CVD Coated Turning Inserts for Stainless Steel

- **Increased Productivity**
  Extended tool life at high speeds, feeds, and depths of cut

- **Comprehensive Use**
  A wide grade lineup for most workpiece sizes and types, including heavy interruption (NC9115/NC9125/NC9135)

- **Solutions for Most Common Issues in Stainless Steel Machining**
  Prevents built-up edge, notch wear, plastic deformation, and burr creation
Stainless steels can be roughly divided into three types - the austenite, the martensite and the ferrite. They feature smooth surfaces and excellent corrosion resistance. Their use typically requires no need for surface paints or colors. The most commonly used stainless steels are high hardness types such as 13Cr, 18Cr, 18Cr-8Ni, etc.

The reason Stainless Steel is often considered a hard-to-cut material is its large shearing resistance that can easily cause work hardening, built-up edges, and edge fracture. Its combination of tough and hard material characteristics require the prudent selection of grades and chip breakers. These challenges led KORLOY to develop the CVD coated turning grade series, NC9115 / NC9125 / NC9135 along with new chip breakers MM (for medium cutting) and RM (for roughing). The NC9100 Series can solve most Stainless Steel machining problems with its combination of three layers – the top coat protects against welding, the coating layers protect against wear even at high speeds over 150m/min, and the tough substrate against chipping.

The MM chip breaker for medium cutting is the 1st recommended for stainless steel. Its dual angle land design allows for both sharp cutting performance and strong cutting edges, which promotes extended tool life and minimized cutting force and built-up edge. In addition, wide chip pockets prevent chips from interrupting the minor cutting edges and instead lets the chips out of the cutting area. These chip breaker features help prevent plastic deformation and excessive wear.

The RM chip breaker for roughing is recommended in rough machining and in cases where burrs are an issue. It has a wide land and rake angle lowering cutting resistance. Cutting heats can flow around the gentle slope of rake surface and can be effectively dispersed and evacuated at high feeds and high depths of cut.

**Advantages**
- Solving the four main issues in stainless steel machining
  - Prevents built-up edge, notch wear, plastic deformation, and burrs
- Stable tool life at high speeds, feeds, and depths of cut
  - In case of STS316, high speeds available over 150m/min
  - High chip removal rate for higher productivity
  - Shortened cutting time due to higher cutting conditions
- Ideal combination of grade and chip breaker
  - Stable tool life
  - Applicable to a wide range of applications from roughing to finishing
- Versatile applications for different workpiece materials
  - Machining of various workpieces such as austenitic, martensitic and ferritic stainless steel

**NC9100 Series**
- Can solve most Stainless Steel machining problems
- Combination of three layers
  - Top coat protects against welding
  - Coating layers protect against wear at high speeds
  - Tough substrate against chipping

**Chip Breakers**
- **MM** for medium cutting
  - Dual angle land design
  - Extended tool life
  - Minimized cutting force and built-up edge
  - Wide chip pockets prevent interruptions
- **RM** for roughing
  - Wide land and rake angle
  - Lowering cutting resistance
  - Cutting heats effectively dispersed and evacuated
Common Problems when Machining Stainless Steel

- Sheared chips impact cutting edges repeatedly and cause edge damage.
- Difficult chip breakage leads to built-up edge, work hardening, and promotes excessive notch wear.

1. Built-up edge
2. Notch wear

NC9100 Series (NC9115/NC9125/NC9135) Development

- Excellent coating film for medium/rough turning of stainless steel
- Optimized substrate for different cutting speeds, feeds, and degrees of interruption

Development Effects

1. Inhibited built-up edge and blade damage
2. Inhibited notch wear and relief surface wear
## MM Chip Breaker (For medium cutting)

- The 1st recommended chip breaker for stainless steel machining
- Sharp cutting performance and insert toughness achieved by the use of a dual land
- Wide chip pockets for stable chip evacuation at high feeds/deptths of cut

### MM Chip Breaker Features

#### Variable Land
- Excellent chip control and sharp cutting at low depths of cut
- Delays crater wear
- Prevents plastic deformation

#### Dual Land
- Balance between requirements of sharp and tough cutting edges
- Sharp cutting edge for high speed machining
- Prevents chipping in interrupted machining

#### Wide Chip Pocket
- Stable chip evacuation at high speeds/feeds
- Improved surface finishes by reduced workpiece scratches caused by work-hardened chips at high depths of cut
- Prevents built-up edge

#### Low Cutting Force at 100° corner
- 100° corner angle is recommended for roughing outer diameters and preventing burrs
- Reduced cutting load for high feed machining

### Application Range

#### Continuous cutting
- Workpiece range:
  - P: Steel
  - M: Stainless Steel
  - K: Cast iron

#### General cutting
- Application range:
  - F: Finish
  - M: Medium
  - R: Rough

### Recommended Cutting Range

#### Medium Cutting
- Depth of cut, ap (mm): 0.5 to 5.5
- Feed, fn (mm/rev): 0.12 to 0.45

#### Rough Cutting
- Depth of cut, ap (mm): 3.0 to 5.5
- Feed, fn (mm/rev): 0.25 to 0.45

### Recommended Cutting Conditions

<table>
<thead>
<tr>
<th>Application</th>
<th>Chip breaker</th>
<th>Depth of cut, ap (mm)</th>
<th>Feed, fn (mm/rev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium cutting</td>
<td>MM</td>
<td>Min. 0.5 Rec. 3.0 Max. 5.5</td>
<td>Min. 0.12 Rec. 0.25 Max. 0.45</td>
</tr>
</tbody>
</table>
RM Chip Breaker (For rough cutting)

- The 1st recommended chip breaker for rough and interrupted machining of stainless steel
- Prevents notch wear and burrs at high feeds and depths of cut
- Reduced cutting force extends tool life in high feed machining

RM Chip Breaker Features

**Variable Land**
- Excellent chip control and sharp cutting at low depths of cut
- Delays crater wear
- Prevents plastic deformation

**Wide Land & Gentle Front Angle**
- Sharp cutting edges and wide land reduce cutting force
- Reduced burrs
- Dispersed cutting load enables higher toughness

**Stepped Design**
- Stepped design makes chip evacuation easier
- Smooth chip evacuation prevents plastic deformation

**Low Cutting Force at 100° corner**
- 100° corner angle is recommended for roughing outer diameters and preventing notch wear
- Stepped design reduces cutting load

### Application Range

<table>
<thead>
<tr>
<th>Continuous cutting</th>
<th>General cutting</th>
<th>Interrupted cutting</th>
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<tbody>
<tr>
<td>Workpiece range</td>
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<tr>
<td>P : Steel</td>
<td>MM NC9115</td>
<td>MM NC9115</td>
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<tr>
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<td>K : Cast iron</td>
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<td>RM NC9125</td>
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<tr>
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<td>RM NC9135</td>
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<tr>
<td>F : Finish</td>
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<td>M : Medium</td>
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<td>R : Rough</td>
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</table>

### Recommended Cutting Range

![Diagram of recommended cutting range](image)

### Recommended Cutting Conditions

<table>
<thead>
<tr>
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<th>Chip breaker</th>
<th>Recommended Cutting conditions</th>
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<tr>
<td>Rough cutting</td>
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<td>Feed, fn (mm/rev)</td>
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<td>Min.</td>
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<td>2.0</td>
<td>4.0</td>
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</table>
### Cutting Performance

#### Built-up edge
- **Workpiece**: X6CrAl13 (Ferrite)
- **Cutting conditions**: \( vc(m/min) = 180 \), \( fn(mm/rev) = 0.3 \), \( ap(mm) = 3.0 \), wet
- **Tools**: Insert CNMG120408-MM (NC9125)  
- **Holder**: PCLNL2525-M12

#### Notch wear
- **Workpiece**: X12Cr13 (Martensite)
- **Cutting conditions**: \( vc(m/min) = 150 \), \( fn(mm/rev) = 0.25 \), \( ap(mm) = 3.0 \), wet
- **Tools**: Insert CNMG120408-RM (NC9115)  
- **Holder**: PCLNL2525-M12

#### Plastic deformation
- **Workpiece**: X5CrNiMo17-12-2 (Austenite)
- **Cutting conditions**: \( vc(m/min) = 200 \), \( fn(mm/rev) = 0.35 \), \( ap(mm) = 2.0 \), dry
- **Tools**: Insert CNMG120408-MM (NC9135)  
- **Holder**: PCLNL2525-M12

#### Burr
- **Workpiece**: Duplex
- **Cutting conditions**: \( vc(m/min) = 120 \), \( fn(mm/rev) = 0.2 \), \( ap(mm) = 2.0 \), dry
- **Tools**: Insert CNMG120408-RM (NC9125)  
- **Holder**: PCLNL2525-M12

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- A gentle slope of MM chip breaker minimizes built-up edge
- Improved surface finish and chip control from inhibited built-up edges
- A wide land and rake angle of RM chip breaker disperse cutting loads and prevents notch wear
- Improved surface finish and reduced burrs by preventing notch wear
- The MM chip breaker promptly dissipates the concentrated cutting edge heat to prevent plastic deformation during machining
- Less vibration and cutting load due to reduced plastic deformation
- The wide land and rake angle of the RM chip breaker improves cutting performance and prevents burrs
- Improved chip control improves surface finish and extends tool life
### Recommended Grade and Chip Breaker per Stainless Steel Type

#### Austenitic Stainless Steel
- Heavy work hardening (Edge chipping accelerates wear)
- Poor heat conductivity (Three times lower than carbon steel → Increase in cutting area temperature)
- High ductility (Strong chance for deformation at high temperature → Long chips or tough chips occurs)
- Type: X10CrNiS18-9, X5CrNi18-9, X50NiMo17-12-2 etc.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cutting speed (m/min)</th>
<th>Continuous</th>
<th>Low interrupted</th>
<th>High interrupted</th>
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<tr>
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<tr>
<td>NC9125</td>
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<td>MM / RM / RM</td>
<td>RM</td>
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<tr>
<td>NC9135</td>
<td></td>
<td></td>
<td>MM / RM / RM</td>
<td>RM</td>
</tr>
</tbody>
</table>

#### Ferritic / Martensitic Stainless Steel
- Strong chance for work hardening at high temperature (Crater wear is promoted)
- High toughness through tempering and annealing (Long chips are easily created)
- High carbon contents increase its hardness
- Type: X20Cr13, X12Cr13, X12CrS13, X70CrMo15 etc.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cutting speed (m/min)</th>
<th>Continuous</th>
<th>Low interrupted</th>
<th>High interrupted</th>
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<tr>
<td>NC9115</td>
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<tr>
<td>NC9125</td>
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<tr>
<td>NC9135</td>
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<td></td>
<td>MM / RM / RM</td>
<td>RM</td>
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</table>

#### Duplex Stainless Steel
- Its presence of both austenitic and ferritic fine matrix requires both types of cutting characteristics for each material's attribute.
- One of the most hard to cut stainless steels as its higher yield strength makes chip control harder than the Austenite
- Type: FeM35Cr20Cu4Mo2*, X2CrNiMoN22.5.3*, X2CrNiMoN25.7.4*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cutting speed (m/min)</th>
<th>Continuous</th>
<th>Low interrupted</th>
<th>High interrupted</th>
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<tr>
<td>NC9115</td>
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<td>MM / RM</td>
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<tr>
<td>NC9125</td>
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<tr>
<td>NC9135</td>
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<td>MM / RM / RM</td>
<td>RM</td>
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</tbody>
</table>

* Germany [DIN]

#### Precipitation Hardened(PH) Stainless Steel
- High tensile strength (2 times higher than other stainless steels) increases cutting load
- Low heat conductivity cause cutting edge damage from high temp chips
- Type: X5CrNiCuNb16-4, X7CrNiAl17-7

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cutting speed (m/min)</th>
<th>Continuous</th>
<th>Low interrupted</th>
<th>High interrupted</th>
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<td>NC9125</td>
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<td>NC9135</td>
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<td>MM / RM / RM</td>
<td>RM</td>
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</tbody>
</table>
The NC9100 Series CVD coated grades are differentiated from PVD grades by their application range.

Compared to PVD coated grades with similar substrates, CVD coated ones have longer tool life over the PVD, in large scale rough machining at high speeds or in high temperature conditions.

The NC9115/NC9125/NC9135 grades are provided according to the degree of interruption or vibration during machining.

### Turning Grade Comparison Chart for Stainless Steel

<table>
<thead>
<tr>
<th>ISO</th>
<th>KORLOY</th>
<th>Competitor A</th>
<th>Competitor B</th>
<th>Competitor C</th>
<th>Competitor D</th>
<th>Competitor E</th>
<th>Competitor F</th>
<th>Competitor G</th>
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<tr>
<td>M15</td>
<td>NC9115</td>
<td>TT9215</td>
<td>GC2015</td>
<td>CA6515</td>
<td>MC7015</td>
<td>TM2000</td>
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<td>GC235</td>
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<td>US735</td>
<td>-</td>
<td>WAM30</td>
<td>AC630M</td>
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### Turning Chip Breaker Comparison Chart for Stainless Steel (Negative type)

<table>
<thead>
<tr>
<th>Application</th>
<th>KORLOY</th>
<th>Competitor A</th>
<th>Competitor B</th>
<th>Competitor C</th>
<th>Competitor D</th>
<th>Competitor E</th>
<th>Competitor F</th>
<th>Competitor G</th>
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<tbody>
<tr>
<td>Rough cutting</td>
<td>RM</td>
<td>GS</td>
<td>ET</td>
<td>MR</td>
<td>MU</td>
<td>RM</td>
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<td>MM</td>
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<td>NM4</td>
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<td>Finish cutting</td>
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<td>MF</td>
<td>-</td>
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<td>MF1</td>
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### Turning Chip Breaker Comparison Chart for Stainless Steel (Positive type)

<table>
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<th>Application</th>
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<th>Competitor A</th>
<th>Competitor B</th>
<th>Competitor C</th>
<th>Competitor D</th>
<th>Competitor E</th>
<th>Competitor F</th>
<th>Competitor G</th>
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<tr>
<td>Medium cutting</td>
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<td>PC, MT</td>
<td>MM</td>
<td>HQ</td>
<td>MV</td>
<td>MF2</td>
<td>PS5</td>
<td>MU</td>
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<tr>
<td>Finish cutting</td>
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<td>FA</td>
<td>MF</td>
<td>MQ</td>
<td>FV</td>
<td>FF1</td>
<td>PF4</td>
<td>SU</td>
</tr>
</tbody>
</table>
### Application Examples

#### Hydraulics part (Mechanical seal)

- **Workpiece**: X5CrNi18-9
- **Cutting conditions**: 
  - vc(m/min) = 140, fn(mm/rev) = 0.28, ap(mm) = 3.0, wet
- **Tools**: 
  - Insert: CNMG120408-MM (NC9125)
  - Holder: S32S-PCLCR-12
- **MM (NC9125)**: 9ea/edge
- **Competitor A (M25)**: 5ea/edge

- **Stable chip evacuation reduces cutting load and plastic deformation, which increases tool life 80% longer tool life than competitor A (M25)**

#### Valve part (Piston valve)

- **Workpiece**: X5CrNi18-9 (Solution treatment)
- **Cutting conditions**: 
  - vc(m/min) = 140, fn(mm/rev) = 0.28, ap(mm) = 3.0, wet
- **Tools**: 
  - Insert: CNMG120408-MM (NC9125)
  - Holder: DCLNL2525-M12
- **MM (NC9125)**: 5ea/edge
- **Competitor B (M25)**: 2ea/edge

- **Dual land design combines sharp cutting performance and high toughness in high hardness machining 150% longer tool life than competitor B (M25)**

#### Wind power/offshore plant part (Flange)

- **Workpiece**: X6CrNiNb18-10* (Outer diameter roughing)
- **Cutting conditions**: 
  - vc(m/min) = 150, fn(mm/rev) = 0.3~0.5, ap(mm) = 4.0~6.0, wet
- **Tools**: 
  - Insert: CNMG160616-MM (NC9125)
  - Holder: PCLNR3232-P16
- **MM (NC9125)**: 15ea/edge
- **Competitor C (M25)**: 10ea/edge

- **50% longer tool life than competitor C (M25)**

#### Wind power/offshore plant part (Flange)

- **Workpiece**: X6CrNiNb18-10* (Inner diameter finishing)
- **Cutting conditions**: 
  - vc(m/min) = 175, fn(mm/rev) = 0.45, ap(mm) = ~1.0, wet
- **Tools**: 
  - Insert: SNMG190616-MM (NC9125)
  - Holder: S50U-PCLCR-19
- **MM (NC9125)**: 12ea/edge
- **Competitor D (M25)**: 8ea/edge

- **50% longer tool life than competitor D (M25)**

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* Germany [DIN]
Application Examples

Wind power plant part (Flange)
- Workpiece: X5CrNiMo17-12-2
- Cutting conditions: \(v_c (\text{m/min}) = 175\), \(f_n (\text{mm/rev}) = 0.3\text{~}0.8\), \(a_p (\text{mm}) = 0.5\), wet
- Tools:
  - Insert: TNMG220416-RM (NC9135)
  - Holder: PTFN3232-P22

RM (NC9135)
- Number of edges: 5

Competitor E (M35)
- Number of edges: 2

150% more

Extended tool life from improved chipping resistance and reduced built-up edge
150% longer tool life than competitor E (M35)

Plant part (Flange)
- Workpiece: Super Duplex
- Cutting conditions: \(v_c (\text{m/min}) = 100\), \(f_n (\text{mm/rev}) = 0.5\), \(a_p (\text{mm}) = 3\), wet
- Tools:
  - Insert: CNMG160616-MM (NC9125)
  - Holder: PCLN3232-P16

MM (NC9125)
- Number of edges: 12

Competitor F (M25)
- Number of edges: 8

50% more

Extended tool life from inhibited wear and chipping
50% longer tool life than competitor F (M25)

Hydraulics part
- Workpiece: Duplex
- Cutting conditions: \(v_c (\text{m/min}) = 120\), \(f_n (\text{mm/rev}) = 0.4\), \(a_p (\text{mm}) = 6\), wet
- Tools:
  - Insert: CNMG160616-RM (NC9125)
  - Holder: DCLN3232-P16

RM (NC9125)
- Number of edges: 7

Competitor G (M25)
- Number of edges: 5

40% more

Improved blade stability compared to competitor’s
40% longer tool life than competitor G (M25)

Machinery part
- Workpiece: X5CrNi18-9
- Cutting conditions: \(v_c (\text{m/min}) = 180\), \(f_n (\text{mm/rev}) = 0.4\), \(a_p (\text{mm}) = 1.5\), wet
- Tools:
  - Insert: CNMG120408-MM (NC9125)
  - Holder: DCLN2525-M12

MM (NC9125)
- Number of edges: 6

VM (PC9030)
- Number of edges: 3

100% more

Extended tool life from superior resistance to built-up edge and wear compared to PC9030
100% higher productivity than PC9030 under higher cutting conditions
### Available Stock [Negative type]

<table>
<thead>
<tr>
<th>Insert shape</th>
<th>Designation</th>
<th>Application</th>
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### Available Stock [Positive type]

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**Note:**
- Available Stock [Negative type] and Available Stock [Positive type] columns are separated for clarity.
- Stock levels are indicated by ● ● ●, with the stock levels for NC9115, NC9125, and NC9135 varied accordingly.
- Insert shape and designation are provided for each type of cutting, including designation, stock, and application.
- The table format is used throughout to organize the information efficiently.