



### Side Milling - Roughing & Semi-Finishing (LDR 4xD)

For LDR Greater See LDR Notes

**High Speed Machining Guide (Aggressive Parameters)**

| Material | Stainless Steel (annealed) |                |           | Stainless Steel (hardened) |                |                 | Titanium Alloys      |       |                |                 | Heat Resistant Alloys (annealed) |       |                |                 | Heat Resistant Alloys (hardened) |       |                |                 |                      |       |                |                 |                      |
|----------|----------------------------|----------------|-----------|----------------------------|----------------|-----------------|----------------------|-------|----------------|-----------------|----------------------------------|-------|----------------|-----------------|----------------------------------|-------|----------------|-----------------|----------------------|-------|----------------|-----------------|----------------------|
|          | Tool Dia. (Inch)           | Tool Dia. (mm) | No. Teeth | RPM                        | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa) | RPM   | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa)             | RPM   | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa)             | RPM   | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa) | RPM   | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa) |
| ZDKT11   | 0.625                      | 16             | 2         | 1985                       | 0.009          | 35.73           | 0.200                | 1620  | 0.007          | 22.68           | 0.200                            | 950   | 0.009          | 17.10           | 0.200                            | 855   | 0.005          | 8.55            | 0.200                | 700   | 0.004          | 5.60            | 0.200                |
|          | 0.750                      | 20             | 3         | 1655                       | 0.009          | 44.69           | 0.200                | 1350  | 0.007          | 28.35           | 0.200                            | 790   | 0.009          | 21.33           | 0.200                            | 715   | 0.005          | 10.73           | 0.200                | 585   | 0.004          | 7.02            | 0.200                |
|          | 1.000                      | 25             | 3         | 1240                       | 0.009          | 33.48           | 0.200                | 1015  | 0.007          | 21.32           | 0.200                            | 595   | 0.009          | 16.07           | 0.200                            | 535   | 0.005          | 8.03            | 0.200                | 440   | 0.004          | 5.28            | 0.200                |
|          | 1.250                      | 32             | 4         | 1240                       | 0.009          | 44.64           | 0.200                | 1015  | 0.007          | 28.42           | 0.200                            | 595   | 0.009          | 21.42           | 0.200                            | 535   | 0.005          | 10.70           | 0.200                | 440   | 0.004          | 7.04            | 0.200                |
|          |                            |                | 5         | 995                        | 0.009          | 26.87           | 0.200                | 810   | 0.007          | 17.01           | 0.200                            | 475   | 0.009          | 12.83           | 0.200                            | 430   | 0.005          | 6.45            | 0.200                | 350   | 0.004          | 4.20            | 0.200                |
|          | 2.000                      | 50             | 5         | 995                        | 0.009          | 44.78           | 0.200                | 810   | 0.007          | 28.35           | 0.200                            | 475   | 0.009          | 21.38           | 0.200                            | 430   | 0.005          | 10.75           | 0.200                | 350   | 0.004          | 7.00            | 0.200                |
|          |                            |                | 6         | 620                        | 0.009          | 27.90           | 0.200                | 510   | 0.007          | 17.85           | 0.200                            | 300   | 0.009          | 13.50           | 0.200                            | 270   | 0.005          | 6.75            | 0.200                | 220   | 0.004          | 4.40            | 0.200                |
|          | 2.500                      | 63             | 7         | 620                        | 0.009          | 39.06           | 0.200                | 510   | 0.007          | 24.99           | 0.200                            | 300   | 0.009          | 18.90           | 0.200                            | 270   | 0.005          | 9.45            | 0.200                | 220   | 0.004          | 6.16            | 0.200                |
|          |                            |                | 8         | 495                        | 0.009          | 26.73           | 0.200                | 405   | 0.007          | 17.01           | 0.200                            | 240   | 0.009          | 12.96           | 0.200                            | 215   | 0.005          | 6.45            | 0.200                | 175   | 0.004          | 4.20            | 0.200                |
|          | 3.000                      | 80             | 8         | 495                        | 0.009          | 35.64           | 0.200                | 405   | 0.007          | 22.68           | 0.200                            | 240   | 0.009          | 17.28           | 0.200                            | 215   | 0.005          | 8.60            | 0.200                | 175   | 0.004          | 5.60            | 0.200                |
|          |                            |                | 7         | 415                        | 0.009          | 26.15           | 0.200                | 340   | 0.007          | 16.66           | 0.200                            | 200   | 0.009          | 12.60           | 0.200                            | 180   | 0.005          | 6.30            | 0.200                | 150   | 0.004          | 4.20            | 0.200                |
|          | ZDKT15                     | 1.000          | 25        | 2                          | 1240           | 0.010           | 24.80                | 0.250 | 1015           | 0.008           | 16.24                            | 0.250 | 595            | 0.011           | 13.09                            | 0.250 | 535            | 0.005           | 5.35                 | 0.250 | 440            | 0.004           | 3.52                 |
| 1.250    |                            | 32             | 2         | 995                        | 0.010          | 19.90           | 0.250                | 810   | 0.008          | 12.96           | 0.250                            | 475   | 0.011          | 10.45           | 0.250                            | 430   | 0.005          | 4.30            | 0.250                | 350   | 0.004          | 2.80            | 0.250                |
|          |                            |                | 3         | 995                        | 0.010          | 29.85           | 0.250                | 810   | 0.008          | 19.44           | 0.250                            | 475   | 0.011          | 15.68           | 0.250                            | 430   | 0.005          | 6.45            | 0.250                | 350   | 0.004          | 4.20            | 0.250                |
| 1.500    |                            | 40             | 3         | 830                        | 0.010          | 24.90           | 0.250                | 675   | 0.008          | 16.20           | 0.250                            | 395   | 0.011          | 13.04           | 0.250                            | 360   | 0.005          | 5.40            | 0.250                | 295   | 0.004          | 3.54            | 0.250                |
|          |                            |                | 4         | 830                        | 0.010          | 33.20           | 0.250                | 675   | 0.008          | 21.60           | 0.250                            | 395   | 0.011          | 17.38           | 0.250                            | 360   | 0.005          | 7.20            | 0.250                | 295   | 0.004          | 4.72            | 0.250                |
| 2.000    |                            | 50             | 3         | 620                        | 0.010          | 18.60           | 0.250                | 510   | 0.008          | 12.24           | 0.250                            | 300   | 0.011          | 9.90            | 0.250                            | 270   | 0.005          | 4.05            | 0.250                | 220   | 0.004          | 2.64            | 0.250                |
|          |                            |                | 5         | 620                        | 0.010          | 31.00           | 0.250                | 510   | 0.008          | 20.40           | 0.250                            | 300   | 0.011          | 16.50           | 0.250                            | 270   | 0.005          | 6.75            | 0.250                | 220   | 0.004          | 4.40            | 0.250                |
| 2.500    |                            | 63             | 4         | 495                        | 0.010          | 19.80           | 0.250                | 405   | 0.008          | 12.96           | 0.250                            | 240   | 0.011          | 10.56           | 0.250                            | 215   | 0.005          | 4.30            | 0.250                | 175   | 0.004          | 2.80            | 0.250                |
|          |                            |                | 6         | 495                        | 0.010          | 29.70           | 0.250                | 405   | 0.008          | 19.44           | 0.250                            | 240   | 0.011          | 15.84           | 0.250                            | 215   | 0.005          | 6.45            | 0.250                | 175   | 0.004          | 4.20            | 0.250                |
| 3.000    |                            | 80             | 5         | 415                        | 0.010          | 20.75           | 0.250                | 340   | 0.008          | 13.60           | 0.250                            | 200   | 0.011          | 11.00           | 0.250                            | 180   | 0.005          | 4.50            | 0.250                | 150   | 0.004          | 3.00            | 0.250                |
|          |                            |                | 8         | 415                        | 0.010          | 33.20           | 0.250                | 340   | 0.008          | 21.76           | 0.250                            | 200   | 0.011          | 17.60           | 0.250                            | 180   | 0.005          | 7.20            | 0.250                | 150   | 0.004          | 4.80            | 0.250                |
| 4.000    |                            | 100            | 7         | 310                        | 0.010          | 21.70           | 0.250                | 255   | 0.008          | 14.28           | 0.250                            | 150   | 0.011          | 11.55           | 0.250                            | 135   | 0.005          | 4.73            | 0.250                | 110   | 0.004          | 3.08            | 0.250                |
|          | 10                         |                | 310       | 0.010                      | 31.00          | 0.250           | 255                  | 0.008 | 20.40          | 0.250           | 150                              | 0.011 | 16.50          | 0.250           | 135                              | 0.005 | 6.75           | 0.250           | 110                  | 0.004 | 4.40           | 0.250           |                      |
| 5.000    | 125                        | 8              | 250       | 0.010                      | 20.00          | 0.250           | 205                  | 0.008 | 13.12          | 0.250           | 120                              | 0.011 | 10.56          | 0.250           | 110                              | 0.005 | 4.40           | 0.250           | 90                   | 0.004 | 2.88           | 0.250           |                      |
|          |                            | 11             | 250       | 0.010                      | 27.50          | 0.250           | 205                  | 0.008 | 18.04          | 0.250           | 120                              | 0.011 | 14.52          | 0.250           | 110                              | 0.005 | 6.05           | 0.250           | 90                   | 0.004 | 3.96           | 0.250           |                      |
| 6.000    | 160                        | 10             | 210       | 0.010                      | 21.00          | 0.250           | 170                  | 0.008 | 13.60          | 0.250           | 100                              | 0.011 | 11.00          | 0.250           | 90                               | 0.005 | 4.50           | 0.250           | 75                   | 0.004 | 3.00           | 0.250           |                      |
|          |                            | 12             | 210       | 0.010                      | 25.20          | 0.250           | 170                  | 0.008 | 16.32          | 0.250           | 100                              | 0.011 | 13.20          | 0.250           | 90                               | 0.005 | 5.40           | 0.250           | 75                   | 0.004 | 3.60           | 0.250           |                      |

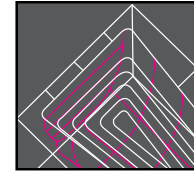
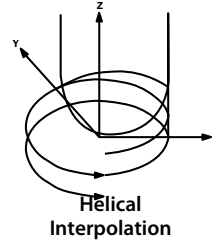
**Machining Guide (Moderate Parameters)**

| Material | Stainless Steel (annealed) |                |           | Stainless Steel (hardened) |                |                 | Titanium Alloys      |      |                |                 | Heat Resistant Alloys (annealed) |     |                |                 | Heat Resistant Alloys (hardened) |     |                |                 |                      |     |                |                 |                      |
|----------|----------------------------|----------------|-----------|----------------------------|----------------|-----------------|----------------------|------|----------------|-----------------|----------------------------------|-----|----------------|-----------------|----------------------------------|-----|----------------|-----------------|----------------------|-----|----------------|-----------------|----------------------|
|          | Tool Dia. (Inch)           | Tool Dia. (mm) | No. Teeth | RPM                        | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa) | RPM  | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa)             | RPM | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa)             | RPM | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa) | RPM | Feed per Tooth | Feed Rate (IPM) | Axial Cut Depth (aa) |
| ZDKT11   | 0.625                      | 16             | 2         | 1620                       | 0.007          | 22.68           | 0.200                | 1315 | 0.0055         | 14.47           | 0.200                            | 795 | 0.007          | 11.13           | 0.200                            | 700 | 0.004          | 5.60            | 0.200                | 580 | 0.003          | 3.48            | 0.200                |
|          | 0.750                      | 20             | 3         | 1350                       | 0.007          | 28.35           | 0.200                | 1095 | 0.0055         | 18.07           | 0.200                            | 665 | 0.007          | 13.97           | 0.200                            | 585 | 0.004          | 7.02            | 0.200                | 485 | 0.003          | 4.37            | 0.200                |
|          | 1.000                      | 25             | 3         | 1015                       | 0.007          | 21.32           | 0.200                | 820  | 0.0055         | 13.53           | 0.200                            | 500 | 0.007          | 10.50           | 0.200                            | 440 | 0.004          | 5.28            | 0.200                | 365 | 0.003          | 3.29            | 0.200                |
|          |                            |                | 4         | 1015                       | 0.007          | 28.42           | 0.200                | 820  | 0.0055         | 18.04           | 0.200                            | 500 | 0.007          | 14.00           | 0.200                            | 440 | 0.004          | 7.04            | 0.200                | 365 | 0.003          | 4.38            | 0.200                |
|          | 1.250                      | 32             | 3         | 810                        | 0.007          | 17.01           | 0.200                | 660  | 0.0055         | 10.89           | 0.200                            | 400 | 0.007          | 8.40            | 0.200                            | 350 | 0.004          | 4.20            | 0.200                | 290 | 0.003          | 2.61            | 0.200                |
|          |                            |                | 5         | 810                        | 0.007          | 28.35           | 0.200                | 660  | 0.0055         | 18.15           | 0.200                            | 400 | 0.007          | 14.00           | 0.200                            | 350 | 0.004          | 7.00            | 0.200                | 290 | 0.003          | 4.35            | 0.200                |
|          | 2.000                      | 50             | 5         | 510                        | 0.007          | 17.85           | 0.200                | 410  | 0.0055         | 11.28           | 0.200                            | 250 | 0.007          | 8.75            | 0.200                            | 220 | 0.004          | 4.40            | 0.200                | 180 | 0.003          | 2.70            | 0.200                |
|          |                            |                | 7         | 510                        | 0.007          | 24.99           | 0.200                | 410  | 0.0055         | 15.79           | 0.200                            | 250 | 0.007          | 12.25           | 0.200                            | 220 | 0.004          | 6.16            | 0.200                | 180 | 0.003          | 3.78            | 0.200                |
|          | 2.500                      | 63             | 6         | 405                        | 0.007          | 17.01           | 0.200                | 330  | 0.0055         | 10.89           | 0.200                            | 200 | 0.007          | 8.40            | 0.200                            | 175 | 0.004          | 4.20            | 0.200                | 145 | 0.003          | 2.61            | 0.200                |
|          |                            |                | 8         | 405                        | 0.007          | 22.68           | 0.200                | 330  | 0.0055         | 14.52           | 0.200                            | 200 | 0.007          | 11.20           | 0.200                            | 175 | 0.004          | 5.60            | 0.200                | 145 | 0.003          | 3.48            | 0.200                |
|          | 3.000                      | 80             | 7         | 340                        | 0.007          | 16.66           | 0.200                | 275  | 0.0055         | 10.59           | 0.200                            | 165 | 0.007          | 8.09            | 0.200                            | 150 | 0.004          | 4.20            | 0.200                | 120 | 0.003          | 2.52            | 0.200                |
|          |                            |                | 10        | 340                        | 0.007          | 23.80           | 0.200                | 275  | 0.0055         | 15.13           | 0.200                            | 165 | 0.007          | 11.55           | 0.200                            | 150 | 0.004          | 6.00            | 0.200                | 120 | 0.003          | 3.60            | 0.200                |
| ZDKT15   | 1.000                      | 25             | 2         | 1015                       | 0.008          | 16.24           | 0.250                | 820  | 0.0065         | 10.66           | 0.250                            | 500 | 0.009          | 9.00            | 0.250                            | 440 | 0.004          | 3.52            | 0.250                | 365 | 0.003          | 2.19            | 0.250                |
|          | 1.250                      | 32             | 2         | 810                        | 0.008          | 12.96           | 0.250                | 660  | 0.0065         | 8.58            | 0.250                            | 400 | 0.009          | 7.20            | 0.250                            | 350 | 0.004          | 2.80            | 0.250                | 290 | 0.003          | 1.74            | 0.250                |
|          |                            |                | 3         | 810                        | 0.008          | 19.44           | 0.250                | 660  | 0.0065         | 12.87           | 0.250                            | 400 | 0.009          | 10.80           | 0.250                            | 350 | 0.004          | 4.20            | 0.250                | 290 | 0.003          | 2.61            | 0.250                |
|          | 1.500                      | 40             | 3         | 675                        | 0.008          | 16.20           | 0.250                | 550  | 0.0065         | 10.73           | 0.250                            | 330 | 0.009          | 8.91            | 0.250                            | 295 | 0.004          | 3.54            | 0.250                | 240 | 0.003          | 2.16            | 0.250                |
|          |                            |                | 4         | 675                        | 0.008          | 21.60           | 0.250                | 550  | 0.0065         | 14.30           | 0.250                            | 330 | 0.009          | 11.88           | 0.250                            | 295 | 0.004          | 4.72            | 0.250                | 240 | 0.003          | 2.88            | 0.250                |
|          | 2.000                      | 50             | 3         | 510                        | 0.008          | 12.24           | 0.250                | 410  | 0.0065         | 8.00            | 0.250                            | 250 | 0.009          | 6.75            | 0.250                            | 220 | 0.004          | 2.64            | 0.250                | 180 | 0.003          | 1.62            | 0.250                |
|          |                            |                | 5         | 510                        | 0.008          | 20.40           | 0.250                | 410  | 0.0065         | 13.33           | 0.250                            | 250 | 0.009          | 11.25           | 0.250                            | 220 | 0.004          | 4.40            | 0.250                | 180 | 0.003          | 2.70            | 0.250                |
|          | 2.500                      | 63             | 4         | 405                        | 0.008          | 12.96           | 0.250                | 330  | 0.0065         | 8.58            | 0.250                            | 200 | 0.009          | 7.20            | 0.250                            | 175 | 0.004          | 2.80            | 0.250                | 145 | 0.003          | 1.74            | 0.250                |
|          |                            |                | 6         | 405                        | 0.008          | 19.44           | 0.250                | 330  | 0.0065         | 12.87           | 0.250                            | 200 | 0.009          | 10.80           | 0.250                            | 175 | 0.004          | 4.20            | 0.250                | 145 | 0.003          | 2.61            | 0.250                |
|          | 3.000                      | 80             | 5         | 340                        | 0.008          | 13.60           | 0.250                | 275  | 0.0065         | 8.94            | 0.250                            | 165 | 0.009          | 7.43            | 0.250                            | 150 | 0.004          | 3.00            | 0.250                | 120 | 0.003          | 1.80            | 0.250                |
|          |                            |                | 8         | 340                        | 0.008          | 21.76           | 0.250                | 275  | 0.0065         | 14.30           | 0.250                            | 165 | 0.009          | 11.88           | 0.250                            | 150 | 0.004          | 4.80            | 0.250                | 120 | 0.003          | 2.88            | 0.250                |
|          | 4.000                      | 100            | 7         | 255                        | 0.008          | 14.28           | 0.250                | 205  | 0.0065         | 9.33            | 0.250                            | 125 | 0.009          | 7.88            | 0.250                            | 110 | 0.004          | 3.08            | 0.250                | 90  | 0.003          | 1.89            | 0.250                |
|          |                            |                |           |                            |                |                 |                      |      |                |                 |                                  |     |                |                 |                                  |     |                |                 |                      |     |                |                 |                      |

# High Speed Machining Guide

## Machining Tips

- Use Z-Level climb cutting for roughing operations.
- Use Helical for material engagement whenever possible for material entry (See Helical chart for ramp angles and arc limits depending on tool dia.).
- Add radiuses larger than cutter to corner of tool path for smooth operation.
- LDR should always be as short as possible.
- LDR of 4xD or less use chart on reverse side.
- LDR of 6xD to 10xD reduce spindle speed by 35% and feed rate by 25% to get started.
- LDR of 10xD and over reduce RPM by 50% and depth of cut by 65% to get started. **Machining is very difficult over 10xD.**
- Leave extra stock for semi-finishing to prevent gouging of surface when using long reach tools.
- Use air or oil mist for all applications except those involving gummy or sticky materials such as stainless, which machines well with water based coolant.



Corner Rounding on Tool Path

## Formulas

$$\text{RPM} = (3.82 \times \text{SFM}) / \text{Tool Diameter}$$

$$\text{SFM} = 0.262 \times \text{RPM} \times \text{Tool Diameter}$$

$$\text{IPM} = \text{RPM} \times \# \text{ Flutes} \times \text{Chip Load}$$

$$\text{Chip Load} = \text{IPM} / (\text{RPM} \times \# \text{ Flutes})$$

## Depth of Cut

Adjusting depths of cuts based on LDR (Length Diameter Ratio)

### Axial Depths of Cuts

- Depth of cut should be reduced by 5% per increment of LDR.

### Radial Depths of Cuts

- This cutter performs best with step over amounts up to 20% of cutter diameter. Larger amounts will result in less stability and reduce performance overall.

## Diagnosing Problems

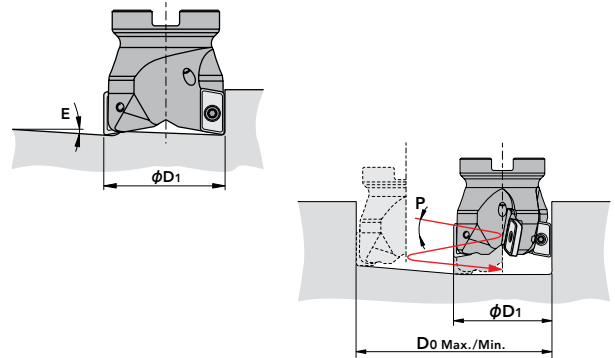
**Insert Chipping** - early during use means chip load too high, please reduce feed rate in increments of 20% until problem is resolved or shorten the length of the tool.

**Insert Burning** - of coating or glowing at the tip means RPM is too high. Reduce RPM by 20% increments until problem is resolved along with feed rate until excessive heat is subdued.

**Chatter** - excessive tool length is a primary cause. After reducing tool length if possible, lower RPM and feed rate until chatter is minimized.

## Maximum Helical Ramping Angle

| Insert Size | ZDKT11          |               |                        |               | ZDKT15        |                        |               |      |
|-------------|-----------------|---------------|------------------------|---------------|---------------|------------------------|---------------|------|
|             | Diameter (Inch) | Ramping Angle | Helical Milling (Inch) | Helical Angle | Ramping Angle | Helical Milling (Inch) | Helical Angle |      |
| 0.625       | 10.8            | 0.709         | 1.142                  | 9.5           | -             | -                      | -             | -    |
| 0.750       | 9.8             | 1.181         | 1.457                  | 7.0           | -             | -                      | -             | -    |
| 1.000       | 7.5             | 1.575         | 1.850                  | 4.5           | 9.5           | 1.457                  | 1.889         | 7.5  |
| 1.250       | 4.8             | 2.087         | 2.402                  | 3.2           | 6.8           | 1.850                  | 2.441         | 5.0  |
| 1.500       | 2.9             | 2.835         | 3.031                  | 2.2           | 5.1           | 2.480                  | 3.071         | 3.2  |
| 2.000       | 2.2             | 3.661         | 3.858                  | 1.7           | 2.5           | 3.386                  | 3.858         | 2.5  |
| 2.500       | 1.8             | 4.646         | 4.843                  | 1.5           | 2.5           | 4.370                  | 4.882         | 1.5  |
| 3.000       | 1.4             | 5.984         | 6.181                  | 1.0           | 2.0           | 5.787                  | 6.220         | 1.3  |
| 4.000       | -               | -             | -                      | -             | 1.5           | 7.480                  | 7.795         | 1.1  |
| 5.000       | -               | -             | -                      | -             | 0.9           | 9.449                  | 9.764         | 0.9  |
| 6.000       | -               | -             | -                      | -             | 0.7°          | 11.488                 | 11.921        | 0.6° |



## Recommended Materials by Application

| Insert Grade | Chip Breaker | Coolant | Carbon Steels | Stainless Steels | Cast Irons | Non-Ferrous | Hi-Temp Alloys | Hardened Steels |
|--------------|--------------|---------|---------------|------------------|------------|-------------|----------------|-----------------|
|              |              |         | P             | M                | K          | N           | S              | H               |
| CK010        | NM           | Yes     |               |                  |            | ⊙           |                |                 |
| XP3035       | GL           | -       | ⊙             | ○                | ○          |             |                |                 |
|              | GM           |         |               |                  |            |             |                |                 |
| XP2040       | GR           | Yes     |               | ⊙                |            |             | ○              | ⊙               |
|              | GL           |         |               |                  |            |             |                |                 |
| XC1015       | GM           | -       |               |                  | ⊙          |             |                |                 |
|              | GR           |         |               |                  |            |             |                |                 |
| XC5035       | SM           | -       |               | ⊙                |            |             |                | ○               |
|              |              | Yes     |               |                  |            |             |                |                 |
| XC5040       | SM           | Yes     |               | ○                |            | ○           |                | ○               |
| XP6015       | HR           | -       | ○             |                  | ○          |             |                | ⊙               |

GL: Light Cutting GM: Medium Cutting GR: Heavy Cutting NM: Aluminum SM: Heat Resistant Alloy HR: Hardened Steel

○ good ⊙ best

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