |  |

### Series 0: 12,93 through 17,53

|        |        |        |       |       |            |       |  |
|--------|--------|--------|-------|-------|------------|-------|--|
| 34,93  | 73,03  | 123,03 | 20,00 | 50,00 | 1/8-28 BSP | 8S0SS |  |
| 63,50  | 101,60 | 151,60 | 20,00 | 50,00 | 1/8-28 BSP | 8S0SM |  |
| 114,30 | 152,40 | 202,40 | 20,00 | 50,00 | 1/8-28 BSP | 8S0SL |  |

### Series 0.5: 15,47 through 17,53

|        |        |        |       |       |            |         |  |
|--------|--------|--------|-------|-------|------------|---------|--|
| 34,93  | 73,03  | 123,03 | 20,00 | 50,00 | 1/8-28 BSP | 8S0.5SS |  |
| 63,50  | 101,60 | 151,60 | 20,00 | 50,00 | 1/8-28 BSP | 8S0.5SM |  |
| 114,30 | 152,40 | 202,40 | 20,00 | 50,00 | 1/8-28 BSP | 8S0.5SL |  |

### Series 1: 17,54 through 24,38

|        |        |        |       |       |            |       |  |
|--------|--------|--------|-------|-------|------------|-------|--|
| 66,68  | 109,93 | 165,93 | 25,00 | 56,00 | 1/4-19 BSP | 8S1SS |  |
| 117,48 | 160,73 | 216,73 | 25,00 | 56,00 | 1/4-19 BSP | 8S1SM |  |
| 168,28 | 211,53 | 267,53 | 25,00 | 56,00 | 1/4-19 BSP | 8S1SL |  |
| 269,88 | 313,13 | 369,13 | 25,00 | 56,00 | 1/4-19 BSP | 8S1SE |  |

### Series 1.5: 21,82 through 24,38

|        |        |        |       |       |            |         |  |
|--------|--------|--------|-------|-------|------------|---------|--|
| 66,68  | 109,93 | 165,93 | 25,00 | 56,00 | 1/4-19 BSP | 8S1.5SS |  |
| 117,48 | 160,73 | 216,73 | 25,00 | 56,00 | 1/4-19 BSP | 8S1.5SM |  |
| 168,28 | 211,53 | 267,53 | 25,00 | 56,00 | 1/4-19 BSP | 8S1.5SL |  |
| 269,88 | 313,13 | 369,13 | 25,00 | 56,00 | 1/4-19 BSP | 8S1.5SE |  |

continued on next page



| Max/<br>Drill Depth | Body<br>Length | Overall<br>Length | Shank<br>Diameter | Shank<br>Length | Pipe<br>Tap | Straight Flute<br>EDP Number | Helical Flute<br>EDP Number |
|---------------------|----------------|-------------------|-------------------|-----------------|-------------|------------------------------|-----------------------------|
|---------------------|----------------|-------------------|-------------------|-----------------|-------------|------------------------------|-----------------------------|

## Metric Size Holders with Straight Shanks

(continued)

### Series 2: 24,41 through 35,05

|        |        |        |       |       |            |
|--------|--------|--------|-------|-------|------------|
| 85,73  | 130,18 | 190,19 | 32,00 | 60,00 | 1/4-19 BSP |
| 136,53 | 180,98 | 240,98 | 32,00 | 60,00 | 1/4-19 BSP |
| 187,33 | 231,78 | 291,78 | 32,00 | 60,00 | 1/4-19 BSP |
| 288,93 | 333,38 | 393,38 | 32,00 | 60,00 | 1/4-19 BSP |



### Series 2.5: 30,15 through 35,05

|        |        |        |       |       |            |
|--------|--------|--------|-------|-------|------------|
| 85,73  | 132,16 | 192,16 | 32,00 | 60,00 | 1/4-19 BSP |
| 136,53 | 183,36 | 243,36 | 32,00 | 60,00 | 1/4-19 BSP |
| 187,33 | 234,16 | 294,16 | 32,00 | 60,00 | 1/4-19 BSP |
| 288,93 | 335,76 | 395,76 | 32,00 | 60,00 | 1/4-19 BSP |

### Series 3: 35,08 through 47,73

|        |        |        |       |       |            |
|--------|--------|--------|-------|-------|------------|
| 120,65 | 173,04 | 243,04 | 40,00 | 70,00 | 1/4-19 BSP |
| 158,75 | 211,14 | 281,14 | 40,00 | 70,00 | 1/4-19 BSP |
| 209,55 | 261,94 | 331,94 | 40,00 | 70,00 | 1/4-19 BSP |

### Series 4: 47,95 through 65,28

|        |        |        |       |       |            |
|--------|--------|--------|-------|-------|------------|
| 130,18 | 184,94 | 254,94 | 40,00 | 70,00 | 1/4-19 BSP |
| 180,98 | 235,74 | 305,74 | 40,00 | 70,00 | 1/4-19 BSP |
| 231,78 | 286,54 | 356,54 | 40,00 | 70,00 | 1/4-19 BSP |

### Series 5: 63,50 through 88,90 holds series 5 + series 6

|        |        |        |       |       |            |
|--------|--------|--------|-------|-------|------------|
| 171,45 | 227,01 | 307,01 | 50,00 | 80,00 | 1/4-19 BSP |
| 222,25 | 277,81 | 357,81 | 50,00 | 80,00 | 1/4-19 BSP |
| 273,05 | 328,61 | 408,61 | 50,00 | 80,00 | 1/4-19 BSP |

### Series 7: 88,93 through 114,30 holds series 7 + series 8

|        |        |        |       |       |            |
|--------|--------|--------|-------|-------|------------|
| 171,45 | 238,13 | 328,13 | 63,00 | 90,00 | 1/4-19 BSP |
| 222,25 | 288,93 | 378,93 | 63,00 | 90,00 | 1/4-19 BSP |
| 273,05 | 339,73 | 429,73 | 63,00 | 90,00 | 1/4-19 BSP |

## Holdings for R-8 (Bridgeport) Applications

| Max/<br>Drill Depth | Gage<br>Length | Overall<br>Length | Morse<br>Taper | Pipe<br>Tap | Straight Flute<br>EDP Number | Helical Flute<br>EDP Number |
|---------------------|----------------|-------------------|----------------|-------------|------------------------------|-----------------------------|
|---------------------|----------------|-------------------|----------------|-------------|------------------------------|-----------------------------|

### Series 0: .509" through .690"

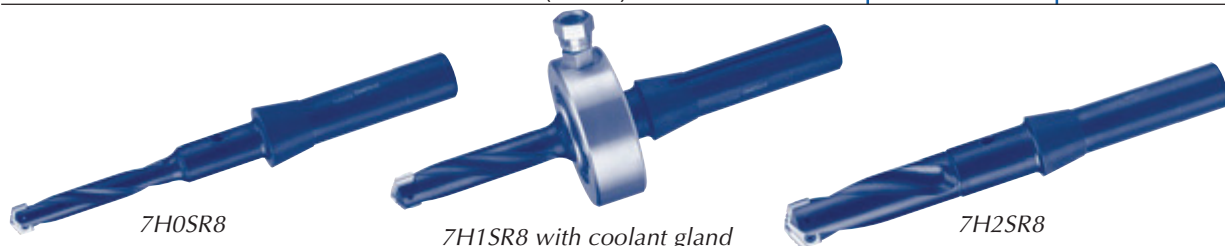
|      |      |      |             |         |   |        |
|------|------|------|-------------|---------|---|--------|
| 3.29 | 5.19 | 9.19 | R8 (16°50') | 1/16-27 | — | 7H0SR8 |
|------|------|------|-------------|---------|---|--------|

### Series 1: .691" through .960"

|      |      |      |             |         |   |        |
|------|------|------|-------------|---------|---|--------|
| 3.34 | 5.19 | 9.19 | R8 (16°50') | 1/16-27 | — | 7H1SR8 |
|------|------|------|-------------|---------|---|--------|

### Series 2: .961" through 1.380"

|      |      |      |             |         |   |        |
|------|------|------|-------------|---------|---|--------|
| 3.32 | 5.19 | 9.19 | R8 (16°50') | 1/16-27 | — | 7H2SR8 |
|------|------|------|-------------|---------|---|--------|





| Max/<br>Drill Depth                      | Gage<br>Length | Overall<br>Length | Morse<br>Taper | Pipe<br>Tap | Straight Flute<br>EDP Number | Helical Flute<br>EDP Number |
|------------------------------------------|----------------|-------------------|----------------|-------------|------------------------------|-----------------------------|
| <b>Holders with Taper Shanks</b>         |                |                   |                |             |                              |                             |
| <b>Series Y: .375" through .436"</b>     |                |                   |                |             |                              |                             |
| 1.39                                     | 3.37           | 6.31              | 2              | 1/8         | 7SYTS                        | 7HYTS                       |
| 2.27                                     | 4.25           | 7.19              | 2              | 1/8         | 7SYTM                        | 7HYTM                       |
| 3.15                                     | 5.13           | 8.07              | 2              | 1/8         | 7SYTL                        | 7HYTL                       |
| 4.46                                     | 6.44           | 9.38              | 2              | 1/8         | 7SYTE                        | 7HYTE                       |
| <b>Series Z: .437" through .508"</b>     |                |                   |                |             |                              |                             |
| 1.58                                     | 3.56           | 6.50              | 2              | 1/8         | 7SZTS                        | 7HZTS                       |
| 2.59                                     | 4.56           | 7.50              | 2              | 1/8         | 7SZTM                        | 7HZTM                       |
| 3.59                                     | 5.57           | 8.51              | 2              | 1/8         | 7SZTL                        | 7HZTL                       |
| 4.46                                     | 6.44           | 9.38              | 2              | 1/8         | 7SZTE                        | 7HZTE                       |
| <b>Series 0: .509" through .695"</b>     |                |                   |                |             |                              |                             |
| 2.18                                     | 4.16           | 7.10              | 2              | 1/8         | 7S0TS                        | 7H0TS                       |
| 3.44                                     | 5.52           | 8.46              | 2              | 1/8         | 7S0TM                        | 7H0TM                       |
| 4.86                                     | 6.94           | 9.88              | 2              | 1/8         | 7S0TL                        | 7H0TL                       |
| 7.90                                     | 10.00          | 12.93             | 2              | 1/8         | 7S0TE                        | 7H0TE                       |
| <b>Series 0.5: .609" through .695"</b>   |                |                   |                |             |                              |                             |
| 1.98                                     | 4.16           | 7.10              | 2              | 1/8         | —                            | —                           |
| 3.34                                     | 5.52           | 8.46              | 2              | 1/8         | —                            | 7H0.5TM                     |
| 4.76                                     | 6.94           | 9.88              | 2              | 1/8         | 7S0.5TL                      | 7H0.5TL                     |
| 7.80                                     | 10.00          | 12.93             | 2              | 1/8         | 7S0.5TE                      | 7H0.5TE                     |
| <b>Series 1: .690" through .960"</b>     |                |                   |                |             |                              |                             |
| 2.76                                     | 5.04           | 8.73              | 3              | 1/4         | 7S1TS                        | 7H1TS                       |
| 4.71                                     | 6.99           | 10.68             | 3              | 1/4         | 7S1TM                        | 7H1TM                       |
| 6.63                                     | 8.91           | 12.60             | 3              | 1/4         | 7S1TL                        | 7H1TL                       |
| 10.66                                    | 12.94          | 16.63             | 3              | 1/4         | 7S1TE                        | 7H1TE                       |
| <b>Series 1.5: .859" through .960"</b>   |                |                   |                |             |                              |                             |
| 2.55                                     | 5.04           | 8.73              | 3              | 1/4         | 7S1.5TS                      | —                           |
| 4.80                                     | 6.99           | 10.68             | 3              | 1/4         | 7S1.5TM                      | —                           |
| 6.42                                     | 8.91           | 12.60             | 3              | 1/4         | —                            | 7H1.5TL                     |
| 10.45                                    | 12.94          | 16.63             | 3              | 1/4         | —                            | 7H1.5TE                     |
| <b>Series 2: .961" through 1.380"</b>    |                |                   |                |             |                              |                             |
| 3.07                                     | 5.75           | 9.44              | 3              | 1/4         | 7S2TS                        | 7H2TS                       |
| 5.45                                     | 8.13           | 11.82             | 3              | 1/4         | 7S2TM                        | 7H2TM                       |
| 7.82                                     | 10.50          | 14.19             | 3              | 1/4         | 7S2TL                        | 7H2TL                       |
| 10.89                                    | 13.57          | 17.26             | 3              | 1/4         | 7S2TE                        | 7H2TE                       |
| <b>Series 2.5: 1.187" through 1.380"</b> |                |                   |                |             |                              |                             |
| 2.88                                     | 5.75           | 9.44              | 3              | 1/4         | 7S2.5TS                      | 7H2.5TS                     |
| 2.88                                     | 5.75           | 9.44              | 4              | 1/4         | 7S2.5TS-4MT                  | —                           |
| 5.26                                     | 8.13           | 11.82             | 3              | 1/4         | —                            | 7H2.5TM                     |
| 5.26                                     | 8.13           | 11.82             | 4              | 1/4         | 7S2.5TM-4MT                  | —                           |
| 7.63                                     | 10.50          | 14.19             | 3              | 1/4         | 7S2.5TL                      | 7H2.5TL                     |
| 7.63                                     | 10.50          | 14.19             | 4              | 1/4         | 7S2.5TL-4MT                  | —                           |
| 10.70                                    | 13.57          | 17.26             | 3              | 1/4         | 7S2.5TE                      | 7H2.5TE                     |

continued on next page



| Max/<br>Drill Depth                                                     | Gage<br>Length | Overall<br>Length | Morse<br>Taper | Pipe<br>Tap | Straight Flute<br>EDP Number | Helical Flute<br>EDP Number |
|-------------------------------------------------------------------------|----------------|-------------------|----------------|-------------|------------------------------|-----------------------------|
| <b>Holders with Taper Shanks (continued)</b>                            |                |                   |                |             |                              |                             |
| <b>Series 3: 1.381" through 1.879"</b>                                  |                |                   |                |             |                              |                             |
| 4.43                                                                    | 7.50           | 12.13             | 4              | 1/4         | 7S3TS                        | 7H3TS                       |
| 8.43                                                                    | 11.50          | 16.13             | 4              | 1/4         | 7S3TM                        | 7H3TM                       |
| 13.18                                                                   | 16.25          | 20.88             | 4              | 1/4         | 7S3TL                        | 7H3TL                       |
| <b>Series 4: 1.880" through 2.570"</b>                                  |                |                   |                |             |                              |                             |
| 5.90                                                                    | 9.00           | 13.62             | 4              | 1/4         | 7S4TS                        | 7H4TS                       |
| 9.90                                                                    | 13.00          | 17.63             | 4              | 1/4         | 7S4TM                        | 7H4TM                       |
| 16.02                                                                   | 19.12          | 23.75             | 4              | 1/4         | 7S4TL                        | 7H4TL                       |
| <b>Series 5: 2.500" through 3.500" holds series 5 + series 6 blades</b> |                |                   |                |             |                              |                             |
| 6.24                                                                    | 9.50           | 15.38             | 5              | 1/4         | 7S5TS                        | —                           |
| 11.99                                                                   | 15.25          | 21.13             | 5              | 1/4         | 7S5TM                        | 7H5TM                       |
| 17.74                                                                   | 21.00          | 26.88             | 5              | 1/4         | 7S5TL                        | 7H5TL                       |
| <b>Series 7: 3.501 through 4.500" holds series 7 + series 8 blades</b>  |                |                   |                |             |                              |                             |
| 6.88                                                                    | 10.41          | 16.28             | 5              | 1/4         | 7S7TS                        | —                           |
| 12.25                                                                   | 16.41          | 22.28             | 5              | 1/4         | 7S7TM                        | —                           |
| 19.45                                                                   | 24.65          | 30.53             | 5              | 1/4         | 7S7TL                        | —                           |

## ACCESSORIES

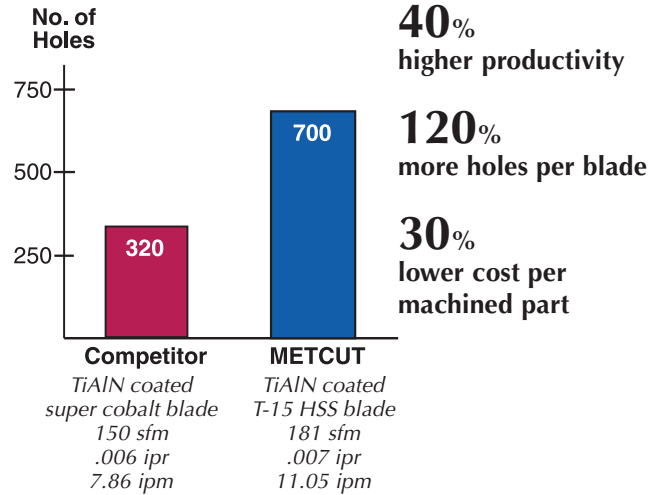
| Holder<br>Series Number | Coolant Gland<br>EDP Number | Locating Pin<br>EDP Number | Torx Screw<br>EDP Number | Torx Wrench<br>EDP Number |
|-------------------------|-----------------------------|----------------------------|--------------------------|---------------------------|
| X                       | —                           | —                          | MS-1454                  | 56-2025                   |
| Y                       | 290-1100                    | SP-1                       | 56-1013                  | 56-2017                   |
| Z                       | 290-1100                    | SP-1                       | 56-1015                  | 56-2026                   |
| 0, 0.5                  | 290-1100<br>290-1075A*      | SP-2                       | 56-1014                  | 56-2017                   |
| 1, 1.5                  | 290-1125<br>290-1100A*      | SP-3                       | 56-1020                  | 56-2028                   |
| 2, 2.5                  | 290-1150<br>290-1100A*      | SP-4                       | 56-1018                  | 56-2015                   |
| 3, 4                    | 290-1175                    | SP-5                       | 56-1585                  | 56-2020                   |
| 5                       | 290-1250                    | SP-6                       | 56-1025                  | 56-2125                   |
| 7                       | 290-1300                    | SP-6                       | 56-1025                  | 56-2125                   |

\* R-8 (Bridgeport) holders only



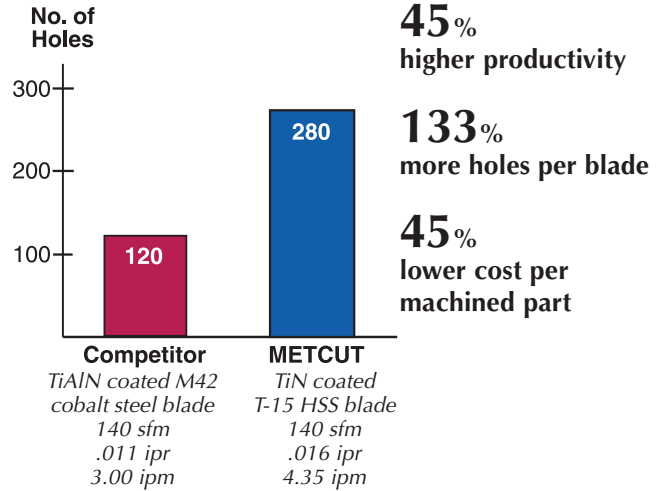
## 1010 Carbon Steel 25 Rc

Drill diameter: 7/16" (.4375") Hole depth: 1.000"



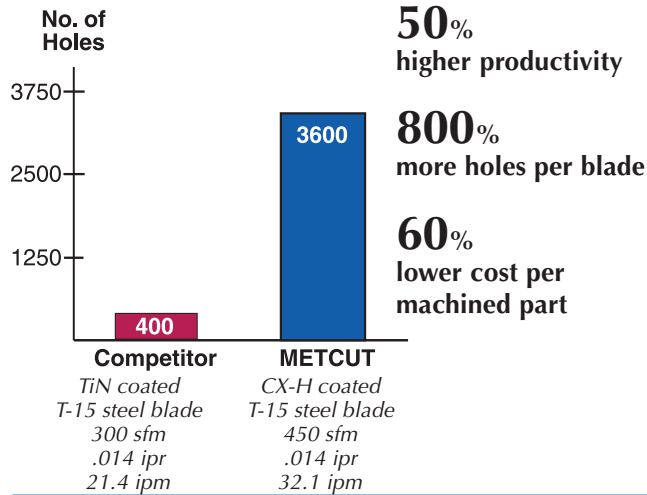
## A-36 Structural Steel 38 Rc

Drill diameter: 1-31/32" (1.9688") Hole depth: 0.6250"



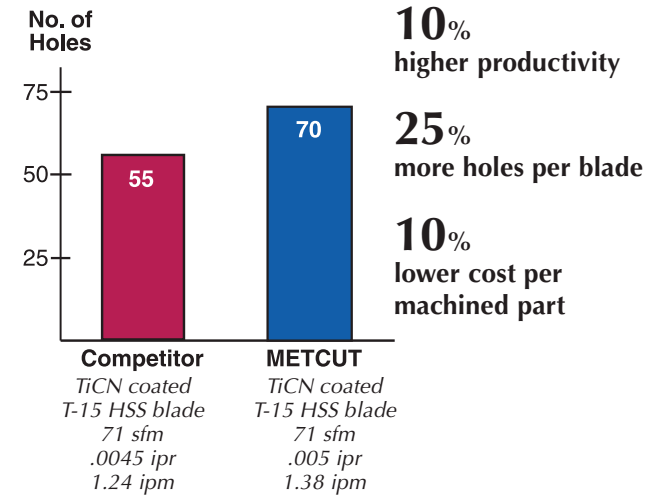
## Red Brass 150 Bhn

Drill diameter: 3/4" (.7500") Hole depth: 1.000"



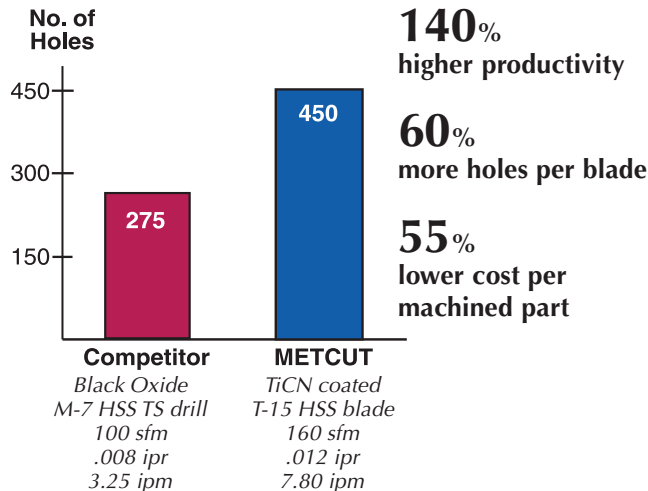
## 15-5 PH Stainless Steel 35 to 38 Rc

Drill diameter: 0.9843" (25.00mm) Hole depth: 5.20"



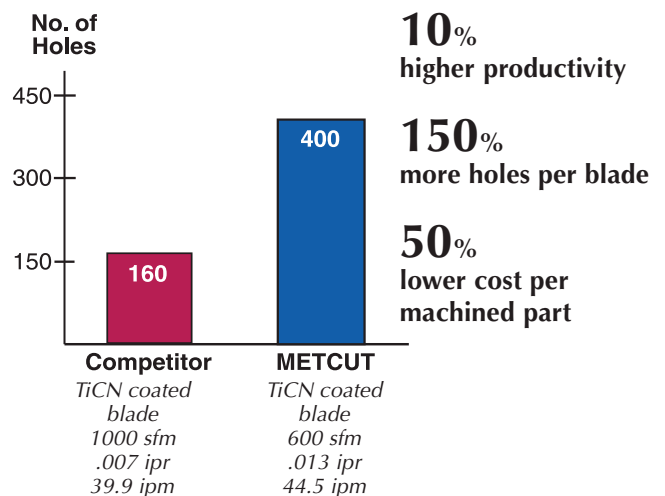
## Structural Iron

Drill diameter: 15/16" (.9375") Hole depth: 2.500"



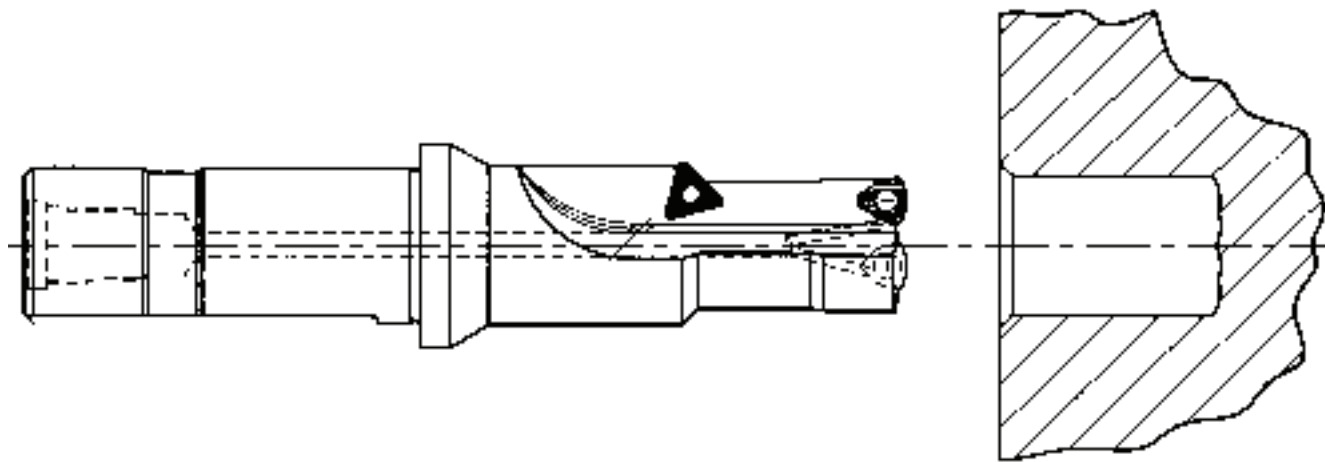
## 6061-T6 Aluminum Alloy

Drill diameter: 17.00mm (.6692") Hole depth: 2.00"

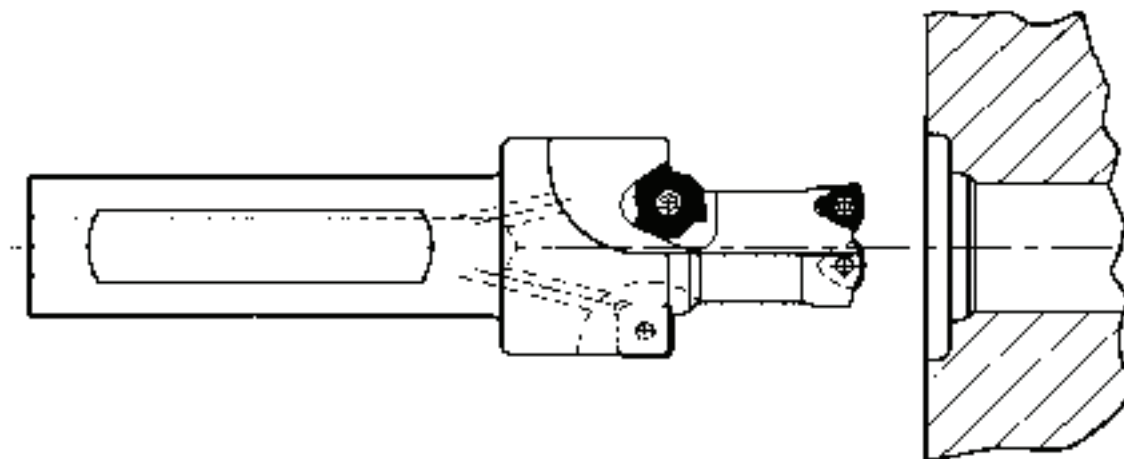


## Examples of Special Drilling and Port Contour Cutting Tools

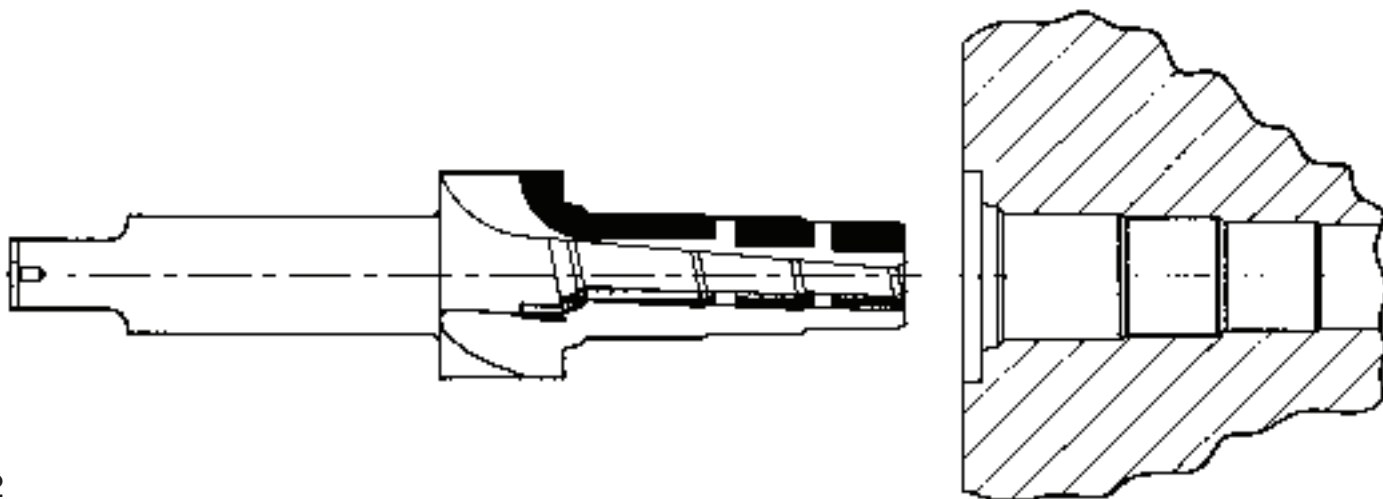
### Drill from Solid and Chamfer Tool



### Drill from Solid and SAE Port Contour Tool

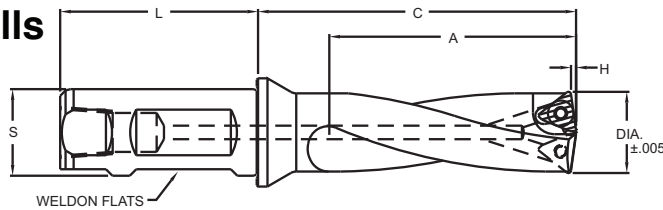


### SAE Port Contour Cutter with Two Extra Bore Diameters



# Indexable Drills

## Double-Feed Drills



| Diameter                           | Part Number     | S<br>Shank<br>Diameter | L<br>Shank<br>Length | C<br>Body<br>Length | A<br>Effective<br>Drilling<br>Depth | H<br>Arc<br>Projection | Inserts<br>(2 req'd)<br>Part Number | Torx<br>Screws<br>(2 req'd)<br>Part Number |
|------------------------------------|-----------------|------------------------|----------------------|---------------------|-------------------------------------|------------------------|-------------------------------------|--------------------------------------------|
| <b>3:1 Depth To Diameter Ratio</b> |                 |                        |                      |                     |                                     |                        |                                     |                                            |
| .8125                              | <b>277-3081</b> | 1.000                  | 2.281                | 3.38                | 2.44                                | .08                    | H-081-HJ                            | 056-1016                                   |
| .8268                              | <b>277-3082</b> | 1.000                  | 2.281                | 3.50                | 2.56                                | .08                    | H-082-HJ                            | 056-1016                                   |
| .8661                              | <b>277-3086</b> | 1.000                  | 2.281                | 3.60                | 2.68                                | .08                    | H-086-HJ                            | 056-1016                                   |
| .8750                              | <b>277-3087</b> | 1.000                  | 2.281                | 3.54                | 2.63                                | .08                    | H-087-HJ                            | 056-1016                                   |
| .9375                              | <b>277-3093</b> | 1.000                  | 2.281                | 3.71                | 2.81                                | .09                    | H-093-HJ                            | 056-1016                                   |
| .9449                              | <b>277-3094</b> | 1.000                  | 2.281                | 3.82                | 2.92                                | .09                    | H-094-HJ                            | 056-1016                                   |
| 1.0000                             | <b>277-3100</b> | 1.000                  | 2.281                | 3.87                | 3.00                                | .09                    | H-100-HJ                            | 056-1020                                   |
| 1.0625                             | <b>277-3106</b> | 1.250                  | 2.281                | 4.28                | 3.19                                | .10                    | H-106-HJ                            | 056-1020                                   |
| 1.1024                             | <b>277-3110</b> | 1.250                  | 2.281                | 4.45                | 3.41                                | .10                    | H-110-HJ                            | 056-1020                                   |
| 1.1250                             | <b>277-3112</b> | 1.250                  | 2.281                | 4.42                | 3.38                                | .10                    | H-112-HJ                            | 056-1020                                   |
| 1.1875                             | <b>277-3118</b> | 1.250                  | 2.281                | 4.61                | 3.56                                | .11                    | H-118-HJ                            | 056-1020                                   |
| 1.2500                             | <b>277-3125</b> | 1.250                  | 2.281                | 4.75                | 3.75                                | .11                    | H-125-HJ                            | 056-1833                                   |
| 1.3125                             | <b>277-3131</b> | 1.500                  | 2.688                | 5.16                | 3.94                                | .13                    | H-131-HJ                            | 056-1833                                   |
| 1.3750                             | <b>277-3137</b> | 1.500                  | 2.688                | 5.29                | 4.13                                | .13                    | H-137-HJ                            | 056-1833                                   |
| 1.4375                             | <b>277-3143</b> | 1.500                  | 2.688                | 5.49                | 4.31                                | .14                    | H-143-HJ                            | 056-1833                                   |
| 1.5000                             | <b>277-3150</b> | 1.500                  | 2.688                | 5.62                | 4.50                                | .14                    | H-150-HJ                            | 056-1833                                   |
| 1.6250                             | <b>277-3162</b> | 1.500                  | 2.688                | 6.01                | 4.88                                | .15                    | H-162-HJ                            | 056-1834                                   |
| 1.7500                             | <b>277-3175</b> | 2.000                  | 3.250                | 6.71                | 5.25                                | .16                    | H-175-HJ                            | 056-1834                                   |
| 1.8750                             | <b>277-3187</b> | 2.000                  | 3.250                | 7.11                | 5.63                                | .17                    | H-187-HJ                            | 056-1834                                   |
| 2.0000                             | <b>277-3200</b> | 2.000                  | 3.250                | 7.37                | 6.00                                | .18                    | H-200-HJ                            | 056-1585                                   |
| <b>5:1 Depth To Diameter Ratio</b> |                 |                        |                      |                     |                                     |                        |                                     |                                            |
| .8125                              | <b>277-5081</b> | 1.000                  | 2.281                | 5.00                | 4.06                                | .08                    | H-081-HJ                            | 056-1016                                   |
| .8268                              | <b>277-5082</b> | 1.000                  | 2.281                | 5.15                | 4.21                                | .08                    | H-082-HJ                            | 056-1016                                   |
| .8661                              | <b>277-5086</b> | 1.000                  | 2.281                | 5.33                | 4.41                                | .08                    | H-086-HJ                            | 056-1016                                   |
| .8750                              | <b>277-5087</b> | 1.000                  | 2.281                | 5.29                | 4.38                                | .08                    | H-087-HJ                            | 056-1016                                   |
| .9375                              | <b>277-5093</b> | 1.000                  | 2.281                | 5.58                | 4.69                                | .09                    | H-093-HJ                            | 056-1016                                   |
| .9449                              | <b>277-5094</b> | 1.000                  | 2.281                | 5.71                | 4.81                                | .09                    | H-094-HJ                            | 056-1016                                   |
| 1.0000                             | <b>277-5100</b> | 1.000                  | 2.281                | 5.87                | 5.00                                | .09                    | H-100-HJ                            | 056-1020                                   |
| 1.0625                             | <b>277-5106</b> | 1.250                  | 2.281                | 6.41                | 5.31                                | .10                    | H-106-HJ                            | 056-1020                                   |
| 1.1024                             | <b>277-5110</b> | 1.250                  | 2.281                | 6.65                | 5.61                                | .10                    | H-110-HJ                            | 056-1020                                   |
| 1.1250                             | <b>277-5112</b> | 1.250                  | 2.281                | 6.67                | 5.63                                | .10                    | H-112-HJ                            | 056-1020                                   |
| 1.1875                             | <b>277-5118</b> | 1.250                  | 2.281                | 6.99                | 5.94                                | .11                    | H-118-HJ                            | 056-1020                                   |
| 1.2500                             | <b>277-5125</b> | 1.250                  | 2.281                | 7.25                | 6.25                                | .11                    | H-125-HJ                            | 056-1833                                   |
| 1.3125                             | <b>277-5131</b> | 1.500                  | 2.688                | 7.78                | 6.56                                | .13                    | H-131-HJ                            | 056-1833                                   |
| 1.3750                             | <b>277-5137</b> | 1.500                  | 2.688                | 8.80                | 6.88                                | .13                    | H-137-HJ                            | 056-1833                                   |
| 1.4375                             | <b>277-5143</b> | 1.500                  | 2.688                | 8.36                | 7.19                                | .14                    | H-143-HJ                            | 056-1833                                   |
| 1.5000                             | <b>277-5150</b> | 1.500                  | 2.688                | 8.62                | 7.50                                | .14                    | H-150-HJ                            | 056-1833                                   |
| 1.6250                             | <b>277-5162</b> | 1.500                  | 2.688                | 9.26                | 8.13                                | .15                    | H-162-HJ                            | 056-1834                                   |
| 1.7500                             | <b>277-5175</b> | 2.000                  | 3.250                | 10.21               | 8.75                                | .16                    | H-175-HJ                            | 056-1834                                   |
| 1.8750                             | <b>277-5187</b> | 2.000                  | 3.250                | 10.86               | 9.38                                | .17                    | H-187-HJ                            | 056-1834                                   |
| 2.0000                             | <b>277-5200</b> | 2.000                  | 3.250                | 11.37               | 10.00                               | .18                    | H-200-HJ                            | 056-1585                                   |
| <b>7:1 Depth To Diameter Ratio</b> |                 |                        |                      |                     |                                     |                        |                                     |                                            |
| 0.8125                             | <b>277-7081</b> | 1.000                  | 2.281                | 6.63                | 5.69                                | .08                    | H-081-HJ                            | 056-1016                                   |
| 0.8750                             | <b>277-7087</b> | 1.000                  | 2.281                | 7.04                | 6.13                                | .08                    | H-087-HJ                            | 056-1016                                   |
| 0.9375                             | <b>277-7093</b> | 1.000                  | 2.281                | 7.46                | 6.56                                | .09                    | H-093-HJ                            | 056-1016                                   |
| 1.0000                             | <b>277-7100</b> | 1.000                  | 2.281                | 7.87                | 7.00                                | .09                    | H-100-HJ                            | 056-1020                                   |
| 1.0625                             | <b>277-7106</b> | 1.250                  | 2.281                | 8.53                | 7.44                                | .10                    | H-106-HJ                            | 056-1020                                   |
| 1.1250                             | <b>277-7112</b> | 1.250                  | 2.281                | 8.92                | 7.88                                | .10                    | H-112-HJ                            | 056-1020                                   |
| 1.1875                             | <b>277-7118</b> | 1.250                  | 2.281                | 9.36                | 8.31                                | .11                    | H-118-HJ                            | 056-1020                                   |
| 1.2500                             | <b>277-7125</b> | 1.250                  | 2.281                | 9.75                | 8.75                                | .11                    | H-125-HJ                            | 056-1833                                   |
| 1.3125                             | <b>277-7131</b> | 1.500                  | 2.688                | 10.41               | 9.19                                | .13                    | H-131-HJ                            | 056-1833                                   |
| 1.3750                             | <b>277-7137</b> | 1.500                  | 2.688                | 10.79               | 9.63                                | .13                    | H-137-HJ                            | 056-1833                                   |
| 1.4375                             | <b>277-7143</b> | 1.500                  | 2.688                | 11.24               | 10.06                               | .14                    | H-143-HJ                            | 056-1833                                   |
| 1.5000                             | <b>277-7150</b> | 1.500                  | 2.688                | 11.62               | 10.50                               | .14                    | H-150-HJ                            | 056-1833                                   |
| 1.6250                             | <b>277-7162</b> | 1.500                  | 2.688                | 12.51               | 11.38                               | .15                    | H-162-HJ                            | 056-1834                                   |
| 1.7500                             | <b>277-7175</b> | 2.000                  | 3.250                | 13.71               | 12.25                               | .16                    | H-175-HJ                            | 056-1834                                   |
| 1.8750                             | <b>277-7187</b> | 2.000                  | 3.250                | 14.61               | 13.13                               | .17                    | H-187-HJ                            | 056-1834                                   |
| 2.0000                             | <b>277-7200</b> | 2.000                  | 3.250                | 15.37               | 14.00                               | .18                    | H-200-HJ                            | 056-1585                                   |

Note: Inserts must be ordered separately.

Note: Chip disposal will be impaired if hole depth exceeds effective drilling depth.

## Application Information

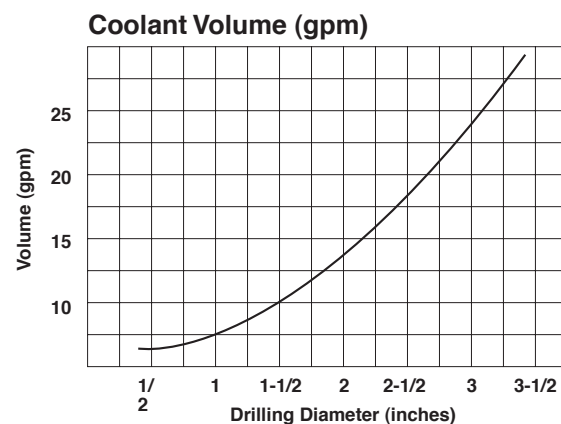
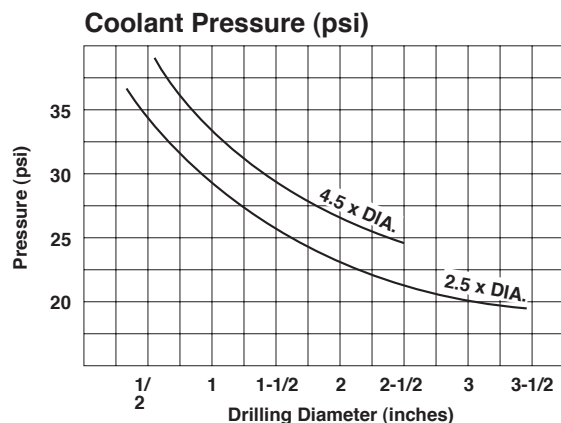
| Material Group | Hardness                                        |          | Cutting Speed* |     |     |     |      |      |      |      |      |      |      |      |     | Feed Rate** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|                |                                                 |          | m/min.         |     |     |     |      |      |      |      |      |      |      |      |     | mm/min.     |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                | BHN                                             | Rockwell | SFM            |     |     |     |      |      |      |      |      |      |      |      |     | IPR         |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                |                                                 |          | 30             | 61  | 91  | 122 | 152  | 183  | 274  | 366  | .025 | 0.05 | 0.1  | 0.15 | 0.2 | 0.25        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 100            | 200                                             | 300      | 400            | 500 | 600 | 900 | 1200 | .001 | .002 | .004 | .006 | .008 | .010 |      |     |             |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 11             | Low Carbon Steels<br>1018, 12L14<br>8620, 11L17 | 125      | 28 Rc          |     |     |     |      |      |      |      |      |      |      |      |     |             |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

\* Recommended insert grades are labeled in order of preference (1st, 2nd, 3rd).

\*\* Feed rates shown can be increased by up to 50% when using square negative rake drills, and increased up to 100% when using double-feed drills.

# Application Information

## Application Guidelines



### Concentricity

On live spindle applications such as boring mills and machining centers, it is necessary to have a rigid and true running spindle. Spindle runout must be no more than .004" TIR.

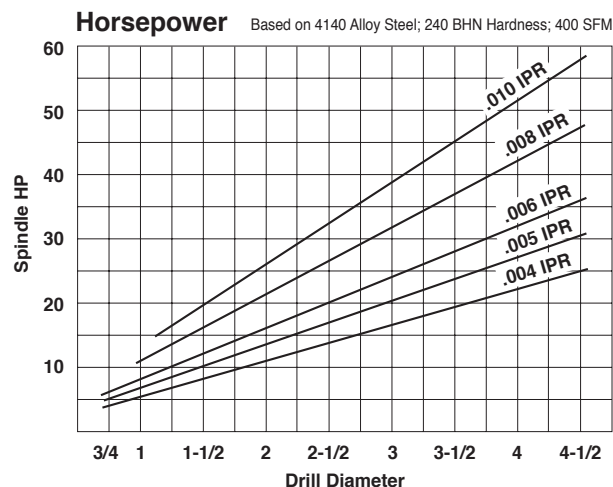
On turning machine applications, it is necessary that the drill be on center or concentric with the spindle centerline within .004" TIR. Angularity must not exceed .003" in 6". Both of these conditions are easily checked with an indicator magnetically mounted on the face of the spindle. Another way to check concentricity is to drill a hole and measure size. Then rotate the drill 180°, drill a hole, and measure size. One quarter of the difference between the two hole sizes is the distance the drill is off center.

### Starting Feed Rate

In some extremely tough materials, it may be advisable to reduce the feed to about 30% per revolution until the full diameter of the drill is in the cut. The same procedure may be necessary when using extra length drills.

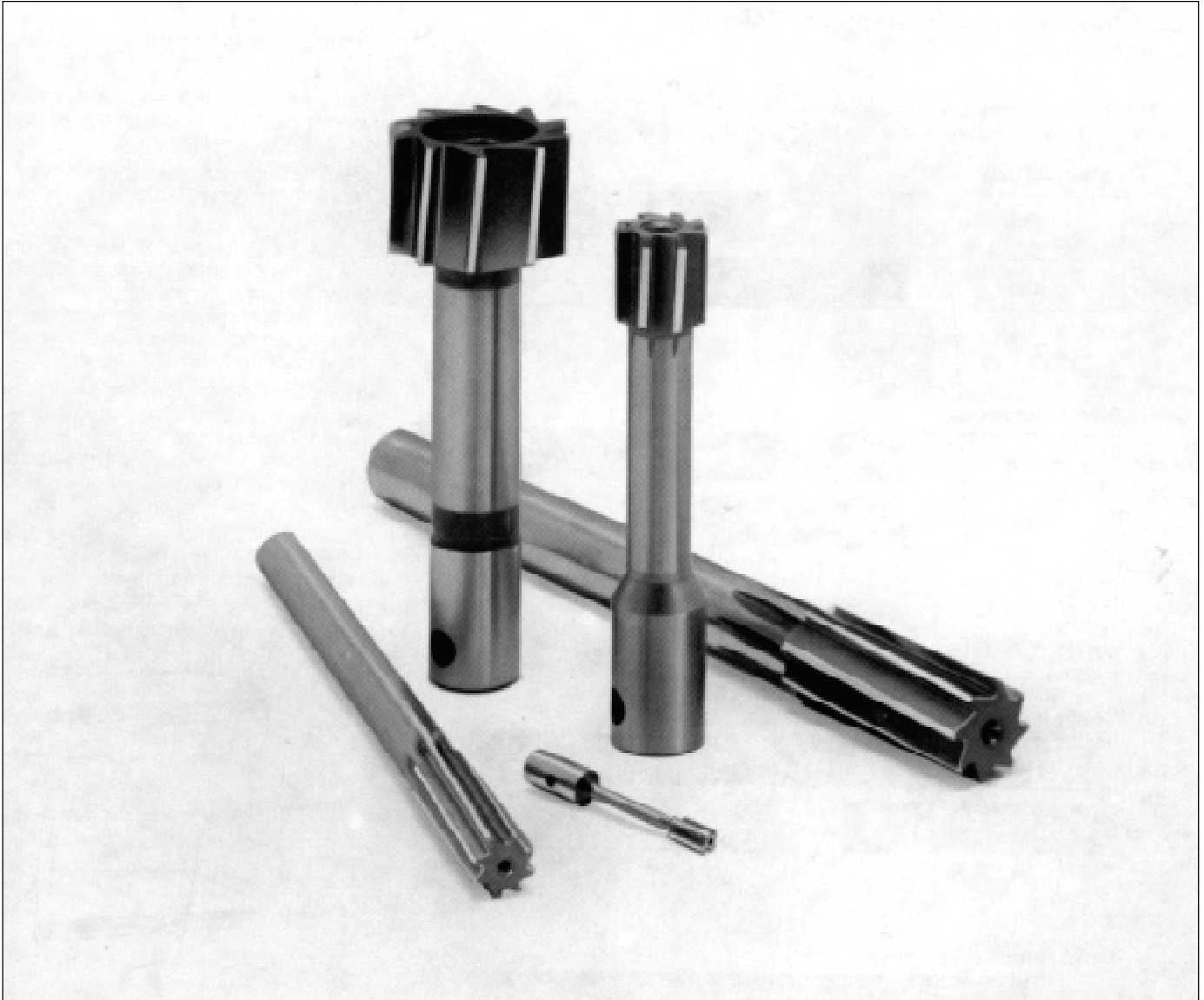
### Coolant

In steel cutting applications, coolant should be fed through the tool to insure maximum cooling at the cutting edge and to flush chips out of the hole. Shallow holes may be drilled in steel with a well-directed flow of flood coolant. Cast iron can be run dry or with flood coolant, but through-the-tool coolant is preferable.



## Troubleshooting Guide

| Problem                        | Cause                                                                             | Solution                                                                         |
|--------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Drill body rubbing in the hole | 1. Drill is off-center and cutting a small hole<br>2. Drill is deflecting         | 1. Correct the off-center condition<br>2. Reduce penetration rate                |
| Center insert chipping         | 1. Drill is off-center<br>2. Improper grade selection                             | 1. Correct off-center condition<br>2. See insert grade selection chart           |
| Chips snarling and clogging    | 1. Feed is too light to break chips<br>2. RPM too slow<br>3. Insufficient coolant | 1. Increase feed rate<br>2. Increase RPM<br>3. Use coolant pressure booster pump |
| Chatter or vibration           | 1. Too much overhang<br>2. Lack of rigidity in the machine tool or the set-up     | 1. Reduce overhang<br>2. Take appropriate corrective measures                    |
| Severe retract marks           | 1. Excessive penetration rate causes drill to deflect and cut undersize           | 1. Reduce penetration rate                                                       |



## Higher Feed Rates, Longer Tool Life

METCUT® reamers are designed to operate at feed rates up to twice conventional reamer feed rates, resulting in higher productivity. And METCUT® reamers last longer, which means less machine downtime due to tool changes, and more production per tool. The net result is that METCUT® reamers provide the lowest cost per hole.

## Surface Finishes of 25 RMS or Better

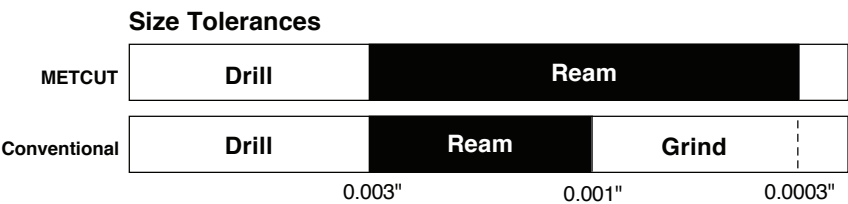
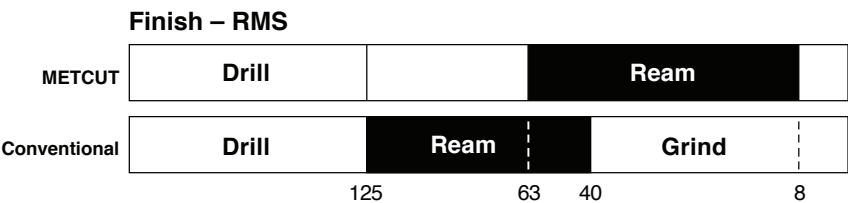
The use of METCUT® reamers can eliminate the need for some subsequent grinding, honing or burnishing operations by producing surface finishes of 25 RMS or better in free-machining materials. Hole-finishing accuracy and repeatability are unmatched:

- Roundness accuracy to within 0.0001".
- Hole size accuracy to within 0.0003".
- Straightness accuracy to within 0.0002".
- Higher depth-to-diameter ratios at above tolerances.
- Technical assistance available to achieve **16RMS** or better, and consistently hold hole size to less than **.0003"**

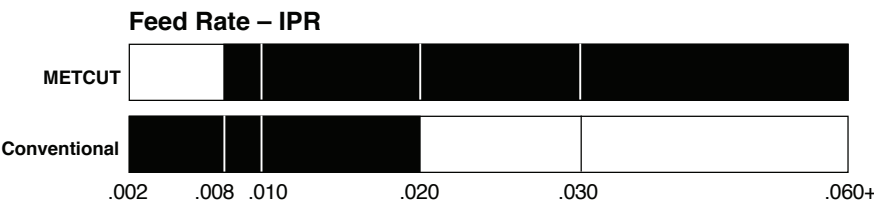
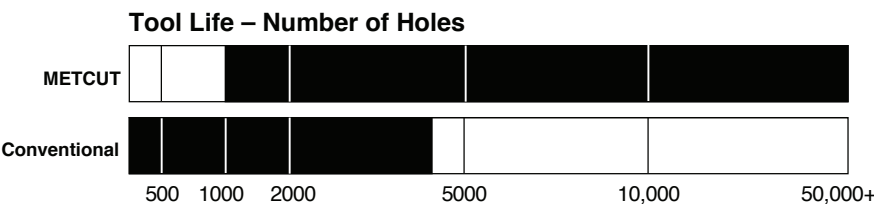
# Reamers

## METCUT Reamers vs. Conventional Reamers – Performance Overview

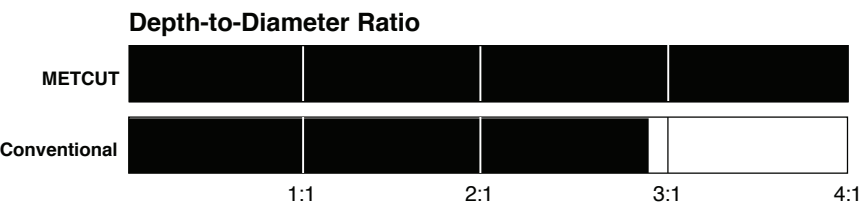
METCUT reamers can produce surface finishes and size tolerances otherwise achieved only through finish grinding, burnishing, or honing.



METCUT reamers provide significantly increased tool life and higher feed rates.



METCUT reamers offer higher depth-to-diameter ratios at stated size, straightness and roundness tolerances.



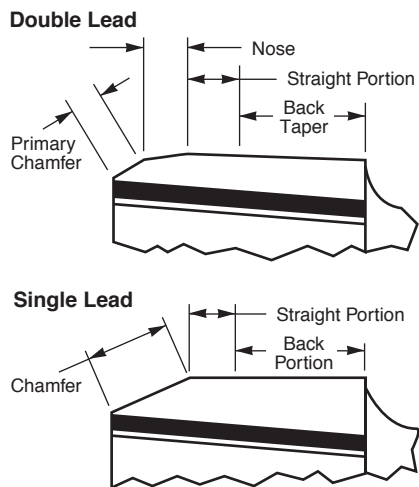
## Sharpening Profile

The profile form on the reamer is important in obtaining the best finish and longest possible tool life.

METCUT offers two basic types of profiles with our controlled CNC form type sharpening methods.

I. The Double Lead Profile for enhanced surface finish. Following the primary chamfer, a nose section is blended into the straight portion. The nose section removes the feed marks prior to the final sizing of the hole and provides a 25 to 50 RMS finish.

II. Single Lead Profile for enhanced tool life where finish is not as critical. This provides a profile of a chamfer tangent to the straight portion as shown in the diagram.



## What Makes METCUT Reamers Better?

### Custom Sharpened For Your Application

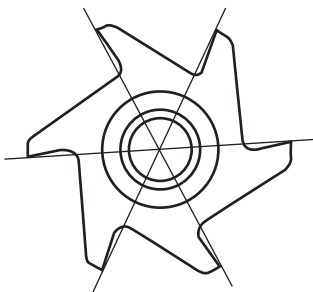
Our application engineers will select a sharpening profile best suited to accomplish your specific hole finishing and production objectives. Significant variables include the material you are reaming, the surface finish you require, and the tool life you require. Generally, there is a trade-off between degree of surface finish and tool life (the finer the finish required, the shorter the tool life). METCUT engineers will work to optimize the variables to best meet your quality, productivity, and cost objectives.

When ordering, please provide the following information:

- Roundness, size and straightness tolerances.
- Finish requirement.
- Material to be reamed.
- Stationary or rotating work piece.
- Diameter of bushing (if applicable).
- Floating or fixed tool holder.
- Blind hole clearance.
- Any other special feature of the application, such as cross holes, intersection holes, etc.

### Irregularly-Spaced Flutes

Irregular spacing is a standard feature of all METCUT oil-feed reamers. This type of spacing provides a controlled cutting action that resists chatter and the formation of "welts." This flute spacing design, combined with the oil-feed and cam-controlled sharpening features allows these reamers to produce surface finishes which do not require additional finishing operations. The teeth are spaced diametrically opposite each other for easy and accurate inspection.

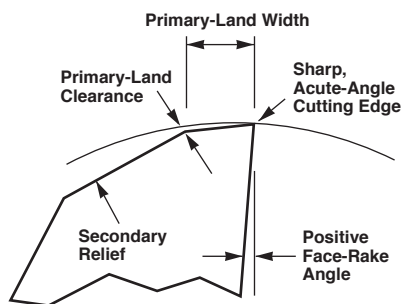


### Unique Cutting-Edge Geometry Ensures "Free Cutting Action"

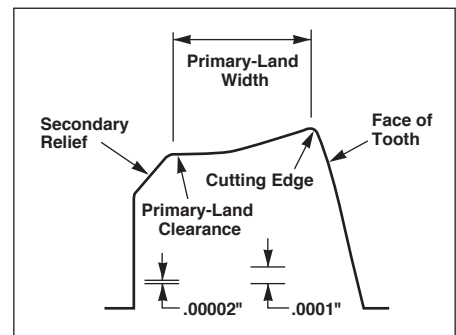
A precise combination of positive clearance angles, sharp cutting edges, and irregularly spaced flutes serves to minimize friction, harmonics, chatter, welts, and galling – common problems that diminish the life and performance of conventional reamers.

This unique cutting-edge design is produced on the most sophisticated CNC production equipment, ensuring that each cutting edge is accurately ground. All of the reamers produced to a particular set of specifications are virtually identical providing maximum tool-to-tool repeatability. State-of-the-art electronic gaging equipment ensures that flute height variation, land width, and clearance angles are being held to allowable limits.

### METCUT Tooth Profile

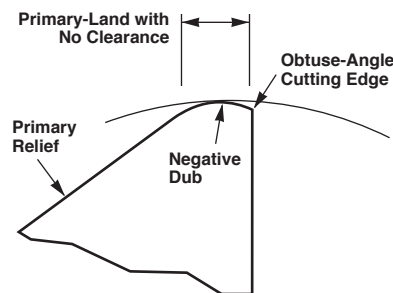


Only the sharp cutting edge is in contact with the workpiece.

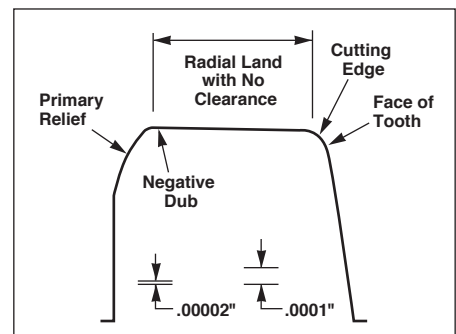


METCUT tooth profile as measured and graphed by our electronic gaging equipment

### Conventional Tooth Profile



The back of the tooth is in greater contact with the work than the cutting edge.

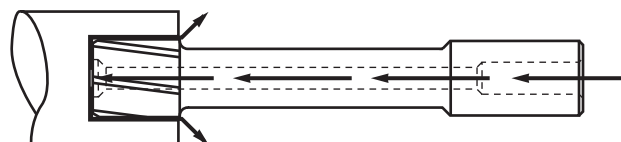


Conventional tooth profile as measured and graphed by our electronic gaging equipment

### Designed for Effective Chip Disposal

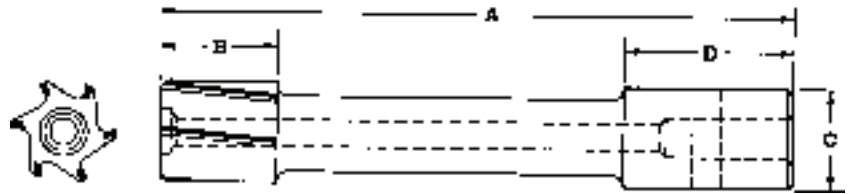
Coolant-Feed reamers provide maximum chip-flushing action in blind-hole reaming applications. The coolant is fed through the reamer body; it hits the end of the blind hole and is forced back through the flutes, flushing the chips from the cutting area while lubricating and cooling the cutting edges.

### Oil Flow in Coolant-Feed Reamer Application



# Custom Sharpened Reamers – Coolant Feed

## Carbide



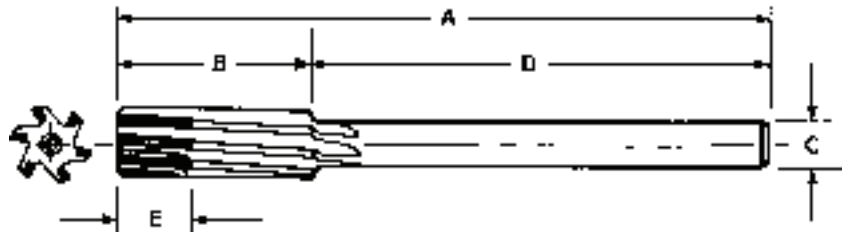
|              |                | Diameter        | Part Number | A     | B     | C     | D     | Number of Flutes |
|--------------|----------------|-----------------|-------------|-------|-------|-------|-------|------------------|
| Coolant Feed | Solid Carbide  | .0930 to .125   | SOFC0125    | 2.500 | .375  | .250  | .750  | 4                |
|              |                | .1251 to .157   | SOFC0157    | 2.500 | .375  | .250  | .750  | 4                |
|              |                | .1571 to .175   | SOFC0175    | 2.500 | .375  | .250  | .750  | 6                |
|              |                | .1751 to .210   | SOFC0210    | 2.500 | .375  | .375  | .750  | 6                |
|              |                | .2101 to .255   | SOFC0255    | 2.500 | .500  | .375  | .750  | 6                |
|              |                | .2551 to .286   | SOFC0286    | 2.500 | .500  | .375  | .750  | 6                |
|              |                | .2861 to .318   | SOFC0318    | 2.500 | .500  | .375  | .750  | 6                |
|              |                | .3181 to .380   | SOFC0380    | 2.500 | .500  | .375  | .750  | 6                |
|              | Carbide Tipped | .3801 to .436   | OFC0436     | 2.625 | .500  | .375  | .750  | 6                |
|              |                | .4361 to .505   | OFC0505     | 3.500 | .625  | .625  | 1.000 | 6                |
|              |                | .5051 to .630   | OFC0630     | 3.750 | .750  | .625  | 1.000 | 6                |
|              |                | .6301 to .755   | OFC0755     | 4.250 | .750  | .625  | 1.000 | 6                |
|              |                | .7551 to .880   | OFC0880     | 4.750 | .875  | .625  | 1.000 | 6                |
|              |                | .8801 to 1.005  | OFC1005     | 5.500 | 1.000 | 1.000 | 1.500 | 8                |
|              |                | 1.0051 to 1.130 | OFC1130     | 6.000 | 1.250 | 1.000 | 1.500 | 8                |
|              |                | 1.1301 to 1.255 | OFC1255     | 6.000 | 1.250 | 1.000 | 1.500 | 8                |
|              |                | 1.2551 to 1.380 | OFC1380     | 6.000 | 1.250 | 1.000 | 1.500 | 8                |
|              |                | 1.3801 to 1.505 | OFC1505     | 6.000 | 1.250 | 1.000 | 1.500 | 8                |
|              |                | 1.5051 to 1.630 | OFC1630     | 6.000 | 1.250 | 1.000 | 1.500 | 10               |
|              |                | 1.6301 to 1.755 | OFC1755     | 6.000 | 1.250 | 1.000 | 1.500 | 10               |
|              |                | 1.7551 to 1.880 | OFC1880     | 6.000 | 1.250 | 1.000 | 1.500 | 10               |
|              |                | 1.8801 to 2.015 | OFC2015     | 6.000 | 1.250 | 1.000 | 1.500 | 10               |

All dimensions shown in inches.

Diameter Tolerance:  $\pm .0001$

# Custom Sharpened Reamers – Chucking

## Carbide



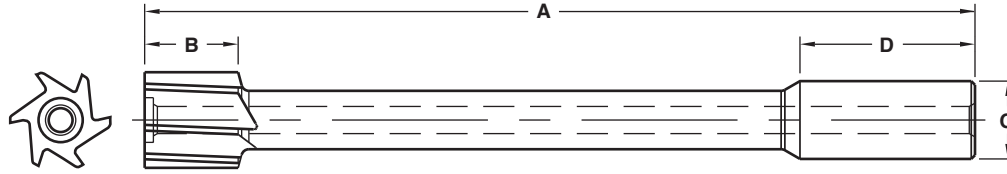
|                  |                | Diameter         | Part Number | A      | B     | C           | D     | E     | Number of Flutes |
|------------------|----------------|------------------|-------------|--------|-------|-------------|-------|-------|------------------|
| Non Coolant Feed | Solid Carbide  | .0930 to .1250   | SCRC0125    | 2.250  | .625  | .0880/.0870 | 1.625 | .625  | 4                |
|                  |                | .1251 to .1570   | SCRC0157    | 2.500  | .750  | .1190/.1180 | 1.750 | .750  | 4                |
|                  |                | .1571 to .1875   | SCRC0187    | 2.750  | .875  | .1510/.1500 | 1.875 | .875  | 6                |
|                  |                | .1876 to .2188   | SCRC0218    | 3.000  | 1.000 | .1805/.1795 | 2.000 | 1.000 | 6                |
|                  |                | .2189 to .2500   | SCRC0250    | 3.000  | 1.000 | .2075/.2065 | 2.000 | 1.000 | 6                |
|                  |                | .2501 to .2812   | SCRC0281    | 3.250  | 1.125 | .2485/.2475 | 2.125 | 1.125 | 6                |
|                  |                | .2813 to .3125   | SCRC0312    | 3.250  | 1.125 | .2792/.2782 | 2.125 | 1.125 | 6                |
|                  |                | .3126 to .3437   | SCRC0343    | 3.500  | 1.250 | .2792/.2782 | 2.250 | 1.250 | 6                |
|                  |                | .3438 to .3750   | SCRC0375    | 3.500  | 1.250 | .3105/.3095 | 2.250 | 1.250 | 6                |
| Coolant Feed     | Carbide Tipped | .2550 to .2969   | CRC0296     | 6.000  | 1.500 | .2485/.2475 | 4.500 | .500  | 4                |
|                  |                | .2970 to .3438   | CRC0343     | 6.000  | 1.500 | .2792/.2782 | 4.500 | .500  | 6                |
|                  |                | .3439 to .4062   | CRC0406     | 7.000  | 1.750 | .3105/.3095 | 5.250 | .500  | 6                |
|                  |                | .4063 to .4688   | CRC0468     | 7.000  | 1.750 | .3730/.3720 | 5.250 | .500  | 6                |
|                  |                | .4689 to .5312   | CRC0531     | 8.000  | 2.000 | .4355/.4345 | 6.000 | .625  | 6                |
|                  |                | .5313 to .5938   | CRC0593     | 8.000  | 2.000 | .4355/.4345 | 6.000 | .625  | 6                |
|                  |                | .5939 to .6875   | CRC0687     | 9.000  | 2.250 | .5620/.5605 | 6.750 | .750  | 6                |
|                  |                | .6876 to .8125   | CRC0812     | 9.500  | 2.500 | .6245/.6230 | 7.000 | .750  | 6                |
|                  |                | .8126 to .9375   | CRC0937     | 10.000 | 2.625 | .7495/.7480 | 7.375 | .875  | 6                |
|                  |                | .9376 to 1.0313  | CRC1031     | 10.500 | 2.750 | .8745/.8730 | 7.750 | .875  | 8                |
|                  |                | 1.0314 to 1.1560 | CRC1156     | 11.000 | 2.875 | .9995/.9980 | 8.125 | .875  | 8                |
|                  |                | 1.1561 to 1.2810 | CRC1281     | 11.500 | 3.000 | .9995/.9980 | 8.500 | .875  | 8                |
|                  |                | 1.2811 to 1.4060 | CRC1406     | 12.000 | 3.250 | .9995/.9980 | 8.750 | .875  | 8                |
|                  |                | 1.4061 to 1.5310 | CRC1531     | 12.500 | 3.500 | .9995/.9980 | 9.000 | .875  | 8                |

All dimensions shown in inches.

Diameter Tolerance:  $\pm .0001$

# Chucking Coolant-Feed Reamers

## High Speed Steel

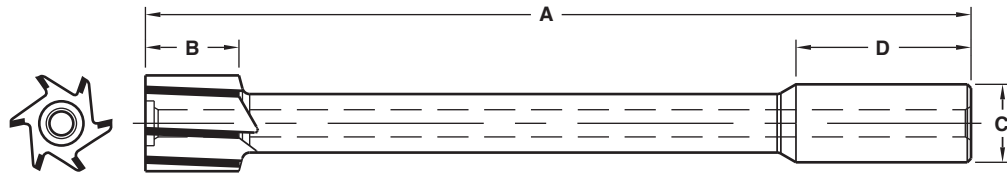


|              | Diameter      | Part Number | A      | B     | C     | D     | Number of Flutes |
|--------------|---------------|-------------|--------|-------|-------|-------|------------------|
| Coolant Feed | .2500-.3120   | COF-0312    | 5.500  | .500  | .312  | 1.500 | 6                |
|              | .3121-.3750   | COF-0375    | 5.500  | .500  | .625  | 1.500 | 6                |
|              | .3751-.5000   | COF-0500    | 8.000  | .625  | .625  | 1.500 | 6                |
|              | .5001-.6250   | COF-0625    | 8.000  | .625  | .625  | 1.500 | 6                |
|              | .6251-.7500   | COF-0750    | 8.000  | .750  | .625  | 1.500 | 6                |
|              | .7501-.8750   | COF-0875    | 10.000 | .875  | 1.000 | 2.500 | 6                |
|              | .8751-1.0000  | COF-1000    | 10.000 | 1.000 | 1.000 | 2.500 | 8                |
|              | 1.0001-1.1250 | COF-1125    | 10.000 | 1.000 | 1.000 | 2.500 | 8                |

All dimensions shown in inches.

Diameter Tolerance:  $\pm .0001$

## Carbide



|              | Diameter      | Part Number | A      | B     | C     | D     | Number of Flutes |
|--------------|---------------|-------------|--------|-------|-------|-------|------------------|
| Coolant Feed | .2500-.3120   | COFC-0312   | 5.500  | .500  | .312  | 1.500 | 6                |
|              | .3121-.3750   | COFC-0375   | 5.500  | .500  | .625  | 1.500 | 6                |
|              | .3751-.5000   | COFC-0500   | 8.000  | .625  | .625  | 1.500 | 6                |
|              | .5001-.6250   | COFC-0625   | 8.000  | .625  | .625  | 1.500 | 6                |
|              | .6251-.7500   | COFC-0750   | 8.000  | .750  | .625  | 1.500 | 6                |
|              | .7501-.8750   | COFC-0875   | 10.000 | .875  | 1.000 | 2.500 | 6                |
|              | .8751-1.0000  | COFC-1000   | 10.000 | 1.000 | 1.000 | 2.500 | 8                |
|              | 1.0001-1.1250 | COFC-1125   | 10.000 | 1.000 | 1.000 | 2.500 | 8                |
|              | 1.1251-1.2500 | COFC-1250   | 10.000 | 1.000 | 1.000 | 2.500 | 8                |
|              | 1.2501-1.5000 | COFC-1500   | 10.000 | 1.000 | 1.000 | 2.500 | 8                |

All dimensions shown in inches.

Diameter Tolerance:  $\pm .0001$

# Application Information

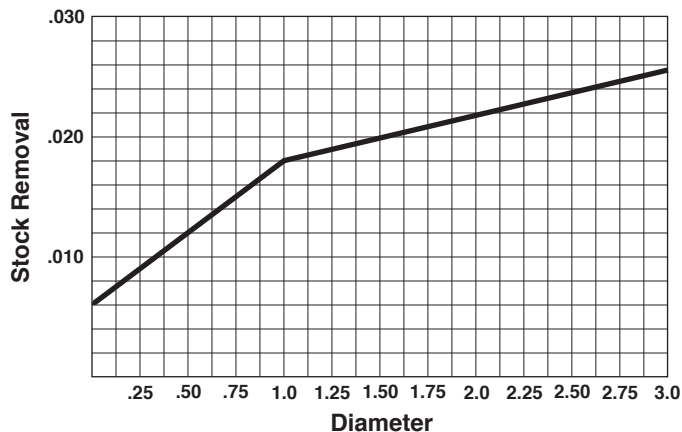
## Recommended Feed & Speed Rates for Reamers

| Material            | TCT Speed (SFM) | TCT Reamers                               |                      |                    |                  | HSS Speed (SFM) | HSS Reamers                               |                       |                     |                  |
|---------------------|-----------------|-------------------------------------------|----------------------|--------------------|------------------|-----------------|-------------------------------------------|-----------------------|---------------------|------------------|
|                     |                 | Recommended Starting Feed Rate in ( IPR ) |                      |                    |                  |                 | Recommended Starting Feed Rate in ( IPR ) |                       |                     |                  |
|                     |                 | 4-Flute Below .1875"                      | 6-Flute .1875"-.875" | 8-Flute .875"-1.5" | 10-Flute 1.5"-2" |                 | 4-Flute Below .1875"                      | 6-Flute .1875"-.5625" | 8-Flute .5625"-1.5" | 10-Flute 1.5"-2" |
| Aluminum            | 160             | .006                                      | .012                 | .016               | .020             | 100             | .006                                      | .012                  | .016                | .020             |
|                     | 180             | .012                                      | .018                 | .024               | .030             | 150             | .012                                      | .018                  | .024                | .030             |
| Brass               | 70              | .006                                      | .012                 | .016               | .020             | 45              | .006                                      | .012                  | .016                | .020             |
|                     | 90              | .012                                      | .018                 | .024               | .030             | 65              | .012                                      | .018                  | .024                | .030             |
| Bronze              | 50              | .006                                      | .012                 | .016               | .020             | 40              | .006                                      | .012                  | .016                | .020             |
|                     | 70              | .012                                      | .018                 | .024               | .030             | 60              | .012                                      | .018                  | .024                | .030             |
| Grey Cast Iron      | 55              | .006                                      | .012                 | .016               | .020             | 40              | .006                                      | .012                  | .016                | .020             |
|                     | 75              | .012                                      | .018                 | .024               | .030             | 60              | .012                                      | .018                  | .024                | .030             |
| Ductile Cast Iron   | 45              | .006                                      | .012                 | .016               | .020             | 35              | .006                                      | .012                  | .016                | .020             |
|                     | 65              | .012                                      | .018                 | .024               | .030             | 55              | .012                                      | .018                  | .024                | .030             |
| Malleable Cast Iron | 60              | .006                                      | .012                 | .016               | .020             | 40              | .006                                      | .012                  | .016                | .020             |
|                     | 80              | .012                                      | .018                 | .024               | .030             | 60              | .012                                      | .018                  | .024                | .030             |
| Inconel             | 20              | .004                                      | .010                 | .016               | .020             | 10              | .004                                      | .010                  | .016                | .020             |
|                     | 30              | .010                                      | .014                 | .020               | .030             | 15              | .010                                      | .014                  | .020                | .030             |
| Low Carbon Steel    | 60              | .006                                      | .012                 | .016               | .020             | 40              | .006                                      | .012                  | .016                | .020             |
|                     | 80              | .012                                      | .018                 | .024               | .030             | 60              | .012                                      | .018                  | .024                | .030             |
| Med. Carbon Steel   | 50              | .006                                      | .012                 | .016               | .020             | 30              | .006                                      | .012                  | .016                | .020             |
|                     | 70              | .012                                      | .018                 | .024               | .030             | 50              | .012                                      | .018                  | .024                | .030             |
| High Carbon Steel   | 35              | .006                                      | .012                 | .016               | .020             | 30              | .006                                      | .012                  | .016                | .020             |
|                     | 55              | .012                                      | .018                 | .024               | .030             | 50              | .012                                      | .018                  | .024                | .030             |
| Alloy Steel         | 35              | .006                                      | .012                 | .016               | .020             | 25              | .006                                      | .012                  | .016                | .020             |
|                     | 55              | .012                                      | .018                 | .024               | .030             | 40              | .012                                      | .018                  | .024                | .030             |
| Monel               | 35              | .006                                      | .012                 | .016               | .020             | 25              | .006                                      | .012                  | .016                | .020             |
|                     | 45              | .012                                      | .018                 | .024               | .030             | 35              | .012                                      | .018                  | .024                | .030             |
| Stainless Steel     | 50              | .004                                      | .010                 | .016               | .020             | 30              | .004                                      | .010                  | .016                | .025             |
|                     | 70              | .010                                      | .014                 | .020               | .025             | 40              | .010                                      | .014                  | .020                | .025             |
| Titanium            | 40              | .004                                      | .010                 | .016               | .020             | 30              | .004                                      | .010                  | .016                | .020             |
|                     | 60              | .010                                      | .014                 | .020               | .025             | 40              | .010                                      | .014                  | .020                | .025             |

METCUT coated reamers should be run at 10-25% faster speeds.

## Stock Removal

Stock removal depends on work piece material and finish required. This graph shows starting points for various diameters.



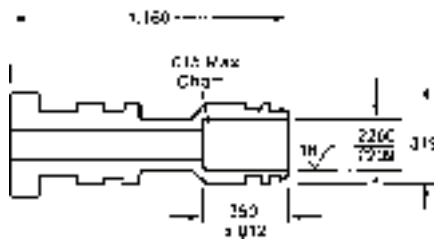
# Application Information

## Troubleshooting Guide

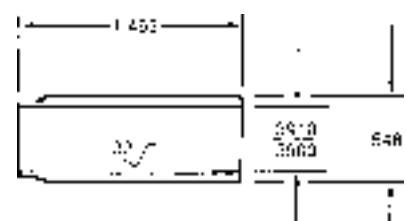
| Problem                                    | Cause                                                                                                         | Solution                                                                                                                                                                                     |
|--------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Bell Mouth</b>                          | 1. Misalignment; Reamer axis angular to work piece axis.                                                      | A. Reset alignment<br>B. Use floating holder.                                                                                                                                                |
| <b>Chatter</b>                             | 1. Not enough material being removed by reamer.                                                               | A. Leave more stock in hole from preceding operation.<br>B. Increase feed rate.                                                                                                              |
|                                            | 2. Speed too high and/or feed rate too low.                                                                   | A. See Recommended Feed & Speed Rates and Stock Removal, page 34.                                                                                                                            |
|                                            | 3. Set-up not rigid enough.                                                                                   | A. Reset. Eliminate any looseness that allows vibration during operation.<br>B. Check operations occurring at same time as reaming for harmonics.                                            |
|                                            | 4. Lead-in on work piece too blunt.                                                                           | A. Chamfer I.D. of work piece bore entrance.<br>B. Reamer may require long lead in chamfers or front pilot.                                                                                  |
|                                            | 5. Excessive clearance in primary land of reamer.                                                             | A. Contact METCUT application engineers.                                                                                                                                                     |
| <b>Oversized</b>                           | 1. Reamer too big.                                                                                            | A. Replace with correct size reamer.<br>B. Return to METCUT for resharpener to proper diameter.                                                                                              |
|                                            | 2. Chatter.                                                                                                   | A. See problem: "Chatter."                                                                                                                                                                   |
|                                            | 3. Reamer axis not centered with work piece axis.                                                             | A. Reset alignment.                                                                                                                                                                          |
|                                            | 4. Excessive chuck pressure.                                                                                  | A. Reset chuck, or change jaws.                                                                                                                                                              |
|                                            | 5. Bottoming out reamer.                                                                                      | A. Reset stroke length.<br>B. Have leads of reamer shortened.                                                                                                                                |
| <b>Undersized (Tight Hole)</b>             | 1. Reamer too small.                                                                                          | A. Replace with correct size reamer.<br>B. Return to METCUT for correction.                                                                                                                  |
|                                            | 2. Thermal contraction of bore.                                                                               | A. Check coolant flow and mix.<br>B. Check feeds, speeds and stock allowance.                                                                                                                |
|                                            | 3. Misalignment.                                                                                              | A. Reset.                                                                                                                                                                                    |
| <b>Lobing</b>                              | 1. Incorrect clearance.                                                                                       | A. Contact METCUT application engineers.                                                                                                                                                     |
| <b>Rough Finish</b>                        | 1. Too much material being removed.                                                                           | A. Leave less stock in hole from preceding operation.                                                                                                                                        |
|                                            | 2. Too little material being removed.                                                                         | A. Increase stock in hole from preceding operation.<br>B. Check for marks in bore left from preceding operation that are too deep for reamer to clean.                                       |
|                                            | 3. Build-up of material on reamer.                                                                            | A. Check stock allowance, feed, speed, coolant mix and additives.<br>B. May need surface treatment on reamer.<br>C. Reamer dull.                                                             |
|                                            | 4. Misalignment.                                                                                              | A. Reset alignment.<br>B. Use floating holder.                                                                                                                                               |
|                                            | 5. Chatter.                                                                                                   | A. See problem: "Chatter."                                                                                                                                                                   |
|                                            | 6. Dull Reamer.                                                                                               | A. Return to METCUT for resharpener or retipping.                                                                                                                                            |
|                                            | 7. Feed rate and/or speed settings improper.                                                                  | A. Reset.                                                                                                                                                                                    |
|                                            | 8. Improper sharpening or wrong axial profile on reamer.                                                      | A. Contact METCUT application engineers. Be sure to specify finish required when ordering reamer.                                                                                            |
| <b>Reverse Bell Mouth (Bottom of Hole)</b> | 1. Misalignment.                                                                                              | A. Reset.                                                                                                                                                                                    |
|                                            | 2. Straight portions of reamer went past end of part. Reamer dropped into its back taper prior to retraction. | A. Reset stroke length.                                                                                                                                                                      |
|                                            | 3. Chips packing in flutes.                                                                                   | A. Check stock allowance for reamer.<br>B. Reduce/increase stock allowance.<br>C. Increase coolant amount and pressure.<br>D. Wrong profile on reamer. Contact METCUT application engineers. |
| <b>Tapered Bore</b>                        | 1. Misalignment.                                                                                              | A. Reset.                                                                                                                                                                                    |
|                                            | 2. Leads of reamer not put completely through work piece.                                                     | A. Reset stroke length. Taper will only be at bottom of bore.                                                                                                                                |
|                                            | 3. Reamer straight portions ground with front taper.                                                          | A. Check tool on comparator. Contact METCUT application engineers.                                                                                                                           |
|                                            | 4. Not enough back taper.                                                                                     | A. Contact METCUT application engineers.                                                                                                                                                     |

## Application Histories

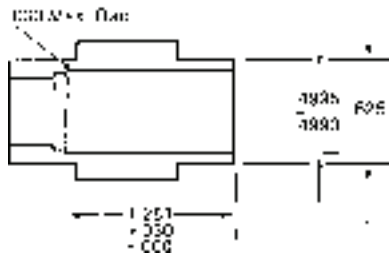
OF 567 (.532 Dia.)  
.00004/.00010 Clearance  
#18 Profile  
.006/Inch B.T.



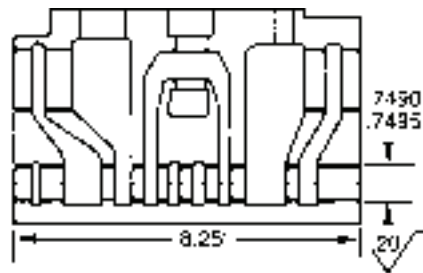
OFC 255 (.233 Dia.)  
.00000/.00004 Clearance  
End Cutting  
#54 Profile  
Replaced Roller Burnish Operation



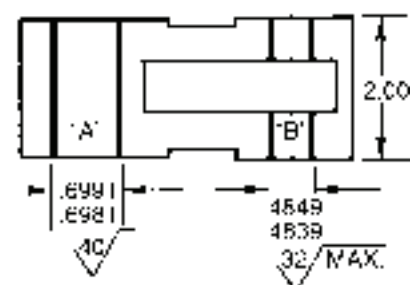
OF 436 (.3910 Dia.)  
.00004/.00010 Clearance  
#57 Profile  
.012/Inch B.T.



OFC 505 (.4993 Dia.)  
 .00000/.00004 Clearance  
 #18 Profile  
 .006/Inch B.T.  
 .020±.005 Chamfer



Coolant-Feed, Carbide Tipped  
.7492/.7493 Diameter  
.00003/.00008 Primary Clearance  
#18 Profile  
Replaced Honing Operation



Coolant-Feed, Carbide Tipped  
Rear Pilot for Guide Bushing  
.6986/.6988 Diameter A  
.4844/.4846 Diameter B  
.00004/.00010 Primary Clearance  
#18 Profile  
Finished Hole Cost Savings: 50%

# Reamer Reconditioning & Special Designs

## Reamer Reconditioning

All METCUT reamers can be returned for reconditioning. We offer three basic services, all of which result in re-establishment of the original, precisely controlled cutting edge.

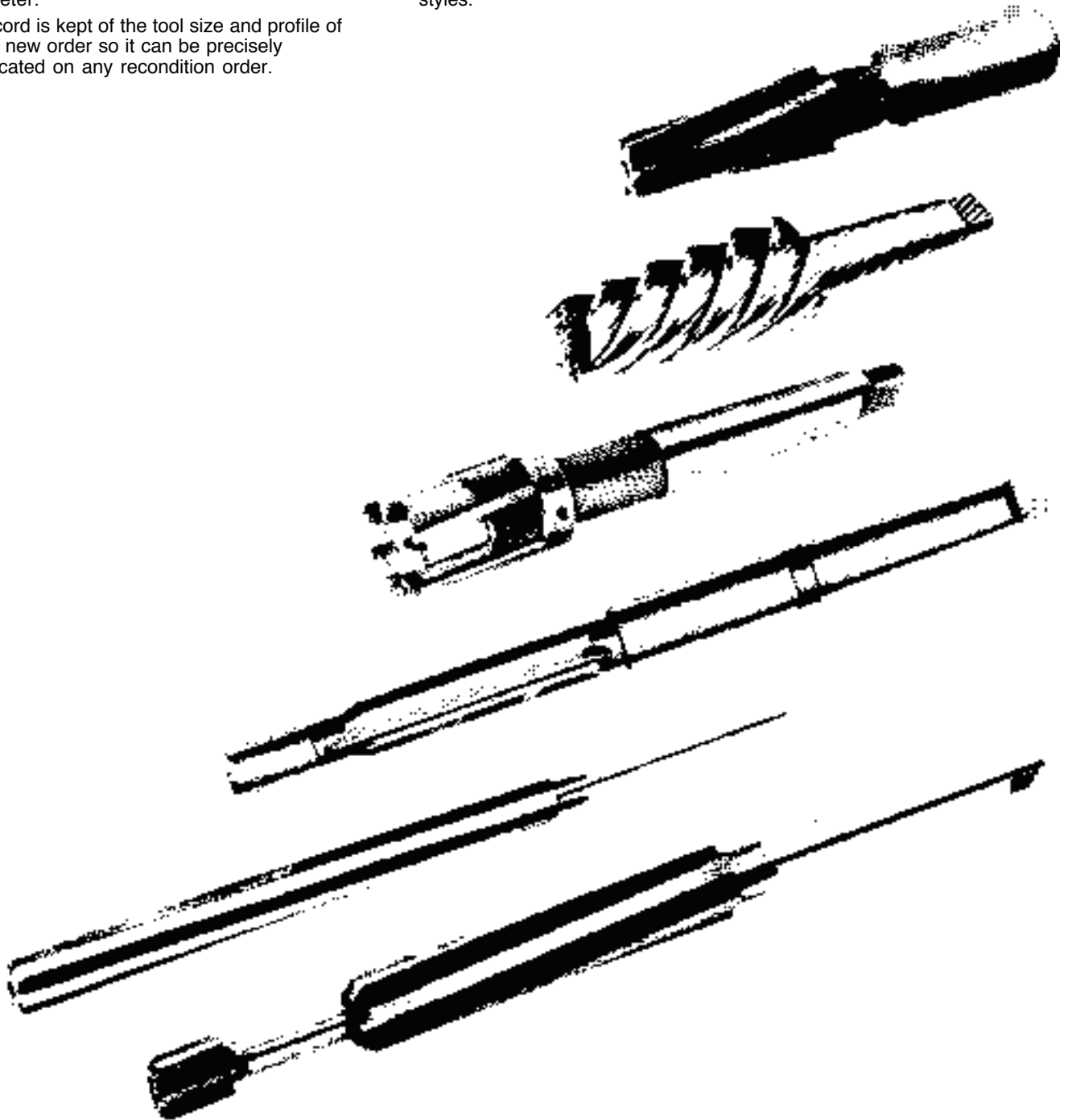
For high speed steel, solid carbide, and carbide-tipped tools that are not badly worn, a lead sharpening is a very economical way to regain the fine finish and precise sizing these tools provide. If the reamer is badly worn or is undersize, we can resize it to a smaller diameter within its range; or, for carbide tipped reamers, we can replace the carbide and size the reamer to its original diameter.

A record is kept of the tool size and profile of each new order so it can be precisely duplicated on any recondition order.

## Special Designs

In addition to the standard reamers listed in this catalog, special designs can be furnished while still utilizing our special features.

Upon inquiry and/or submission of part data, our engineering department will quote your special application, whether it be a "stub" type reamer, extra length shank, taper design, or larger diameter than offered within our stock line. Inserted blade reamers are also available by special order, as are multi-diameter, front-piloted, rear-piloted and jig bore styles.

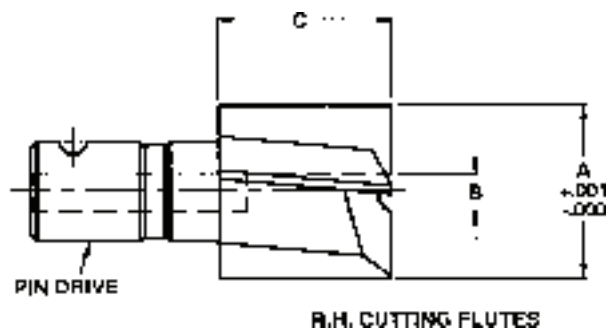


**To help us provide you with the best reamer for your application  
please complete this questionnaire and include a copy of it with your inquiry or order.**

A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 10 units wide by 10 units high. There are no margins or additional markings on the page.

# Counterbores – Pin Drive (can be used as a straight shank counterbore)

## High Speed Steel



Use with 400 Series Pilots (Pages 48–49) and 300 & 303 Series Holders (Page 45)

| A<br>Cutter<br>Diameter | Part<br>Number | Pin<br>Drive<br>No. | B<br>Pilot<br>Hole | No.<br>of<br>Flutes | C<br>Head<br>Length |
|-------------------------|----------------|---------------------|--------------------|---------------------|---------------------|
| .2500                   | 100-0025       | 0                   | .0937              | 4                   | 1.125               |
| .3125                   | 100-0031       | 0                   | .1250              | 4                   | 1.125               |
| .3438                   | 100-0034       | 0                   | .1250              | 4                   | 1.125               |
| .3750                   | 100-0037       | 0                   | .1250              | 4                   | 1.125               |
| .4063                   | 100-0040       | 0                   | .1250              | 4                   | 1.125               |
| .4375                   | 100-0043       | 0                   | .1250              | 4                   | 1.125               |
| .4375                   | 100-1043       | 1                   | .1875              | 4                   | 1.375               |
| .4688                   | 100-1046       | 1                   | .1875              | 4                   | 1.375               |
| .5000                   | 100-1050       | 1                   | .1875              | 4                   | 1.375               |
| .5313                   | 100-1053       | 1                   | .1875              | 4                   | 1.375               |
| .5625                   | 100-1056       | 1                   | .1875              | 4                   | 1.375               |
| .5938                   | 100-1059       | 1                   | .1875              | 4                   | 1.375               |
| .6250                   | 100-1062       | 1                   | .1875              | 4                   | 1.375               |
| .6563                   | 100-1065       | 1                   | .1875              | 4                   | 1.375               |
| .6875                   | 100-1068       | 1                   | .2500              | 4                   | 1.375               |
| .7188                   | 100-1071       | 1                   | .2500              | 4                   | 1.375               |
| .7500                   | 100-1075       | 1                   | .2500              | 4                   | 1.375               |
| .7813                   | 100-1078       | 1                   | .2500              | 4                   | 1.375               |
| .8125                   | 100-1081       | 1                   | .2500              | 4                   | 1.375               |
| .8750                   | 100-1087       | 1                   | .2500              | 4                   | 1.375               |
| .9375                   | 100-1093       | 1                   | .2500              | 4                   | 1.375               |
| 1.0000                  | 100-1100       | 1                   | .2500              | 4                   | 1.375               |
| 1.0625                  | 100-1106       | 1                   | .2500              | 4                   | 1.375               |
| 1.1250                  | 100-1112       | 1                   | .2500              | 4                   | 1.375               |
| 1.0625                  | 100-2106       | 2                   | .3125              | 4                   | 1.375               |
| 1.1250                  | 100-2112       | 2                   | .3125              | 4                   | 1.375               |
| 1.1875                  | 100-2118       | 2                   | .3125              | 4                   | 1.375               |
| 1.2500                  | 100-2125       | 2                   | .3125              | 4                   | 1.375               |
| 1.3125                  | 100-2131       | 2                   | .3125              | 4                   | 1.375               |
| 1.3750                  | 100-2137       | 2                   | .3125              | 4                   | 1.375               |
| 1.4375                  | 100-2143       | 2                   | .3125              | 4                   | 1.375               |

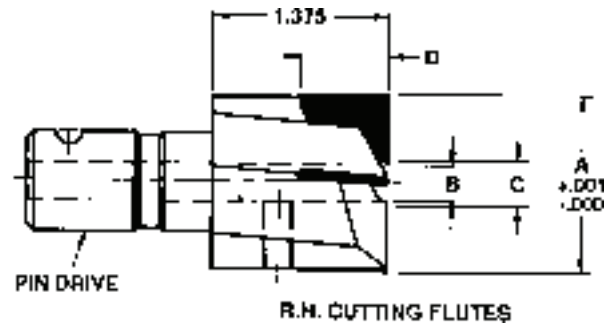
All dimensions shown in inches.

| A<br>Cutter<br>Diameter | Part<br>Number | Pin<br>Drive<br>No. | B<br>Pilot<br>Hole | No.<br>of<br>Flutes | C<br>Head<br>Length |
|-------------------------|----------------|---------------------|--------------------|---------------------|---------------------|
| 1.5000                  | 100-2150       | 2                   | .3125              | 4                   | 1.375               |
| 1.5625                  | 100-2156       | 2                   | .3125              | 4                   | 1.375               |
| 1.6250                  | 100-2162       | 2                   | .3125              | 4                   | 1.375               |
| 1.6875                  | 100-2168       | 2                   | .3125              | 4                   | 1.375               |
| 1.7500                  | 100-2175       | 2                   | .3125              | 4                   | 1.375               |
| 1.6875                  | 100-3168       | 3                   | .4375              | 6                   | 1.375               |
| 1.7500                  | 100-3175       | 3                   | .4375              | 6                   | 1.375               |
| 1.8125                  | 100-3181       | 3                   | .4375              | 6                   | 1.375               |
| 1.8750                  | 100-3187       | 3                   | .4375              | 6                   | 1.375               |
| 2.0000                  | 100-3200       | 3                   | .4375              | 6                   | 1.375               |
| 2.1250                  | 100-3212       | 3                   | .4375              | 6                   | 1.375               |
| 2.2500                  | 100-3225       | 3                   | .4375              | 6                   | 1.375               |
| 2.3750                  | 100-3237       | 3                   | .4375              | 6                   | 1.375               |
| 2.5000                  | 100-3250       | 3                   | .5000              | 6                   | 1.375               |
| 2.6250                  | 100-3262       | 3                   | .5000              | 6                   | 1.375               |
| 2.7500                  | 100-3275       | 3                   | .5000              | 6                   | 1.375               |
| 2.8750                  | 100-3287       | 3                   | .5000              | 6                   | 1.375               |
| 3.0000                  | 100-3300       | 3                   | .5000              | 6                   | 1.375               |
| 3.1250                  | 100-3312       | 3                   | .5000              | 6                   | 1.375               |
| 3.0000                  | 100-4300       | 4                   | .7500              | 6                   | 1.375               |
| 3.1250                  | *100-4312      | 4                   | .7500              | 6                   | 1.375               |
| 3.2500                  | 100-4325       | 4                   | .7500              | 6                   | 1.375               |
| 3.3750                  | *100-4337      | 4                   | .7500              | 6                   | 1.375               |
| 3.5000                  | 100-4350       | 4                   | .7500              | 6                   | 1.375               |
| 3.6250                  | *100-4362      | 4                   | .7500              | 6                   | 1.375               |
| 3.7500                  | 100-4375       | 4                   | .7500              | 6                   | 1.375               |
| 3.8750                  | *100-4387      | 4                   | .7500              | 6                   | 1.375               |
| 4.0000                  | 100-4400       | 4                   | .7500              | 6                   | 1.375               |

All dimensions shown in inches.  
\*Non-stocked.

# Counterbores – Pin Drive (can be used as a straight shank counterbore)

## Tungsten Carbide Tipped



Use with 400 & 410 Series Pilots (Pages 48–50) and 300 & 303 Series Holders (Page 45)

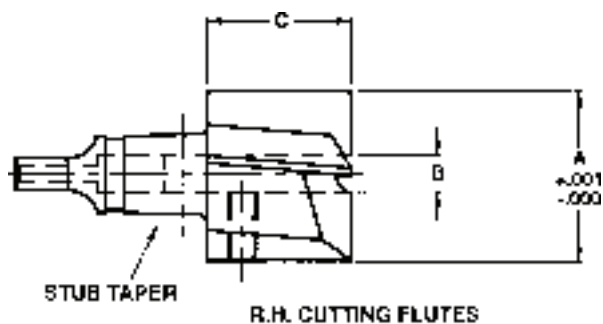
| A<br>Cutter<br>Diameter | Part<br>Number | Pin Drive<br>Number | B<br>Pilot Hole | Number<br>of Flutes | D<br>Length of<br>Carbide | C<br>Minimum<br>Cutting<br>Diameter |
|-------------------------|----------------|---------------------|-----------------|---------------------|---------------------------|-------------------------------------|
| .5000                   | 200-1050       | 1                   | .1875           | 3                   | .750                      | .219                                |
| .5625                   | 200-1056       | 1                   | .1875           | 3                   | .750                      | .219                                |
| .6250                   | 200-1062       | 1                   | .1875           | 3                   | .750                      | .219                                |
| .6875                   | 200-1068       | 1                   | .2500           | 4                   | .750                      | .313                                |
| .7500                   | 200-1075       | 1                   | .2500           | 4                   | .750                      | .313                                |
| .8125                   | 200-1081       | 1                   | .2500           | 4                   | .750                      | .313                                |
| .8750                   | 200-1087       | 1                   | .2500           | 4                   | .750                      | .313                                |
| .9375                   | 200-1093       | 1                   | .2500           | 4                   | .750                      | .313                                |
| 1.0000                  | 200-1100       | 1                   | .2500           | 4                   | .750                      | .313                                |
| 1.0625                  | 200-1106       | 1                   | .2500           | 4                   | .750                      | .313                                |
| 1.1250                  | 200-1112       | 1                   | .2500           | 4                   | .750                      | .313                                |
| 1.0625                  | 200-2106       | 2                   | .3125           | 4                   | .750                      | .375                                |
| 1.1250                  | 200-2112       | 2                   | .3125           | 4                   | .750                      | .375                                |
| 1.1875                  | 200-2118       | 2                   | .3125           | 4                   | .750                      | .375                                |
| 1.2500                  | 200-2125       | 2                   | .3125           | 4                   | .750                      | .375                                |
| 1.3125                  | 200-2131       | 2                   | .3125           | 4                   | .750                      | .375                                |
| 1.3750                  | 200-2137       | 2                   | .3125           | 4                   | .750                      | .375                                |
| 1.4375                  | 200-2143       | 2                   | .3125           | 4                   | .500                      | .375                                |
| 1.5000                  | 200-2150       | 2                   | .3125           | 4                   | .500                      | .375                                |
| 1.5625                  | *200-2156      | 2                   | .3125           | 4                   | .500                      | .375                                |
| 1.6250                  | 200-2162       | 2                   | .3125           | 4                   | .500                      | .375                                |
| 1.6875                  | 200-2168       | 2                   | .3125           | 4                   | .500                      | .375                                |
| 1.7500                  | 200-2175       | 2                   | .3125           | 4                   | .500                      | .375                                |
| 1.7500                  | 200-3175       | 3                   | .4375           | 6                   | .500                      | .500                                |
| 1.8750                  | 200-3187       | 3                   | .4375           | 6                   | .500                      | .500                                |
| 2.0000                  | 200-3200       | 3                   | .4375           | 6                   | .500                      | .500                                |
| 2.1250                  | 200-3212       | 3                   | .4375           | 6                   | .500                      | .500                                |
| 2.2500                  | 200-3225       | 3                   | .4375           | 6                   | .500                      | .500                                |
| 2.3750                  | 200-3237       | 3                   | .4375           | 6                   | .500                      | .500                                |
| 2.5000                  | 200-3250       | 3                   | .5000           | 6                   | .500                      | .563                                |
| 2.7500                  | 200-3275       | 3                   | .5000           | 6                   | .500                      | .563                                |
| 3.0000                  | 200-3300       | 3                   | .5000           | 6                   | .500                      | .563                                |

All dimensions shown in inches.

\*Non-stocked.

# Counterbores – Stub Taper

## High Speed Steel



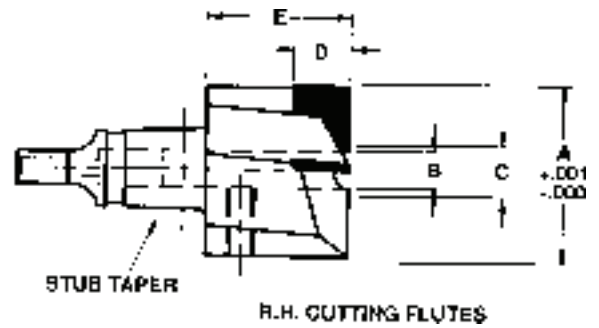
Use with 410 Series Pilots (Page 50) & 310 Series Holders (Page 46)

| A<br>Cutter<br>Diameter | Part<br>Number  | Stub<br>Taper<br>Drive No. | B<br>Pilot Hole | Number<br>of Flutes | C<br>Head<br>Length |
|-------------------------|-----------------|----------------------------|-----------------|---------------------|---------------------|
| .4375                   | <b>110-1043</b> | 1                          | .1875           | 4                   | 1.250               |
| .5000                   | <b>110-1050</b> | 1                          | .1875           | 4                   | 1.250               |
| .5625                   | <b>110-1056</b> | 1                          | .1875           | 4                   | 1.250               |
| .6250                   | <b>110-1062</b> | 1                          | .1875           | 4                   | 1.250               |
| .6875                   | <b>110-1068</b> | 1                          | .1875           | 4                   | 1.250               |
| .7500                   | <b>110-2075</b> | 2                          | .2500           | 4                   | 1.250               |
| .8125                   | <b>110-2081</b> | 2                          | .2500           | 4                   | 1.250               |
| .8750                   | <b>110-2087</b> | 2                          | .2500           | 4                   | 1.250               |
| .9375                   | <b>110-2093</b> | 2                          | .2500           | 4                   | 1.250               |
| 1.0000                  | <b>110-2100</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.0625                  | <b>110-2106</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.1250                  | <b>110-2112</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.1875                  | <b>110-2118</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.2500                  | <b>110-2125</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.3125                  | <b>110-2131</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.3750                  | <b>110-2137</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.4375                  | <b>110-2143</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.5000                  | <b>110-2150</b> | 2                          | .3125           | 4                   | 1.250               |
| 1.5625                  | <b>110-3156</b> | 3                          | .4375           | 6                   | 1.250               |
| 1.6250                  | <b>110-3162</b> | 3                          | .4375           | 6                   | 1.250               |
| 1.6875                  | <b>110-3168</b> | 3                          | .4375           | 6                   | 1.250               |
| 1.7500                  | <b>110-3175</b> | 3                          | .4375           | 6                   | 1.250               |
| 1.8125                  | <b>110-3181</b> | 3                          | .4375           | 6                   | 1.250               |
| 1.8750                  | <b>110-3187</b> | 3                          | .4375           | 6                   | 1.250               |
| 1.9375                  | <b>110-3193</b> | 3                          | .4375           | 6                   | 1.250               |
| 2.0000                  | <b>110-4200</b> | 4                          | .5000           | 6                   | 1.500               |
| 2.1250                  | <b>110-4212</b> | 4                          | .5000           | 6                   | 1.500               |
| 2.2500                  | <b>110-4225</b> | 4                          | .5000           | 6                   | 1.500               |
| 2.3750                  | <b>110-4237</b> | 4                          | .5000           | 6                   | 1.500               |
| 2.5000                  | <b>110-4250</b> | 4                          | .5000           | 6                   | 1.500               |
| 2.7500                  | <b>110-4275</b> | 4                          | .5000           | 6                   | 1.500               |
| 3.0000                  | <b>110-4300</b> | 4                          | .5000           | 6                   | 1.500               |

All dimensions shown in inches.

# Counterbores – Stub Taper

## Tungsten Carbide Tipped



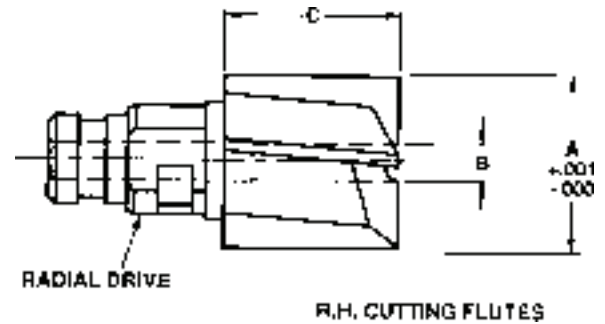
Use with 410 Series Pilots (Page 50) & 310 Series Holders (Page 46)

| A<br>Cutter<br>Diameter | Part<br>Number | Stub<br>Taper<br>Drive No. | B<br>Pilot Hole | Number<br>of Flutes | D<br>Length of<br>Carbide | C<br>Minimum<br>Cutting<br>Diameter | E<br>Head<br>Length |
|-------------------------|----------------|----------------------------|-----------------|---------------------|---------------------------|-------------------------------------|---------------------|
| .5000                   | 210-1050       | 1                          | .1875           | 3                   | .750                      | .219                                | 1.250               |
| .5625                   | 210-1056       | 1                          | .1875           | 3                   | .750                      | .219                                | 1.250               |
| .6250                   | 210-1062       | 1                          | .1875           | 3                   | .750                      | .219                                | 1.250               |
| .6875                   | 210-1068       | 1                          | .1875           | 4                   | .750                      | .219                                | 1.250               |
| .7500                   | 210-2075       | 2                          | .2500           | 4                   | .750                      | .313                                | 1.250               |
| .8125                   | 210-2081       | 2                          | .2500           | 4                   | .750                      | .313                                | 1.250               |
| .8750                   | 210-2087       | 2                          | .2500           | 4                   | .750                      | .313                                | 1.250               |
| .9375                   | 210-2093       | 2                          | .2500           | 4                   | .750                      | .313                                | 1.250               |
| 1.0000                  | 210-2100       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.0625                  | 210-2106       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.1250                  | 210-2112       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.1875                  | 210-2118       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.2500                  | 210-2125       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.3125                  | 210-2131       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.3750                  | 210-2137       | 2                          | .3125           | 4                   | .750                      | .375                                | 1.250               |
| 1.4375                  | 210-2143       | 2                          | .3125           | 4                   | .500                      | .375                                | 1.250               |
| 1.5000                  | 210-2150       | 2                          | .3125           | 4                   | .500                      | .375                                | 1.250               |
| 1.5625                  | 210-3156       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 1.6250                  | 210-3162       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 1.6875                  | 210-3168       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 1.7500                  | 210-3175       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 1.8125                  | 210-3181       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 1.8750                  | 210-3187       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 1.9375                  | 210-3193       | 3                          | .4375           | 6                   | .500                      | .500                                | 1.250               |
| 2.0000                  | 210-4200       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |
| 2.1250                  | 210-4212       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |
| 2.2500                  | 210-4225       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |
| 2.3750                  | 210-4237       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |
| 2.5000                  | 210-4250       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |
| 2.7500                  | 210-4275       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |
| 3.0000                  | 210-4300       | 4                          | .5000           | 6                   | .500                      | .563                                | 1.500               |

All dimensions shown in inches.

# Counterbores – Radial Drive

## High Speed Steel



Use with 400 Series Pilots (Pages 48–49) and 320, 321 & 323 Series Holders (Pages 46–47)

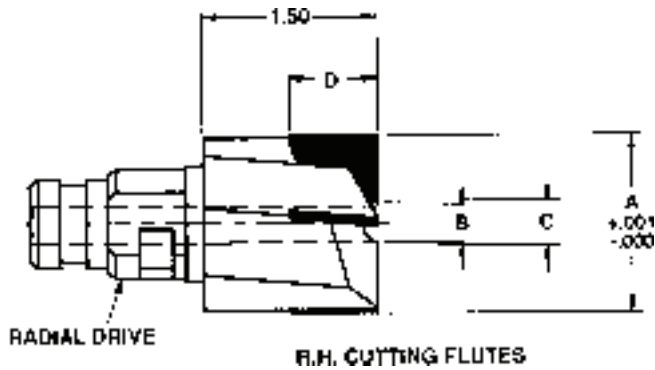
| A<br>Cutter<br>Diameter | Part<br>Number | Radial<br>Drive<br>No. | B<br>Pilot<br>Hole | No.<br>of<br>Flutes | C<br>Head<br>Length |
|-------------------------|----------------|------------------------|--------------------|---------------------|---------------------|
| .2500                   | 120-1025       | RA                     | .0937              | 4                   | 1.250               |
| .3125                   | 120-1031       | RA                     | .1250              | 4                   | 1.250               |
| .3438                   | 120-1034       | RA                     | .1250              | 4                   | 1.250               |
| .3750                   | 120-1037       | RA                     | .1250              | 4                   | 1.250               |
| .4063                   | 120-1040       | RA                     | .1250              | 4                   | 1.250               |
| .4375                   | 120-1043       | RA                     | .1250              | 4                   | 1.250               |
| .4375                   | 120-2043       | RB                     | .1875              | 4                   | 1.500               |
| .4688                   | 120-2046       | RB                     | .1875              | 4                   | 1.500               |
| .5000                   | 120-2050       | RB                     | .1875              | 4                   | 1.500               |
| .5313                   | 120-2053       | RB                     | .1875              | 4                   | 1.500               |
| .5625                   | 120-2056       | RB                     | .1875              | 4                   | 1.500               |
| .5938                   | 120-2059       | RB                     | .1875              | 4                   | 1.500               |
| .6250                   | 120-2062       | RB                     | .1875              | 4                   | 1.500               |
| .6563                   | 120-2065       | RB                     | .1875              | 4                   | 1.500               |
| .6875                   | 120-2068       | RB                     | .2500              | 4                   | 1.500               |
| .7188                   | 120-2071       | RB                     | .2500              | 4                   | 1.500               |
| .7500                   | 120-2075       | RB                     | .2500              | 4                   | 1.500               |
| .7813                   | 120-2078       | RB                     | .2500              | 4                   | 1.500               |
| .8125                   | 120-2081       | RB                     | .2500              | 4                   | 1.500               |
| .8750                   | 120-2087       | RB                     | .2500              | 4                   | 1.500               |
| .9375                   | 120-2093       | RB                     | .2500              | 4                   | 1.500               |
| 1.0000                  | 120-2100       | RB                     | .2500              | 4                   | 1.500               |
| .9375                   | 120-3093       | RC                     | .3125              | 4                   | 1.500               |
| 1.0000                  | 120-3100       | RC                     | .3125              | 4                   | 1.500               |
| 1.0625                  | 120-3106       | RC                     | .3125              | 4                   | 1.500               |
| 1.1250                  | 120-3112       | RC                     | .3125              | 4                   | 1.500               |
| 1.1875                  | 120-3118       | RC                     | .3125              | 4                   | 1.500               |
| 1.2500                  | 120-3125       | RC                     | .3125              | 4                   | 1.500               |
| 1.3125                  | 120-3131       | RC                     | .3125              | 4                   | 1.500               |
| 1.3750                  | 120-3137       | RC                     | .3125              | 4                   | 1.500               |
| 1.3125                  | 120-4131       | RE                     | .3125              | 4                   | 1.500               |
| 1.3750                  | 120-4137       | RE                     | .3125              | 4                   | 1.500               |
| 1.4375                  | 120-4143       | RE                     | .3125              | 4                   | 1.500               |
| 1.5000                  | 120-4150       | RE                     | .3125              | 4                   | 1.500               |

| A<br>Cutter<br>Diameter | Part<br>Number | Radial<br>Drive<br>No. | B<br>Pilot<br>Hole | No.<br>of<br>Flutes | C<br>Head<br>Length |
|-------------------------|----------------|------------------------|--------------------|---------------------|---------------------|
| 1.5625                  | 120-4156       | RE                     | .3125              | 4                   | 1.500               |
| 1.6250                  | 120-4162       | RE                     | .3125              | 4                   | 1.500               |
| 1.5000                  | 120-5150       | RF                     | .4375              | 4                   | 1.500               |
| 1.5625                  | 120-5156       | RF                     | .4375              | 4                   | 1.500               |
| 1.6250                  | 120-5162       | RF                     | .4375              | 4                   | 1.500               |
| 1.6875                  | 120-5168       | RF                     | .4375              | 6                   | 1.500               |
| 1.7500                  | 120-5175       | RF                     | .4375              | 6                   | 1.500               |
| 1.8125                  | 120-5181       | RF                     | .4375              | 6                   | 1.500               |
| 1.8750                  | 120-5187       | RF                     | .4375              | 6                   | 1.500               |
| 1.9375                  | 120-5193       | RF                     | .4375              | 6                   | 1.500               |
| 2.0000                  | 120-5200       | RF                     | .4375              | 6                   | 1.500               |
| 2.0000                  | 120-6200       | RJ                     | .5000              | 6                   | 1.500               |
| 2.0625                  | 120-6206       | RJ                     | .5000              | 6                   | 1.500               |
| 2.1250                  | 120-6212       | RJ                     | .5000              | 6                   | 1.500               |
| 2.2500                  | 120-6225       | RJ                     | .5000              | 6                   | 1.500               |
| 2.3750                  | 120-6237       | RJ                     | .5000              | 6                   | 1.500               |
| 2.5000                  | 120-6250       | RJ                     | .5000              | 6                   | 1.500               |
| 2.6250                  | 120-6262       | RJ                     | .5000              | 6                   | 1.500               |
| 2.7500                  | 120-7275       | RS                     | .7500              | 6                   | 1.500               |
| 2.8750                  | 120-7287       | RS                     | .7500              | 6                   | 1.500               |
| 3.0000                  | 120-7300       | RS                     | .7500              | 6                   | 1.500               |
| 3.1250                  | 120-7312       | RS                     | .7500              | 6                   | 1.500               |
| 3.2500                  | 120-7325       | RS                     | .7500              | 6                   | 1.500               |
| 3.3750                  | 120-7337       | RS                     | .7500              | 6                   | 1.500               |
| 3.5000                  | 120-7350       | RS                     | .7500              | 6                   | 1.500               |
| 3.6250                  | 120-7362       | RS                     | .7500              | 6                   | 1.500               |
| 3.7500                  | 120-7375       | RS                     | .7500              | 6                   | 1.500               |
| 4.0000                  | 120-7400       | RS                     | .7500              | 6                   | 1.500               |

All dimensions shown in inches.

# Counterbores – Radial Drive

## Tungsten Carbide Tipped



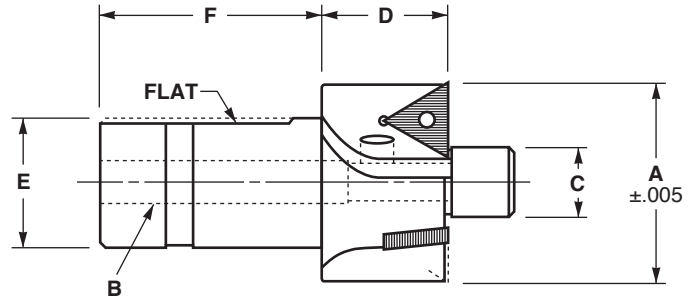
Use with 400 Series Pilots (Pages 48–49) and 320, 321 & 323 Series Holders (Pages 46–47)

| A<br>Cutter<br>Diameter | Part<br>Number | Radial<br>Drive<br>Number | B<br>Pilot Hole | Number<br>of Flutes | D<br>Length of<br>Carbide | C<br>Minimum<br>Cutting<br>Diameter |
|-------------------------|----------------|---------------------------|-----------------|---------------------|---------------------------|-------------------------------------|
| .5000                   | 220-2050       | RB                        | .1875           | 3                   | .750                      | .219                                |
| .5625                   | 220-2056       | RB                        | .1875           | 3                   | .750                      | .219                                |
| .6250                   | 220-2062       | RB                        | .1875           | 3                   | .750                      | .219                                |
| .6875                   | 220-2068       | RB                        | .2500           | 4                   | .750                      | .313                                |
| .7500                   | 220-2075       | RB                        | .2500           | 4                   | .750                      | .313                                |
| .8125                   | 220-2081       | RB                        | .2500           | 4                   | .750                      | .313                                |
| .8750                   | 220-2087       | RB                        | .2500           | 4                   | .750                      | .313                                |
| .9375                   | 220-2093       | RB                        | .2500           | 4                   | .750                      | .313                                |
| 1.0000                  | 220-2100       | RB                        | .2500           | 4                   | .750                      | .313                                |
| 1.0000                  | 220-3100       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.0625                  | 220-3106       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.1250                  | 220-3112       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.1875                  | 220-3118       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.2500                  | 220-3125       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.3125                  | 220-3131       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.3750                  | 220-3137       | RC                        | .3125           | 4                   | .750                      | .375                                |
| 1.3750                  | 220-4137       | RE                        | .3125           | 4                   | .750                      | .375                                |
| 1.5000                  | 220-4150       | RE                        | .3125           | 4                   | .500                      | .375                                |
| 1.6250                  | 220-4162       | RE                        | .3125           | 4                   | .500                      | .375                                |
| 1.5000                  | 220-5150       | RF                        | .4375           | 4                   | .500                      | .500                                |
| 1.6250                  | 220-5162       | RF                        | .4375           | 4                   | .500                      | .500                                |
| 1.7500                  | 220-5175       | RF                        | .4375           | 6                   | .500                      | .500                                |
| 1.8750                  | 220-5187       | RF                        | .4375           | 6                   | .500                      | .500                                |
| 2.0000                  | 220-5200       | RF                        | .4375           | 6                   | .500                      | .500                                |
| 2.0000                  | 220-6200       | RJ                        | .5000           | 6                   | .500                      | .563                                |
| 2.1250                  | 220-6212       | RJ                        | .5000           | 6                   | .500                      | .563                                |
| 2.2500                  | 220-6225       | RJ                        | .5000           | 6                   | .500                      | .563                                |
| 2.3750                  | 220-6237       | RJ                        | .5000           | 6                   | .500                      | .563                                |
| 2.5000                  | 220-6250       | RJ                        | .5000           | 6                   | .500                      | .563                                |
| 2.6250                  | 220-6262       | RJ                        | .5000           | 6                   | .500                      | .563                                |
| 2.7500                  | 220-7275       | RS                        | .5000           | 6                   | .500                      | .563                                |
| 2.8750                  | 220-7287       | RS                        | .5000           | 6                   | .500                      | .563                                |
| 3.0000                  | 220-7300       | RS                        | .5000           | 6                   | .500                      | .563                                |

All dimensions shown in inches.

# Counterbores – Straight Shank

**Indexable**



(3) R.H. CUTTING FLUTES

**Use with 410 Series Pilots** (Page 50)

| A<br>Cutting<br>Diameter | Part<br>Number   | B<br>Pilot Hole<br>Diameter | C<br>Minimum<br>Pilot<br>Diameter | D<br>Head<br>Length | E<br>Shank<br>Diameter | F<br>Shank<br>Length | Standard<br>Insert<br>Number | Lock<br>Pin<br>Number |
|--------------------------|------------------|-----------------------------|-----------------------------------|---------------------|------------------------|----------------------|------------------------------|-----------------------|
| *.7500                   | <b>7810-0048</b> | .1875                       | .310                              | 1.250               | .750                   | 2.375                | F-156-BD                     | 056-1010              |
| *.8120                   | <b>7810-0052</b> | .1875                       | .340                              | 1.250               | .750                   | 2.375                | F-156-BD                     | 056-1010              |
| *.8750                   | <b>7810-0056</b> | .1875                       | .310                              | 1.250               | .750                   | 2.375                | F-218-BD                     | 056-1012              |
| *.9380                   | <b>7810-0060</b> | .1875                       | .340                              | 1.250               | .750                   | 2.375                | F-218-BD                     | 056-1012              |
| *1.000                   | <b>7810-0100</b> | .1875                       | .400                              | 1.250               | .750                   | 2.375                | F-218-BD                     | 056-1012              |
| 1.0625                   | <b>7810-0104</b> | .1875                       | .335                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.1250                   | <b>7810-0108</b> | .1875                       | .385                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.1875                   | <b>7810-0112</b> | .1875                       | .440                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.2500                   | <b>7810-0116</b> | .3125                       | .500                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.3125                   | <b>7810-0120</b> | .3125                       | .555                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.3750                   | <b>7810-0124</b> | .3125                       | .615                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.4375                   | <b>7810-0128</b> | .3125                       | .675                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.5000                   | <b>7810-0132</b> | .3125                       | .735                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.5625                   | <b>7810-0136</b> | .3125                       | .795                              | 1.250               | .750                   | 2.375                | G-250-BD                     | 053-0231              |
| 1.6250                   | <b>7810-0140</b> | .3125                       | .540                              | 1.250               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 1.6875                   | <b>7810-0144</b> | .3125                       | .595                              | 1.250               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 1.7500                   | <b>7810-0148</b> | .4375                       | .650                              | 1.750               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 1.8125                   | <b>7810-0152</b> | .4375                       | .710                              | 1.750               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 1.8750                   | <b>7810-0156</b> | .4375                       | .770                              | 1.750               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 1.9375                   | <b>7810-0160</b> | .4375                       | .830                              | 1.750               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 2.0000                   | <b>7810-0200</b> | .4375                       | .890                              | 1.750               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 2.0625                   | <b>7810-0204</b> | .4375                       | .950                              | 1.750               | 1.000                  | 2.375                | G-375-BD                     | 053-0331              |
| 2.1250                   | <b>7810-0208</b> | .5000                       | 1.010                             | 1.750               | 1.250                  | 2.625                | G-375-BD                     | 053-0331              |
| 2.1875                   | <b>7810-0212</b> | .5000                       | 1.070                             | 1.750               | 1.250                  | 2.625                | G-375-BD                     | 053-0331              |
| 2.2500                   | <b>7810-0216</b> | .5000                       | .720                              | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.3125                   | <b>7810-0220</b> | .5000                       | .780                              | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.3750                   | <b>7810-0224</b> | .5000                       | .835                              | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.4375                   | <b>7810-0228</b> | .5000                       | .895                              | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.5000                   | <b>7810-0232</b> | .5000                       | .955                              | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.5625                   | <b>7810-0236</b> | .5000                       | 1.015                             | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.6250                   | <b>7810-0240</b> | .5000                       | 1.075                             | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.6875                   | <b>7810-0244</b> | .5000                       | 1.140                             | 1.750               | 1.250                  | 2.625                | G-500-BD                     | 053-0440              |
| 2.7500                   | <b>7810-0248</b> | .5000                       | .940                              | 1.750               | 1.250                  | 2.625                | G-625-BD                     | 053-0541              |
| 2.8125                   | <b>7810-0252</b> | .5000                       | 1.000                             | 1.750               | 1.250                  | 2.625                | G-625-BD                     | 053-0541              |
| 2.8750                   | <b>7810-0256</b> | .5000                       | 1.060                             | 1.750               | 2.000                  | 3.250                | G-625-BD                     | 053-0541              |
| 2.9375                   | <b>7810-0260</b> | .5000                       | 1.120                             | 1.750               | 2.000                  | 3.250                | G-625-BD                     | 053-0541              |
| 3.0000                   | <b>7810-0300</b> | .5000                       | 1.180                             | 1.750               | 2.000                  | 3.250                | G-625-BD                     | 053-0541              |

All dimensions shown in inches.

\*These sizes use Positive Rake Inserts.

Note: Inserts must be ordered separately.

-CVD Tri-phase TiCN/TiC/TiN Coated Inserts

# Counterbores Application Information

## Counterboring—Surface Feet Per Minute (SFPM)

Converting SFPM to Revolutions Per Minute (RPM): 
$$\text{RPM} = \frac{3.82 \times \text{SFPM}}{\text{Cutter Diameter}}$$

The table below lists starting SFPM rates for certain materials using carbide or high speed steel cutters. These speeds are starting recommendations only. There are many variables, such as machine and spindle condition, available power, fixturing, tool holding, spindle deflection, tooling and production expectations, etc. Some adjustments may be required for your specific operation. METCUT's experienced sales engineers will be happy to help you attain the highest efficiency possible in your application.

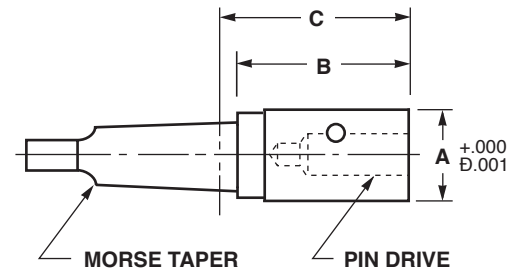
Since counterboring is often a secondary operation, it is sometimes performed on machines that are quite worn, with excessive run-out and insufficient power. When trouble is encountered, the condition of the machine, as well as the cutter, should be considered.

| Material                                |              | Carbide | HSS |
|-----------------------------------------|--------------|---------|-----|
| <b>Aluminum</b>                         |              | 1000    | 600 |
| <b>Alloy Steels</b> (Chrome–Molybdenum) | Soft         | 250     | 60  |
|                                         | Hard         | 180     | 45  |
| <b>Brass</b>                            |              | 500     | 250 |
| <b>Carbon Steel</b>                     | Soft         | 400     | 110 |
|                                         | Hard         | 270     | 70  |
| <b>Cast Iron</b>                        | Soft         | 400     | 100 |
|                                         | Hard         | 300     | 70  |
| <b>Forgings</b> (Heat Treated)          | 200 Brinnell | 220     | 55  |
|                                         | 300 Brinnell | 180     | 40  |
|                                         | 350 Brinnell | 240     | 30  |
| <b>Magnesium</b>                        |              | 1400    | 600 |
| <b>Malleable Iron</b>                   |              | 300     | 70  |
| <b>Monel</b>                            |              | 160     | 30  |
| <b>Stainless Steel</b>                  |              | 200     | 40  |
| <b>Tool Steel</b> (Annealed)            |              | 160     | 40  |

Feed on 4-Fluted Counterbores is approximately .008— .012 FPR (Feed Per Revolution).

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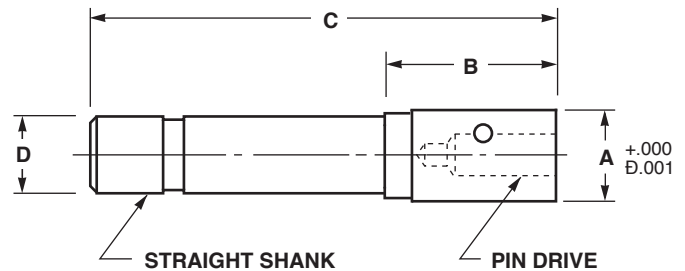


Use with 100 & 200 Series Cutters (Pages 37–38)

| Cutter Range     | Part Number | Pin Drive | Morse Taper | A Body Diameter | B Head Length | C Projection |
|------------------|-------------|-----------|-------------|-----------------|---------------|--------------|
| .3125 to .4375   | 300-0107    | 0         | 1           | .7500           | 2.250         | 2.375        |
| .3125 to .4375   | 300-0207    | 0         | 2           | .7500           | 2.250         | 2.437        |
| .4375 to 1.1250  | 300-1110    | 1         | 1           | 1.0625          | 3.000         | 3.375        |
| .4375 to 1.1250  | 300-1210    | 1         | 2           | 1.0625          | 3.000         | 3.187        |
| .4375 to 1.1250  | 300-1310    | 1         | 3           | 1.0625          | 3.000         | 3.187        |
| 1.0625 to 1.7500 | 300-2215    | 2         | 2           | 1.5000          | 3.250         | 3.437        |
| 1.0625 to 1.7500 | 300-2315    | 2         | 3           | 1.5000          | 3.000         | 3.187        |
| 1.0625 to 1.7500 | 300-2415    | 2         | 4           | 1.5000          | 3.000         | 3.250        |
| 1.6875 to 3.1250 | 300-3320    | 3         | 3           | 2.0000          | 3.313         | 3.500        |
| 1.6875 to 3.1250 | 300-3420    | 3         | 4           | 2.0000          | 3.000         | 3.250        |
| 1.6875 to 3.1250 | 300-3520    | 3         | 5           | 2.0000          | 3.000         | 3.250        |
| 3.0000 to 4.0000 | 300-4430    | 4         | 4           | 3.0000          | 3.500         | 3.750        |
| 3.0000 to 4.0000 | 300-4530    | 4         | 5           | 3.0000          | 3.000         | 3.250        |

All dimensions shown in inches.

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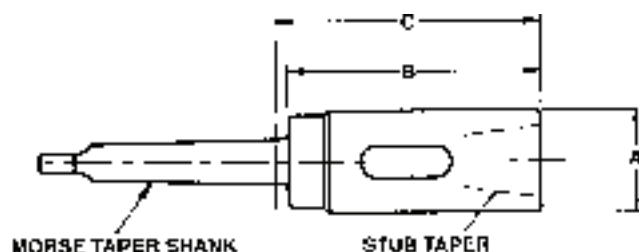
Use with 100 & 200 Series Cutters (Pages 37–38)

| Cutter Range     | Part Number | Pin Drive | A Body Diameter | B Head Length | C Overall Length | D Shank Diameter |
|------------------|-------------|-----------|-----------------|---------------|------------------|------------------|
| .2500 to .4375   | 303-0007    | 0         | .7500           | 2.250         | 5.250            | .500             |
| .4375 to 1.1250  | 303-1010    | 1         | 1.0625          | 3.000         | 6.000            | .500             |
| .4375 to 1.1250  | 303-1110    | 1         | 1.0625          | 3.000         | 6.000            | .750             |
| 1.0625 to 1.7500 | 303-2115    | 2         | 1.5000          | 3.000         | 7.000            | .750             |
| 1.0625 to 1.7500 | 303-2215    | 2         | 1.5000          | 3.000         | 7.000            | 1.000            |
| 1.6875 to 3.1250 | 303-3220    | 3         | 2.0000          | 3.000         | 7.000            | 1.000            |
| 1.6875 to 3.1250 | 303-3320    | 3         | 2.0000          | 3.000         | 7.000            | 1.250            |
| 1.6875 to 3.1250 | 303-3423    | 3         | 2.3750          | 3.000         | 7.000            | 1.500            |
| 3.0000 to 4.0000 | 303-4530    | 4         | 3.0000          | 3.000         | 7.500            | 2.000            |

All dimensions shown in inches.

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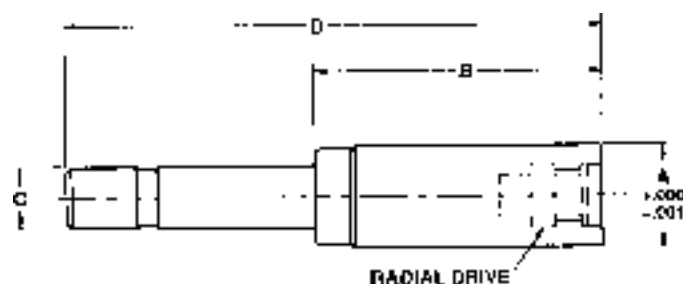


Use with 110 & 210 Series Cutters (Pages 39–40)

| Cutter Range     | Part Number | Stub Taper | Morse Taper | A Body Diameter | B Body Length | C Projection |
|------------------|-------------|------------|-------------|-----------------|---------------|--------------|
| .4375 to .6875   | 310-1208    | 1          | 2           | .8750           | 1.750         | 1.938        |
| .7500 to 1.5625  | 310-2211    | 2          | 2           | 1.1875          | 2.188         | 2.375        |
| .7500 to 1.5625  | 310-2311    | 2          | 3           | 1.1875          | 2.188         | 2.375        |
| .7500 to 1.5625  | 310-2411    | 2          | 4           | 1.1875          | 2.188         | 2.438        |
| 1.5625 to 2.0625 | 310-3214    | 3          | 2           | 1.4375          | 2.563         | 2.750        |
| 1.5625 to 2.0625 | 310-3314    | 3          | 3           | 1.4375          | 2.563         | 2.750        |
| 1.5625 to 2.0625 | 310-3414    | 3          | 4           | 1.4375          | 2.563         | 2.813        |
| 2.0000 to 3.0000 | 310-4318    | 4          | 3           | 1.8750          | 3.000         | 3.188        |
| 2.0000 to 3.0000 | 310-4418    | 4          | 4           | 1.8750          | 3.000         | 3.250        |
| 2.0000 to 3.0000 | 310-4518    | 4          | 5           | 1.8750          | 3.000         | 3.250        |
| 2.8750 to 3.0000 | 310-5527    | 5          | 5           | 2.7500          | 3.750         | 4.000        |

All dimensions shown in inches.

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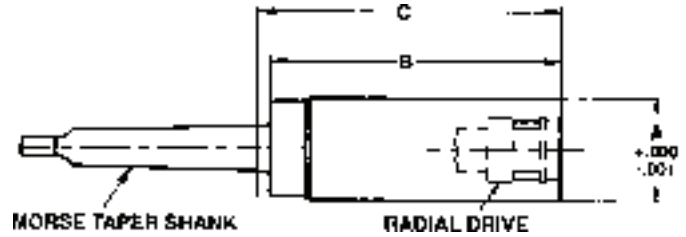
Use with 120 & 220 Series Cutters (Pages 41–42)

| Cutter Range     | Part Number | Radial Drive | A Body Dia. | B Body Length | C Shank Dia. | D Overall Length |
|------------------|-------------|--------------|-------------|---------------|--------------|------------------|
| .2500 to .4375   | 323-1107    | RA           | .7500       | 2.250         | .5000        | 5.25             |
| .4375 to 1.0000  | 323-2210    | RB           | 1.0625      | 3.000         | .6250        | 6.00             |
| .9375 to 1.1250  | 323-3310    | RC           | 1.0625      | 3.000         | .7500        | 6.00             |
| .9375 to 1.3750  | 323-3410    | RC           | 1.0625      | 3.000         | 1.0000       | 7.00             |
| 1.3125 to 1.6250 | 323-4415    | RE           | 1.5000      | 3.000         | 1.0000       | 7.00             |
| 1.5000 to 2.0000 | 323-5515    | RF           | 1.5000      | 3.000         | 1.2500       | 7.00             |
| 1.5000 to 2.0000 | 323-5615    | RF           | 1.5000      | 3.000         | 1.5000       | 7.50             |
| 2.0000 to 2.6875 | 323-6620    | RJ           | 2.0000      | 3.000         | 1.5000       | 7.50             |
| 2.7500 to 4.5000 | 323-7727    | RS           | 2.7500      | 3.000         | 2.0000       | 7.50             |

All dimensions shown in inches.

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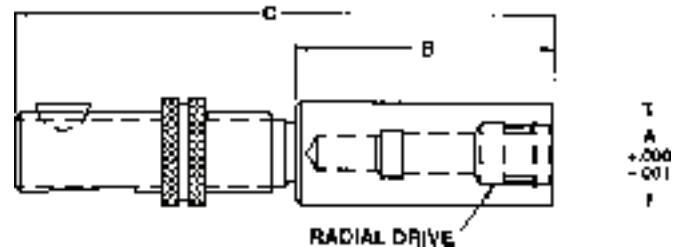


Use with 120, 160, 220 & 260 Series Cutters (Pages 41–42, 58, 60)

| Cutter Range     | Part Number | Radial Drive | Morse Taper | A Body Diameter | B Body Length | C Projection |
|------------------|-------------|--------------|-------------|-----------------|---------------|--------------|
| .2500 to .4375   | 320-1107    | RA           | 1           | .7500           | 2.250         | 2.375        |
| .2500 to .4375   | 320-1207    | RA           | 2           | .7500           | 2.250         | 2.438        |
| .4375 to 1.0000  | 320-2108    | RB           | 1           | 1.0625          | 3.000         | 3.125        |
| .4375 to 1.0000  | 320-2208    | RB           | 2           | 1.0625          | 3.000         | 3.188        |
| .9375 to 1.3750  | 320-3210    | RC           | 2           | 1.0625          | 3.000         | 3.188        |
| .9375 to 1.3750  | 320-3310    | RC           | 3           | 1.0625          | 3.000         | 3.188        |
| 1.3125 to 1.6250 | 320-4313    | RE           | 3           | 1.5000          | 3.000         | 3.188        |
| 1.3125 to 1.6250 | 320-4413    | RE           | 4           | 1.5000          | 3.000         | 3.250        |
| 1.5000 to 2.0000 | 320-5315    | RF           | 3           | 1.5000          | 3.000         | 3.188        |
| 1.5000 to 2.0000 | 320-5415    | RF           | 4           | 1.5000          | 3.000         | 3.250        |
| 2.0000 to 2.6250 | 320-6320    | RJ           | 3           | 2.0000          | 3.000         | 3.188        |
| 2.0000 to 2.6250 | 320-6420    | RJ           | 4           | 2.0000          | 3.000         | 3.250        |
| 2.0000 to 2.6250 | 320-6520    | RJ           | 5           | 2.0000          | 3.000         | 3.250        |
| 2.7500 to 4.5000 | 320-7427    | RS           | 4           | 2.7500          | 3.000         | 3.250        |
| 2.7500 to 4.5000 | 320-7527    | RS           | 5           | 2.7500          | 3.000         | 3.250        |

All dimensions shown in inches.

## 



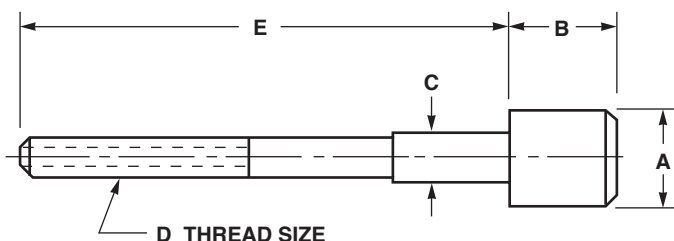
Use with 120, 160, 220 & 260 Series Cutters (Pages 41–42, 58, 60)

| Cutter Range     | Part Number | Radial Drive | Acme Shank | A Body Diameter | B Body Length | C Overall Length |
|------------------|-------------|--------------|------------|-----------------|---------------|------------------|
| .4375 to 1.0000  | 321-2109    | RB           | 5/8–16     | .9375           | 3.000         | 6.000            |
| .4375 to 1.0000  | 321-2309    | RB           | 7/8–12     | .9375           | 3.000         | 6.630            |
| .9375 to 1.3750  | 321-3310    | RC           | 7/8–12     | 1.0625          | 3.000         | 6.630            |
| .9375 to 1.3750  | 321-3510    | RC           | 1-1/16–12  | 1.0625          | 3.000         | 6.630            |
| .9375 to 1.3750  | 321-3610    | RC           | 1-3/8–12   | 1.0625          | 3.000         | 7.630            |
| 1.3125 to 1.6250 | 321-4313    | RE           | 7/8–12     | 1.3750          | 3.000         | 6.630            |
| 1.3125 to 1.6250 | 321-4513    | RE           | 1-1/16–12  | 1.3750          | 3.000         | 6.630            |
| 1.5000 to 2.0000 | 321-5615    | RF           | 1-3/8–12   | 1.5000          | 3.000         | 7.630            |

All dimensions shown in inches.

# Pilots for Counterbores & Countersinks

## Long Pilots for Pin Drive & Radial Drive



| A<br>Head<br>Diameter   | Shank Diameter & Part Number |                                  |                                  |                                  |                                  |                                  |                      |
|-------------------------|------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------|
|                         | .0938<br>Shank               | .1250<br>Shank                   | .1875<br>Shank                   | .2500<br>Shank                   | .3125<br>Shank                   | .4375<br>Shank                   | .5000<br>Shank       |
| .1250<br>.1563          | 400-0012<br>400-0015         | 400-1015                         |                                  |                                  |                                  |                                  |                      |
| .1719<br>.1875<br>.2031 | 400-0018<br>400-0020         | 400-1017<br>400-1018<br>400-1020 | 400-2020                         |                                  |                                  |                                  |                      |
| .2188<br>.2344<br>.2500 | 400-0021<br>400-0025         | 400-1021<br>400-1023<br>400-1025 | 400-2021<br>400-2023<br>400-2025 |                                  |                                  |                                  |                      |
| .2656<br>.2813<br>.2969 |                              | 400-1026<br>400-1028             | 400-2026<br>400-2028<br>400-2029 | 400-3026<br>400-3028<br>400-3029 |                                  |                                  |                      |
| .3125<br>.3281<br>.3438 |                              | 400-1031<br>400-1032<br>400-1034 | 400-2031<br>400-2032<br>400-2034 | 400-3031<br>400-3032<br>400-3034 | 400-4032<br>400-4034             |                                  |                      |
| .3594<br>.3750<br>.3906 |                              | 400-1037                         | 400-2035<br>400-2037<br>400-2039 | 400-3035<br>400-3037<br>400-3039 | 400-4035<br>400-4037<br>400-4039 |                                  |                      |
| .4063<br>.4219<br>.4375 |                              |                                  | 400-2040<br>400-2042<br>400-2043 | 400-3040<br>400-3042<br>400-3043 | 400-4040<br>400-4042<br>400-4043 |                                  |                      |
| .4531<br>.4688<br>.4844 |                              |                                  | 400-2045<br>400-2046<br>400-2048 | 400-3045<br>400-3046<br>400-3048 | 400-4045<br>400-4046<br>400-4048 |                                  |                      |
| .5000<br>.5156<br>.5313 |                              |                                  | 400-2050<br>400-2051<br>400-2053 | 400-3050<br>400-3051<br>400-3053 | 400-4050<br>400-4051<br>400-4053 | 400-5050<br>400-5053             |                      |
| .5469<br>.5625<br>.5781 |                              |                                  | 400-2056                         | 400-3054<br>400-3056<br>400-3057 | 400-4054<br>400-4056<br>400-4057 | 400-5056                         | 400-6056             |
| .5938<br>.6094<br>.6250 |                              |                                  |                                  | 400-3059<br>400-3060<br>400-3062 | 400-4059<br>400-4060<br>400-4062 | 400-5059<br>400-5062             | 400-6059<br>400-6062 |
| .6406<br>.6563<br>.6719 |                              |                                  |                                  | 400-3064<br>400-3065<br>400-3067 | 400-4064<br>400-4065<br>400-4067 | 400-5064<br>400-5065<br>400-5067 | 400-6065             |
| .6875<br>.7031<br>.7188 |                              |                                  |                                  | 400-3068<br>400-3071             | 400-4068<br>400-4070<br>400-4071 | 400-5068<br>400-5070<br>400-5071 | 400-6068<br>400-6071 |
| .7344<br>.7500          |                              |                                  |                                  | 400-3075                         | 400-4073<br>400-4075             | 400-5075                         | 400-6075             |

### Head Dimension

| A                                                                       | A<br>Less | B                               |
|-------------------------------------------------------------------------|-----------|---------------------------------|
| .125-.1875<br>.2031-.2500<br>.2656-.2813                                | .002      | .25<br>.25<br>.38               |
| .2969-.3750<br>.3906-.4375<br>.4531-.5625<br>.5781-.6875<br>.7031-.8750 | .004      | .38<br>.44<br>.62<br>.62<br>.75 |
| .8906-1.2500                                                            | .006      | .75                             |
| 1.3125-2.0000<br>2.1250-2.6250                                          | .007      | 1.00<br>1.25                    |

### Shank Dimension

| C                                | D                                      | E                            |
|----------------------------------|----------------------------------------|------------------------------|
| .0938<br>.1250<br>.1875<br>.2500 | #3-48<br>#5-40<br>10-24<br>1/4-20      | 2.31<br>2.31<br>3.19<br>3.19 |
| .3125<br>.4375<br>.5000<br>.7500 | 5/16-18<br>7/16-14<br>1/2-13<br>3/4-10 | 3.38<br>3.44<br>3.44<br>3.62 |

All dimensions shown in inches.

All dimensions shown in inches.

# Pilots for Counterbores & Countersinks

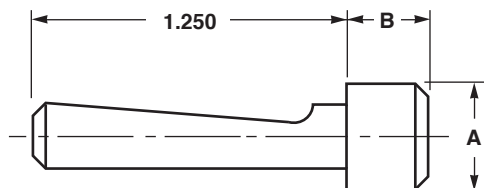
## Long Pilots – Continued

| A<br>Head<br>Diameter      | Shank Diameter & Part Number |                                  |                                  |                                  |                                  |
|----------------------------|------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
|                            | .2500<br>Shank               | .3125<br>Shank                   | .4375<br>Shank                   | .5000<br>Shank                   | .7500<br>Shank                   |
| .7656<br>.7813<br>.7969    | 400-3078                     | 400-4076<br>400-4078<br>400-4079 | 400-5076<br>400-5078<br>400-5079 | 400-6078                         |                                  |
| .8125<br>.8281<br>.8438    |                              | 400-4081<br>400-4082<br>400-4084 | 400-5081<br>400-5082<br>400-5084 | 400-6081<br>400-6084             |                                  |
| .8594<br>.8750<br>.8906    |                              | 400-4085<br>400-4087<br>400-4089 | 400-5085<br>400-5087<br>400-5089 | 400-6087                         |                                  |
| .9063<br>.9219<br>.9375    | 400-3093                     | 400-4090<br>400-4092<br>400-4093 | 400-5090<br>400-5092<br>400-5093 | 400-6090<br>400-6093             |                                  |
| .9531<br>.9688<br>.9845    |                              | 400-4095<br>400-4096<br>400-4098 | 400-5095<br>400-5096<br>400-5098 | 400-6096                         |                                  |
| 1.0000<br>1.0625<br>1.1250 |                              | 400-4100<br>400-4106<br>400-4112 | 400-5100<br>400-5106<br>400-5112 | 400-6100<br>400-6106<br>400-6112 |                                  |
| 1.1875<br>1.2500<br>1.3125 |                              | 400-4118<br>400-4125<br>400-4131 | 400-5118<br>400-5125<br>400-5131 | 400-6118<br>400-6125<br>400-6131 | 400-7125<br>400-7131             |
| 1.3750<br>1.4375<br>1.5000 |                              | 400-4137<br>400-4143             | 400-5137<br>400-5143<br>400-5150 | 400-6137<br>400-6143<br>400-6150 | 400-7137<br>400-7143<br>400-7150 |
| 1.5625<br>1.6250<br>1.6875 |                              |                                  | 400-5156<br>400-5162<br>400-5168 | 400-6156<br>400-6162<br>400-6168 | 400-7156<br>400-7162<br>400-7168 |
| 1.7500<br>1.8125<br>1.8750 |                              |                                  | 400-5175<br>400-5181<br>400-5187 | 400-6175<br>400-6181<br>400-6187 | 400-7175<br>400-7181<br>400-7187 |
| 1.9375<br>2.0000<br>2.1250 |                              |                                  |                                  | 400-6193<br>400-6200<br>400-6212 | 400-7193<br>400-7200<br>400-7212 |
| 2.2500<br>2.3750<br>2.5000 |                              |                                  |                                  | 400-6225                         | 400-7225<br>400-7237<br>400-7250 |
| 2.6250                     |                              |                                  |                                  |                                  | 400-7262                         |

All dimensions shown in inches.

# Pilots for Counterbores & Countersinks

## Short Pilots for Stub Taper, Indexable, & TCT Pin Drive, & Piloted Counterbores



| A<br>Head<br>Diameter | Shank Diameter & Part Number |                |                |                |                |
|-----------------------|------------------------------|----------------|----------------|----------------|----------------|
|                       | .1875<br>Shank               | .2500<br>Shank | .3125<br>Shank | .4375<br>Shank | .5000<br>Shank |
| .2500                 | 410-2025                     |                |                |                |                |
| .2813                 | 410-2028                     | 410-3028       |                |                |                |
| .3125                 | 410-2031                     | 410-3031       |                |                |                |
| .3438                 | 410-2034                     | 410-3034       | 410-4034       |                |                |
| .3750                 | 410-2037                     | 410-3037       | 410-4037       |                |                |
| .4063                 | 410-2040                     | 410-3040       | 410-4040       |                |                |
| .4375                 | 410-2043                     | 410-3043       | 410-4043       |                |                |
| .4688                 | 410-2046                     | 410-3046       | 410-4046       |                |                |
| .5000                 | 410-2050                     | 410-3050       | 410-4050       | 410-5050       |                |
| .5313                 | 410-2053                     | 410-3053       | 410-4053       | 410-5053       |                |
| .5625                 | 410-2056                     | 410-3056       | 410-4056       | 410-5056       | 410-6056       |
| .5938                 |                              | 410-3059       | 410-4059       | 410-5059       | 410-6059       |
| .6250                 |                              | 410-3062       | 410-4062       | 410-5062       |                |
| .6406                 |                              |                | 410-4064       |                |                |
| .6563                 |                              | 410-3065       | 410-4065       |                |                |
| .6875                 |                              | 410-3068       | 410-4068       | 410-5068       |                |
| .7188                 |                              |                | 410-4071       | 410-5071       | 410-6071       |
| .7500                 |                              |                | 410-4075       | 410-5075       | 410-6075       |
| .7656                 |                              |                | 410-4076       |                |                |
| .7813                 |                              |                | 410-4078       | 410-5078       | 410-6078       |
| .8125                 |                              | 410-3081       | 410-4081       | 410-5081       | 410-6081       |
| .8750                 |                              | 410-3087       | 410-4087       | 410-5087       | 410-6087       |
| .9375                 |                              |                | 410-4093       | 410-5093       | 410-6093       |
| .9687                 |                              |                | 410-4096       |                |                |
| 1.0000                |                              |                | 410-4100       | 410-5100       | 410-6100       |
| 1.0625                |                              |                | 410-4106       | 410-5106       | 410-6106       |
| 1.1250                |                              |                | 410-4112       | 410-5112       | 410-6112       |
| 1.1875                |                              |                |                | 410-5118       | 410-6118       |
| 1.2500                |                              |                |                | 410-5125       | 410-6125       |
| 1.3125                |                              |                |                |                | 410-6131       |
| 1.3750                |                              |                |                |                | 410-6137       |
| 1.4375                |                              |                |                | 410-5143       | 410-6143       |
| 1.5000                |                              |                |                |                | 410-6150       |
| 1.5625                |                              |                |                |                | 410-6156       |
| 1.6250                |                              |                |                |                | 410-6162       |
| 1.6875                |                              |                |                |                | 410-6168       |
| 1.7500                |                              |                |                |                | 410-6175       |
| 1.8750                |                              |                |                |                | 410-6187       |

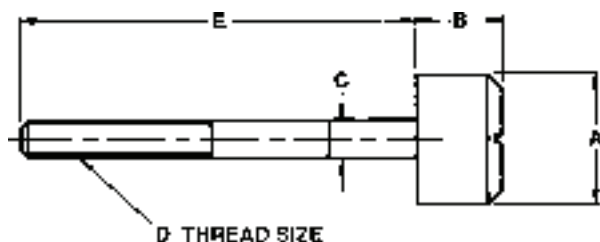
All dimensions shown in inches.

| A<br>Head Diameter | A<br>Less | B<br>Length |
|--------------------|-----------|-------------|
| .2500–.2813        | .002      | .438        |
| .3125–.3750        |           | .438        |
| .4063–.4375        |           | .438        |
| .4688–.5625        | .004      | .620        |
| .5938–.6875        |           | .656        |
| .7188–.8750        |           | .750        |
| .9375–1.2500       | .006      | .750        |
| 1.3125–1.8750      | .007      | 1.000       |

All dimensions shown in inches.

# Pilots for Counterbores

## for HEX Drive Type C HSS Counterbores



| A<br>Head<br>Diameter      | Shank Diameter & Part Number        |                                     |                                     |                                     |                                     |
|----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
|                            | #5-40<br>Shank                      | 1/4-20<br>Shank                     | 5/16-18<br>Shank                    | 7/16-14<br>Shank                    | 5/8-11<br>Shank                     |
| .1563<br>.1875<br>.2188    | 5021-0010<br>5021-0012<br>5021-0014 |                                     |                                     |                                     |                                     |
| .2500<br>.2813<br>.3125    | 5021-0016<br>5021-0018<br>5021-0020 | 5022-0018<br>5022-0020              |                                     |                                     |                                     |
| .3438<br>.3750<br>.4063    | 5021-0022<br>5021-0024              | 5022-0022<br>5022-0024<br>5022-0026 | 5023-0022<br>5023-0024<br>5023-0026 |                                     |                                     |
| .4375<br>.4688<br>.5000    |                                     | 5022-0028<br>5022-0030<br>5022-0032 | 5023-0028<br>5023-0030<br>5023-0032 |                                     |                                     |
| .5625<br>.6250<br>.6875    |                                     | 5022-0036<br>5022-0040<br>5022-0044 | 5023-0036<br>5023-0040<br>5023-0044 | 5024-0044                           |                                     |
| .7500<br>.8125<br>.8750    |                                     | 5022-0048<br>5022-0056              | 5023-0048<br>5023-0052<br>5023-0056 | 5024-0048<br>5024-0052<br>5024-0056 |                                     |
| .9375<br>1.0000<br>1.0625  |                                     |                                     | 5023-0060<br>5023-0100<br>5023-0104 | 5024-0060<br>5024-0100<br>5024-0104 |                                     |
| 1.1250<br>1.1875<br>1.2500 |                                     |                                     | 5023-0108<br>5023-0112<br>5023-0116 | 5024-0108<br>5024-0112<br>5024-0116 |                                     |
| 1.3125<br>1.3750<br>1.4375 |                                     |                                     |                                     | 5024-0120<br>5024-0124<br>5024-0128 | 5025-0120<br>5025-0124<br>5025-0128 |
| 1.5000<br>1.5625<br>1.6250 |                                     |                                     |                                     | 5024-0132<br>5024-0136              | 5025-0132<br>5025-0136<br>5025-0140 |
| 1.6875<br>1.7500<br>1.8125 |                                     |                                     |                                     |                                     | 5025-0144<br>5025-0148              |
| 1.8750<br>1.9375<br>2.0000 |                                     |                                     |                                     |                                     | 5025-0160<br>5025-0200              |

All dimensions shown in inches.

### Head Dimension

| A                                                                 | A Less | B                               |
|-------------------------------------------------------------------|--------|---------------------------------|
| .1562-.2812                                                       | .002   | .38                             |
| .3125-.3750<br>.4062-.4375<br>.4688-.5625<br>.6250<br>.6875-.8750 | .004   | .38<br>.44<br>.56<br>.62<br>.75 |
| .9375-1.0000<br>1.0600-1.1875                                     | .006   | .75<br>1.00                     |
| 1.2500-2.000                                                      | .007   | 1.250                           |

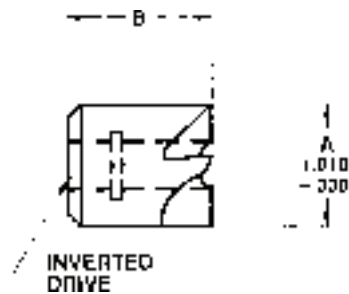
### Shank Dimension

| C                       | D                          | E                       | Used On              |
|-------------------------|----------------------------|-------------------------|----------------------|
| .1250<br>.2500<br>.3125 | #5-40<br>1/4-20<br>5/16-18 | 2.625<br>2.875<br>3.438 | C-11<br>C-12<br>C-13 |
| .4375<br>.6250          | 7/16-14<br>5/8-11          | 4.625<br>5.688          | C-14<br>C-15         |

All dimensions shown in inches.

# Back Spotfacers – Balanced Drive

## High Speed Steel

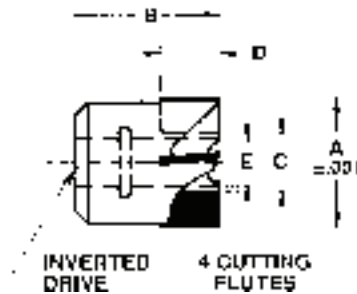


Use with 450 & 453 Series Pilots (Page 54)

| A Diameter | Part Number | Drive Size | B Overall Length | No. of Flutes |
|------------|-------------|------------|------------------|---------------|
| .500       | 150-1050    | .3125      | .750             | 4             |
| .563       | 150-1056    | .3125      | .750             | 4             |
| .625       | 150-1062    | .3125      | .750             | 4             |
| .688       | 150-1068    | .3125      | .750             | 4             |
| .750       | 150-1075    | .3125      | .750             | 4             |
| .750       | 150-2075    | .3750      | .750             | 4             |
| .813       | 150-2081    | .3750      | .750             | 4             |
| .875       | 150-2087    | .3750      | .750             | 4             |
| .938       | 150-2093    | .3750      | .750             | 4             |
| 1.000      | 150-2100    | .3750      | .750             | 4             |
| 1.000      | 150-3100    | .5000      | .750             | 4             |
| 1.063      | 150-3106    | .5000      | .750             | 4             |
| 1.125      | 150-3112    | .5000      | .750             | 4             |
| 1.188      | 150-3118    | .5000      | .750             | 4             |
| 1.250      | 150-3125    | .5000      | .750             | 4             |
| 1.313      | 150-3131    | .5000      | .750             | 4             |
| 1.375      | 150-3137    | .5000      | .750             | 4             |
| 1.438      | 150-3143    | .5000      | .750             | 4             |
| 1.500      | 150-3150    | .5000      | .750             | 4             |
| 1.375      | 150-4137    | .7500      | .750             | 6             |
| 1.438      | 150-4143    | .7500      | .750             | 6             |
| 1.500      | 150-4150    | .7500      | .750             | 6             |
| 1.563      | 150-4156    | .7500      | .750             | 6             |
| 1.625      | 150-4162    | .7500      | .750             | 6             |
| 1.688      | 150-4168    | .7500      | .750             | 6             |
| 1.750      | 150-4175    | .7500      | .750             | 6             |
| 1.813      | 150-4181    | .7500      | .750             | 6             |
| 1.875      | 150-4187    | .7500      | .750             | 6             |
| 1.938      | 150-4193    | .7500      | .750             | 6             |
| 2.000      | 150-4200    | .7500      | .750             | 6             |
| 2.000      | 150-5200    | 1.0000     | 1.000            | 6             |
| 2.063      | 150-5206    | 1.0000     | 1.000            | 6             |
| 2.125      | 150-5212    | 1.0000     | 1.000            | 6             |
| 2.188      | 150-5218    | 1.0000     | 1.000            | 6             |
| 2.250      | 150-5225    | 1.0000     | 1.000            | 6             |
| 2.375      | 150-5237    | 1.0000     | 1.000            | 6             |
| 2.500      | 150-5250    | 1.0000     | 1.000            | 6             |
| 2.625      | 150-5262    | 1.0000     | 1.000            | 6             |
| 2.750      | 150-5275    | 1.0000     | 1.000            | 6             |
| 2.875      | 150-5287    | 1.0000     | 1.000            | 6             |
| 3.000      | 150-5300    | 1.0000     | 1.000            | 6             |
| 3.250      | 150-5325    | 1.0000     | 1.000            | 6             |

All dimensions shown in inches.

## Tungsten Carbide Tipped



Use with 450 Series & 453 Series Pilots (Page 54)

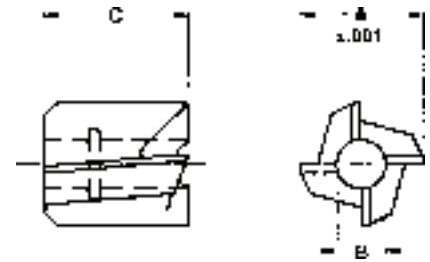
| A Diameter | Part Number | B Overall Length | C Carbide Root Dia. | D Carbide Length | E Drive Size |
|------------|-------------|------------------|---------------------|------------------|--------------|
| .625       | 250-1062    | .750             | .343                | .312             | .3125        |
| .688       | 250-1068    | .750             | .343                | .312             | .3125        |
| .750       | 250-1075    | .750             | .343                | .375             | .3125        |
| .750       | 250-2075    | .750             | .405                | .312             | .3750        |
| .813       | 250-2081    | .750             | .405                | .375             | .3750        |
| .875       | 250-2087    | .750             | .405                | .375             | .3750        |
| .938       | 250-2093    | .750             | .405                | .375             | .3750        |
| 1.000      | 250-2100    | .750             | .405                | .375             | .3750        |
| 1.000      | 250-3100    | .750             | .530                | .375             | .5000        |
| 1.063      | 250-3106    | .750             | .530                | .375             | .5000        |
| 1.125      | 250-3112    | .750             | .530                | .375             | .5000        |
| 1.188      | 250-3118    | .750             | .530                | .375             | .5000        |
| 1.250      | 250-3125    | .750             | .530                | .375             | .5000        |
| 1.375      | 250-3137    | .750             | .530                | .375             | .5000        |
| 1.500      | 250-3150    | .750             | .530                | .375             | .5000        |
| 1.375      | 250-4137    | .750             | .782                | .375             | .7500        |
| 1.500      | 250-4150    | .750             | .782                | .375             | .7500        |
| 1.625      | 250-4162    | .750             | .782                | .375             | .7500        |
| 1.750      | 250-4175    | .750             | .782                | .375             | .7500        |
| 1.875      | 250-4187    | .750             | .782                | .375             | .7500        |
| 2.000      | 250-4200    | .750             | .782                | .375             | .7500        |

All dimensions shown in inches.

NOTE: For 250 Series Back Spotfacers, the pilot diameter must be greater than the carbide root diameter.

# Back Counterbores – Balanced Drive

## High Speed Steel



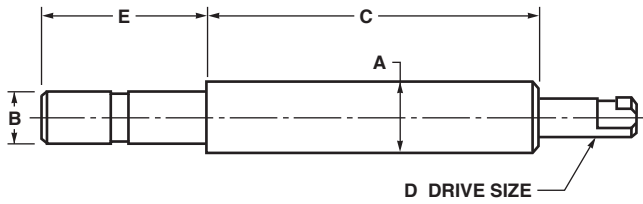
Use with 450 & 453 Series Pilots (Page 54)

| A<br>Diameter | Part<br>Number  | B<br>Drive<br>Size | C<br>Overall<br>Length | Number<br>of<br>Flutes |
|---------------|-----------------|--------------------|------------------------|------------------------|
| .750          | <b>151-1075</b> | .313               | .750                   | 4                      |
| .813          | <b>151-1081</b> | .313               | .750                   | 4                      |
| .875          | <b>151-1087</b> | .313               | .750                   | 4                      |
| .938          | <b>151-1093</b> | .313               | .750                   | 4                      |
| .938          | <b>151-2093</b> | .375               | .750                   | 4                      |
| 1.000         | <b>151-2100</b> | .375               | .750                   | 4                      |
| 1.063         | <b>151-2106</b> | .375               | .750                   | 4                      |
| 1.125         | <b>151-2112</b> | .375               | .750                   | 4                      |
| 1.188         | <b>151-2118</b> | .375               | .750                   | 4                      |
| 1.125         | <b>151-3112</b> | .500               | .750                   | 4                      |
| 1.187         | <b>151-3118</b> | .500               | .750                   | 4                      |
| 1.250         | <b>151-3125</b> | .500               | .750                   | 4                      |
| 1.313         | <b>151-3131</b> | .500               | .750                   | 4                      |
| 1.375         | <b>151-3137</b> | .500               | .750                   | 4                      |
| 1.438         | <b>151-3143</b> | .500               | .750                   | 4                      |
| 1.500         | <b>151-3150</b> | .500               | .750                   | 4                      |
| 1.563         | <b>151-3156</b> | .500               | .750                   | 4                      |
| 1.625         | <b>151-3162</b> | .500               | .750                   | 4                      |
| 1.625         | <b>151-4162</b> | .750               | .750                   | 6                      |
| 1.688         | <b>151-4168</b> | .750               | .750                   | 6                      |
| 1.750         | <b>151-4175</b> | .750               | .750                   | 6                      |
| 1.813         | <b>151-4181</b> | .750               | .750                   | 6                      |
| 1.875         | <b>151-4187</b> | .750               | .750                   | 6                      |
| 1.938         | <b>151-4193</b> | .750               | .750                   | 6                      |
| 2.000         | <b>151-4200</b> | .750               | .750                   | 6                      |
| 2.063         | <b>151-4206</b> | .750               | .750                   | 6                      |
| 2.000         | <b>151-5200</b> | 1.000              | 1.000                  | 6                      |
| 2.063         | <b>151-5206</b> | 1.000              | 1.000                  | 6                      |
| 2.125         | <b>151-5212</b> | 1.000              | 1.000                  | 6                      |
| 2.250         | <b>151-5225</b> | 1.000              | 1.000                  | 6                      |
| 2.375         | <b>151-5237</b> | 1.000              | 1.000                  | 6                      |

All dimensions shown in inches.

# Pilots for Balanced Drive Back Spotfacers & Back Counterbores

## with Straight Shank



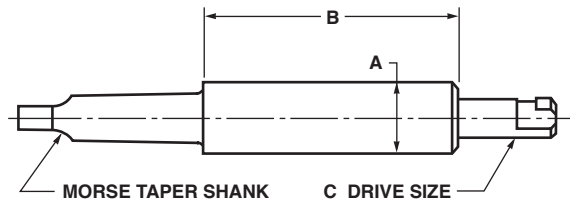
Use with 150 & 250 Series Back Spotfacers (Page 52)  
and 151 Series Back Counterbores (Page 53)

| A Pilot Diameter* | Part Number | B Shank Dia. | C Body Length | D Inverted Drive | E Shank Length |
|-------------------|-------------|--------------|---------------|------------------|----------------|
| .3125             | 453-1031    | .500         | 2.500         | .3125            | 2.000          |
| .3438             | 453-1034    | .500         | 2.500         | .3125            | 2.000          |
| .3750             | 453-1037    | .500         | 2.500         | .3125            | 2.000          |
| .4063             | 453-1040    | .500         | 2.500         | .3125            | 2.000          |
| .4375             | 453-1043    | .500         | 2.500         | .3125            | 2.000          |
| .4688             | 453-1046    | .500         | 2.500         | .3125            | 2.000          |
| .5000             | 453-1050    | .500         | 2.500         | .3125            | 2.000          |
| .5313             | 453-1053    | .500         | 2.500         | .3125            | 2.000          |
| .3750             | 453-2037    | .500         | 2.500         | .3750            | 2.000          |
| .4063             | 453-2040    | .500         | 2.500         | .3750            | 2.000          |
| .4375             | 453-2043    | .500         | 2.500         | .3750            | 2.000          |
| .4688             | 453-2046    | .500         | 2.500         | .3750            | 2.000          |
| .5000             | 453-2050    | .500         | 2.500         | .3750            | 2.000          |
| .5313             | 453-2053    | .500         | 2.500         | .3750            | 2.000          |
| .5625             | 453-2056    | .500         | 2.500         | .3750            | 2.000          |
| .5938             | 453-2059    | .500         | 2.500         | .3750            | 2.000          |
| .6250             | 453-2062    | .500         | 2.500         | .3750            | 2.000          |
| .6563             | 453-2065    | .500         | 2.500         | .3750            | 2.000          |
| .5000             | 453-3050    | .500         | 2.500         | .5000            | 2.000          |
| .5313             | 453-3053    | .500         | 2.500         | .5000            | 2.000          |
| .5625             | 453-3056    | .500         | 2.500         | .5000            | 2.000          |
| .5938             | 453-3059    | .500         | 2.500         | .5000            | 2.000          |
| .6250             | 453-3062    | .500         | 2.500         | .5000            | 2.000          |
| .6563             | 453-3065    | .500         | 2.500         | .5000            | 2.000          |
| .6875             | 453-3068    | .500         | 2.500         | .5000            | 2.000          |
| .7500             | 453-3075    | .500         | 2.500         | .5000            | 2.000          |
| .7813             | 453-3078    | .500         | 2.500         | .5000            | 2.000          |
| .8125             | 453-3081    | .500         | 3.500         | .5000            | 2.000          |
| .8750             | 453-3087    | .500         | 3.500         | .5000            | 2.000          |
| .9063             | 453-3090    | .500         | 3.500         | .5000            | 2.000          |
| 1.0313            | 453-3103    | .500         | 3.500         | .5000            | 2.000          |
| .7500             | 453-4075    | .750         | 3.500         | .7500            | 2.250          |
| .8125             | 453-4081    | .750         | 3.500         | .7500            | 2.250          |
| .8750             | 453-4087    | .750         | 3.500         | .7500            | 2.250          |
| .9375             | 453-4093    | .750         | 3.500         | .7500            | 2.250          |
| 1.0000            | 453-4100    | .750         | 3.500         | .7500            | 2.250          |
| 1.1250            | 453-4112    | .750         | 3.500         | .7500            | 2.250          |
| 1.2500            | 453-4125    | .750         | 3.500         | .7500            | 2.250          |
| 1.3750            | 453-4137    | .750         | 3.500         | .7500            | 2.250          |
| 1.0000            | 453-5100    | 1.000        | 3.500         | 1.0000           | 2.500          |
| 1.1250            | 453-5112    | 1.000        | 3.500         | 1.0000           | 2.500          |
| 1.2500            | 453-5125    | 1.000        | 3.500         | 1.0000           | 2.500          |
| 1.3750            | 453-5137    | 1.000        | 3.500         | 1.0000           | 2.500          |
| 1.5000            | 453-5150    | 1.000        | 5.000         | 1.0000           | 2.500          |
| 1.6250            | 453-5162    | 1.000        | 5.000         | 1.0000           | 2.500          |

All dimensions shown in inches.

\*Finish ground for running fit in nominal size hole.

## with Taper Shank



Use with 150 & 250 Series Back Spotfacers (Page 52)  
and 151 Series Back Counterbores (Page 53)

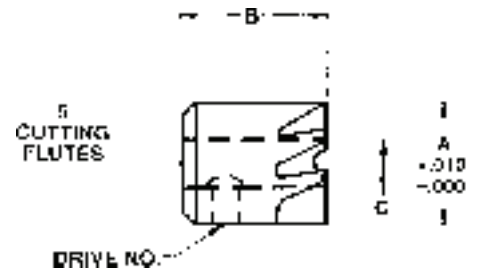
| A Pilot Diameter* | Part Number | Morse Taper Shank | B Body Length | C Inverted Drive |
|-------------------|-------------|-------------------|---------------|------------------|
| .3125             | 450-1031    | 2                 | 2.500         | .3125            |
| .3438             | 450-1034    | 2                 | 2.500         | .3125            |
| .3750             | 450-1037    | 2                 | 2.500         | .3125            |
| .4063             | 450-1040    | 2                 | 2.500         | .3125            |
| .4375             | 450-1043    | 2                 | 2.500         | .3125            |
| .4688             | 450-1046    | 2                 | 2.500         | .3125            |
| .5000             | 450-1050    | 2                 | 2.500         | .3125            |
| .5313             | 450-1053    | 2                 | 2.500         | .3125            |
| .3750             | 450-2037    | 2                 | 2.500         | .3750            |
| .4063             | 450-2040    | 2                 | 2.500         | .3750            |
| .4375             | 450-2043    | 2                 | 2.500         | .3750            |
| .4688             | 450-2046    | 2                 | 2.500         | .3750            |
| .5000             | 450-2050    | 2                 | 2.500         | .3750            |
| .5313             | 450-2053    | 2                 | 2.500         | .3750            |
| .5625             | 450-2056    | 2                 | 2.500         | .3750            |
| .5938             | 450-2059    | 2                 | 2.500         | .3750            |
| .6250             | 450-2062    | 2                 | 2.500         | .3750            |
| .6563             | 450-2065    | 2                 | 2.500         | .3750            |
| .5000             | 450-3050    | 2                 | 2.500         | .5000            |
| .5313             | 450-3053    | 2                 | 2.500         | .5000            |
| .5625             | 450-3056    | 2                 | 2.500         | .5000            |
| .5938             | 450-3059    | 2                 | 2.500         | .5000            |
| .6250             | 450-3062    | 2                 | 2.500         | .5000            |
| .6563             | 450-3065    | 2                 | 2.500         | .5000            |
| .6875             | 450-3068    | 2                 | 2.500         | .5000            |
| .7500             | 450-3075    | 2                 | 2.500         | .5000            |
| .7813             | 450-3078    | 2                 | 2.500         | .5000            |
| .8125             | 450-3081    | 2                 | 3.500         | .5000            |
| .8750             | 450-3087    | 2                 | 3.500         | .5000            |
| .9063             | 450-3090    | 2                 | 3.500         | .5000            |
| 1.0313            | 450-3103    | 2                 | 3.500         | .5000            |
| .7500             | 450-4075    | 3                 | 3.500         | .7500            |
| .8125             | 450-4081    | 3                 | 3.500         | .7500            |
| .8750             | 450-4087    | 3                 | 3.500         | .7500            |
| .9375             | 450-4093    | 3                 | 3.500         | .7500            |
| 1.0000            | 450-4100    | 3                 | 3.500         | .7500            |
| 1.1250            | 450-4112    | 3                 | 3.500         | .7500            |
| 1.2500            | 450-4125    | 3                 | 3.500         | .7500            |
| 1.3750            | 450-4137    | 3                 | 3.500         | .7500            |
| 1.0000            | 450-5100    | 4                 | 3.500         | 1.0000           |
| 1.1250            | 450-5112    | 4                 | 3.500         | 1.0000           |
| 1.2500            | 450-5125    | 4                 | 3.500         | 1.0000           |
| 1.3750            | 450-5137    | 4                 | 3.500         | 1.0000           |
| 1.5000            | 450-5150    | 4                 | 5.000         | 1.0000           |
| 1.6250            | 450-5162    | 4                 | 5.000         | 1.0000           |

All dimensions shown in inches.

\*Finish ground for running fit in nominal size hole.

# Back Spotfacers – Ball Pin Drive, D Style

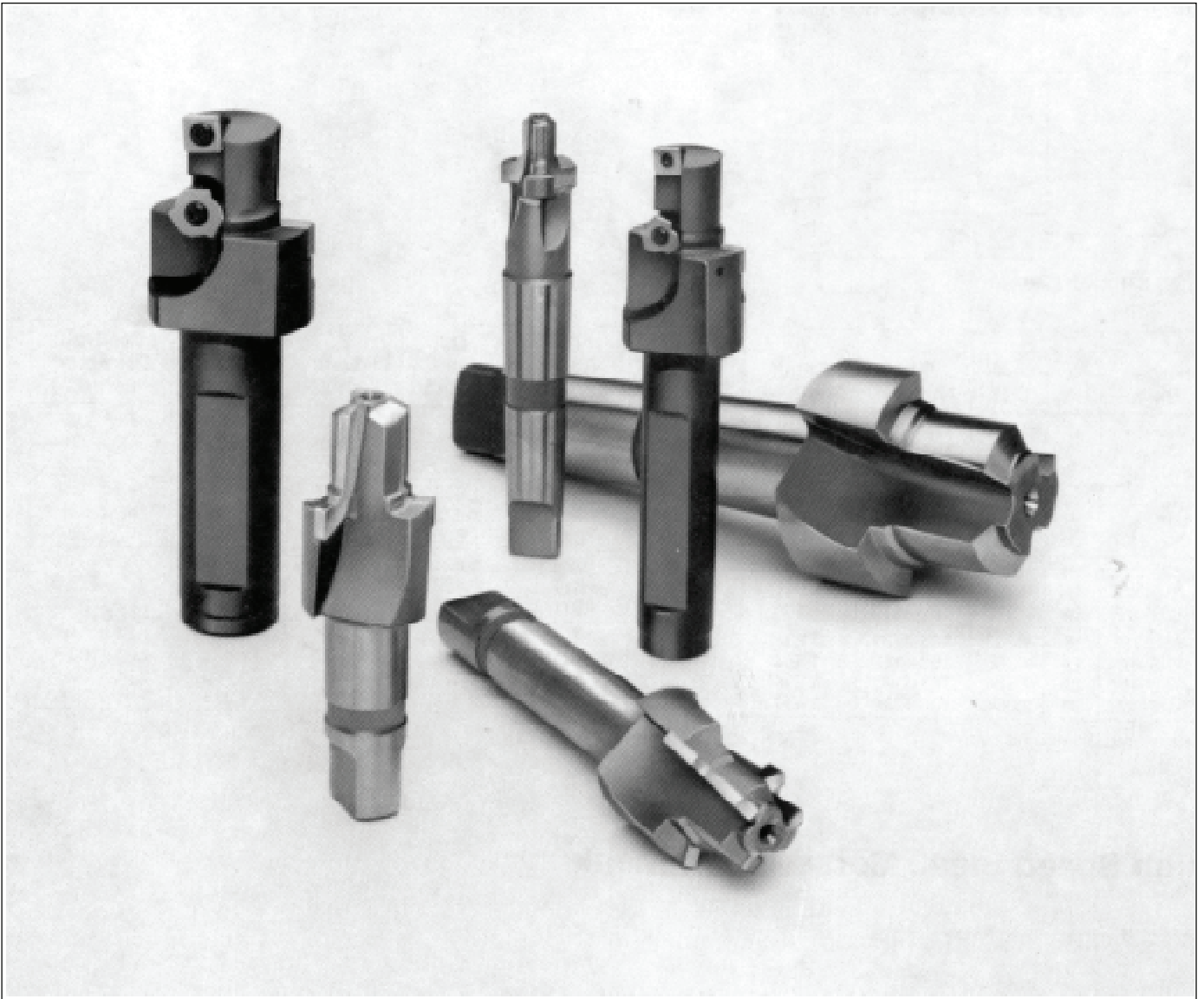
High Speed Steel



Use with 3571, 3572, 3573, 3574, 3575 & 3576 Series Pilots

| A<br>Diameter | Part<br>Number | B<br>Overall<br>Length | Drive<br>Number | C<br>Hole I.D. | Drive Pin<br>Number |
|---------------|----------------|------------------------|-----------------|----------------|---------------------|
| .5000         | 3511-0032      | .625                   | D-1             | .250           | 3500-9001           |
| .5625         | 3511-0036      | .625                   | D-1             | .250           | 3500-9001           |
| .6250         | 3511-0040      | .625                   | D-1             | .250           | 3500-9001           |
| .6875         | 3511-0044      | .625                   | D-1             | .250           | 3500-9001           |
| .7500         | 3511-0048      | .625                   | D-1             | .250           | 3500-9001           |
| .7500         | 3512-0048      | .688                   | D-2             | .375           | 3500-9002           |
| .8125         | 3512-0052      | .688                   | D-2             | .375           | 3500-9002           |
| .8750         | 3512-0056      | .688                   | D-2             | .375           | 3500-9002           |
| .9375         | 3512-0060      | .688                   | D-2             | .375           | 3500-9002           |
| 1.0000        | 3512-0100      | .688                   | D-2             | .375           | 3500-9002           |
| .9375         | 3513-0060      | .750                   | D-3             | .500           | 3500-9003           |
| 1.0000        | 3513-0100      | .750                   | D-3             | .500           | 3500-9003           |
| 1.0625        | 3513-0104      | .750                   | D-3             | .500           | 3500-9003           |
| 1.1250        | 3513-0108      | .750                   | D-3             | .500           | 3500-9003           |
| 1.1875        | 3513-0112      | .750                   | D-3             | .500           | 3500-9003           |
| 1.2500        | 3513-0116      | .750                   | D-3             | .500           | 3500-9003           |
| 1.1875        | 3514-0112      | .875                   | D-4             | .625           | 3500-9003           |
| 1.2500        | 3514-0116      | .875                   | D-4             | .625           | 3500-9003           |
| 1.3125        | 3514-0120      | .875                   | D-4             | .625           | 3500-9003           |
| 1.3750        | 3514-0124      | .875                   | D-4             | .625           | 3500-9003           |
| 1.4375        | 3514-0128      | .875                   | D-4             | .625           | 3500-9003           |
| 1.5000        | 3514-0132      | .875                   | D-4             | .625           | 3500-9003           |
| 1.5625        | 3514-0136      | .875                   | D-4             | .625           | 3500-9003           |
| 1.6250        | 3514-0140      | .875                   | D-4             | .625           | 3500-9003           |
| 1.4375        | 3515-0128      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.5000        | 3515-0132      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.5625        | 3515-0136      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.6250        | 3515-0140      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.6875        | 3515-0144      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.7500        | 3515-0148      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.8125        | 3515-0152      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.8750        | 3515-0156      | 1.063                  | D-5             | .750           | 3500-9004           |
| 1.5625        | 3516-0136      | 1.125                  | D-6             | .875           | 3500-9004           |
| 1.6250        | 3516-0140      | 1.125                  | D-6             | .875           | 3500-9004           |
| 1.6875        | 3516-0144      | 1.125                  | D-6             | .875           | 3500-9004           |
| 1.7500        | 3516-0148      | 1.125                  | D-6             | .875           | 3500-9004           |
| 1.8125        | 3516-0152      | 1.125                  | D-6             | .875           | 3500-9004           |
| 1.8750        | 3516-0156      | 1.125                  | D-6             | .875           | 3500-9004           |
| 2.0000        | 3516-0200      | 1.125                  | D-6             | .875           | 3500-9004           |
| 2.1250        | 3516-0208      | 1.125                  | D-6             | .875           | 3500-9004           |
| 2.1875        | 3516-0212      | 1.125                  | D-6             | .875           | 3500-9004           |

All dimensions shown in inches.



### **A Full Range of Porting Tools for SAE, ISO, BSPP/BSPPF & NASA Specifications**

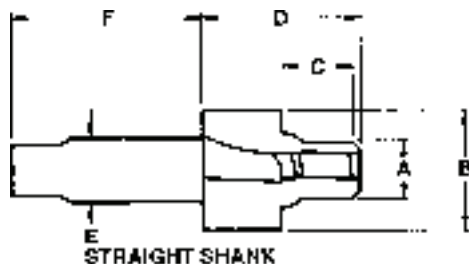
METCUT Port Contour Cutters produce the form and finish required on internal straight thread o-ring ports in a single operation. Straight thread ports usually are required for high-pressure hydraulic fittings, which must be in compliance with automotive, military, aerospace and commercial specifications.

METCUT porting tools are form-relief ground and designed so that a simple face grinding reconditions the tool with no dimensional loss.

METCUT produces the most complete line of Port Contour Cutters in the industry. High speed steel and carbide tipped are standard in all sizes. Straight, morse taper and radial drive shank styles are available on all size tools. Indexable porting tools are available for meeting SAE and military specifications.

# Port Contour Cutters – SAE J1926, MS 16142

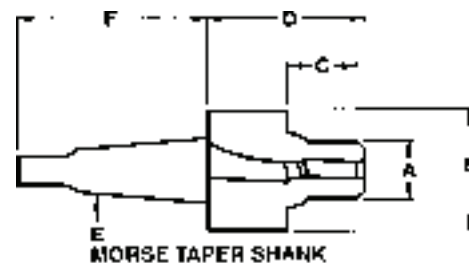
## High Speed Steel, Straight Shank



| Thread Size | Tube |       | Part Number | A Small Diameter | B Spotface | C Bore Length | D Head Length | E Shank Diameter | F Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|------------------|------------|---------------|---------------|------------------|----------------|---------------------------|
|             | No.  | O.D.  |             |                  |            |               |               |                  |                |                           |
| 5/16-24     | 2    | .125  | 163-2031    | .272             | .682       | .473          | 1.625         | .500             | 3.125          | F x .688                  |
| 3/8-24      | 3    | .187  | 163-2037    | .335             | .760       | .473          | 1.625         | .500             | 3.125          | O x .688                  |
| 7/16-20     | 4    | .250  | 163-2043    | .389             | .838       | .552          | 1.625         | .500             | 3.125          | U x .812                  |
| 1/2-20      | 5    | .312  | 163-2050    | .452             | .916       | .552          | 1.625         | .500             | 3.125          | .44 x .812                |
| 9/16-18     | 6    | .375  | 163-2056    | .509             | .994       | .614          | 1.625         | .500             | 3.125          | .48 x .875                |
| 3/4-16      | 8    | .500  | 163-3075    | .689             | 1.198      | .693          | 1.875         | .750             | 3.875          | .67 x .937                |
| 7/8-14      | 10   | .625  | 163-3087    | .806             | 1.354      | .786          | 1.875         | .750             | 3.875          | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | 163-3106    | .981             | 1.635      | .911          | 2.125         | .750             | 3.875          | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | 163-3118    | 1.106            | 1.775      | .911          | 2.125         | .750             | 3.875          | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | 163-3131    | 1.231            | 1.939      | .911          | 2.125         | .750             | 3.875          | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | 163-4162    | 1.544            | 2.280      | .911          | 2.375         | 1.000            | 4.875          | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | 163-4187    | 1.794            | 2.570      | .911          | 2.375         | 1.000            | 4.875          | 1.78 x 1.250              |
| 2-1/2-12    | 32   | 2.000 | 163-4250    | 2.419            | 3.490      | .911          | 2.375         | 1.000            | 4.875          | 2.41 x 1.250              |

All dimensions shown in inches.

## High Speed Steel, Morse Taper Shank

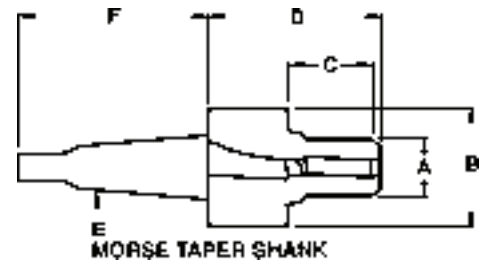


| Thread Size | Tube |       | Part Number | A Small Diameter | B Spotface | C Bore Length | D Head Length | E Shank Diameter | F Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|------------------|------------|---------------|---------------|------------------|----------------|---------------------------|
|             | No.  | O.D.  |             |                  |            |               |               |                  |                |                           |
| 5/16-24     | 2    | .125  | 163-2031    | .272             | .682       | .473          | 1.625         | .500             | 3.125          | F x .688                  |
| 3/8-24      | 3    | .187  | 163-2037    | .335             | .760       | .473          | 1.625         | .500             | 3.125          | O x .688                  |
| 7/16-20     | 4    | .250  | 163-2043    | .389             | .838       | .552          | 1.625         | .500             | 3.125          | U x .812                  |
| 1/2-20      | 5    | .312  | 163-2050    | .452             | .916       | .552          | 1.625         | .500             | 3.125          | .44 x .812                |
| 9/16-18     | 6    | .375  | 163-2056    | .509             | .994       | .614          | 1.625         | .500             | 3.125          | .48 x .875                |
| 3/4-16      | 8    | .500  | 163-3075    | .689             | 1.198      | .693          | 1.875         | .750             | 3.875          | .67 x .937                |
| 7/8-14      | 10   | .625  | 163-3087    | .806             | 1.354      | .786          | 1.875         | .750             | 3.875          | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | 163-3106    | .981             | 1.635      | .911          | 2.125         | .750             | 3.875          | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | 163-3118    | 1.106            | 1.775      | .911          | 2.125         | .750             | 3.875          | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | 163-3131    | 1.231            | 1.939      | .911          | 2.125         | .750             | 3.875          | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | 163-4162    | 1.544            | 2.280      | .911          | 2.375         | 1.000            | 4.875          | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | 163-4187    | 1.794            | 2.570      | .911          | 2.375         | 1.000            | 4.875          | 1.78 x 1.250              |
| 2-1/2-12    | 32   | 2.000 | 163-4250    | 2.419            | 3.490      | .911          | 2.375         | 1.000            | 4.875          | 2.41 x 1.250              |

All dimensions shown in inches.

# Port Contour Cutters – SAE J1926, MS 16142

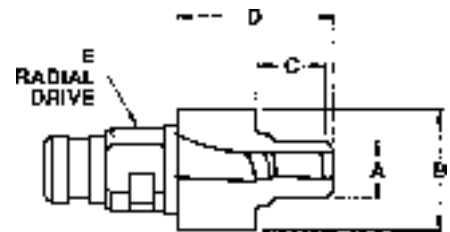
## High Speed Steel, Taper Shank with Extra Length Reamer



| Thread Size | Tube |       | Part Number     | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Morse Taper | F Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-----------------|------------------|---------------------|---------------|---------------|---------------|----------------|---------------------------|
|             | No.  | O.D.  |                 |                  |                     |               |               |               |                |                           |
| 5/16-24     | 2    | .125  | <b>161-2031</b> | .272             | .682                | .580          | 1.750         | 2             | 3.125          | F x .812                  |
| 3/8-24      | 3    | .187  | <b>161-2037</b> | .335             | .760                | .580          | 1.750         | 2             | 3.125          | O x .812                  |
| 7/16-20     | 4    | .250  | <b>161-2043</b> | .389             | .838                | .690          | 1.750         | 2             | 3.125          | U x .937                  |
| 1/2-20      | 5    | .312  | <b>161-2050</b> | .452             | .916                | .690          | 1.750         | 2             | 3.125          | .44 x .937                |
| 9/16-18     | 6    | .375  | <b>161-2056</b> | .509             | .979                | .750          | 1.750         | 2             | 3.125          | .48 x .968                |
| 3/4-16      | 8    | .500  | <b>161-3075</b> | .689             | 1.198               | .840          | 2.000         | 3             | 3.875          | .67 x 1.090               |
| 7/8-14      | 10   | .625  | <b>161-3087</b> | .806             | 1.354               | .970          | 2.000         | 3             | 3.875          | .78 x 1.220               |
| 1-1/16-12   | 12   | .750  | <b>161-3106</b> | .981             | 1.635               | 1.125         | 2.250         | 3             | 3.875          | .95 x 1.470               |
| 1-3/16-12   | 14   | .875  | <b>161-3118</b> | 1.106            | 1.775               | 1.125         | 2.250         | 3             | 3.875          | 1.09 x 1.470              |
| 1-5/16-12   | 16   | 1.000 | <b>161-3131</b> | 1.231            | 1.920               | 1.125         | 2.250         | 3             | 3.875          | 1.21 x 1.470              |
| 1-5/8-12    | 20   | 1.250 | <b>161-4162</b> | 1.544            | 2.280               | 1.125         | 2.250         | 4             | 4.875          | 1.53 x 1.470              |
| 1-7/8-12    | 24   | 1.500 | <b>161-4187</b> | 1.794            | 2.570               | 1.125         | 2.250         | 4             | 4.875          | 1.78 x 1.470              |
| 2-1/2-12    | 32   | 2.000 | <b>161-4250</b> | 2.419            | 3.490               | 1.125         | 2.250         | 4             | 4.875          | 2.41 x 1.470              |

All dimensions shown in inches.

## High Speed Steel, Radial Drive

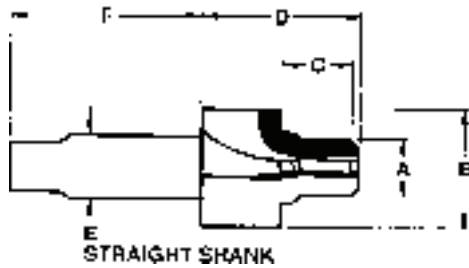


| Thread Size | Tube |       | Part Number     | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Radial Drive | Number of Flutes | Pre-Drill Diameter/Length |
|-------------|------|-------|-----------------|------------------|---------------------|---------------|---------------|----------------|------------------|---------------------------|
|             | No.  | O.D.  |                 |                  |                     |               |               |                |                  |                           |
| 5/16-24     | 2    | .125  | <b>160-2031</b> | .272             | .875                | .473          | 1.50          | RB             | 3                | F x .687                  |
| 3/8-24      | 3    | .188  | <b>160-2037</b> | .335             | .875                | .473          | 1.50          | RB             | 3                | O x .687                  |
| 7/16-20     | 4    | .250  | <b>160-2043</b> | .389             | .875                | .552          | 1.50          | RB             | 3                | U x .812                  |
| 1/2-20      | 5    | .313  | <b>160-2050</b> | .452             | .938                | .552          | 1.50          | RB             | 3                | .44 x .812                |
| 9/16-18     | 6    | .375  | <b>160-2056</b> | .509             | 1.000               | .614          | 1.63          | RB             | 3                | .48 x .875                |
| 3/4-16      | 8    | .500  | <b>160-3075</b> | .689             | 1.219               | .693          | 1.63          | RC             | 3                | .67 x .937                |
| 7/8-14      | 10   | .625  | <b>160-3087</b> | .806             | 1.375               | .786          | 1.75          | RC             | 4                | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | <b>160-4106</b> | .981             | 1.656               | .911          | 1.88          | RE             | 4                | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | <b>160-5118</b> | 1.106            | 1.813               | .911          | 1.88          | RF             | 4                | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | <b>160-5131</b> | 1.231            | 2.000               | .911          | 1.88          | RF             | 4                | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | <b>160-6162</b> | 1.544            | 2.313               | .911          | 1.88          | RJ             | 4                | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | <b>160-6187</b> | 1.794            | 2.563               | .911          | 1.88          | RJ             | 4                | 1.78 x 1.250              |

All dimensions shown in inches.

# Port Contour Cutters – SAE J1926, MS 16142

## Tungsten Carbide Tipped, Straight Shank



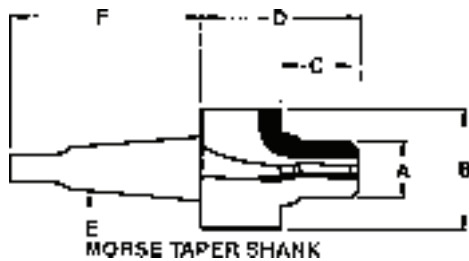
| Thread Size | Tube |       | Part Number | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Shank Diameter | F Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|------------------|---------------------|---------------|---------------|------------------|----------------|---------------------------|
|             | No.  | O.D.  |             |                  |                     |               |               |                  |                |                           |
| 5/16-24     | 2    | .125  | 263-2031    | .272             | .682                | .473          | 1.625         | .500             | 3.125          | F x .688                  |
| 3/8-24      | 3    | .187  | 263-2037    | .335             | .760                | .473          | 1.625         | .500             | 3.125          | O x .688                  |
| 7/16-20     | 4    | .250  | 263-2043    | .389             | .838                | .552          | 1.625         | .500             | 3.125          | U x .812                  |
| 1/2-20      | 5    | .312  | 263-2050    | .452             | .916                | .552          | 1.625         | .500             | 3.125          | .44 x .812                |
| 9/16-18     | 6    | .375  | 263-2056    | .509             | .994                | .614          | 1.625         | .500             | 3.125          | .48 x .875                |
| 3/4-16      | 8    | .500  | 263-3075    | .689             | 1.198               | .693          | 1.875         | .750             | 3.875          | .67 x .937                |
| 7/8-14      | 10   | .625  | 263-3087    | .806             | 1.354               | .786          | 1.875         | .750             | 3.875          | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | 263-3106    | .981             | 1.635               | .911          | 2.125         | .750             | 3.875          | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | 263-3118    | 1.106            | 1.775               | .911          | 2.125         | .750             | 3.875          | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | 263-3131    | 1.231            | 1.920               | .911          | 2.125         | .750             | 3.875          | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | 263-4162    | 1.544            | 2.280               | .911          | 2.125         | 1.000            | 4.875          | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | 263-4187    | 1.794            | 2.570               | .911          | 2.125         | 1.000            | 4.875          | 1.78 x 1.250              |
| 2-1/2-12    | 32   | 2.000 | 263-4250    | 2.419            | 3.490               | .911          | 2.125         | 1.000            | 4.875          | 2.41 x 1.250              |

All dimensions shown in inches.

Special carbide grades and coatings available upon request.

Call quotations for price and availability.

## Tungsten Carbide Tipped, Morse Taper Shank



| Thread Size | Tube |       | Part Number | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Morse Taper | F Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|------------------|---------------------|---------------|---------------|---------------|----------------|---------------------------|
|             | No.  | O.D.  |             |                  |                     |               |               |               |                |                           |
| 5/16-24     | 2    | .125  | 262-2031    | .272             | .682                | .473          | 1.625         | 2             | 3.125          | F x .688                  |
| 3/8-24      | 3    | .187  | 262-2037    | .335             | .760                | .473          | 1.625         | 2             | 3.125          | O x .688                  |
| 7/16-20     | 4    | .250  | 262-2043    | .389             | .838                | .552          | 1.625         | 2             | 3.125          | U x .812                  |
| 1/2-20      | 5    | .312  | 262-2050    | .452             | .916                | .552          | 1.625         | 2             | 3.125          | .44 x .812                |
| 9/16-18     | 6    | .375  | 262-2056    | .509             | .979                | .614          | 1.625         | 2             | 3.125          | .48 x .875                |
| 3/4-16      | 8    | .500  | 262-3075    | .689             | 1.198               | .693          | 1.875         | 3             | 3.875          | .67 x .937                |
| 7/8-14      | 10   | .625  | 262-3087    | .806             | 1.354               | .786          | 1.875         | 3             | 3.875          | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | 262-3106    | .981             | 1.635               | .911          | 2.125         | 3             | 3.875          | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | 262-3118    | 1.106            | 1.775               | .911          | 2.125         | 3             | 3.875          | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | 262-3131    | 1.231            | 1.920               | .911          | 2.125         | 3             | 3.875          | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | 262-4162    | 1.544            | 2.280               | .911          | 2.125         | 4             | 4.875          | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | 262-4187    | 1.794            | 2.570               | .911          | 2.125         | 4             | 4.875          | 1.78 x 1.250              |
| 2-1/2-12    | 32   | 2.000 | 262-4250    | 2.419            | 3.490               | .911          | 2.125         | 4             | 4.875          | 2.41 x 1.250              |

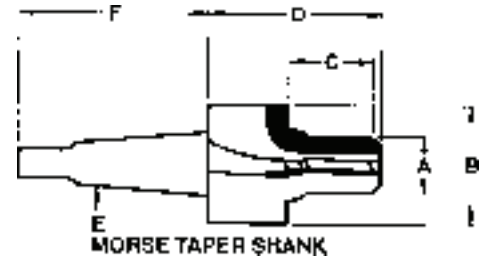
All dimensions shown in inches.

Special carbide grades and coatings available upon request.

Call quotations for price and availability.

# Port Contour Cutters – SAE J1926, MS 16142

## Tungsten Carbide Tipped Taper Shank with Extra Length Reamer



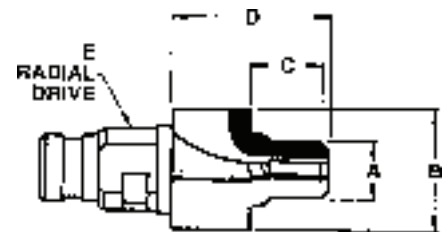
| Thread Size | Tube |       | Part Number | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Morse Taper | F Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|------------------|---------------------|---------------|---------------|---------------|----------------|---------------------------|
|             | No.  | O.D.  |             |                  |                     |               |               |               |                |                           |
| 5/16-24     | 2    | .125  | 261-2031    | .272             | .682                | .580          | 1.750         | 2             | 3.125          | F x .812                  |
| 3/8-24      | 3    | .187  | 261-2037    | .335             | .760                | .580          | 1.750         | 2             | 3.125          | O x .812                  |
| 7/16-20     | 4    | .250  | 261-2043    | .389             | .838                | .690          | 1.750         | 2             | 3.125          | U x .937                  |
| 1/2-20      | 5    | .312  | 261-2050    | .452             | .916                | .690          | 1.750         | 2             | 3.125          | .44 x .937                |
| 9/16-18     | 6    | .375  | 261-2056    | .509             | .979                | .750          | 1.750         | 2             | 3.125          | .48 x .968                |
| 3/4-16      | 8    | .500  | 261-3075    | .689             | 1.198               | .840          | 2.000         | 3             | 3.875          | .67 x 1.090               |
| 7/8-14      | 10   | .625  | 261-3087    | .806             | 1.354               | .970          | 2.000         | 3             | 3.875          | .78 x 1.220               |
| 1-1/16-12   | 12   | .750  | 261-3106    | .981             | 1.635               | 1.125         | 2.250         | 3             | 3.875          | .95 x 1.470               |
| 1-3/16-12   | 14   | .875  | 261-3118    | 1.106            | 1.775               | 1.125         | 2.250         | 3             | 3.875          | 1.09 x 1.470              |
| 1-5/16-12   | 16   | 1.000 | 261-3131    | 1.231            | 1.920               | 1.125         | 2.250         | 3             | 3.875          | 1.21 x 1.470              |
| 1-5/8-12    | 20   | 1.250 | 261-4162    | 1.544            | 2.280               | 1.125         | 2.250         | 4             | 4.875          | 1.53 x 1.470              |

All dimensions shown in inches.

Special carbide grades and coatings available upon request.

Call quotations for price and availability.

## Tungsten Carbide Tipped, Radial Drive



Use with 320, 321 & 323 Series Holders (Pages 46-47)

| Thread Size | Tube |       | Part Number | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Radial Drive | Number of Flutes | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|------------------|---------------------|---------------|---------------|----------------|------------------|---------------------------|
|             | No.  | O.D.  |             |                  |                     |               |               |                |                  |                           |
| 5/16-24     | 2    | .125  | 260-2031    | .272             | .875                | .473          | 1.50          | RB             | 3                | F x .687                  |
| 3/8-24      | 3    | .188  | 260-2037    | .335             | .875                | .473          | 1.50          | RB             | 3                | O x .687                  |
| 7/16-20     | 4    | .250  | 260-2043    | .389             | .875                | .552          | 1.50          | RB             | 3                | U x .812                  |
| 1/2-20      | 5    | .313  | 260-2050    | .452             | .938                | .552          | 1.50          | RB             | 3                | .44 x .812                |
| 9/16-18     | 6    | .375  | 260-2056    | .509             | 1.000               | .614          | 1.63          | RB             | 3                | .48 x .875                |
| 3/4-16      | 8    | .500  | 260-3075    | .689             | 1.219               | .693          | 1.63          | RC             | 3                | .67 x .937                |
| 7/8-14      | 10   | .625  | 260-3087    | .806             | 1.375               | .786          | 1.75          | RC             | 4                | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | 260-4106    | .981             | 1.656               | .911          | 1.88          | RE             | 4                | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | 260-5118    | 1.106            | 1.813               | .911          | 1.88          | RF             | 4                | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | 260-5131    | 1.231            | 2.000               | .911          | 1.88          | RF             | 4                | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | 260-6162    | 1.544            | 2.313               | .911          | 1.88          | RJ             | 4                | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | 260-6187    | 1.794            | 2.563               | .911          | 1.88          | RJ             | 4                | 1.78 x 1.250              |
| 2-1/2-12    | 32   | 2.000 | 260-7250    | 2.419            | 3.500               | .911          | 1.88          | RS             | 4                | 2.41 x 1.250              |

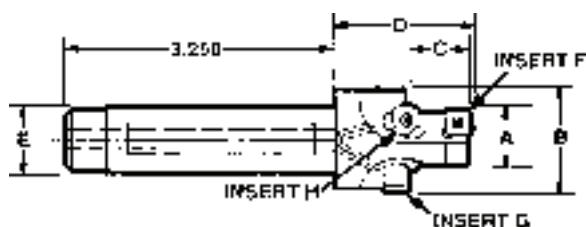
All dimensions shown in inches.

Special carbide grades and coatings available upon request.

Call quotations for price and availability.

# Port Contour Cutters – SAE J1926, MS 16142

## Indexable, Straight Shank - Through Coolant



| Thread Size | Tube |       | Part Number     | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Shank Diameter | Pre-Drill Diameter/Length |
|-------------|------|-------|-----------------|------------------|---------------------|---------------|---------------|------------------|---------------------------|
|             | No.  | O.D.  |                 |                  |                     |               |               |                  |                           |
| 7/16-20     | 4    | .250  | <b>267-3043</b> | .389             | .875                | .552          | 1.389         | .750             | U x .812                  |
| 1/2-20      | 5    | .312  | <b>267-3050</b> | .452             | .916                | .552          | 1.389         | .750             | .44 x .812                |
| 9/16-18     | 6    | .375  | <b>267-3056</b> | .509             | .979                | .614          | 1.819         | .750             | .48 x .875                |
| 3/4-16      | 8    | .500  | <b>267-3075</b> | .689             | 1.198               | .693          | 1.654         | .750             | .67 x .937                |
| 7/8-14      | 10   | .625  | <b>267-3087</b> | .806             | 1.354               | .786          | 1.874         | .750             | .78 x 1.062               |
| 1-1/16-12   | 12   | .750  | <b>267-4106</b> | .981             | 1.635               | .911          | 2.014         | 1.000            | .95 x 1.250               |
| 1-3/16-12   | 14   | .875  | <b>267-4118</b> | 1.106            | 1.775               | .911          | 2.014         | 1.000            | 1.09 x 1.250              |
| 1-5/16-12   | 16   | 1.000 | <b>267-4131</b> | 1.231            | 1.920               | .911          | 2.014         | 1.000            | 1.21 x 1.250              |
| 1-5/8-12    | 20   | 1.250 | <b>267-5162</b> | 1.544            | 2.280               | .911          | 2.275         | 1.250            | 1.53 x 1.250              |
| 1-7/8-12    | 24   | 1.500 | <b>267-5187</b> | 1.794            | 2.570               | .911          | 2.275         | 1.250            | 1.78 x 1.250              |
| 2-1/2-12    | 32   | 2.000 | <b>267-8250</b> | 2.419            | 3.490               | .911          | 2.685         | 2.000            | 2.41 x 1.250              |

All dimensions shown in inches. Inserts included with tool.

## Inserts & Accessories for Indexable, Straight Shank Port Contour Cutters

| Tool Number     | Insert "F&G" Honed Coated | Insert "F&G" Unhoned Uncoated | Torx Screw | Torx Wrench   | Insert "H" Honed Coated | Insert "H" Unhoned Uncoated | Torx Screw | Torx Wrench   |
|-----------------|---------------------------|-------------------------------|------------|---------------|-------------------------|-----------------------------|------------|---------------|
| <b>267-3043</b> | C-250-BD                  | C-250-CC                      | 056-1017   | 056-2017 T-7  | D-312-GF                | D-312-FE                    | 056-1017   | 056-2017 T-7  |
| <b>267-3050</b> | C-250-BD                  | C-250-CC                      | 056-1017   | 056-2017 T-7  | D-312-GF                | D-312-FE                    | 056-1017   | 056-2017 T-7  |
| <b>267-3056</b> | C-250-BD                  | C-250-CC                      | 056-1017   | 056-2017 T-7  | D-312-GF                | D-312-FE                    | 056-1017   | 056-2017 T-7  |
| <b>267-3075</b> | C-312-BD                  | C-312-CC                      | 056-1020   | 056-2028 T-8  | D-375-GF                | D-375-FE                    | 056-1033   | 056-2033 T-10 |
| <b>267-3087</b> | C-312-BD                  | C-312-CC                      | 056-1020   | 056-2028 T-8  | D-375-GF                | D-375-FE                    | 056-1033   | 056-2033 T-10 |
| <b>267-4106</b> | C-375-BD                  | C-375-CC                      | 056-1018   | 056-2015 T-15 | D-500-GF                | D-500-FE                    | 056-1018   | 056-2015 T-15 |
| <b>267-4118</b> | C-375-BD                  | C-375-CC                      | 056-1018   | 056-2015 T-15 | D-500-GF                | D-500-FE                    | 056-1018   | 056-2015 T-15 |
| <b>267-4131</b> | C-375-BD                  | C-375-CC                      | 056-1018   | 056-2015 T-15 | D-500-GF                | D-500-FE                    | 056-1018   | 056-2015 T-15 |
| <b>267-5162</b> | C-500-BD                  | C-500-CC                      | 056-1018   | 056-2015 T-15 | D-500-GF                | D-500-FE                    | 056-1018   | 056-2015 T-15 |
| <b>267-5187</b> | C-500-BD                  | C-500-CC                      | 056-1018   | 056-2015 T-15 | D-500-GF                | D-500-FE                    | 056-1018   | 056-2015 T-15 |
| <b>267-8250</b> | C-502-BD                  | C-502-CC                      | 056-1018   | 056-2015 T-15 | D-500-GF                | D-500-FE                    | 056-1018   | 056-2015 T-15 |

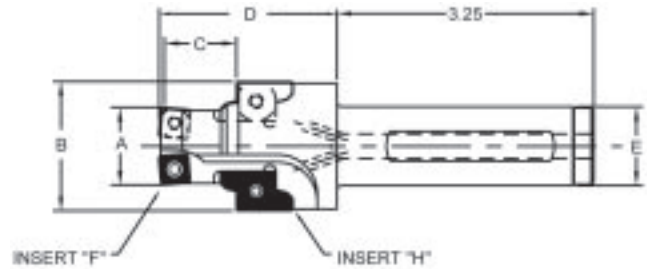
NOTE: Sizes not listed, and special configurations available on request.

NOTE: Insert G is available with 1/64" nose radius (e.g. C-251-BD, C-313-BD, C-376-BD, C-501-BD). Prices on request.

NOTE: Insert H is available with a 'HF' chip breaker for long chipping materials such as 300 series stainless steel (e.g., D-375-HF)

# Port Contour Cutters – SAE J1926, MS 16142

## Double Feed Indexable Porting Tools (Two Effective Flutes)



| Thread Size | Tube |       | Part Number     | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Shank Diameter | Pre-Drill Diameter/Length |
|-------------|------|-------|-----------------|------------------|---------------------|---------------|---------------|------------------|---------------------------|
|             | No.  | O.D.  |                 |                  |                     |               |               |                  |                           |
| 9/16-18     | 6    | .375  | <b>367-3056</b> | .509             | .979                | .614          | 2.000         | .750             | .41 x .875                |
| 3/4-16      | 8    | .500  | <b>367-3075</b> | .689             | 1.297               | .693          | 2.250         | .750             | .53 x .937                |
| 7/8-14      | 10   | .625  | <b>367-3087</b> | .806             | 1.348               | .786          | 2.250         | .750             | .65 x 1.062               |
| 1-1/16-12   | 12   | .750  | <b>367-4106</b> | .981             | 1.642               | .911          | 2.500         | 1.000            | .81 x 1.250               |
| 1-5/16-12   | 16   | 1.000 | <b>367-4131</b> | 1.231            | 1.939               | .911          | 2.500         | 1.000            | 1.05 x 1.250              |

Protected under Greenfield Industries US Patent No. 5816753, "Port Cutting Tool with Multiple Function Inserts".

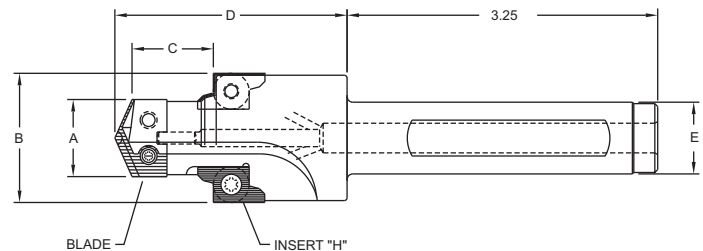
## Inserts & Accessories for Double Feed Indexable Porting Tools

| Part Number     | Insert "F" Standard | Insert "F" Unhoned | Torx Screw | Torx Wrench   | Insert "H" Unhoned Coated | Insert "H" Unhoned Uncoated | Insert "H" Honed Coated | Torx Screw | Torx Wrench   |
|-----------------|---------------------|--------------------|------------|---------------|---------------------------|-----------------------------|-------------------------|------------|---------------|
| <b>367-3056</b> | C-187-BD            | C-187-CC           | 056-1115   | 056-2025 T-5  | J-312-FF                  | J-312-FE                    | J-312-GF                | 056-1020   | 056-2028 T-8  |
| <b>367-3075</b> | C-250-BD            | C-250-CC           | 056-1017   | 056-2017 T-7  | J-375-FF                  | J-375-FE                    | J-375-GF                | 056-1033   | 056-2033 T-10 |
| <b>367-3087</b> | C-312-BD            | C-312-CC           | 056-1020   | 056-2028 T-8  | J-375-FF                  | J-375-FE                    | J-375-GF                | 056-1033   | 056-2033 T-10 |
| <b>367-4106</b> | C-375-BD            | C-375-CC           | 056-1018   | 056-2015 T-15 | J-500-FF                  | J-500-FE                    | J-500-GF                | 056-1834   | 056-2015 T-15 |
| <b>367-4131</b> | C-375-BD            | C-375-CC           | 056-1018   | 056-2015 T-15 | J-501-FF                  | J-501-FE                    | J-501-GF                | 056-1834   | 056-2015 T-15 |

Sizes and special configurations not listed call 1-888-434-4370 for price and availability.

Protected under Greenfield Industries US Patent No. 5957633, "Multiple Function Inserts for Port Cutting Tool".

## Double Feed Indexable Porting Tool with Spade Blade Insert



| Thread    | Tube |       | Part Number     | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Shank Diameter |
|-----------|------|-------|-----------------|------------------|---------------------|---------------|---------------|------------------|
|           | No.  | O.D.  |                 |                  |                     |               |               |                  |
| 9/16-18   | 6    | .375  | <b>467-3056</b> | .509             | .979                | .628          | 2.09          | .750             |
| 3/4-16    | 8    | .500  | <b>467-3075</b> | .689             | 1.297               | .736          | 2.38          | .750             |
| 7/8-14    | 10   | .625  | <b>467-3087</b> | .806             | 1.348               | .851          | 2.43          | .750             |
| 1-1/16-12 | 12   | .750  | <b>467-4106</b> | .981             | 1.642               | .954          | 2.44          | 1.000            |
| 1-5/16-12 | 16   | 1.000 | <b>467-4131</b> | 1.231            | 1.939               | .954          | 2.75          | 1.000            |

Application information can be found on METCUT's Spade Blade Brochure.

## Spade Blades, Inserts & Accessories for Double Feed Indexable Porting

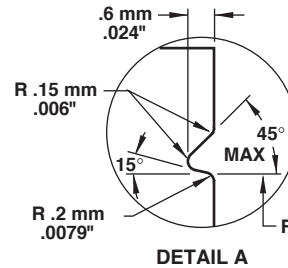
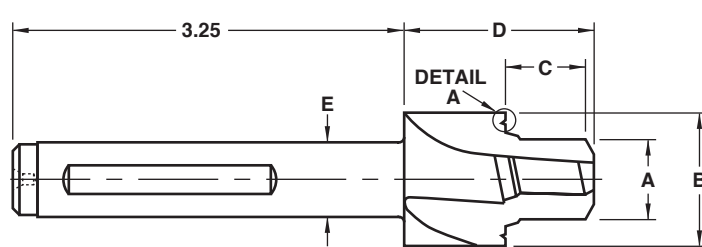
| Part Number     | Blade                  |           | Locating Pin | Torx Screw | Torx Wrench   | Seat Insert "H" | Torx Screw | Torx Wrench   |
|-----------------|------------------------|-----------|--------------|------------|---------------|-----------------|------------|---------------|
|                 | Multi Layer (TiN/TiCN) | TiALN     |              |            |               |                 |            |               |
| <b>467-3056</b> | 7F0-0509G              | 7F0-0509A | SP-2         | 056-1014   | 056-2017 T-7  | J312-FF         | 056-1020   | 056-2028 T-8  |
| <b>467-3075</b> | 7F0-0689G              | 7F0-0689A | SP-2         | 056-1014   | 056-2017 T-7  | J375-FF         | 056-1033   | 056-2033 T-10 |
| <b>467-3087</b> | 7F1-0806G              | 7F1-0806A | SP-3         | 056-1020   | 056-2028 T-8  | J375-FF         | 056-1033   | 056-2033 T-10 |
| <b>467-4106</b> | 7F2-0981G              | 7F2-0981A | SP-4         | 056-1018   | 056-2015 T-15 | J500-FF         | 056-1834   | 056-2015 T-15 |
| <b>467-4131</b> | 7F2-1231G              | 7F2-1231A | SP-4         | 056-1018   | 056-2015 T-15 | J501-FF         | 056-1834   | 056-2015 T-15 |

Sizes and special configurations not listed call 1-888-434-4370 for price and availability.

Protected under Greenfield Industries US Patent No. 5957633, "Multiple Function Inserts for Port Cutting Tool".

# Port Contour Cutters in Metric Sizes – ISO 6149-1, SAE J2244/1

## High Speed Steel, Straight Shank, *With Groove*



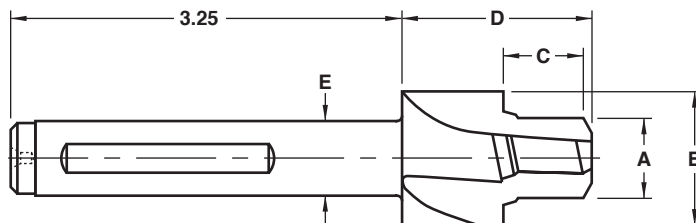
**Metric Sizes**

| Thread Size | Part Number     | A<br>Small Diameter | B<br>Spotface Diameter* | C<br>Bore Length | D<br>Head Length | E<br>Shank Dia. | F<br>Groove Diameter | Pre-Drill Diameter/Length |
|-------------|-----------------|---------------------|-------------------------|------------------|------------------|-----------------|----------------------|---------------------------|
| M 8 x 1     | <b>169-0008</b> | 7.035 (.277)        | 17 (.669)               | 11.5 (.4528)     | 44.45 (1.75)     | 12.7 (.500)     | 14 (.551)            | (D x .589)                |
| M 10 x 1    | <b>169-0010</b> | 9.042 (.356)        | 20 (.787)               | 11.5 (.4528)     | 44.45 (1.75)     | 19.05 (.750)    | 16 (.6299)           | (P x .589)                |
| M 12 x 1.5  | <b>169-0012</b> | 10.541 (.415)       | 23 (.9055)              | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | 19 (.748)            | (W x .681)                |
| M 14 x 1.5  | <b>169-0014</b> | 12.522 (.493)       | 25 (.9843)              | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | 21 (.8268)           | (.45 x .681)              |
| M 16 x 1.5  | <b>169-0016</b> | 14.528 (.572)       | 28 (1.1024)             | 15.5 (.6102)     | 50.8 (2.00)      | 19.05 (.750)    | 24 (.9449)           | (.54 x .740)              |
| M 18 x 1.5  | <b>169-0018</b> | 16.535 (.651)       | 30 (1.1811)             | 17 (.6693)       | 50.8 (2.00)      | 19.05 (.750)    | 26 (1.0236)          | (.62 x .809)              |
| M 22 x 1.5  | <b>169-0022</b> | 20.523 (.808)       | 34 (1.3386)             | 18 (.7087)       | 50.8 (2.00)      | 19.05 (.750)    | 29 (1.1417)          | (.78 x .849)              |
| M 27 x 2    | <b>169-0027</b> | 25.019 (.985)       | 40 (1.578)              | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | 34 (1.3386)          | (.95 x 1.01)              |
| M 33 x 2    | <b>169-0033</b> | 31.013 (1.221)      | 49 (1.9291)             | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | 43 (1.6929)          | (1.17 x 1.01)             |
| M 42 x 2    | <b>169-0042</b> | 40.030 (1.576)      | 60 (2.3622)             | 22.5 (.8858)     | 57.15 (2.25)     | 31.75 (1.25)    | 52 (2.0472)          | (1.54 x 1.03)             |
| M 48 x 2    | <b>169-0048</b> | 46.025 (1.812)      | 66 (2.5984)             | 25 (.9843)       | 57.15 (2.25)     | 31.75 (1.25)    | 57 (2.2441)          | (1.78 x 1.13)             |

Inches are shown in parentheses; all other dimensions are in millimeters.

\* Includes groove.

## High Speed Steel, Straight Shank, without Groove



**Metric Sizes**

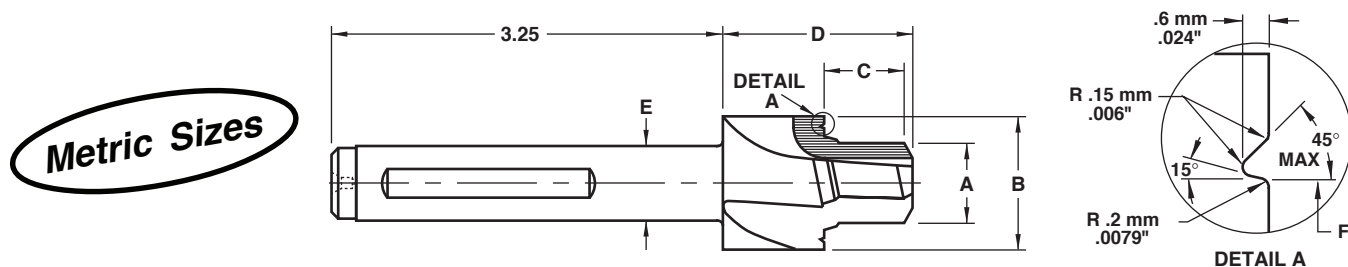
| Thread Size | Part Number     | A<br>Small Diameter | B<br>Spotface Diameter | C<br>Bore Length | D<br>Head Length | E<br>Shank Dia. | Pre-Drill Diameter/Length |
|-------------|-----------------|---------------------|------------------------|------------------|------------------|-----------------|---------------------------|
| M 8 x 1     | <b>169-1008</b> | 7.035 (.277)        | 14 (.5512)             | 11.5 (.4528)     | 44.45 (1.75)     | 12.7 (.500)     | (D x .589)                |
| M 10 x 1    | <b>169-1010</b> | 9.042 (.356)        | 16 (.6299)             | 11.5 (.4528)     | 44.45 (1.75)     | 19.05 (.750)    | (P x .589)                |
| M 12 x 1.5  | <b>169-1012</b> | 10.541 (.415)       | 19 (.748)              | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | (W x .681)                |
| M 14 x 1.5  | <b>169-1014</b> | 12.522 (.493)       | 21 (.8268)             | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | (.45 x .681)              |
| M 16 x 1.5  | <b>169-1016</b> | 14.528 (.572)       | 24 (.9449)             | 15.5 (.6102)     | 50.8 (2.00)      | 19.05 (.750)    | (.54 x .740)              |
| M 18 x 1.5  | <b>169-1018</b> | 16.535 (.651)       | 26 (1.0236)            | 17 (.6693)       | 50.8 (2.00)      | 19.05 (.750)    | (.62 x .809)              |
| M 22 x 1.5  | <b>169-1022</b> | 20.523 (.808)       | 29 (1.1417)            | 18 (.7087)       | 50.8 (2.00)      | 19.05 (.750)    | (.78 x .849)              |
| M 27 x 2    | <b>169-1027</b> | 25.019 (.985)       | 34 (1.3386)            | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | (.95 x 1.01)              |
| M 33 x 2    | <b>169-1033</b> | 31.013 (1.221)      | 43 (1.6929)            | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | (1.17 x 1.01)             |
| M 42 x 2    | <b>169-1042</b> | 40.030 (1.576)      | 52 (2.0472)            | 22.5 (.8858)     | 57.15 (2.25)     | 31.75 (1.25)    | (1.54 x 1.03)             |
| M 48 x 2    | <b>169-1048</b> | 46.025 (1.812)      | 57 (2.2441)            | 25 (.9843)       | 57.15 (2.25)     | 31.75 (1.25)    | (1.78 x 1.13)             |

Inches are shown in parentheses; all other dimensions are in millimeters.

**Metric Indexable models are available price on application (POA)**  
**ISO-6149 & SAE J2444 (1980-1993) Specifications available as (POA)**

# Port Contour Cutters in Metric Sizes – ISO 6149-1, SAE J2244/1

## Tungsten Carbide Tipped, Straight Shank, *With Groove*

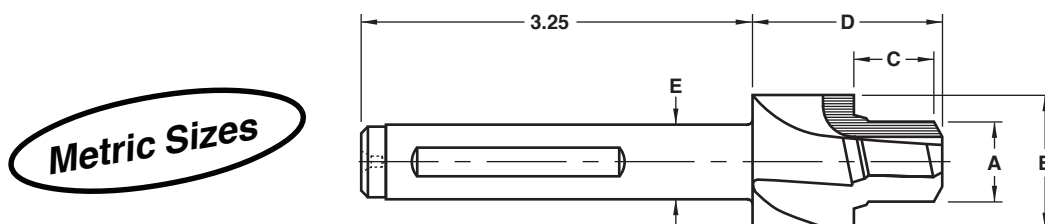


| Thread Size | Part Number | A<br>Small Diameter | B<br>Spotface Diameter* | C<br>Bore Length | D<br>Head Length | E<br>Shank Dia. | F<br>Groove Diameter | Pre-Drill Diameter/Length |
|-------------|-------------|---------------------|-------------------------|------------------|------------------|-----------------|----------------------|---------------------------|
| M 8 x 1     | 269-0008    | 7.035 (.277)        | 17 (.669)               | 11.5 (.4528)     | 44.45 (1.75)     | 12.7 (.500)     | 14 (.5512)           | (D x .589)                |
| M 10 x 1    | 269-0010    | 9.042 (.356)        | 20 (.787)               | 11.5 (.4528)     | 44.45 (1.75)     | 19.05 (.750)    | 16 (.6299)           | (P x .589)                |
| M 12 x 1.5  | 269-0012    | 10.541 (.415)       | 23 (.9055)              | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | 19 (.7480)           | (W x .681)                |
| M 14 x 1.5  | 269-0014    | 12.522 (.493)       | 25 (.9843)              | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | 21 (.8268)           | (.45 x .681)              |
| M 16 x 1.5  | 269-0016    | 14.528 (.572)       | 28 (1.1024)             | 15.5 (.6102)     | 50.8 (2.00)      | 19.05 (.750)    | 24 (.9449)           | (.54 x .740)              |
| M 18 x 1.5  | 269-0018    | 16.535 (.651)       | 30 (1.1811)             | 17 (.6693)       | 50.8 (2.00)      | 19.05 (.750)    | 26 (1.0236)          | (.62 x .809)              |
| M 22 x 1.5  | 269-0022    | 20.523 (.808)       | 34 (1.3386)             | 18 (.7087)       | 50.8 (2.00)      | 19.05 (.750)    | 29 (1.1417)          | (.78 x .849)              |
| M 27 x 2    | 269-0027    | 25.019 (.985)       | 40 (1.578)              | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | 34 (1.3386)          | (.95 x 1.01)              |
| M 33 x 2    | 269-0033    | 31.013 (1.221)      | 49 (1.9291)             | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | 43 (1.6929)          | (1.17 x 1.01)             |
| M 42 x 2    | 269-0042    | 40.030 (1.576)      | 60 (2.3622)             | 22.5 (.8858)     | 57.15 (2.25)     | 31.75 (1.25)    | 52 (2.0472)          | (1.54 x 1.03)             |
| M 48 x 2    | 269-0048    | 46.025 (1.812)      | 66 (2.5984)             | 25 (.9843)       | 57.15 (2.25)     | 31.75 (1.25)    | 57 (2.2441)          | (1.78 x 1.13)             |
| M 60 x 2    | 269-0060    | 58.013 (2.284)      | 79 (2.9921)             | 27.5 (1.0827)    | 57.15 (2.25)     | 38.1 (1.50)     | 67 (2.6378)          | (2.25 x 1.22)             |

Inches are shown in parentheses; all other dimensions are in millimeters.

\* Includes groove.

## Tungsten Carbide Tipped, Straight Shank, *Without Groove*



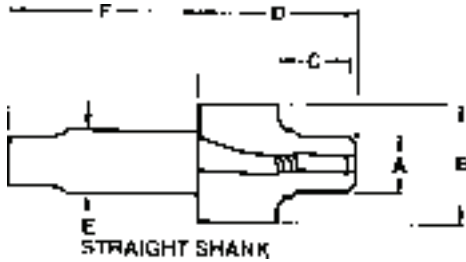
| Thread Size | Part Number | A<br>Small Diameter | B<br>Spotface Diameter | C<br>Bore Length | D<br>Head Length | E<br>Shank Dia. | Pre-Drill Diameter/Length |
|-------------|-------------|---------------------|------------------------|------------------|------------------|-----------------|---------------------------|
| M 8 x 1     | 269-1008    | 7.035 (.277)        | 14 (.5512)             | 11.5 (.4528)     | 44.45 (1.75)     | 12.7 (.500)     | (D x .589)                |
| M 10 x 1    | 269-1010    | 9.042 (.356)        | 16 (.6299)             | 11.5 (.4528)     | 44.45 (1.75)     | 19.05 (.750)    | (P x .589)                |
| M 12 x 1.5  | 269-1012    | 10.541 (.415)       | 19 (.748)              | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | (W x .681)                |
| M 14 x 1.5  | 269-1014    | 12.522 (.493)       | 21 (.8268)             | 14 (.5512)       | 44.45 (1.75)     | 19.05 (.750)    | (.45 x .681)              |
| M 16 x 1.5  | 269-1016    | 14.528 (.572)       | 24 (.9449)             | 15.5 (.6102)     | 50.8 (2.00)      | 19.05 (.750)    | (.54 x .740)              |
| M 18 x 1.5  | 269-1018    | 16.535 (.651)       | 26 (1.0236)            | 17 (.6693)       | 50.8 (2.00)      | 19.05 (.750)    | (.62 x .809)              |
| M 22 x 1.5  | 269-1022    | 20.523 (.808)       | 29 (1.1417)            | 18 (.7087)       | 50.8 (2.00)      | 19.05 (.750)    | (.78 x .849)              |
| M 27 x 2    | 269-1027    | 25.019 (.985)       | 34 (1.3386)            | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | (.95 x 1.01)              |
| M 33 x 2    | 269-1033    | 31.013 (1.221)      | 43 (1.6929)            | 22 (.8661)       | 57.15 (2.25)     | 25.4 (1.00)     | (1.17 x 1.01)             |
| M 42 x 2    | 269-1042    | 40.030 (1.576)      | 52 (2.0472)            | 22.5 (.8858)     | 57.15 (2.25)     | 31.75 (1.25)    | (1.54 x 1.03)             |
| M 48 x 2    | 269-1048    | 46.025 (1.812)      | 57 (2.2441)            | 25 (.9843)       | 57.15 (2.25)     | 31.75 (1.25)    | (1.78 x 1.13)             |
| M 60 x 2    | 269-1060    | 58.013 (2.284)      | 67 (2.6378)            | 27.5 (1.0827)    | 57.15 (2.25)     | 38.1 (1.50)     | (2.25 x 1.22)             |

Inches shown in parentheses; all other dimensions are in millimeters.

**Metric Indexable models are available price on application (POA)**  
**ISO-6149 & SAE J2444 (1980-1993) Specifications available as (POA)**

# Port Contour Cutters – MS 33649, NASA MC 240

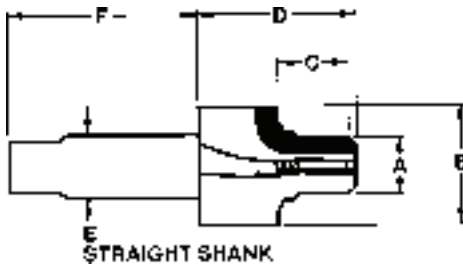
## High Speed Steel, Straight Shank



| Thread Size | Tube |       | Part Number | A**<br>Small Diameter | B<br>Spotface Diameter | C<br>Bore Length | D<br>Head Length | E<br>Shank Diameter | F<br>Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|-----------------------|------------------------|------------------|------------------|---------------------|-------------------|---------------------------|
|             | No.  | O.D.  |             |                       |                        |                  |                  |                     |                   |                           |
| 5/16 - 24   | 2    | .125  | 164-0031    | .276                  | .682                   | .582             | 1.750            | .500                | 2.00              | F x .812                  |
| 3/8 - 24    | 3    | .187  | 164-0037    | .338                  | .760                   | .588             | 1.750            | .500                | 2.00              | O x .812                  |
| 7/16 - 20   | 4    | .250  | 164-0043    | .393                  | .838                   | .661             | 1.750            | .500                | 2.00              | U x .937                  |
| 1/2 - 20    | 5    | .312  | 164-0050    | .455                  | .916                   | .661             | 1.750            | .500                | 2.00              | .44 x .937                |
| 9/16 - 18   | 6    | .375  | 164-0056    | .513                  | .979                   | .714             | 1.750            | .500                | 2.00              | .48 x .968                |
| 5/8 - 18    | 7    | .438  | 164-0062    | .575                  | 1.105                  | .745             | 1.750            | .500                | 2.00              | .55 x 1.030               |
| 3/4 - 16    | 8    | .500  | 164-0075    | .693                  | 1.198                  | .839             | 2.000            | .750                | 2.00              | .67 x 1.090               |
| 7/8 - 14    | 10   | .625  | 164-0087    | .810                  | 1.354                  | .935             | 2.000            | .750                | 2.00              | .78 x 1.220               |
| 1 - 12      | 11   | .688  | 164-0100    | .924                  | 1.500                  | 1.080            | 2.000            | .750                | 2.00              | .90 x 1.410               |
| 1 1/16 - 12 | 12   | .750  | 164-0106    | .986                  | 1.635                  | 1.069            | 2.250            | .750                | 2.00              | .95 x 1.410               |
| 1 3/16 - 12 | 14   | .875  | 164-0118    | 1.111                 | 1.790                  | 1.080            | 2.250            | .750                | 2.00              | 1.09 x 1.410              |
| 1 5/16 - 12 | 16   | 1.000 | 164-0131    | 1.236                 | 1.920                  | 1.069            | 2.250            | .750                | 2.00              | 1.22 x 1.410              |
| 1 5/8 - 12  | 20   | 1.250 | 164-0162    | 1.549                 | 2.280                  | 1.121            | 2.250            | 1.000               | 2.25              | 1.53 x 1.470              |
| 1 7/8 - 12  | 24   | 1.500 | 164-0187    | 1.799                 | 2.570                  | 1.132            | 2.250            | 1.000               | 2.25              | 1.78 x 1.470              |

All dimensions shown in inches.  
 \*\*MIL-S-8879C UNJF Class 3B

## Tungsten Carbide Tipped, Straight Shank

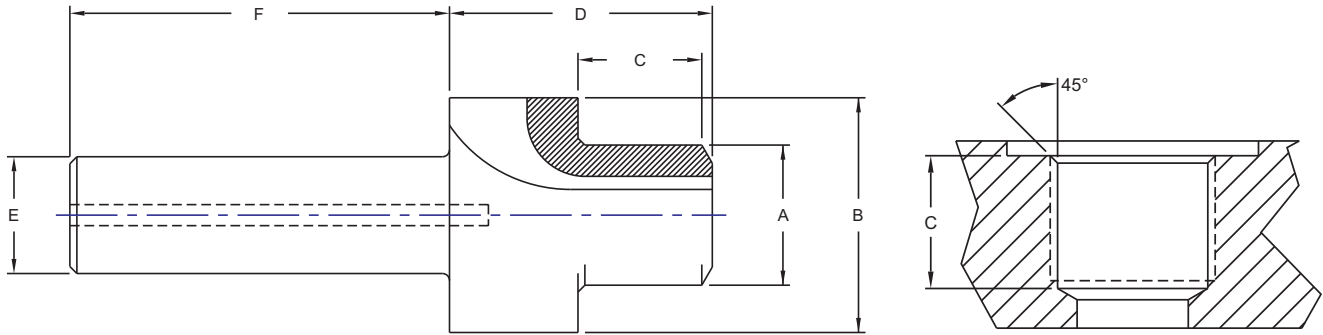


| Thread Size | Tube |       | Part Number | A**<br>Small Diameter | B<br>Spotface Diameter | C<br>Bore Length | D<br>Head Length | E<br>Shank Diameter | F<br>Shank Length | Pre-Drill Diameter/Length |
|-------------|------|-------|-------------|-----------------------|------------------------|------------------|------------------|---------------------|-------------------|---------------------------|
|             | No.  | O.D.  |             |                       |                        |                  |                  |                     |                   |                           |
| 5/16 - 24   | 2    | .125  | 264-0031    | .276                  | .682                   | .582             | 1.750            | .500                | 2.00              | F x .812                  |
| 3/8 - 24    | 3    | .187  | 264-0037    | .338                  | .760                   | .588             | 1.750            | .500                | 2.00              | O x .812                  |
| 7/16 - 20   | 4    | .250  | 264-0043    | .393                  | .838                   | .661             | 1.750            | .500                | 2.00              | U x .937                  |
| 1/2 - 20    | 5    | .312  | 264-0050    | .455                  | .916                   | .661             | 1.750            | .500                | 2.00              | .44 x .937                |
| 9/16 - 18   | 6    | .375  | 264-0056    | .513                  | .979                   | .714             | 1.750            | .500                | 2.00              | .48 x .968                |
| 5/8 - 18    | 7    | .438  | 264-0062    | .575                  | 1.105                  | .745             | 1.750            | .500                | 2.00              | .55 x 1.030               |
| 3/4 - 16    | 8    | .500  | 264-0075    | .693                  | 1.198                  | .839             | 2.000            | .750                | 2.00              | .67 x 1.090               |
| 7/8 - 14    | 10   | .625  | 264-0087    | .810                  | 1.354                  | .935             | 2.000            | .750                | 2.00              | .78 x 1.220               |
| 1 - 12      | 11   | .688  | 264-0100    | .924                  | 1.500                  | 1.080            | 2.000            | .750                | 2.00              | .90 x 1.410               |
| 1 1/16 - 12 | 12   | .750  | 264-0106    | .985                  | 1.635                  | 1.069            | 2.250            | .750                | 2.00              | .95 x 1.410               |
| 1 3/16 - 12 | 14   | .875  | 264-0118    | 1.111                 | 1.790                  | 1.080            | 2.250            | .750                | 2.00              | 1.09 x 1.410              |
| 1 5/16 - 12 | 16   | 1.000 | 264-0131    | 1.236                 | 1.920                  | 1.069            | 2.250            | .750                | 2.00              | 1.22 x 1.410              |
| 1 5/8 - 12  | 20   | 1.250 | 264-0162    | 1.549                 | 2.280                  | 1.121            | 2.250            | 1.000               | 2.25              | 1.53 x 1.470              |
| 1 7/8 - 12  | 24   | 1.500 | 264-0187    | 1.799                 | 2.570                  | 1.132            | 2.250            | 1.000               | 2.25              | 1.78 x 1.470              |

All dimensions shown in inches.  
 \*\*MIL-S-8879C UNJF Class 3B

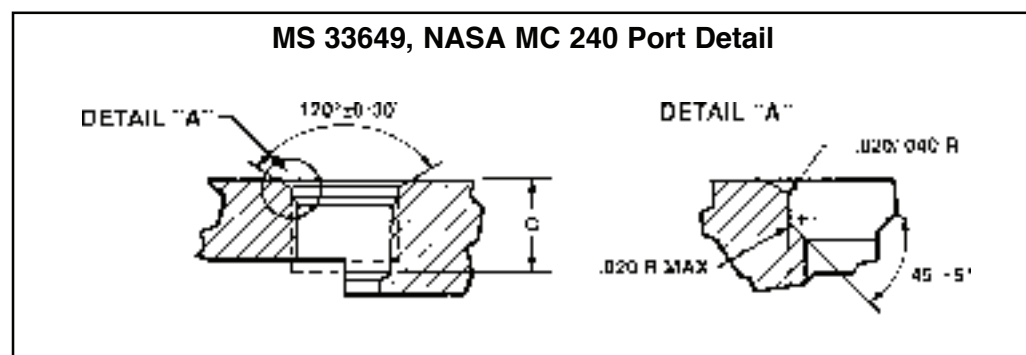
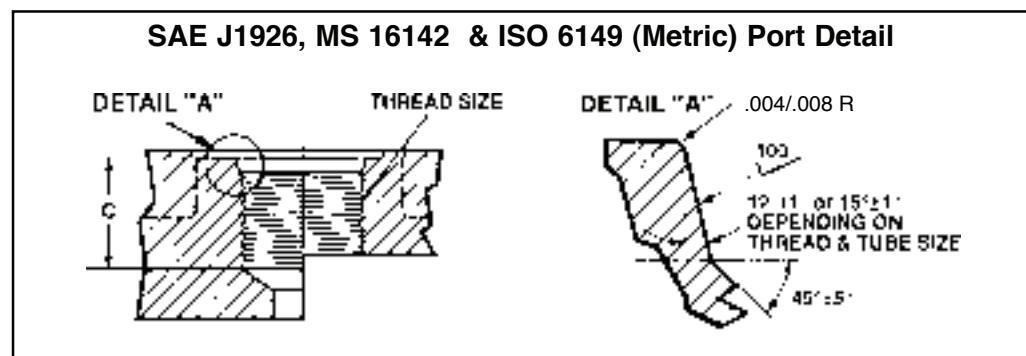
# BSPP/BSPF (Rp) BSI BS21

## Tungsten Carbide Tipped, Straight Shank



| Thread Size | Part Number | A Small Diameter | B Spotface Diameter | C Bore Length | D Head Length | E Shank Diameter | F Shank Length |
|-------------|-------------|------------------|---------------------|---------------|---------------|------------------|----------------|
| 1/8-28      | 265-2012    | .346             | .694                | .625          | 1.750         | .500             | 2.500          |
| 1/4-19      | 265-2025    | .465             | .891                | .830          | 1.750         | .500             | 2.500          |
| 3/8-19      | 265-2037    | .600             | 1.009               | .880          | 2.000         | .500             | 2.500          |
| 1/2-14      | 265-3050    | .748             | 1.186               | 1.066         | 2.250         | .750             | 2.500          |
| 3/4-14      | 265-3075    | .964             | 1.452               | 1.066         | 2.250         | .750             | 3.000          |
| 1-11        | 265-3100    | 1.210            | 1.820               | 1.255         | 2.750         | .750             | 3.000          |
| 1-1/4-11    | 265-4125    | 1.554            | 2.249               | 1.375         | 3.000         | 1.000            | 3.000          |
| 1-1/2-11    | 265-4150    | 1.771            | 2.505               | 1.375         | 3.000         | 1.000            | 3.000          |
| 2-11        | 265-4200    | 2.249            | 3.000               | 1.567         | 3.250         | 1.000            | 3.000          |
| 2-1/2-11    | 265-4250    | 2.874            | 3.500               | 1.849         | 3.500         | 1.000            | 3.250          |

## Port Details



# Port Contour Cutters Application Information

## Surface Feet Per Minute and Feet Per Revolution

| HSS Cutters |      |           | TCT Cutters |      |           |
|-------------|------|-----------|-------------|------|-----------|
| Material    | SFM* | IPR**     | Material    | SFM* | IPR**     |
| Aluminum    | 200  | .009-.012 | Aluminum    | 400  | .009-.012 |
| Cast Iron   | 60   | .009-.012 | Cast Iron   | 150  | .009-.012 |
| Mild Steel  | 50   | .006-.009 | Mild Steel  | 140  | .006-.009 |

\* Based on Small Diameter. \*\* Based on 3-fluted tool.  
All feed and speeds based on uncoated tools.

## Recommended Speeds and Feeds For 267 and 268 Series Indexable Port Contour Cutters

The following speed and feed table should be used only as a starting point. Ultimate speeds and feeds depend upon the machine, the set-up, and material conditions

Note: All indexable tooling should be run on rigid spindle machines.

| Part Number          | Size        | Mild Steel |           | 300 Series Stainless Steel |           | Cast Iron |           | Aluminum  |           |
|----------------------|-------------|------------|-----------|----------------------------|-----------|-----------|-----------|-----------|-----------|
|                      |             | RPM        | IPR       | RPM                        | IPR       | RPM       | IPR       | RPM       | IPR       |
| 267-3043<br>268-3043 | 7/16 – 20   | 2900-3100  | .003-.005 | 2600-2700                  | .003-.004 | 2900-3100 | .003-.005 | 4900-5100 | .003-.005 |
| 267-3050<br>268-3050 | 1/2 – 20    | 2900-3100  | .003-.005 | 2600-2700                  | .003-.004 | 2900-3100 | .003-.005 | 4900-5100 | .003-.005 |
| 267-3056<br>268-3056 | 9/16 – 18   | 2900-3100  | .003-.005 | 2600-2700                  | .003-.004 | 2900-3100 | .003-.005 | 4900-5100 | .003-.005 |
| 267-3075<br>268-3075 | 3/4 – 16    | 2100-2300  | .003-.005 | 1900-2000                  | .003-.004 | 1900-2100 | .004-.006 | 4900-5100 | .003-.005 |
| 267-3087<br>268-3087 | 7/8 – 14    | 1700-1900  | .003-.005 | 1500-1600                  | .003-.004 | 1500-1700 | .004-.006 | 4400-4600 | .003-.005 |
| 267-4106<br>268-4106 | 1-1/16 – 12 | 1500-1700  | .004-.006 | 1350-1450                  | .004-.005 | 1300-1500 | .005-.007 | 3700-3900 | .004-.006 |
| 267-4118<br>268-4118 | 1-3/16 – 12 | 1300-1500  | .004-.006 | 1150-1250                  | .004-.005 | 1100-1300 | .005-.007 | 3300-3500 | .004-.006 |
| 267-4131<br>268-4131 | 1-5/16 – 12 | 1100-1300  | .004-.006 | 1000-1100                  | .004-.005 | 900-1100  | .005-.007 | 2900-3100 | .004-.006 |
| 267-5162<br>268-5162 | 1-5/8 – 12  | 900-1100   | .005-.007 | 800-900                    | .005-.006 | 700-900   | .006-.008 | 2400-2600 | .005-.007 |
| 267-5187<br>268-5187 | 1-7/8 – 12  | 700-900    | .005-.007 | 600-700                    | .005-.006 | 500-700   | .007-.009 | 1900-2100 | .005-.007 |
| 267-8250<br>268-8225 | 2-1/2 – 12  | 500-700    | .005-.007 | 450-550                    | .005-.006 | 400-600   | .007-.009 | 1500-1700 | .005-.007 |

## For 367 Series Double Feed Indexable Porting Tools

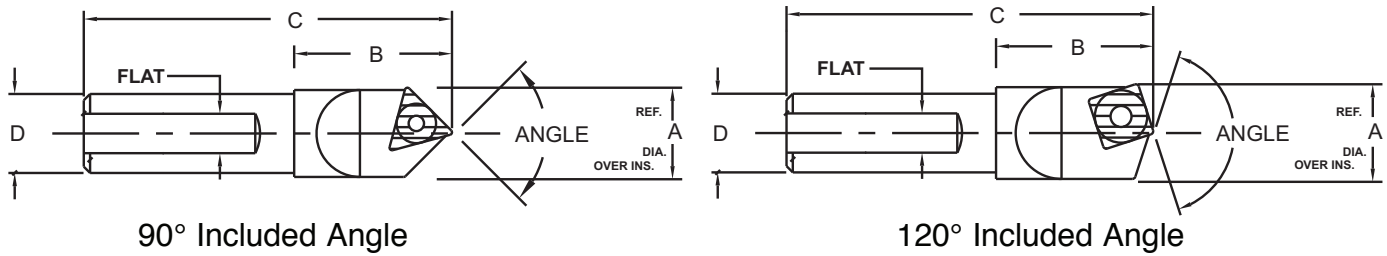
| Part Number | Size        | Mild Steel |           | Cast Iron |           | Aluminum  |           |
|-------------|-------------|------------|-----------|-----------|-----------|-----------|-----------|
|             |             | RPM        | IPR       | RPM       | IPR       | RPM       | IPR       |
| 367-3056    | 9/16 – 18   | 2900-3100  | .006-.010 | 2900-3100 | .006-.010 | 4900-5100 | .006-.010 |
| 367-3075    | 3/4 – 16    | 2100-2300  | .006-.010 | 1900-2100 | .008-.012 | 4900-5100 | .006-.010 |
| 367-3087    | 7/8 – 14    | 1700-1900  | .006-.010 | 1500-1700 | .008-.012 | 4400-4600 | .006-.010 |
| 367-4106    | 1 1/16 – 12 | 1500-1700  | .008-.012 | 1300-1500 | .010-.014 | 3700-3900 | .008-.012 |
| 367-4118    | 1 3/16 – 12 | 1300-1500  | .008-.012 | 1100-1300 | .010-.014 | 3300-3500 | .008-.012 |

## For 467 Series Porting Tools

Please refer to the above 367 series chart for specifying the feed only.  
Please refer to the application chart in the Spade Blade Brochure for the speed only.

# Spot and Chamfer Drills

## Indexable



| Part Number | Included Angle | A<br>Maximum Diameter | B<br>Extension Length | C<br>Overall Length | D<br>Shank Diameter | Effective Inserts | Insert Number |          | Torx Screw Part No. | Torx Wrench Part No. |
|-------------|----------------|-----------------------|-----------------------|---------------------|---------------------|-------------------|---------------|----------|---------------------|----------------------|
| 284-0900    | 90°            | .625                  | 1.50                  | 3.50                | .750                | 1                 | T-375-HM      | T-375-HL | 056-1020            | 056-2028 T-8         |
| 284-1200    | 120°           | .812                  | 1.50                  | 3.50                | .750                | 1                 | S-500-BM      | S-500-BL | 056-1834            | 056-2015 T-15        |

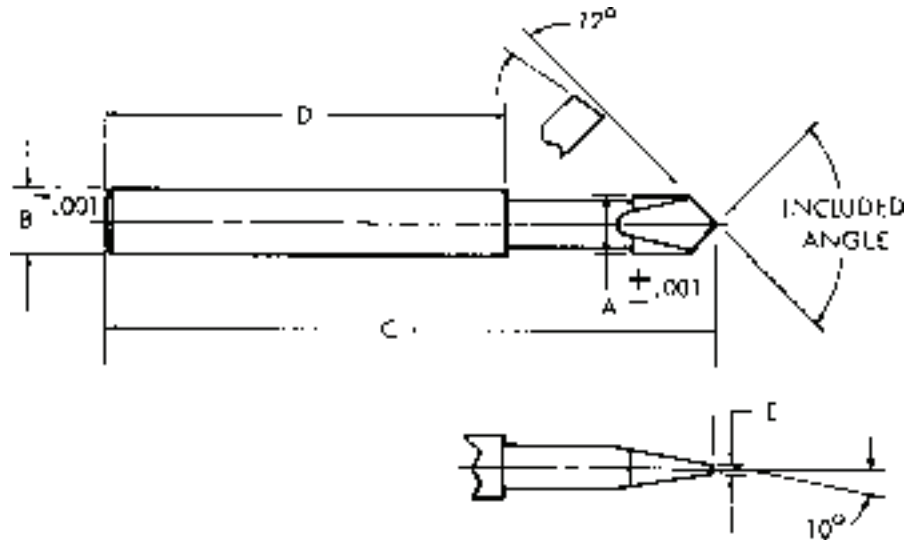
### Carbide Grade Descriptions:

**M** A CVD tri-phase coated tough carbide grade for steels, stainless steel and high temp alloys (HM, BM inserts).

**L** A PVD coated micrograin carbide for cast iron, nonferrous metals, nonmetals, austenitic stainless steels and titanium (HL, BL inserts).

NOTE: Inserts available in a 'H' grade - a PVD coated micrograin carbide for abrasive nonferrous alloys (HH, BH inserts). Prices on request.

## High Speed Steel



| Part Numbers          |                        | Dimensions |       |       |       |      |
|-----------------------|------------------------|------------|-------|-------|-------|------|
| 90°<br>Included Angle | 118°<br>Included Angle | A          | B     | C     | D     | E    |
| 184-3037              | 184-2037               | .375       | .500  | 7.800 | 6.500 | .031 |
| 184-3050              | 184-2050               | .500       | .500  | 7.800 | —     | .031 |
| 184-3075              | 184-2075               | .750       | .750  | 7.800 | —     | .063 |
| 184-3100              | 184-2100               | 1.000      | 1.000 | 7.800 | —     | .063 |

All dimensions shown in inches.

# Technical Reference

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## Decimal & Metric Equivalents

| Fraction |       |       | Inches | mm     |
|----------|-------|-------|--------|--------|
|          |       | 1/64  | .0156  | 0.397  |
|          | 1/32  |       | .0313  | 0.794  |
|          |       | 3/64  | .0469  | 1.191  |
| 1/16     |       |       | .0625  | 1.588  |
|          |       | 5/64  | .0781  | 1.984  |
|          | 3/32  |       | .0938  | 2.381  |
|          |       | 7/64  | .1094  | 2.778  |
| 1/8      |       |       | .1250  | 3.175  |
|          |       | 9/64  | .1406  | 3.572  |
|          | 5/32  |       | .1563  | 3.979  |
|          |       | 11/64 | .1719  | 4.366  |
| 3/16     |       |       | .1875  | 4.763  |
|          |       | 13/64 | .2031  | 5.159  |
|          | 7/32  |       | .2188  | 5.556  |
|          |       | 15/64 | .2344  | 5.953  |
| 1/4      |       |       | .2500  | 6.350  |
|          |       | 17/64 | .2656  | 6.747  |
|          | 9/32  |       | .2813  | 7.144  |
|          |       | 19/64 | .2969  | 7.541  |
| 5/16     |       |       | .3125  | 7.938  |
|          |       | 21/64 | .3281  | 8.334  |
|          | 11/32 |       | .3438  | 8.731  |
|          |       | 23/64 | .3594  | 9.128  |
| 3/8      |       |       | .3750  | 9.525  |
|          |       | 25/64 | .3906  | 9.922  |
|          | 13/32 |       | .4063  | 10.319 |
|          |       | 27/64 | .4219  | 10.716 |
| 7/16     |       |       | .4375  | 11.113 |
|          |       | 29/64 | .4531  | 11.509 |
|          | 15/32 |       | .4688  | 11.906 |
|          |       | 31/64 | .4844  | 12.303 |
| 1/2      |       |       | .5000  | 12.700 |

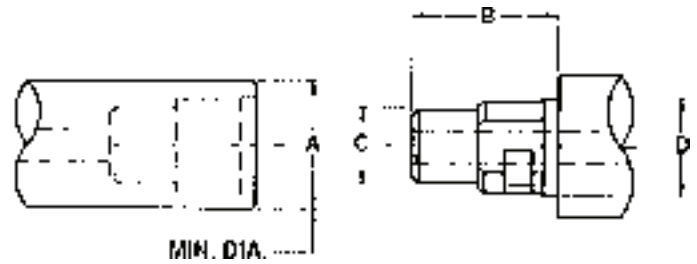
| Fraction |       |       | Inches | mm     |
|----------|-------|-------|--------|--------|
|          |       | 33/64 | .5156  | 13.097 |
|          | 17/32 |       | .5313  | 13.494 |
|          |       | 35/64 | .5469  | 13.891 |
| 9/16     |       |       | .5625  | 14.288 |
|          |       | 37/64 | .5781  | 14.684 |
|          | 19/32 |       | .5938  | 15.081 |
|          |       | 39/64 | .6094  | 15.478 |
| 5/8      |       |       | .6250  | 15.875 |
|          |       | 41/64 | .6406  | 16.272 |
|          | 21/32 |       | .6563  | 16.669 |
|          |       | 43/64 | .6719  | 17.066 |
| 11/16    |       |       | .6875  | 17.463 |
|          |       | 45/64 | .7031  | 17.859 |
|          | 23/32 |       | .7188  | 18.256 |
|          |       | 47/64 | .7344  | 18.653 |
| 3/4      |       |       | .7500  | 19.050 |
|          |       | 49/64 | .7656  | 19.447 |
|          | 25/32 |       | .7813  | 19.844 |
|          |       | 51/64 | .7969  | 20.241 |
| 13/16    |       |       | .8125  | 20.638 |
|          |       | 53/64 | .8281  | 21.034 |
|          | 27/32 |       | .8438  | 21.431 |
|          |       | 55/64 | .8594  | 21.838 |
| 7/8      |       |       | .8750  | 22.225 |
|          |       | 57/64 | .8906  | 22.622 |
|          | 29/32 |       | .9063  | 23.019 |
|          |       | 59/64 | .9219  | 23.416 |
| 15/16    |       |       | .9375  | 23.813 |
|          |       | 61/64 | .9531  | 23.852 |
|          | 31/32 |       | .9688  | 24.606 |
|          |       | 63/64 | .9844  | 25.003 |
| 1        |       |       | 1.0000 | 25.400 |

# Technical Reference

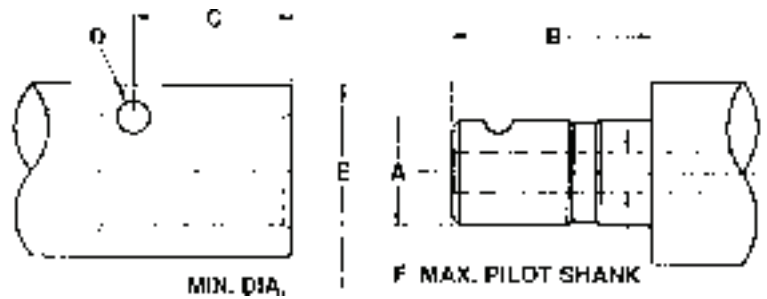
## Shank Details

Radial Drive

| Drive No. | A      | B     | C      | D      |
|-----------|--------|-------|--------|--------|
| RA        | .7500  | .938  | .3750  | .5000  |
| RB        | .8750  | 1.375 | .4375  | .6250  |
| RC        | 1.0625 | 1.375 | .5625  | .7500  |
| RE        | 1.3750 | 1.500 | .7500  | 1.0000 |
| RF        | 1.5000 | 1.563 | .8125  | 1.1250 |
| RJ        | 2.0000 | 1.563 | 1.0000 | 1.3750 |
| RS        | 2.7500 | 1.625 | 1.3750 | 1.7500 |



Pin Drive

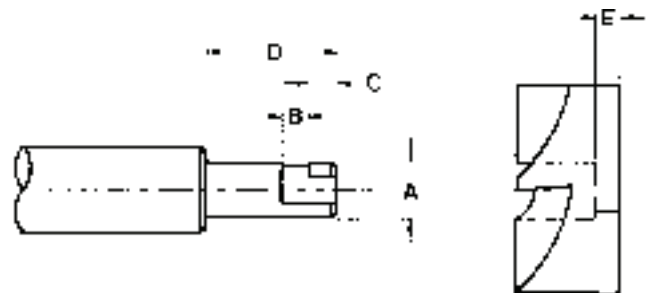


| Pin Drive | A      | B     | C      | D     | E      | F     |
|-----------|--------|-------|--------|-------|--------|-------|
| 0         | .3750  | .938  | .7500  | .1250 | .7500  | .1250 |
| 0A        | .4375  | 1.500 | 1.2500 | .1250 | .8750  | .1875 |
| 1         | .5625  | 1.500 | 1.2500 | .1875 | 1.0625 | .2500 |
| 1C        | .6250  | 1.625 | 1.2500 | .2188 | 1.1250 | .2500 |
| 1A        | .6875  | 1.625 | 1.2500 | .2500 | 1.2500 | .3125 |
| 1B        | .7500  | 1.625 | 1.2500 | .2500 | 1.3750 | .3125 |
| 2         | .8750  | 1.625 | 1.2500 | .2500 | 1.5000 | .3125 |
| 2A        | 1.0000 | 1.625 | 1.2500 | .3125 | 1.7500 | .3125 |
| 3         | 1.2500 | 1.688 | 1.2500 | .3125 | 2.0000 | .5000 |
| 4         | 1.7500 | 1.750 | 1.2500 | .3750 | 3.0000 | .3750 |

Note: Can be used as a straight shank counterbore.

Inverted Drive

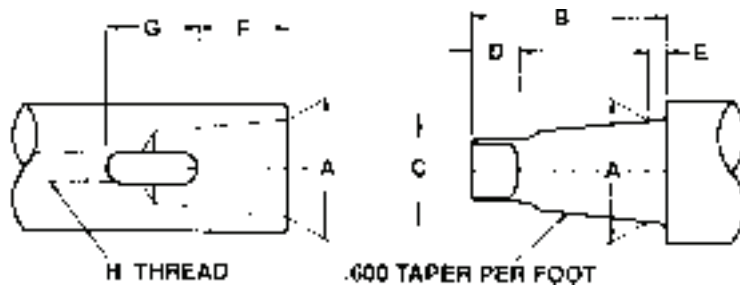
| Drive No. | A      | B    | C    | D     | E    |
|-----------|--------|------|------|-------|------|
| .3125     | .3125  | .197 | .250 | 1.063 | .177 |
| .3750     | .3750  | .197 | .250 | 1.063 | .177 |
| .5000     | .5000  | .197 | .250 | 1.063 | .177 |
| .7500     | .7500  | .260 | .313 | 1.125 | .240 |
| 1.0000    | 1.0000 | .260 | .375 | 1.438 | .240 |



# Technical Reference

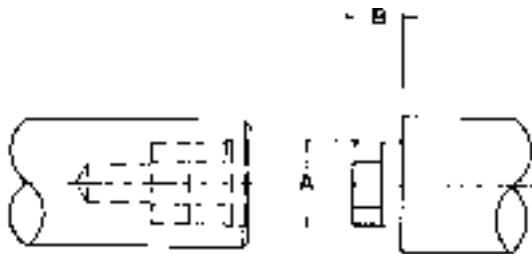
## Shank Details

### Square Drive



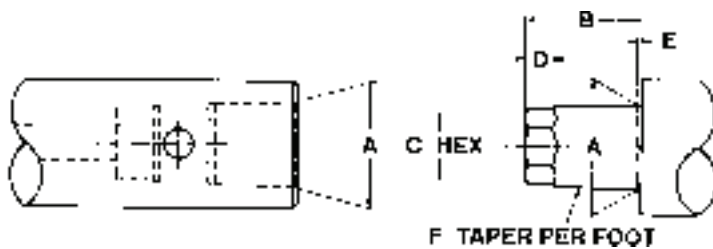
| Square Drive | A      | B     | C     | D    | E     | F     | G     | H       |
|--------------|--------|-------|-------|------|-------|-------|-------|---------|
| 53           | .7500  | 1.625 | .469  | .406 | .0625 | 1.375 | .688  | #10-24  |
| 61           | .9375  | 1.625 | .672  | .500 | .0625 | 1.375 | .750  | 1/4-20  |
| 71           | 1.1250 | 1.688 | .781  | .531 | .0625 | 1.375 | .875  | 1/4-20  |
| 87           | 1.3125 | 1.875 | .906  | .563 | .0625 | 1.563 | .875  | 5/16-18 |
| 92           | 1.5000 | 2.000 | 1.031 | .625 | .0625 | 1.625 | .875  | 5/16-18 |
| 112          | 2.0000 | 2.750 | 1.344 | .750 | .0938 | 2.313 | 1.000 | 5/16-18 |

### HEX Drive Type A



| HEX Drive | A      | B    | HEX Size |
|-----------|--------|------|----------|
| A-1       | .3750  | .410 | .306     |
| A-2       | .5625  | .470 | .495     |
| A-3       | .8750  | .530 | .718     |
| A-4       | 1.2500 | .720 | 1.110    |

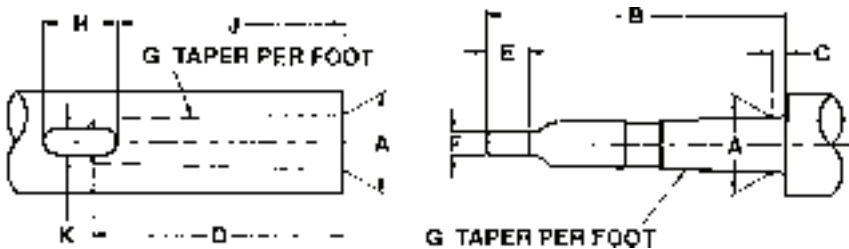
### HEX Drive Type C



| HEX Drive | A      | B     | C     | D    | E    | F    |
|-----------|--------|-------|-------|------|------|------|
| C-11      | .4375  | .781  | .306  | .280 | .060 | .600 |
| C-12      | .5938  | .906  | .495  | .280 | .060 | .600 |
| C-13      | .9063  | 1.313 | .745  | .340 | .060 | .623 |
| C-14      | 1.2500 | 1.719 | .988  | .410 | .060 | .623 |
| C-15      | 1.8125 | 2.469 | 1.488 | .560 | .090 | .630 |

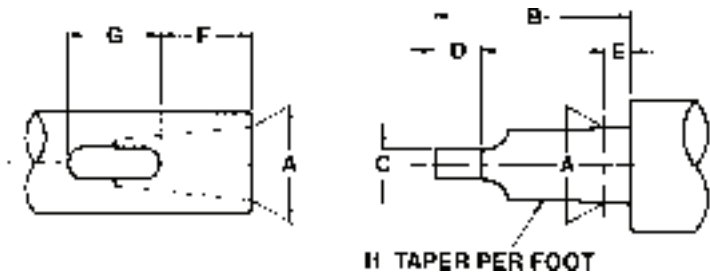
Shank Details

Morse Taper



| Morse Taper No. | A     | B     | C    | D     | E     | F    | G    | H     | J     | K    |
|-----------------|-------|-------|------|-------|-------|------|------|-------|-------|------|
| 0               | .356  | 2.344 | .125 | 2.031 | .250  | .156 | .624 | .563  | 1.938 | .160 |
| 1               | .475  | 2.563 | .125 | 2.188 | .375  | .203 | .599 | .750  | 2.063 | .213 |
| 2               | .700  | 3.125 | .188 | 2.625 | .438  | .250 | .599 | .875  | 2.500 | .260 |
| 3               | .938  | 3.875 | .188 | 3.250 | .563  | .313 | .602 | 1.188 | 3.063 | .322 |
| 4               | 1.231 | 4.875 | .250 | 4.125 | .625  | .469 | .623 | 1.250 | 3.875 | .478 |
| 5               | 1.748 | 6.125 | .250 | 5.250 | .750  | .625 | .632 | 1.500 | 4.938 | .635 |
| 6               | 2.494 | 8.563 | .313 | 7.375 | 1.125 | .750 | .626 | 1.750 | 7.000 | .760 |

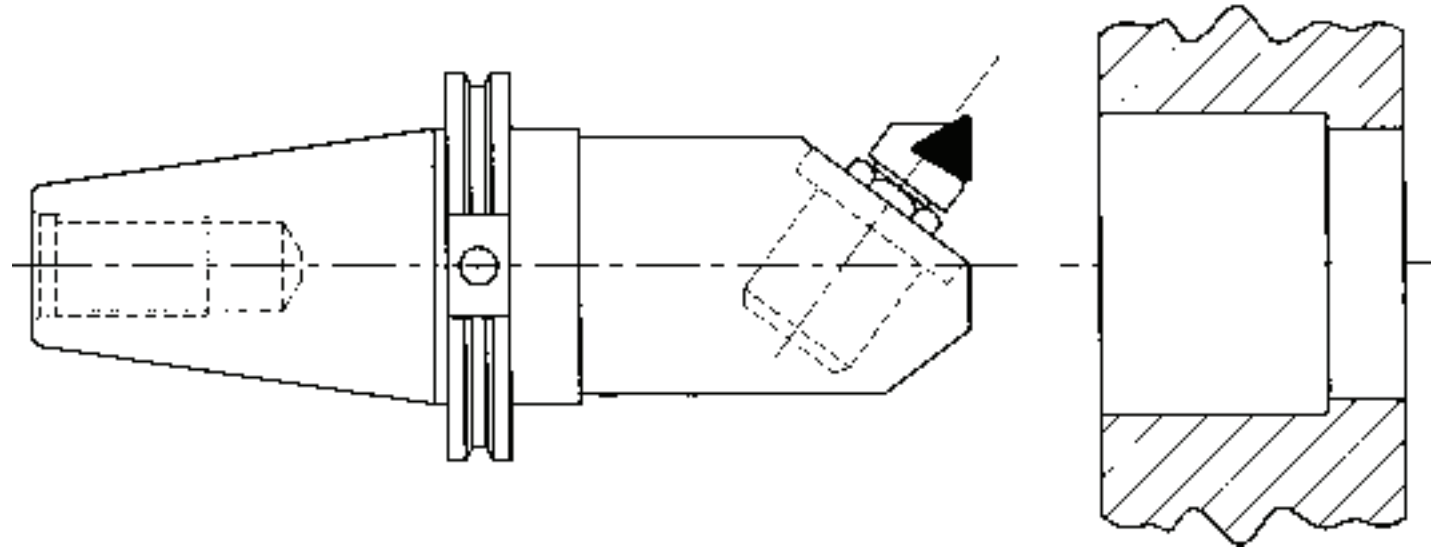
Stub Taper



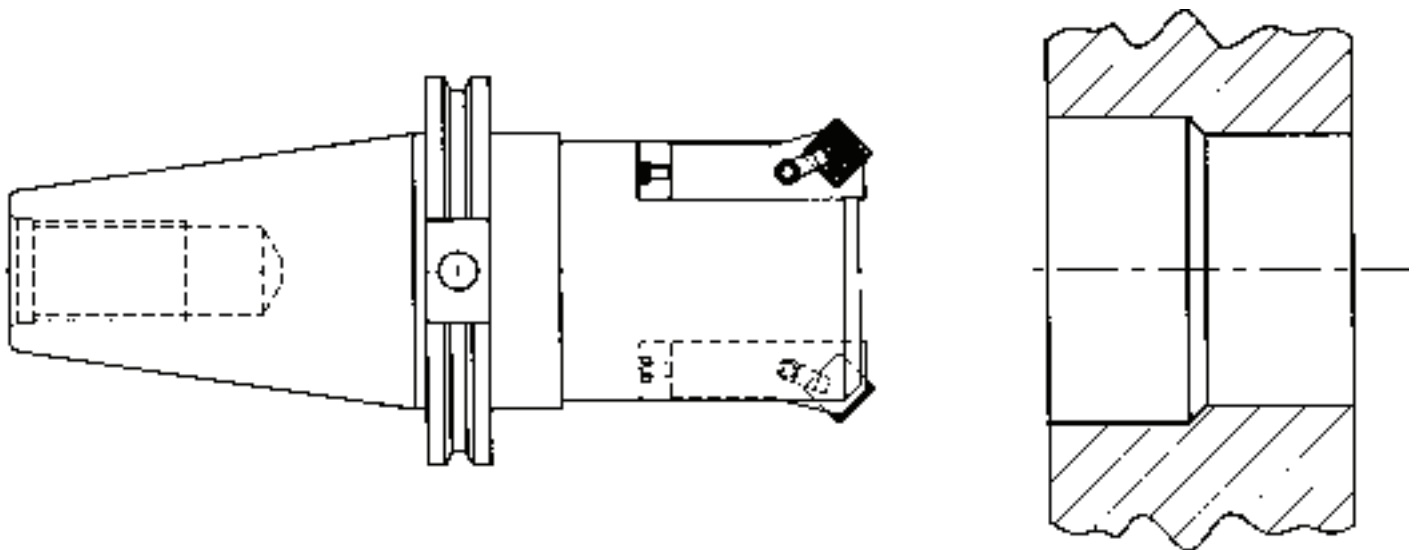
| Stub Taper No. | A     | B     | C    | D    | E    | F     | G     | H    |
|----------------|-------|-------|------|------|------|-------|-------|------|
| 0              | .375  | 1.156 | .156 | .250 | .188 | .656  | .594  | .600 |
| 1              | .475  | 1.313 | .201 | .313 | .188 | .781  | .719  | .600 |
| 2              | .700  | 1.625 | .294 | .438 | .188 | .938  | .938  | .602 |
| 3              | .938  | 1.938 | .388 | .563 | .188 | 1.063 | 1.125 | .602 |
| 4              | 1.231 | 2.250 | .513 | .688 | .188 | 1.188 | 1.375 | .623 |
| 4, 5           | 1.500 | 2.688 | .641 | .813 | .313 | 1.313 | 1.563 | .623 |
| 5              | 1.748 | 3.000 | .750 | .938 | .313 | 1.438 | 1.750 | .630 |

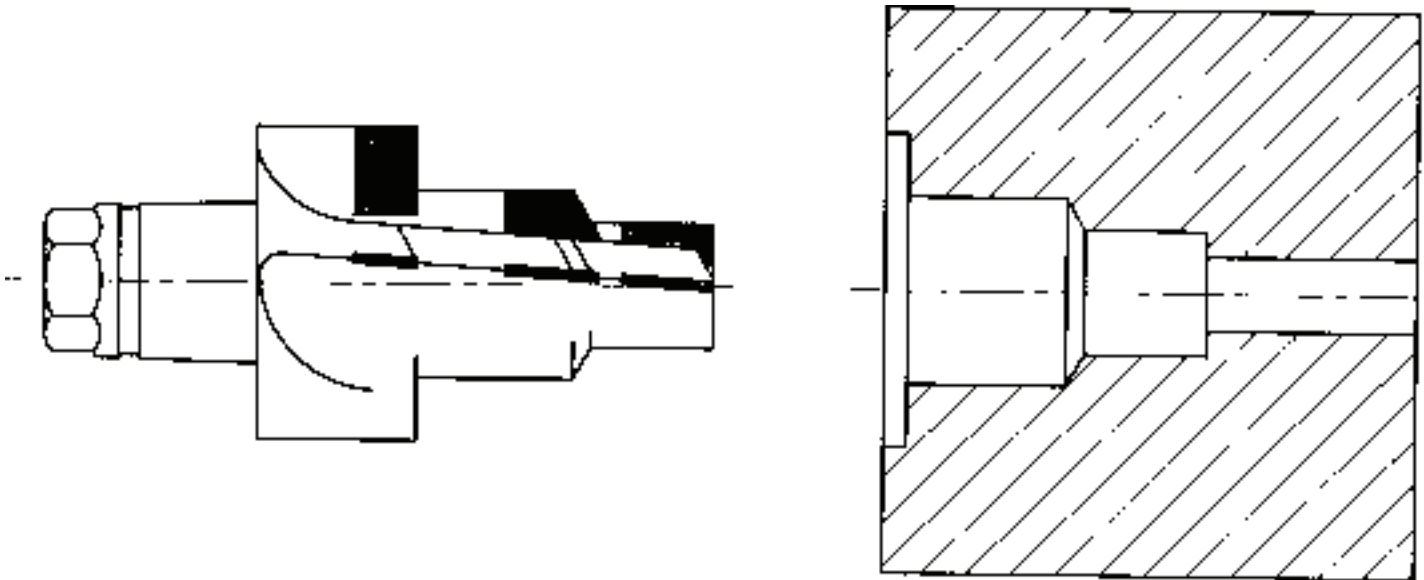
## Examples of Special Boring Tools

### V Flange Shank Boring Bar with Precision Boring Unit



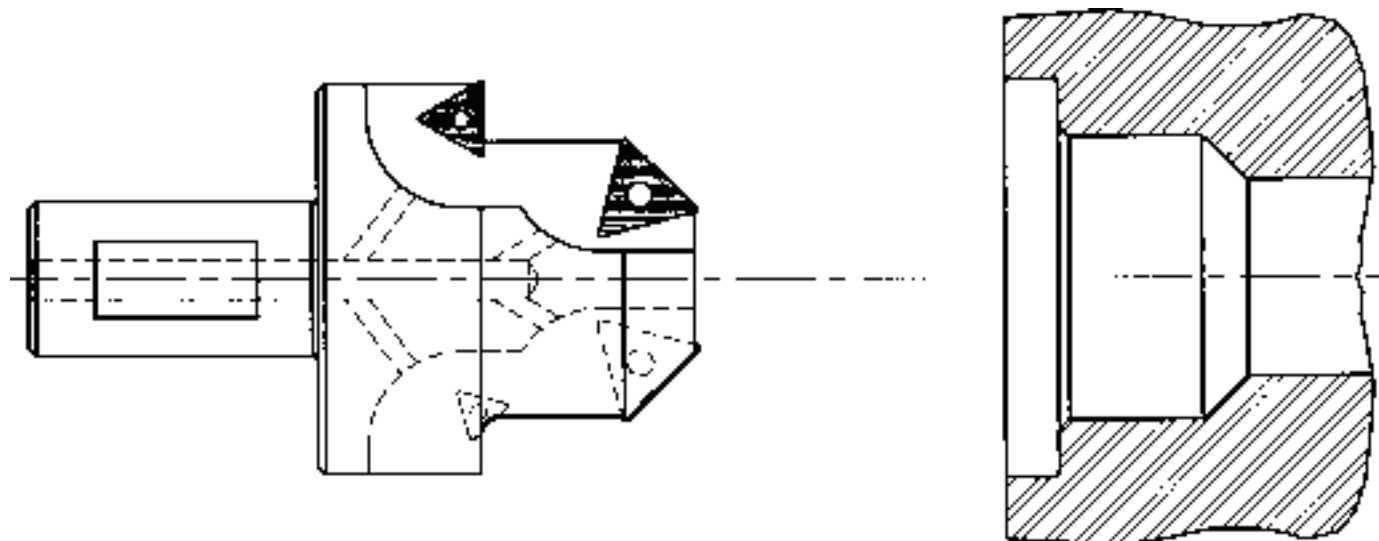
### V Flange Shank Cartridge Bar with Adjustable Boring Cartridges



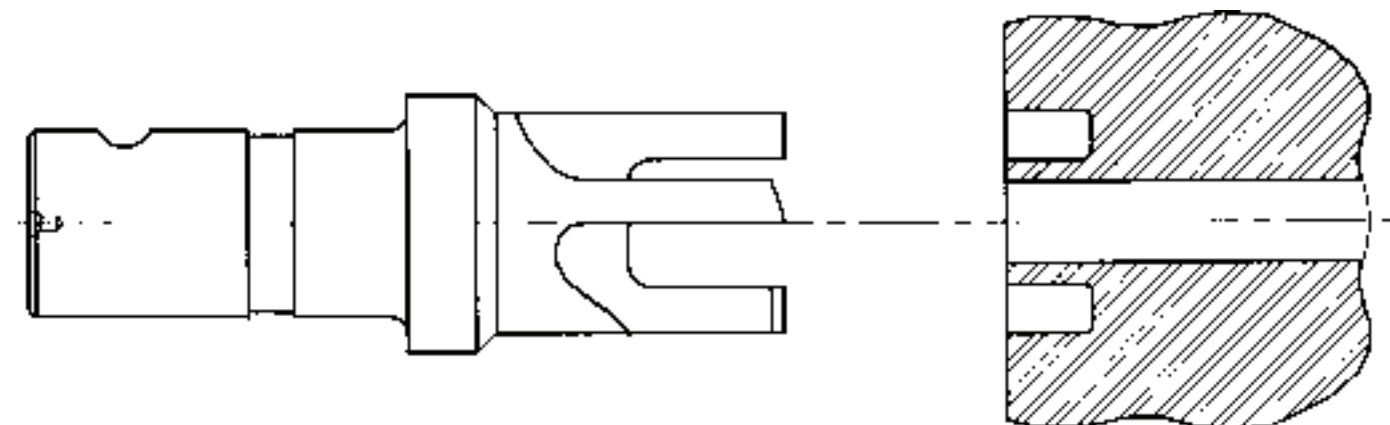
**Examples of Special Boring Tools****Carbide-Tipped, Stepped Multi-Diameter Boring Tool****Solid Carbide Head Multi-Diameter Boring Tool**

## Examples of Special Boring, Spotface, Trepanning & Ball Nose Tools

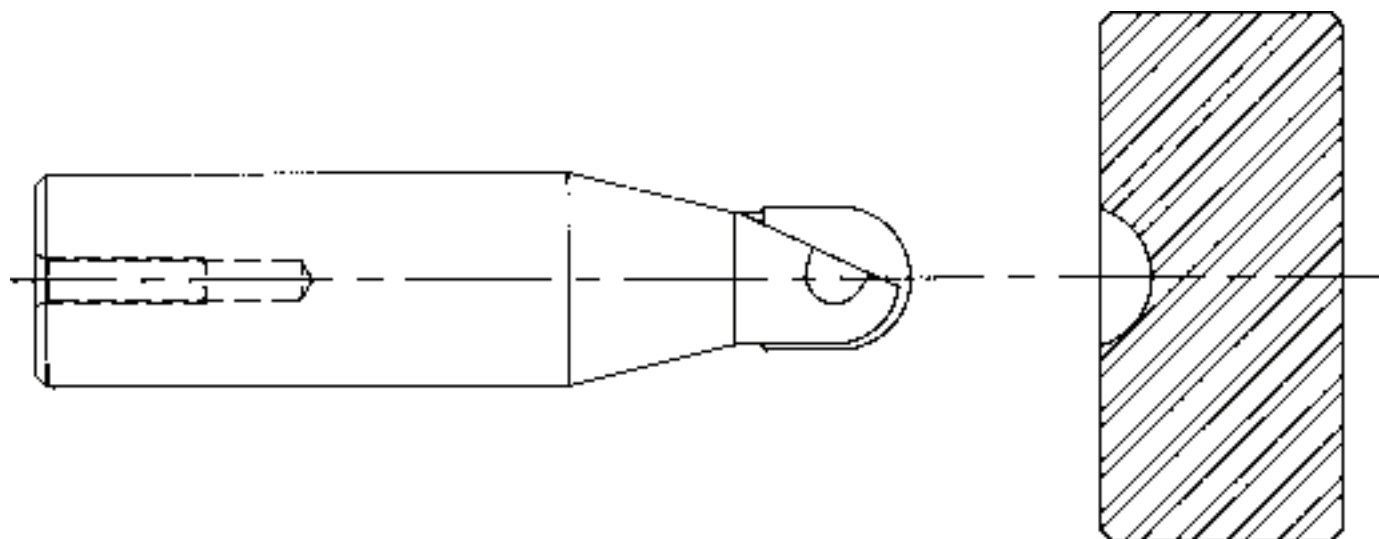
### Body Mount Insert Tool: Bore, Chamfer and Spotface

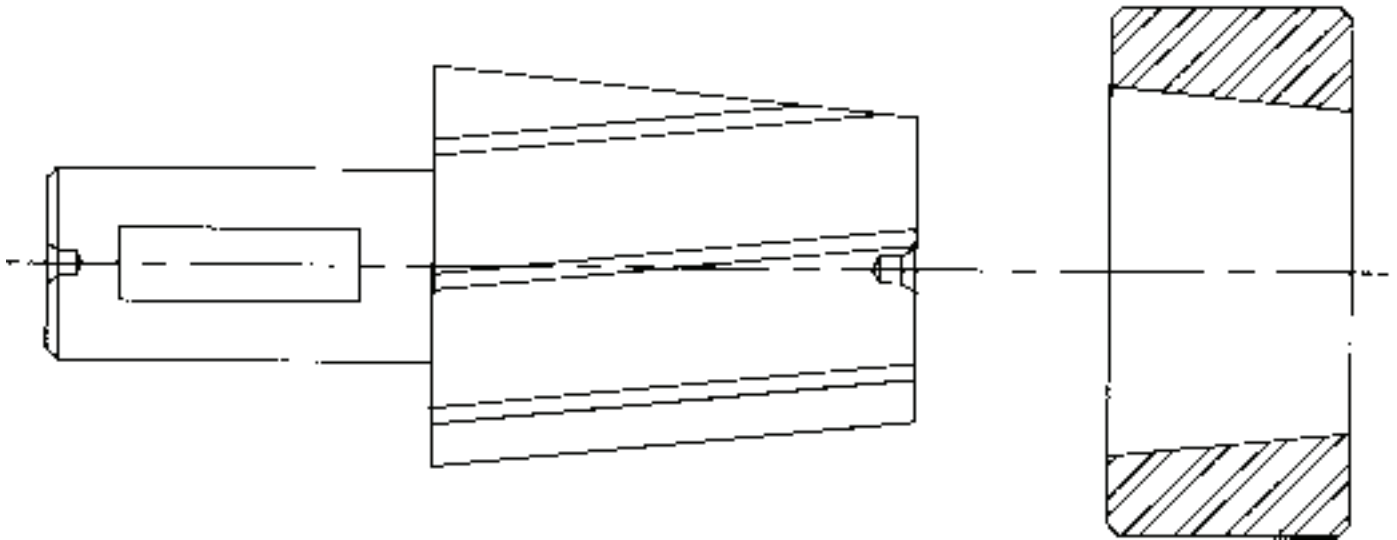
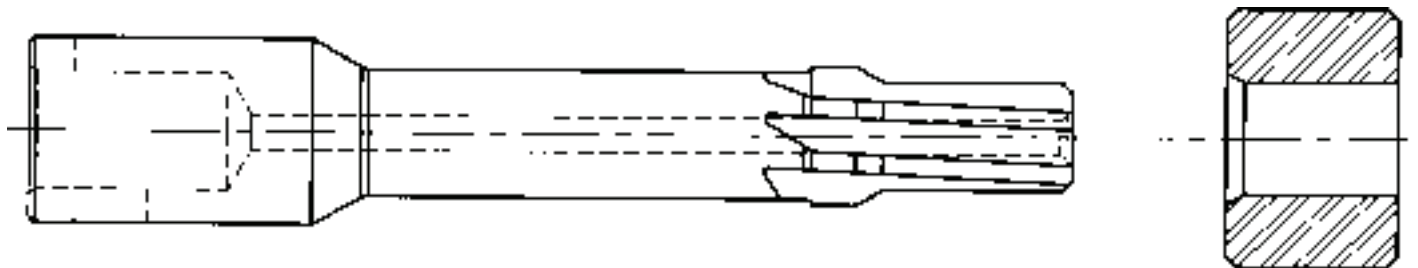


### HSS Trepanning Tool



### Ball Nose



**Examples of Special Reaming Tools****Shank Type Taper Reamer****HSS Reamer and Chamfer Tool****HSS Coolant-Feed Step Reamer**

# ***Metalcutting Safety***

## **IMPORTANT SAFETY INSTRUCTIONS**

**Read before using the tools in this catalog!**

### **Projectile and Fragmentation Hazards**

Modern metalcutting operations involve high spindle and cutter speeds and high temperatures and cutting forces. Hot metal chips may fly off the workpiece during metalcutting. Although cutting tools are designed and manufactured to withstand high cutting forces and temperatures, they can sometimes fragment, particularly if they are subjected to over-stress, severe impact, or other abuse.

#### **To avoid injury:**

- Always wear appropriate personal protective equipment, including safety goggles, when operating metalcutting machines or working nearby.
- Always make sure all machine guards are in place.

### **Breathing and Skin Contact Hazards:**

Grinding carbide or other advanced cutting tool materials produce dust or mist containing metallic particles. Breathing this dust or mist — especially over an extended period — can cause temporary or permanent lung disease or make existing medical conditions worse. Contact with this dust or mist can irritate eyes, skin, and mucous membranes and may make existing skin conditions worse.

#### **To avoid injury:**

- Always wear breathing protection and safety goggles when grinding.
- Provide ventilation control and collect and properly dispose of dust, mist, or sludge from grinding.
- Avoid skin contact with dust or mist.

For more information, read the applicable Material Safety Data Sheet provided by Kennametal and consult General Industry Safety and Health Regulations, Part 1910, Title 29 of the Code of Federal Regulations.

These safety instructions are general guidelines. Many variables affect machining operations. It is impossible to cover every specific situation. The technical information included in this catalog and recommendations on machining practices may not apply to your particular operation. For more information, consult Kennametal's Metalcutting Safety booklet, available free from Kennametal at 724.539.5747 or fax 724.539.5439. For specific product safety and environmental questions, contact our Corporate Environmental Health and Safety Office at 724.539.5066 or fax 724.539.5372.

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