# LIST OF PUBLICATION

## Publication Details

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<th>No. of Co-Authors if any</th>
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<td>Experimental Investigation of Machining parameter in hard Turning using Taguchi Method</td>
<td>International Journal of Futuristic Trends in Engineering and Technology (ISSN: 2348-5264 (Print), International)</td>
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International Journal Papers


# APPENDIX-I CNC MACHINE REPORT

**Inspection report**

## Cutting test

Spindle power: 9/13.5 KW  
Pulley ratio: 1:2  
Material: Mid Steel  
Dimensions: Ø80 X 125mm

### (1) Turning:  
Tool: 5WN-225M-08  
WINMG08508

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Tool: 175LX3-3109

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Tool: 5WN-225M-08  
WINMG08508

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### CHECKED BY
Name: CHANDRESH  
Date: 20/8/2015
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- Tool: TBI 2525 STW

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- Tool: AI-295

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- Tool: DR-039-BB-12-2-2017

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CHECKED BY: Chandresh
Date: 20/8/2015
### External Threading

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### Lacing

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<td>50</td>
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</tr>
<tr>
<td>2</td>
<td>45/47</td>
<td>120</td>
<td>0.1</td>
<td>1200</td>
<td>50</td>
<td>500</td>
<td>Guide ok</td>
</tr>
<tr>
<td>3</td>
<td>45/47</td>
<td>120</td>
<td>0.1</td>
<td>1200</td>
<td>50</td>
<td>500</td>
<td>Guide ok</td>
</tr>
<tr>
<td>4</td>
<td>45/47</td>
<td>120</td>
<td>0.1</td>
<td>1200</td>
<td>50</td>
<td>500</td>
<td>Guide ok</td>
</tr>
<tr>
<td>5</td>
<td>45/47</td>
<td>120</td>
<td>0.1</td>
<td>1200</td>
<td>50</td>
<td>500</td>
<td>Guide ok</td>
</tr>
<tr>
<td>6</td>
<td>45/47</td>
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<td>1200</td>
<td>50</td>
<td>500</td>
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<tr>
<td>7</td>
<td>45/47</td>
<td>120</td>
<td>0.1</td>
<td>1200</td>
<td>50</td>
<td>500</td>
<td>Guide ok</td>
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### Hard part turning

<table>
<thead>
<tr>
<th>ZDEDA (mm)</th>
<th>Cutting Speed (m/Min)</th>
<th>Feed (mm/rev)</th>
<th>Actual Rpm</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>150</td>
<td>0.15</td>
<td>270</td>
<td>✔️</td>
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</tbody>
</table>
### Accuracy

#### Practical Tests

<table>
<thead>
<tr>
<th>Diagram</th>
<th>Test to be Applied</th>
<th>Measuring Instrument</th>
<th>Reference Standard</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notes
- M1: Machine with a worn tool.; Check: interferes with the following items:
  - 4.5 to 6.5 mm check slot element, or
  - With maximum setting limit.
- M2: Machine with a worn tool.; Check: interferes with the following items:
  - 4.5 to 6.5 mm check slot element, or
  - With maximum setting limit.

**Prepared By:** CHANDRABHAN KANDEKAR
**Date:** 20/03/2014

---

#### Checking the circular deviation of a 100° arc on a test piece

- Circular deviation: 0.025
- Observation: Ok
- Measuring instrument: Coordinate measuring machine (CMM), Profile projector

**Prepared By:** CHANDRABHAN KANDEKAR
**Date:** 20/03/2014
Surface roughness tester

Portable Surface Roughness Tester
Surftest SJ-210

The new Surftest® SJ-210 portable surface roughness tester combines high accuracy and measurement speed with numerous innovative features creating a new class leader in surface inspection.

- 2.4” color LCD display includes backlighting and over-size fonts
- Display direction can be changed to be read vertically or horizontally right and left-handed
- Color tolerance judgments, evaluation curves and all data can be displayed in one of 16 languages
- Self-timed measurement supported
- Security management supports password protected function locks

Mitutoyo
Precision in our Professions
A micro SD card supports high-volume portable data storage - up to 10,000 results can be stored

Optional footswitch can be used for touch-free measurement

Multiple output options include RS-232C and USB for maximum versatility

### Main specifications

<table>
<thead>
<tr>
<th>Model No.</th>
<th>52-219</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch No.</td>
<td>578-381-02A</td>
</tr>
</tbody>
</table>

**Measuring range**
- [0 to +10 mm]
- Resolution: 0.001 mm
- Accuracy: ±0.005 mm at 23°C

**Measuring speed**
- Measuring: 0.05 mm/s to 100 mm/s
- Retracting: 0.5 mm/s

**Detector**
- Resolution: 0.001 mm
- Minimum range: 100 microns
- Measured profile accuracy: ±0.01 mm at 100 microns

**Display unit**
- Graphical format: bar graph, line graph, trend graph

**Coordinate Measuring Machines**

**Vision Measuring Systems**

**Form Measuring**

**Optical Measuring**

**Sensor Systems**

**Test Equipment and Inspection Equipment**

**Digital-Scale and DRO Systems**

**Small Tool Instruments and Data Management**

**Mitutoyo America Corporation**

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One Number to Serve You Better

1-888-MITUTOYO (1-888-646-6869)

Mitutoyo: Precision is our Professional

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3716-08 Printed in USA, Jan. 2010

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APPENDIX–III COOLANT USE FOR EXPERIMENT

Mobilcut Series
Soluble cutting fluids for precision machining

Mobil

Mobilcut Series water soluble cutting fluids are designed to help offer longer service life, have low maintenance requirements, and be suitable for a wide range of materials and operations. Offering the right balance between cooling and lubricity, Mobilcut Series aims to deliver excellent tool life and surface finish, which help reduce tooling and component rejects. Formulated to meet the latest health and safety guidelines, the products are particularly suitable for modern machine shop managers aiming to improve productivity and reduce machine downtime.

Low maintenance and easy use help lift machining productivity. Offering a long service life, Mobilcut Series helps generate less waste and improve machine tool availability—especially at critical times. The products are easy to mix and monitor, offering low maintenance costs and showing outstanding residual corrosion protection without undesirable residues. Low foaming tendencies, even under high pressure conditions, help provide trouble-free operation for modern machining operations.

Multipurpose for optimized inventory. Mobilcut Series has been developed to offer outstanding machining performance in tough operating conditions. Its wide application range means the number of products you need can be reduced, leading to product optimization, easier inventory management, and higher product turnaround. From boring, milling, and tapping on a range of alloy and carbon steels to drilling, reaming, and grinding on low carbon and alloy steels and nonferrous metals, Mobilcut Series can be used equally in individual machine tools or in centralized systems.

Compatibility with other Mobil lubricants can mean greater efficiency. Mobilcut Series soluble oils are designed to be compatible with Mobil Vacola Oil Numbered Series slideway oils and Mobil DTE Series hydraulic oils, providing a suite of products to help keep your machine tools running at maximum efficiency.

High Performance Benefits

Excellence rust and corrosion protection
Add long-term protection of machine tools and component parts, solving rejection and rust issues.

Suitability for multiple applications
Helps reduce inventory and misapplications.

Increased machining performance
Helps decrease tooling changes and regrinds while maintaining excellent surface finish.

Chlorine-free
Meets latest environmental standards, helping to reduce disposal costs.
Mobilcut Series — Summary

Product Line

<table>
<thead>
<tr>
<th>Example</th>
<th>Type</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Mobilcut 100</td>
<td>Conventional metal...</td>
<td>Conventional metal suitable at... Multiple...</td>
</tr>
<tr>
<td>Mobilcut 140</td>
<td>Long-life...</td>
<td>High performance, long-life... Designed for...</td>
</tr>
<tr>
<td>Mobilcut 210</td>
<td>Multipurpose...</td>
<td>High performance, multi-purpose... Recommended...</td>
</tr>
<tr>
<td>Mobilcut 250</td>
<td>Multipurpose...</td>
<td>High performance, multi-purpose... Recommended...</td>
</tr>
<tr>
<td>Mobilcut 240</td>
<td>Multipurpose...</td>
<td>High performance, multi-purpose... Recommended...</td>
</tr>
<tr>
<td>Mobilcut 290</td>
<td>Multipurpose...</td>
<td>Versatile cutting fluid for... Recommended...</td>
</tr>
<tr>
<td>Mobilcut 350</td>
<td>Full synthetic...</td>
<td>Fully synthetic metal cutting fluid... Recommended...</td>
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Recommended Concentrations

<table>
<thead>
<tr>
<th></th>
<th>Low-moly/...</th>
<th>Medium/...</th>
<th>High-moly/...</th>
<th>General/moly...</th>
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</thead>
<tbody>
<tr>
<td>Mobilcut 100</td>
<td>5-10%</td>
<td>5-10%</td>
<td>5-10%</td>
<td>3-5%</td>
</tr>
<tr>
<td>Mobilcut 140</td>
<td>4-5%</td>
<td>6-10%</td>
<td>6-10%</td>
<td>4-6%</td>
</tr>
<tr>
<td>Mobilcut 210</td>
<td>4-5%</td>
<td>6-10%</td>
<td>6-10%</td>
<td>4-6%</td>
</tr>
<tr>
<td>Mobilcut 230</td>
<td>4-5%</td>
<td>5-10%</td>
<td>4-6%</td>
<td>4-6%</td>
</tr>
<tr>
<td>Mobilcut 240</td>
<td>4-5%</td>
<td>6-10%</td>
<td>4-6%</td>
<td>4-6%</td>
</tr>
<tr>
<td>Mobilcut 250</td>
<td>6-10%</td>
<td>6-10%</td>
<td>5-10%</td>
<td>3-5%</td>
</tr>
<tr>
<td>Mobilcut 320</td>
<td>4-5%</td>
<td>6-10%</td>
<td>4-6%</td>
<td>4-6%</td>
</tr>
</tbody>
</table>

Soluble Fluids Care and Maintenance Advises

1. Add the concentrate to the water — not water to concentrate. Use fresh mixed product ratio.
2. Monitor and record constant concentrations and conditions regularly, and take the necessary corrective measures if necessary.
3. Keep systems clean by avoiding adding contaminants.
4. Store at room temperature.
5. Ensure all base-oils, oil, additives, and other machine tools are kept at recommended levels ensuring the cleanliness of hydraulic oil contamination.
6. Do not use water from recycled sources, such as the hose, pump, header tank, etc.
7. Do not use cleaner to strip filters. Use other cleaners and follow the specified cleaning procedures carefully.
8. Do not store machines full of coolant for extended periods, particularly in room environments with humidity.
9. Do not prepare products in dirty or contaminated conditions.
10. Do not add any water to the water. Always use diluted emulsion.

Application Guide

For more information on these and other Mobil industrial lubricants and services, please contact the Technical Helpdesk on TechDesk@eu.mobil.com or visit our website at www.mobilindustrial.com
### TEST REPORT

**TEST REPORT No.:** ELTL/0179974  
**DATE OF ISSUE:** 26/01/2017

**REPORT ISSUED To:** Jaydeep Dashaniya  
**SAMPLE COLLECTED BY:** Self  
**SAMPLE IDENTITY:** CRG Cutting Oil (before Use)

### BRAND NAME

- Not Mentioned

### DECLARED VALUE

- ND

### QUANTITY

- 500 ml

### TESTS & RESULTS

<table>
<thead>
<tr>
<th>SI No.</th>
<th>TESTS</th>
<th>TEST METHOD</th>
<th>UNIT</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Viscosity (Spin 61)</td>
<td>By Bruckfield Viscometer</td>
<td>Cp</td>
<td>4.40</td>
</tr>
<tr>
<td>2</td>
<td>pH</td>
<td>Electrometric method</td>
<td>—</td>
<td>6.96</td>
</tr>
</tbody>
</table>

### QUALITATIVE & QUANTITATIVE TEST

- 1. This report, in full or in part, shall not be published, advertised, used for any legal action, unless prior permission has been secured from The Director, ENVITRO LABORATORIES, RAJKOT.
- 2. The test report pertains to the sample tested.
- 3. Sample not drawn by us.

**Approved By:**  
**Tested By:**  
**Authorized Signatory:**
## TEST REPORT

**TEST REPORT No.**: 8LYL419980077  
**DATE OF ISSUE**: 26/01/2017

**REPORT ISSUED TO**: Jaydeep Padihariya  
**SAMPLE COLLECTED BY**: Self  
**SAMPLE Identity**: CNC Cutting Oil (After Use)

<table>
<thead>
<tr>
<th>BRAND NAME</th>
<th>QUANTITY</th>
<th>DECELERED VALUE</th>
<th>DATE OF RECIPIENT</th>
<th>DATE OF START ANALYSIS</th>
<th>DATE OF COMPLETION OF ANALYSIS</th>
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<tr>
<td>Not Mentioned</td>
<td>500 ml</td>
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<td>23/01/2017</td>
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### QUALITATIVE & QUANTITATIVE TEST

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<th>TEST METHOD</th>
<th>UNIT</th>
<th>RESULTS</th>
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</thead>
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<td>50</td>
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<td>2</td>
<td>pH</td>
<td>Electrometric method</td>
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<td>7.14</td>
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</table>

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1. This report, in full or in part, shall not be published, advertised, used for any legal action, unless
   prior permission has been secured from The Director, ENVITRO LABORATORIES, RAJKOT.
2. The test report pertains to the sample tested.
3. Sample not drawn by us.

Approved By:

Tested By:

Authorized Signatory
APPENDIX–IV MACHINING PARAMETERS

Feed and speed for tool materials
<table>
<thead>
<tr>
<th>Workpiece Material</th>
<th>Cutting Tool</th>
<th>General-Purpose Starting Conditions</th>
<th>Range for Roughing and Finishing</th>
<th>Cutting Speed, mm/min</th>
<th>Cutting Speed, mm/min</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Depth of Cut, mm</td>
<td>Feed, m/m</td>
<td>Cutting Speed, m/min</td>
<td>Depth of Cut, mm</td>
</tr>
<tr>
<td>Law-C and free machining steels</td>
<td>Uncarburized</td>
<td>1.5-6.3 (0.06-0.25)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<tr>
<td></td>
<td>Carborundum coated carbide</td>
<td>4.5-3.5 (0.04-0.13)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<tr>
<td></td>
<td>Triplex-carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>TN-coated carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<tr>
<td></td>
<td>Al2O3 ceramic</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>Cermet</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<tr>
<td>Medium and high-C steels</td>
<td>Uncarburized</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>Carborundum coated carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>Triplex-carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>TN-coated carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>Al2O3 ceramic</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>Cermet</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<tr>
<td>Cast iron, gray</td>
<td>Uncarburized</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
</tr>
<tr>
<td></td>
<td>Carborundum coated carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
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<td></td>
<td>Triplex-carbide</td>
<td>1.5-3.0 (0.05-0.12)</td>
<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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<tr>
<td></td>
<td>Cermet</td>
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<td>0.35 (0.014)</td>
<td>90 (300)</td>
<td>0.5-7.6 (0.02-0.3)</td>
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</table>
Cutting environment for various materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Type of fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>D, MO, E, MO + FO, CSN</td>
</tr>
<tr>
<td>Beryllium</td>
<td>MC, E, CSN</td>
</tr>
<tr>
<td>Copper</td>
<td>D, E, CSN, MO + FO</td>
</tr>
<tr>
<td>Magnesium</td>
<td>D, MO, MO + FO</td>
</tr>
<tr>
<td>Nickel</td>
<td>MC, E, CSN</td>
</tr>
<tr>
<td>Refractory</td>
<td>MC, E, EP</td>
</tr>
<tr>
<td>Steels (carbon and low alloy)</td>
<td>D, MO, E, CSN, EP</td>
</tr>
<tr>
<td>Steels (stainless)</td>
<td>D, MO, E, CSN</td>
</tr>
<tr>
<td>Titanium</td>
<td>CSN, EP, MO</td>
</tr>
<tr>
<td>Zinc</td>
<td>C, MC, E, CSN</td>
</tr>
<tr>
<td>Zirconium</td>
<td>D, E, CSN</td>
</tr>
</tbody>
</table>

*Note: CSN, chemicals and synthetics; D, dry; E, emulsion; EP, extreme pressure; FO, fatty oil; and MO, mineral oil.*
Introduction

Sandvik Coromant offers a comprehensive range of products for all external and internal turning operations (CoroTurn RC/ TR/107/111), including products optimized for small part (CoroTurn/CoroCut XS), heavy duty and multi-task machining (CoroFlex).

A wide range of modern insert geometries and grades (carbide, cermet, ceramic, CSM, PCD), for all different workpiece materials, together with the modular CoroTurn SL and Coromant Capto holding system, forms the basis for productive turning solutions.

The new generation of wiper inserts (WMX), the ingenious locking interface (Lock) for positive inserts (CoroTurn IR), and the high pressure coolant technology (CoroTurn HP), are examples of innovative, new technologies for productive and trouble-free production.

Coromant Capto® is a registered trademark of Sandvik.

Trends

Machines and machining methods
- Demand for high precision
- Multi-task machining and advanced NC-control systems
- Reduction in set-up time to maximize income producing time.

Components and materials
- More complex components machined in one setup
- More high-alloyed materials are used in existing applications.
Getting started

Turning methods

This chapter will help you utilize our products to their full potential, maximizing productivity and minimizing your machining costs.

The “Getting started” section, pages A 3 – A 21, provides an overview of turning products and general recommendations about how to choose and use the tools.

Turning in different materials

Insert geometry, grade and machining recommendations for different types of steels, stainless, cast irons, aluminiums, heat resistant alloys, titanium, and hard part turning. See pages A 22 – A 45.

Turning methods

Pages A 46 – A 98 describe how to choose the right turning products for different applications, and how to apply them in the best manner to maximize productivity and avoid problems. This section is divided into three sub sections:

- External turning – longitudinal, profiling and facing
- Internal turning – longitudinal and profiling
- Dedicated methods – multi-task and small part turning

Heavy turning

Heavy turning, bar peeling and railway wheel turning are described in a separate dedicated catalogue/application guide, order No. C-1002.3. Contact your local Sandvik Coromant representative, or order it at www.coromant.sandvik.com

Turn milling

In multi-task machines, milling can sometimes be an alternative to conventional turning. For more information, see chapter D, milling.

Choice of method

Three different areas should be considered to determine the best method and tooling solution.
Initial considerations

1. Component features
Analyze the dimensions and quality demands of the component to be machined:
- Type of operation (external or internal, e.g., longitudinal, profiling, facing).
- The operation type affects the tool choice.
- Roughing, finishing.
- Large, stable component.
- Small, long, slender, thin-walled component.
- Corner radius.
- Quality demand (tolerance, surface finish).

2. The component
After analyzing the features, it is time to look at the component:
- Does the material have good chip-breaking qualities?
- Batch size – a single component or mass production, which would justify an optimally engineered tool to maximize productivity?
- Can the component be held securely?
- Is chip evacuation a critical issue?

3. The machine
Finally, a look at some important machine considerations:
- Stability, power and torque, especially for larger components.
- Cutting fluid and coolant supply.
- Is there any need for high pressure coolant for chip-breaking in long chipping materials?
- Tool changing times/number of tools in turret.
- rpm limitations, bar feed magazine.
- Sub-spindle, or tail stock available?
- Consider ConPlex tools for use in the B-spindle.
Overview - turning programme

Insert type (basic shape)

- Negative
  - CoroTurn® HC
- Negative
  - T-Max® P lever
- Positive
  - CoroTurn® 107
- Positive
  - CoroTurn® TR
- Negative
  - CoroCut® XS
- Negative
  - CoroCut® XS

Min. hole (mm)

- 40
  - CoroTurn® SL QC
- 25
  - CoroTurn® RC
- 20
  - T-Max® P lever
- 20
  - CoroCut® 107
- 10
  - CoroCut® WC

Insert type (basic shape)

- HP
- Negative
  - CoroCut® XS
- Positive
  - CoroCut® XS

Tools, dedicated for small part machining

- Positive
  - CoroCut® 107/QS
- Positive
  - CoroCut® TR
- Positive
  - CoroCut® XS/QS

- HP
- Negative
  - CoroCut® XS
- Positive
  - CoroCut® XS

HP - Also available with high pressure coolant

Tools dedicated for small part machining:

- Positive
  - CoroTurn® MB

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Clamping T-Max® P negative basic-shaped inserts

Two systems are used for clamping negative inserts.

**CoreTurn® RC rigid clamping system**

CoreTurn RC is a top and hole clamping system, and is the first choice when stability and security are essential for productive turning of large components.

The system is mostly used for external turning, from finishing to roughing, but also for internal turning, when chip evacuation is good.

**Advantages:**
- Excellent clamping
- Easy indexing
- Good repeatability

**T-Max® P lever system**

The T-Max P lever is a hole clamping system, and is the first choice system for internal turning, when free chip flow is needed.

For external turning, the lever system is an alternative to CoreTurn RC.

**Advantages:**
- Free chip flow
- Easy indexing

Clamping of CoroTurn® positive basic-shape inserts

**CoroTurn® TR screw clamping system**

The CoroTurn TR clamping system uses positive, single-sided inserts and is the first choice system for external and internal profiling.

The interface between tool holder and insert provides a good source of stability for demanding profile turning operations.

**Advantages:**
- Secure clamping
- Free chip flow
- Good repeatability

**CoroTurn® 107 screw clamping system**

CoroTurn 107 screw clamping system uses positive, single-sided inserts with 7° clearance angles and is the first choice system for both internal and external longitudinal machining of long and slender components.

**CoroTurn® 111 screw clamping system**

Uses 11° positive inserts, and is an alternative to CoroTurn 107. It is only used in boring bars for internal turning.

**Advantages:**
- Secure clamping
- Free chip flow
General Turning – getting started

Tools dedicated for small part machining

CoreCut® XS

Screw clamping

The CoreCut XS system for small part machining uses positive, double-edged inserts and is used for external machining. Insert clamping screw with Torx Plus grip on each side.

Advantages:
• Secure clamping.
• Free chip flow.

CoreCut® MB

Screw clamping

CoreCut MB is used for internal machining. It provides secure and stable machining due to rigid front screw clamping. The CoreCut MB design has rails on the insert and corresponding slots in the tip seat.

Advantages:
• Secure clamping.
• Free chip flow.

CoreTurn® XS

Screw clamping

CoreTurn XS is used for internal machining. Locating mechanism locks the insert into the correct orientation. Guaranteed centre height every time.

Advantages:
• Secure clamping.

Tools dedicated for multi-task machining

CorePlex MT, CorePlex TT and the CorePlex SL mini-turret have been developed specifically to meet the needs and requirements of multi-task machines, i.e. turn-mill and mill-turn centres.

Advantages:
• Optimized to be used in the B-spindle
• Minimizes tool change time
• Multi-purpose, which means fewer tools in the tool magazine.
CoroTurn® HP high pressure coolant

The CoroTurn HP coolant supply technology is optional for T-Max P/CoroTurn TR and CoroTurn 107 cutting units and cutting heads. It provides very precise coolant jets directed at the cutting zone, which leads to improved chip control and tool life.

CoroTurn HP can be used at coolant pressures from 10 – 80 bars:
- Chip control and trouble-free production in all materials
- Increased cutting speed for roughing in difficult materials
- Longer tool life when roughing to finishing in difficult materials.

Tool holding selection

For best productivity and cost efficiency in both external and internal turning, we recommend the Coromant Capto system.

The Coromant Capto system offers exceptional accuracy and stability and a complete product range of index clamping systems, cutting units and adaptors.

For more information, see Tool holding/Machining, Chapter 6.

CoroTurn® SL

CoroTurn SL is a modular tool system of boring bar adaptors and exchangeable cutting heads for internal and external applications within turning, parting and grooving, and threading.

A flexible, modular system

In a CoroTurn SL bar adaptor, various types of cutting heads, in different clamping systems, can be used for turning:
- CoroTurn RC
- T-Max P liner
- CoroTurn TR
- CoroTurn 107/111
- CoroCut X5.

Choice of bar adaptors

The CoroTurn SL assortment consists of:
- Coromant Capto system and round shank bars
- Dimplied Silent Tool bars, solid steel bars and carbide re-inforced bars.
Tool maintenance

Establishing a routine for tool maintenance in the work shop will prevent problems and save a lot of money.

Check the insert seat

It is important to ensure that the insert seat has not been damaged during machining or handling.

Look for:
- Oversized pockets due to wear. The insert does not seat properly in the pocket sides. Use a 0.02 mm shim to check the gap.
- Small gaps in the corners, between the shim and the bottom of the pocket.
- Damaged shims. Shims should not have chipped corners in the cutting area.
- Wear from the chip breaking and/or impressions from the insert.

Clean the insert seat

Make sure that the insert seat is free from dust or chips from the machining. If necessary, clean the insert seat with compressed air.

If boring bars with CoroTurn SL cutting heads are used, it is also important to check and clean the coupling between the head and the bar when changing the cutting head.

Torque wrench

To get the best performance out of each insert clamping system, a torque wrench should be used to correctly tighten the insert.

Torque that is too high will negatively affect the performance of the tool and can cause insert and screw breakage.

Torque that is too low will cause insert movement, vibrations and degrade the cutting result.

See Main catalogue for the correct insert tightening torque.

Clamping screws

Always use a torque wrench to ensure that screws are correctly tightened.

Apply sufficient screw lubrication to prevent seizure. Lubricant should be applied to the screw threads as well as to the screw head face.

Replace worn or damaged screws.
Turning theory – definition of terms

Cutting speed
The workpiece rotates at a certain number of revolutions (n) per minute. This gives a specific cutting speed, \( v_c \) (or surface speed), measured in (m/min) at the cutting edge.

Cutting depth
The cutting depth (\( a_p \)) is the difference between the un-cut and cut surfaces. The cutting depth is measured in mm and at a right angle (90°) to the feed direction.

Feed
The axial (or in face turning the radial) tool movement is called feed, \( f \), and is measured in mm/rev. When feeding radially towards the centre of the workpiece, the rpm will increase, until it reaches the rpm limit of the machine spindle. When this limitation is passed, the cutting speed, \( v_c \), will decrease until it reaches 0 m/min at the component centre.

Chip thickness
The chip thickness, \( h_{ct} \), is equal to \( f \), when using a tool holder with an entering angle \( \kappa = 90° \).
When using a smaller entering angle, \( h_{ct} \) is reduced.

Inclination and rake angles
\( \gamma \) = the rake angle is a measure of the edge in relation to the cut.
\( \lambda \) = the inclination angle is a measure of the angle at which the insert is mounted in the holder.
General turning - getting started

**Tool life**
The following graphs show the effect that each of the three machining parameters - speed, feed, and depth of cut - has on tool life. The depth of cut has the smallest effect, followed by the feed rate. Cutting speed has the greatest effect on the tool life of the insert.

For best tool life: maximize \( a_p \) - to reduce number of cuts; maximize \( f_a \) - for shorter cutting time; reduce \( v_c \) - for best tool life.

<table>
<thead>
<tr>
<th>Effects of depth of cut</th>
<th>( a_p ) too small</th>
<th>( a_p ) too large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of chip control</td>
<td>High power consumption</td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>Insert breakage</td>
<td></td>
</tr>
<tr>
<td>Excessive heat</td>
<td>Increased cutting forces</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effects of feed rate</th>
<th>( f_a ) too light</th>
<th>( f_a ) too heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stringers</td>
<td>Loss of chip control</td>
<td></td>
</tr>
<tr>
<td>Rough finish wear</td>
<td>Poor surface finish</td>
<td></td>
</tr>
<tr>
<td>Bullnose edge</td>
<td>Crater wear/plastic deformation</td>
<td></td>
</tr>
<tr>
<td>Uneconomic</td>
<td>High power consumption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chip welding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crap tearing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effects of cutting speed</th>
<th>( v_c ) too low</th>
<th>( v_c ) too high</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built-up edge</td>
<td>Rapid flank wear</td>
<td></td>
</tr>
<tr>
<td>Dull edge</td>
<td>Poor finish</td>
<td></td>
</tr>
<tr>
<td>Uneconomic</td>
<td>Rapid crater wear</td>
<td></td>
</tr>
<tr>
<td>Poor surface</td>
<td>Plastic deformation</td>
<td></td>
</tr>
</tbody>
</table>

**How to predict tool life**
The spiral cutting length, SCL, is a method for predicting the tool life.

For more information, see page A 37.

**Safety precautions**
Chips are very hot and have sharp edges, they should not be touched with bare hands. Chips can cause burns to the skin or damage to the eyes.

Be sure that the insert and the component are tightly and secured in the holder to prevent them from coming loose during use. Too much overhang can result in vibration and tool breakage.
Negative versus positive inserts

A negative insert has an angle of 50°, while a positive insert has an angle of less than 90°.
The illustrations below show how the insert is tilted in the tool holder.
Some characteristics of the two insert types are listed below:

Negative inserts
- Double and single sided
- High edge strength
- Zero clearance
- First choice for external turning
- Heavy cutting conditions.

Positive inserts
- Single sided
- Low cutting forces
- Side clearance
- First choice for internal turning
- And for external turning of slender components.

Effect of entering angle

The entering angle, \( \kappa_e \), is the angle between the cutting edge and the feed direction. It is an important angle in selecting the correct turning tool for an operation, and influences:
- Chip formation
- Direction of cutting forces
- Cutting edge length in cut.

Large entering angle

- Forces are directed toward the chuck. There is less tendency for vibration.
- Ability to turn shoulders.
- Higher cutting forces, especially at the entrance and exit of the cut.
- Tendency for notch wear in HRSA and case-hardened workpieces.

Small entering angle

- Reduced load on the cutting edge.
- Produces a thinner chip = higher feed rate.
- Reduces notch wear.
- Can not turn a 90° shoulder.
- Forces are directed both axially and radially, which may result in vibration.
Insert shape

The insert shape should be selected relative to the entering angle accessibility required of the tool. The largest possible nose angle should be selected to provide insert strength and reliability. However, this has to be balanced against the variation of cuts that need to be performed. A large nose angle is strong, but requires more machine power and has a higher tendency for vibration. A small nose angle is weaker and has a smaller cutting edge engagement, both of which can make it more sensitive to the effects of heat.

Factors affecting choice of insert shape

<table>
<thead>
<tr>
<th>Basic shape designation, nose angle</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>R 90°</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>B 89°</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>C 86°</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>D 83°</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>E 35°</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>F 33°</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

- R: Rounding (strength)
- B: Light roughing/semi-finishing (no. of edges)
- C: Finishing, new, or edges
- D: Longitudinal turning (tensile direction)
- E: Profiling (accessibility)
- F: Facing (feed direction)
- G: Operational versatility
- H: Limited machine power
- I: Vibration resistance
- J: Hard materials
- K: Intermittent machining
- L: Large entering angle
- M: Small entering angle

Scale 1 indicates the cutting edge strength. The inserts to the left have larger nose angles and are correspondingly stronger. The inserts to the right have better versatility and accessibility. Scale 2 indicates that vibration tendencies increase to the left, while power requirements increase to the right.

The 88° nose angle (C insert type), rhombic shaped insert is frequently used, as it is an effective compromise for all insert shapes and is suitable for many applications.
Insert shape - number of cutting edges

The number of cutting edges on an insert varies depending on the choice of insert and nose angle. An insert with a negative basic shape normally has twice as many edges compared to a positive insert. In heavy roughing, a single-sided, negative basic shape insert is recommended for best stability. For other roughing operations, a double-sided insert with twice as many cutting edges is recommended. The round insert has the highest number of cutting edges.

<table>
<thead>
<tr>
<th>Basic shape</th>
<th>R</th>
<th>S</th>
<th>C</th>
<th>W</th>
<th>T</th>
<th>D</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Double sided</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Single sided</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Positive</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*) The no. of edges is dependent on the depth of cut in relation to the insert size.

Insert shape - depth of cut

The recommended maximum values in the table are intended to provide machining reliability for continuous cuts using a roughing geometry. Deeper cuts, up to the total cutting edge length, can be made for a shorter period.

Insert size and depth of cut

The depth of cut influences the metal removal rate, the number of necessary cuts, chip breaking, and the power required.

Establish the effective cutting edge length, \( l_e \), along with the shape of the insert, the entering angle, \( \beta_e \), of the tool holder, and the depth of cut, \( a_p \).

The minimum necessary effective cutting edge length can be determined from the table, which shows the relation between the depth of cut, \( a_p \), the entering angle, \( \beta_e \), for extra reliability in more demanding operations, a larger and thicker insert should be considered.

When machining against a shoulder, the depth of cut increases dramatically, in such cases, a stronger insert (thicker or larger) should be used to minimize the risk of insert breakage.

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|c|c|c|c|}
\hline
K \beta_e & a_p, \text{ mm} & \beta_e, \text{ mm} & 1 & 2 & 3 & 4 & 5 & 7 & 8 & 9 & 10 & 15 \\
\hline
\hline
90^\circ & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 15 \\
105^\circ & 7^\circ & 1.05 & 1.1 & 1.1 & 1.1 & 1.1 & 1.1 & 1.1 & 1.1 & 1.1 & 1.1 & 1.1 \\
120^\circ & 9^\circ & 1.2 & 2.3 & 3.5 & 4.7 & 5.9 & 7 & 8 & 8 & 8 & 8 & 8 \\
135^\circ & 4^\circ & 1.4 & 2.9 & 4.9 & 7.1 & 9.3 & 11 & 13 & 13 & 15 & 12 & 15 \\
150^\circ & 3^\circ & 2 & 4 & 5 & 8 & 10 & 12 & 14 & 16 & 18 & 20 & 30 \\
165^\circ & 1^\circ & 4 & 8 & 10 & 16 & 20 & 24 & 27 & 31 & 35 & 39 & 58 \\
\hline
\end{array}
\]
## Insert size – according to chip breaking areas

### Flushing (F)
Operations at low depths of cut and low feeds.

<table>
<thead>
<tr>
<th>Insert size</th>
<th>Minimum depth of cut $a_p$, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td></td>
</tr>
<tr>
<td>Square</td>
<td></td>
</tr>
<tr>
<td>Rhombo 60°</td>
<td></td>
</tr>
<tr>
<td>Triangular</td>
<td></td>
</tr>
<tr>
<td>Rhombo 55°</td>
<td></td>
</tr>
<tr>
<td>Rhombo 35°</td>
<td></td>
</tr>
</tbody>
</table>

### Medium (M)
Medium to light roughing operations. Wide range of depths of cut and feed rate combinations.

<table>
<thead>
<tr>
<th>Insert size</th>
<th>Minimum depth of cut $a_p$, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td></td>
</tr>
<tr>
<td>Square</td>
<td></td>
</tr>
<tr>
<td>Rhombo 60°</td>
<td></td>
</tr>
<tr>
<td>Triangular</td>
<td></td>
</tr>
<tr>
<td>Rhombo 55°</td>
<td></td>
</tr>
<tr>
<td>Rhombo 35°</td>
<td></td>
</tr>
</tbody>
</table>

### Roughing (R)
Operations for maximum stock removal and in severe conditions: high depths of cut and feed rate combinations.

<table>
<thead>
<tr>
<th>Insert size</th>
<th>Minimum depth of cut $a_p$, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round</td>
<td></td>
</tr>
<tr>
<td>Square</td>
<td></td>
</tr>
<tr>
<td>Rhombo 60°</td>
<td></td>
</tr>
<tr>
<td>Triangular</td>
<td></td>
</tr>
<tr>
<td>Rhombo 55°</td>
<td></td>
</tr>
<tr>
<td>Rhombo 35°</td>
<td></td>
</tr>
</tbody>
</table>

General depth of cut recommendations for insert shapes, according to chip breaking for different geometries.

### Insert shape
Selecting the insert size – according to chip breaking areas.
Nose radius

The nose radius, $r_n$, on the insert is a key factor in turning operations. Selection of nose radius depends on the:
- Depth of cut, $a_p$
- Feed, $f_r$

and influences the:
- Surface finish
- Chip breaking
- Insert strength.

Small nose radius
- Ideal for small cutting depths
- Reduces vibration
- Less insert strength.

Large nose radius
- Heavy feed rates
- Large depths of cut
- Stronger edge
- Increased radial forces.

Nose radius and maximum feed

Negative basic-shape inserts

<table>
<thead>
<tr>
<th>Nose radius, $r_n$ mm</th>
<th>0.4</th>
<th>0.6</th>
<th>1.0</th>
<th>1.2</th>
<th>1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. recommended feed, $f_r$ mm/r</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finishing</td>
<td>0.1</td>
<td>0.4</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Medium</td>
<td>0.3</td>
<td>0.5</td>
<td>0.8</td>
<td>1.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Roughing</td>
<td>0.3</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Positive basic-shape inserts

<table>
<thead>
<tr>
<th>Nose radius, $r_n$ mm</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. recommended feed, $f_r$ mm/r</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finishing</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Medium</td>
<td>0.15</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Nose radius in relation to depth of cut

The radial forces that push the insert away from the cutting surface become more axial as the depth of cut increases. The nose radius also affects the chip formation. Generally, chip breaking improves with a smaller radius.

As a general rule of thumb, the depth of cut should be greater than or equal to 2/3 of the nose radius, or 1/2 of the nose radius in the feed direction.
Nose radius – surface finish and feed

In turning operations, the generated surface finish will be directly influenced by the combination of nose radius and feed rate.

Conventional insert
A conventional insert has a single nose radius, which can vary between 0.1 – 2.4 mm, and the surface finish is directly related to the feed used.

Wiper insert
The nose radius on a wiper insert has a modified nose built up around 8 to 9 different radii. This will increase the insert’s engagement length and positively affects the feed rate and the surface.

Rules of thumb for wiper inserts:
- Two times the feed = same surface finish
- Same feed – surface finish is twice as good.

The modified nose radius of the wiper inserts is within the tolerance for C- and W-style inserts, while D- and T-style have a nose configuration that deviates from corresponding conventional inserts.

For more information, see page A 94.

Surface finish measurements
Different methods for measuring surface finish are described in chapter 1.
Chip formation and choice of insert geometry

Breaking the chips:
Chip control is one of the key factors in turning, and there are three principle chip breaking alternatives:

- self breaking, for example cast iron
- against the tool
- against the workpiece

Factors that have an influence on chip breaking are the:
- Insert geometry
- Nose radius, r
- Entering angle, θ_e
- Cutting depth, a
- Feed, f
- Cutting speed, v_c
- Material

Insert geometries

Turning geometries can be divided into three basic styles that are optimized for finishing, medium and roughing operations. The diagram shows the working area for each geometry, based on acceptable chip breaking, in relation to feed and depth of cut.

- Roughing - R
  High depth of cut and feed rate combinations. Operations requiring the highest edge security.

- Medium - M
  Medium operations to light roughing. Wide range of depth of cut and feed rate combinations.

- Finishing - F
  Operations at light depths of cut and low feed rates. Operations requiring low cutting forces.
Example of chip breaking for a-PM geometry

Chip breaking test of a CNMG 120408-PM insert at different cutting depths and feeds. The chip breaking within the marked area is classified as good, and the results are transferred into a diagram.

Insert geometries for different workpiece materials

Many insert geometries are optimized for a certain workpiece material type, i.e., FF, PM, PR for turning of steels, MF, MM, MR for stainless steels, and KF, KM, KR for turning of cast irons, etc. Other geometries, like WMA, WM, WM, WR, are suitable for both steel, stainless and cast iron.

For more information about insert geometries and workpiece materials, see pages A 08 and A 22 . A 46.

<table>
<thead>
<tr>
<th>Wiper inserts</th>
<th>Conventional inserts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>WW, WM, WM, WR</td>
</tr>
<tr>
<td>Stainless steel</td>
<td>WM, WM, WM, WR</td>
</tr>
<tr>
<td>Cast iron</td>
<td>WM, WM, WM, WR</td>
</tr>
<tr>
<td>Aluminium alloys</td>
<td>AL</td>
</tr>
<tr>
<td>Heat resistant alloys</td>
<td>S, S, S</td>
</tr>
<tr>
<td>Hardened steel</td>
<td>HM, HR</td>
</tr>
</tbody>
</table>
Insert grades

The insert grade is primarily selected according to the component material, the type of application and the machining conditions:

- Component material (ISO P, M, K, N, S, H)
- Type of application (F, M, R)
- Machining conditions (good, average, difficult)

The insert geometry and insert grade complement each other when being applied; for example, the toughness of an insert grade can compensate for lack of strength in an insert geometry.

For more information, see section H.

Examples of common grades for different materials:

- Coated cemented carbide (GC4205, GC4215, GC4225, etc)
- Cemented carbide (K10, K13A, etc)
- Cermet (CT1525, CT1515, etc)
- Ceramics (DC06050, DC06050, etc)
- Cubic boron nitride (CB7015, CB7025, etc)
- Polycrystalline diamond (CD10),
Steel turning

The machinability of steel differs depending on alloying elements, heat treatments and manufacturing processes (forged, cast etc.). For more detailed information about materials and classifications, see chapter H. For cutting data recommendations, see Main catalogue.

Steels can be categorized as unalloyed, low alloyed steel and high alloyed steel, all of which affect the machining recommendations for turning.

Unalloyed steel

Material Classification: P.11

Unalloyed steel has a carbon content of up to 0.55%. Low carbon steels (carbon content <0.2%) require special attention, due to the difficult chip breaking and the tendency to smear (built-up edge).

The machining properties for unalloyed steels with a higher carbon content are similar to those for low alloyed steels.

Chip control:
To control the chip flow, use a cutting depth greater than the size of the nose radius. Choose an entering angle as close to 90° as possible. Radial back-turning should be avoided.

Aim for the highest feed possible; the use of Wiper inserts is highly recommended. The -LC and -WL geometries are optimized for low carbon steels.

Cutting data:
Use high cutting speeds to avoid builtup edge on the insert, which can negatively influence both surface finish and tool life. Sharp edges and geometries, together with thin coated grades, e.g., GC2025 or GC1515, will decrease the smearing tendencies and prevent edge deterioration.

At low cutting depths or feed, ground inserts with positive geometries and small nose radii should always be used for best cutting action.
Low alloyed steel

Material Classification: P2.x

Low alloyed steels are the most common material for metal cutting or the market. The group includes both soft and hardened materials (below 50 HRC).

Machinability for low alloyed steels is dependent on alloy content and the heat treatment (hardness). For all materials in this group, the most common wear mechanisms are crater and flank wear.

For low alloyed steels in a non-hardened condition, the first choice is the GC4200 series of grades and the wiper geometries.

Because hardened materials produce higher heat in the cutting zone, plastic deformation is a common wear mechanism.

Thus, extra heat and flank wear resistance are required; cast iron grades are recommended for these operations.

High alloyed steel

Material Classification: P3.x

High alloyed steels include carbon steels with a total alloy content over 5%. The group includes both soft and hardened materials (below 50 HRC). Machinability decreases at higher alloy contents and hardnesses.

As for the low alloyed steels, the first choice is the GC4200 series of grades and the wiper geometries. Steels with more than 5% alloying elements, and with hardness up to 450 HB, impose extra demands on plastic deformation resistance and edge strength, which is why cast iron grades are often a good choice.

CoroTurn® HP coolant supply

CoroTurn® HP can be applied to increase cutting data and improve chip control, especially for steels with a low carbon content. It can also be applied in harder steels to decrease crater wear and plastic deformation.
### First choice geometry and grade recommendations

<table>
<thead>
<tr>
<th></th>
<th>F Finishing</th>
<th>M Medium</th>
<th>R Roughing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insert geometry</td>
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<td><strong>K</strong></td>
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</tr>
<tr>
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<td>MC 220x</td>
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<td>HB 220</td>
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</tr>
<tr>
<td>Nodular cast iron</td>
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<tr>
<td>HB 180</td>
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</tbody>
</table>

**Machining conditions**
- Good conditions: ![Good conditions](image1)
- Average conditions: ![Average conditions](image2)
- Difficult conditions: ![Difficult conditions](image3)

For detailed information about grades and geometries, see product section.
For cutting data recommendations, see tool catalogue.
Cast iron turning

Cast iron can be divided into malleable, grey, nodular, compact graphite iron (CGI), and austempered ductile iron (ADI).

For more detailed information about materials and classifications, see chapter H.

Grey and nodular cast iron
Material classification: K2.x and K3.x
Grey and nodular cast irons are the most common types of cast iron.

- The first choice should be the GC3200 grade series and -WMX geometry for finishing and medium operations. For roughing, HR is the strongest and first choice geometry.
- The complementary grade C0650 (mixed ceramic) is recommended for finishing, and C00990 (SN-ceramic) for medium and rough machining.
- If possible, use coolant in continuous machining, and use dry machining on interrupted cuts. The complementary grade C6650 is the exception, it should be machined dry at all times.
- The complementary grades CB7050 and CB850 (CBN grades) are recommended for finishing to rough machining, but only in grey cast iron.

Malleable cast iron
Material classification: K1.x
Use the same grade and geometry recommendations as for grey cast iron.

CGI – compact graphite iron
Material classification: K4.x
Use the same grade and geometry recommendations as for nodular cast iron.

ADI – austempered ductile iron
Material classification: K5.x
Use the same grade and geometry recommendations as for nodular cast iron.
# First choice geometry and grade recommendations

<table>
<thead>
<tr>
<th>Workplace material</th>
<th>Insert geometry</th>
<th>Insert grade</th>
<th>Insert geometry</th>
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</tr>
<tr>
<td><strong>M</strong> Medium</td>
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</tr>
<tr>
<td><strong>R</strong> Roughing</td>
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</tr>
</tbody>
</table>

## Ferritic/martensitic stainless steel

**MC P5.x**

- **Negative**: 
  - Insert geometry: MF
  - Insert grade: GC2015
  - Insert grade: GI1115
  - Insert grade: GC2025
  - Insert grade: GC2025
  - Insert grade: GI2025

- **Positive**: 
  - Insert geometry: MF
  - Insert grade: GC2015
  - Insert grade: GI1115
  - Insert grade: GC2025
  - Insert grade: GC2025
  - Insert grade: GI2025

## Austenitic stainless steel

**MC M1.x and M2.x**

- **Negative**: 
  - Insert geometry: MF
  - Insert grade: GC2015
  - Insert grade: GI1115
  - Insert grade: GC2025
  - Insert grade: GC2025
  - Insert grade: GI2025

- **Positive**: 
  - Insert geometry: MF
  - Insert grade: GC2015
  - Insert grade: GI1115
  - Insert grade: GC2025
  - Insert grade: GC2025
  - Insert grade: GI2025

## Duplex stainless steel

**MC M3.x**

- **Negative**: 
  - Insert geometry: MF
  - Insert grade: GC2015
  - Insert grade: GI1115
  - Insert grade: GC2025
  - Insert grade: GC2025
  - Insert grade: GI2025

- **Positive**: 
  - Insert geometry: MF
  - Insert grade: GC2015
  - Insert grade: GI1115
  - Insert grade: GC2025
  - Insert grade: GC2025
  - Insert grade: GI2025

### Machining conditions
- **Good conditions**: ○
- **Average conditions**: ●
- **Difficult conditions**: 🔴

For detailed information about grades and geometries, see product section.

For cutting data recommendations, see Main catalogue.
Austenitic stainless steel

Other considerations:
- Always use coolant to decrease crater wear and plastic deformation, and select the largest possible nose radius.
- Due to work-hardening notch wear at the depth of cut, grading to burr formation is common. Use round inserts or small entering angles.
- Smearing tendencies, or built-up edge, are common. They both negatively influence surface finish and tool life. Use sharp edges and/or geometries with a positive rake face.

CoroTurn® HP coolant supply

When machining stainless steels chip control and cooling are important to avoid plastic deformation. By using CoroTurn® HP these problems can be overcome and cutting data can be raised.

Material Classification: M3.4

Duplex (austenitic/ferritic) stainless steels

Duplex stainless steels have a structure that consists of two phases: ferrite and austenite. For higher alloyed duplex steels, designations such as super, or even hyper duplex stainless steels are used.

The higher mechanical strength makes the materials more difficult to machine, particularly when it comes to heat generation, cutting forces and chip control. Common wear mechanisms are flank and crater wear, plastic deformation, chip hammering and notch wear.

Depending on the application, both the GC2000 and GC1100 grade series can be used.

Other considerations:
- Always use coolant to reduce the heat.
- Use small entering angles to avoid notch wear and burr formation.
- Use geometries with good strength in the edge line to withstand the high cutting forces.
Stainless steel turning

The machinability of stainless steels differs, depending on the alloying elements, heat treatments and manufacturing processes (forged, cast, etc.). In general, the machinability decreases at a higher alloy content; however, free-machining materials or materials with improved machinability are available in all groups of stainless steels.

For more detailed information about materials and classifications, see chapter H.

For machining recommendations with turning tools, stainless steels can be categorized in three groups:

- Ferritic/martensitic
- Austenitic
- Duplex (austenitic/ferritic).

Grades, geometries and other important information for each group are given below.

On page A 27, a summary of all recommendations appears in a table.

Ferritic and martensitic stainless steels

Material Classification: P5.x

Ferritic and annealed martensitic stainless steels have machinabilities that are comparable to low alloyed steels, and therefore the general machining recommendations for steel turning can be used.

Austenitic stainless steels

Material Classification: M1.x and M2.x

Austenitic stainless steel is the most common type of stainless steel. The group also includes so-called super-austenitic stainless steels, defined as stainless steels with a Ni content over 20%.

Grade and geometry recommendations:

Use the GC2000 grades. Wiper inserts can be used for finishing and medium machining.

For intermittent cuts, or where chip hammering or chip jamming is the main wear mechanism, use the GC1100 grades. The GC1100 grades are also the first choice when a sharp edge is needed (e.g., at low feeds or at a small depth of cut).

Continued...
## First choice geometry and grade recommendations

<table>
<thead>
<tr>
<th>Workpiece material</th>
<th>Insert geometry</th>
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<tr>
<td>NC P3.6x HB 110</td>
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<td>NC P3.6x HB 200</td>
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<td></td>
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<tr>
<td>NC P3.6x HB 400</td>
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</tr>
</tbody>
</table>

**Machining conditions**
- Good conditions
- Average conditions
- Difficult conditions
HRSA and titanium turning

Heat resistant super alloys (HRSA) can be divided into three material groups: nickel-based, iron-based and cobalt-based alloys. Titanium can be pure or with alpha and beta structures. The machinability of both HRSA and titanium is poor, especially in aged conditions, which impose particular demands on the cutting tools.

In the aerospace industry, machining is divided into three stages: First Stage Machining (FSM), Intermediate Stage Machining (ISM) and Last Stage Machining (LSM). In LSM, surface integrity is of utmost importance, but this limits cutting data. It emphasizes the importance of sharp edges to prevent the formation of so-called white layers, with different hardnesses and residual stresses.

For more detailed information, see the application guide “Heat resistant super alloys” order No. C 2920:24 or “Titanium machining” order No. C 2920:22.

Insert shape and entering angle

A common wear criterion in both titanium and HRSA is notch wear. By choosing a small entering angle or round inserts, feed and tool life can be increased considerably.

The unique Xcel insert combines the accessibility of a 93° angle to the tool holder with the productivity of a 45° entering angle at the cutting edge, at cutting depths up to 2.5 mm. It is suitable for semi-roughing operations.
One-cut strategy
A one-cut "metal removal" strategy is feasible for both external and internal operations. A stable setup is important and the tool overhang should not exceed the bar diameter in internal turning (1xD). For good machining, we recommend chamfered, lightly-bonded inserts (S-type) and moderate speed and feed.

Advantages:
- Quickest possible machining time
- One tool position.

Disadvantages:
- Difficulties in meeting stringent dimensional tolerances
- Shorter tool life than two-cut
- Tolerance deviations due to relatively rapid wear.

Two-cut strategy
A two-cut strategy allows unattended machining of high-quality finished surfaces. We recommend roughing inserts in S-type, with a 1.2 mm radius, and the finishing inserts with a chamfer only, T-type. Both inserts should have wiper geometry.

Advantages:
- Tooling optimized for roughing and finishing
- Higher security, closer tolerances and potentially longer runs between tool changes.

Disadvantages:
- Two inserts are needed
- Two tool positions
- One extra tool change.
Chip control
Efficient chip evacuation prevents scratches on the turned surface and prevents chips from getting stuck inside the bore prior to the second cut.
Chip flow can be improved by: upside down tool mounting, cutting data, tool path, insert radius, forced air.

Coolant may be eliminated
Hard Part Turning (HPT) without coolant is the ideal situation, and is entirely feasible. Both CBN and ceramic inserts tolerate high cutting temperatures, which eliminate the costs and difficulties associated with coolants.
Some applications may require coolant, e.g. to control the thermal stability of the workpiece. In such cases, ensure a continuous flow of coolant throughout the entire turning operation.

Cutting data and wear
High heat in the cutting edge zone reduces the cutting force. Therefore a cutting speed that is too low generates less heat and can cause insert breakage.
Crater wear gradually affects the insert strength, but does not affect the surface finish as much.
In contrast, flank wear gradually affects the dimensional tolerance.

Insert change criteria
Predetermined surface finish is a frequent and practical insert change criterion. Surface finish is automatically measured in a separate station and a value is given to a specified finish quality.
When this set value is reached, it is time to change the tool. Set the predetermined number of components to 10–20% less than the average tool life of an optimized process. The exact figure will need to be determined on a case-to-case basis.
Insert micro geometry

Two types of edge geometries are available for CBN inserts:
- **S-type**: Has the best edge life strength, resistant against micro chipping, and ensures a consistent surface quality.
- **T-type**: For best surface finishes in continuous cuts, and minimized bur formation in interrupted cuts. Lower cutting forces.

Insert corner geometry

If conditions are stable, always use wiper geometry for best productivity:
- **W6 geometry** for semi finishing
- **W9 geometry** optimized for finishing.

Use the Xcel geometry for finishing.
A normal radius insert should be used only when stability is poor (slender workpiece etc.).

Key factors in hard part turning

In addition to the general recommendations for turning, there are some more specific factors that should be highlighted.

Prepare the workpiece in the soft stage
- Avoid burrs
- Maintain close dimensional tolerances
- Chamfer and produce radii in the soft stage
- Do not enter or leave cuts abruptly
- Enter or leave by rolling into or out of the cut.

Set-up
- Good machine stability, clamping and alignment of workpiece are crucial.
- As a guideline, a workpiece length-to-diameter ratio of up to 2:1 is normally acceptable for workpieces that are only supported on one end. If there is additional tailstock support, this ratio can be extended.
- Note, that a thermally symmetrical headstock and tailstock design will add extra dimensional stability.
- Use the Coromant Capto system
- Use ConsTum RC for stable conditions, and ConsTum 107 for slender components and internal turning.
- Minimize all overhangs to maximize system rigidity.
- Consider carbide shank boring bars and Silent Tools for internal turning.
Cutting tool materials

- Carbide is not recommended when the hardness is above 50 HRC.
- Ceramics can be used between approx. 50-60 HRC when surface finish demands are moderate:
  - CC670: Roughing to semi-finishing, interrupted cuts.
  - CC6050: Semi-finishing, continuous cuts.

- Cubic Boron Nitride (CBN) are, however, the ultimate cutting tool material for hard part turning. However, they should not be used on steels softer than approx. 48 HRC. The modern, multi-corner inserts offer up to 8 edges per insert, and the Bote-Lok technology on negative inserts provides extra security. The recommended grades are:
  - CBT015: For continuous cuts and light interruptions.
  - CBT025: For light and heavy interrupted cuts.
  - CBT050: For heavy interrupted cuts and unstable conditions.

Cutting speed

ISO H

CBT015
CBT025
CBT050
C670
C6050

CB = Cubic boron nitride
CC = Ceramic
Hard part turning

A cost efficient alternative to grinding

Turning steel with a hardness over 45 HRC (typically within the range of 55-68 HRC) is defined as hard part turning and is a cost efficient alternative to grinding. Hard part turning has been proven to reduce machining time and costs by 70% or more, and also offers improved flexibility, better lead times and higher quality.

- Simpler production process, similar to normal turning.
- Flexible machine utilization; use the same machine for external and internal machining.
- Increased productivity.
- Lower costs per part.
- Complex component shapes machined in one set-up.
- Environmentally friendly - no coolant, no grinding waste.

Components

Hard part turning is a well accepted method, especially in the automotive industry. Typical components include: gear box housings, brake rotors, transmission gears, steering joints, valve seats, engine blocks, pistons, cylinder liners and clutch housings.
Aluminium turning

The machinability of aluminium differs depending on alloying elements, heat treatments and manufacturing processes (forged, cast, etc.).

Aluminium alloys

(Material classification: N1.2)

The table below shows grade and geometry recommendations for aluminium alloys with a Si-content below 13%.

Inserts with a positive basic shape and sharp edges should always be used. The AL geometry is optimized for aluminium turning:

- GC1005 is a PVD coated carbide grade with high wear resistance, recommended for roughing.
- H10 is uncoated and is the first choice grade in most cases, from roughing to finishing.
- For finishing under stable conditions, the polycrystalline diamond (PCD) tipped insert grade CD10 is recommended. CD10 withstands built-up edge better than carbide grades. It provides a better surface finish and also a longer tool life.

For aluminium alloys with a Si-content above 13%, CD10 (PCD) should be used as the tool life of cemented carbide grades is drastically reduced.

Coolant in aluminium machining is mostly used for chip evacuation.

<table>
<thead>
<tr>
<th>Workpiece material</th>
<th>F (Finishing)</th>
<th>M (Medium)</th>
<th>R (Roughing)</th>
<th>Insert basic shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insert geometry</td>
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<tr>
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<td>CD10</td>
<td>-AL</td>
<td>H10</td>
</tr>
</tbody>
</table>

Machining conditions

- Good conditions
- Average conditions
- Difficult conditions

For detailed information about grades and geometries, see product section.

For cutting data recommendations, see Main catalogue.
Roughing
The objective is to predict when the insert needs to be indexed/changed.

1) Select insert style to suit the component.
2) Use optimized $v_c$, $a_p$, and $f_s$ for that insert.
   Example: CNMG 120408-QM 1025
   $v_c = 50$ m/min, $a_p = 0.25$ mm, $f_s = 2$ mm

3) Note SCL capability (tool life) for that insert.
   Example: SCL = 450 m

4) Calculate SCL.
   Example: $D_{h1} = 600$ mm, $f_m = 150$ mm
   \[
   \text{SCL} = \frac{600 \times 3.14 \times 150}{1000 	imes 0.35} = 807 \text{ m}
   \]

5) Calculate the number of insert edges required.
   Example: $1507/450 = 2$ edges

---

**Inserts for roughing**

<table>
<thead>
<tr>
<th>Insert Code</th>
<th>$v_c$ m/min</th>
<th>$a_p$ mm</th>
<th>$f_s$ mm/min</th>
<th>Tool life</th>
<th>SCL</th>
<th>$Q_n$ mm/min</th>
<th>$V_{at}$ mm/rev</th>
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<tr>
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</tbody>
</table>

For more information, order the Application guide for Heat Resistant Super Alloys, C2520/24.
Predicting tool life – spiral cutting length, SCL

Because inserts have a relatively short tool life when turning HRSA and titanium materials, one insert can often only machine one pass before it is indexed. The spiral cutting length, SCL, calculation is a method used to predict the tool life of an insert edge to avoid unwanted insert changes in the middle of a cut.

Note:
- Each SCL graph is unique and is only applicable for that particular insert, geometry, grade, depth of cut and material.
- In finishing, it is especially important to avoid an insert change in the middle of a pass. Therefore, we offer a range of cutting speeds to allow for different lengths of cut.
- For roughing, we have identified the optimum cutting data for each insert style and the corresponding spiral cutting length, SCL.

Finishing:
The objective is to identify the correct cutting speed, \( v_c \), that will manage a full pass without an insert change.

1) Select insert style to suit the component.

2) Use optimized \( a_p \) and \( f_n \) for that insert.

Example:
- ONSP 120408-1105
  - \( a_p = 0.25 \text{ mm, } f_n = 0.15 \text{ mm} \)

3) Calculate SCL.

Example:
- \( D_{n1} = 500 \text{ mm, } l_m = 150 \text{ mm} \)

\[
SCL = \frac{D_{n1} \pi}{1000} \times \frac{l_m}{f_n} = \frac{500 \times 3.14}{1000} \times \frac{150}{0.15} = 1885 \text{ m}
\]

4) Select cutting speed, \( v_c \), from the SCL / \( v_c \) diagram.

Example:
- ONSP 120408 1105
  - SCL = 1885 m = \( v_c = 50 \text{ m/min} \)

So, with \( v_c = 50 \text{ m/min} \), one edge will manage a spiral cutting length of 1885 m corresponding to a turned component length, \( l_m \), of 150 mm.
Finishing (Last Stage Machining, LSM)

Machining in the aged condition, 35-46 HRC. Due to the high demands for low residual stress, ceramic inserts are not recommended, and cutting speed should be kept below 80 m/min. Other factors influencing the residual stress are:
- Flank wear – maximum 0.2 mm
- Chip thickness – maximum 0.1 mm
- Sharp edges, ground inserts to be preferred.

Carbide inserts:

GC1105 (PVD-coated) has the best notch wear resistance, and is the first choice when:
- Feed is below 0.1 mm/r
- Turning thin-walled or slender components
- The entering angle must be 75° or more
- Long tool overhang cannot be avoided.

SO5 (CVD-coated) provides better tool life than GC1105, it a small entering angle or a round insert can be used.

<table>
<thead>
<tr>
<th>Workpiece material</th>
<th>Insert geometry</th>
<th>Insert grade</th>
<th></th>
<th>Insert geometry</th>
<th>Insert grade</th>
<th></th>
<th>Insert geometry</th>
<th>Insert grade</th>
<th>Insert basic shape</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-23</td>
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<td>23</td>
<td>H13A</td>
<td>G6C1115</td>
<td>-HM</td>
<td>6C2015</td>
<td></td>
<td></td>
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<td>H13A</td>
<td>G6C1115</td>
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<td></td>
<td>-23</td>
<td>K13A</td>
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</tr>
</tbody>
</table>

For detailed information about grades and geometries, see product section.
For cutting data recommendations, see Main catalogue.
Ceramic grades application areas

Cutting parameters – ceramics

The speed should be balanced to create enough heat in the cutting zone to plasticize the chip, but not so high as to unbalance the ceramic.

The feed, \( f \), should be selected to provide a chip thickness, \( h \), which is high enough so as not to work-harden the material, but not so high as to cause edge chipping.

Higher feeds and depths of cut require a reduction in the cutting speed, \( V_c \).

These boundaries will change depending upon the component material hardness and grain size.

Start cutting data recommendations (RN6A 12, ROCX 12) – Isocold 718 (38 to 46 HRc)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Cutting speed, ( V_c )</th>
<th>Cutting depth, ( h )</th>
<th>Feed, ( f )</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC670</td>
<td>200 to 250 m/min</td>
<td>2 mm</td>
<td>0.1 to 0.15 mm/r</td>
</tr>
<tr>
<td>CC6060</td>
<td>250 to 300 m/min</td>
<td>2 to 3 mm</td>
<td>0.15 to 0.2 mm/r</td>
</tr>
<tr>
<td>CC6065</td>
<td>200 to 250 m/min</td>
<td>2 to 3 mm</td>
<td>0.15 to 0.2 mm/r</td>
</tr>
</tbody>
</table>
**Heat resistant super alloys - HRSA**

The operation and condition determine the choice of grades.

**Roughing (First Stage Machining, FSM)**
Machining is done in the annealed condition (approx. 26 HRC).

**Carbide inserts:**
In materials with forged or cast skin, use single-sided inserts with geometries HM or SM in grades GC2025 or GC2015. The entering angle should be small (not larger than 75°) and the depth of cut should be large enough to reach under the hard skin in order to minimize the notch wear.

If a larger entering angle is necessary, PVD-coated grades like GC1105 and GC1115 are better choices. Grade H13A is the first choice for best bulk toughness.

**Ceramic inserts:**
CC670 (whisker reinforced) can be used, but both feed \( f \) and cutting depth \( a_\text{c} \) must be reduced, cutting speed \( v_\text{c} \), on the other hand, can be much higher. Use a small entering angle or round inserts for best tool life.

**Medium (Intermediate stage machining, ISM)**
Machining is performed in the aged condition, 35-45 HRC.

**Carbide inserts:**
The first choice is GC1105. For operations requiring greater toughness, use GC2115.

Use grade S95E, combined with round inserts or small entering angles, for best productivity.

**Ceramic Inserts:**
The advantages in using ceramics in Medium or ISM operations are obvious. The depth of cut in aged materials is lower than that required in the roughing (FSM) operations. Sialon ceramics have excellent notch wear resistance and can be used at much higher cutting speeds, \( v_\text{c} \), (150-280 m/min), in comparison with carbide grades. The feed, \( f_\text{c} \), can also be kept at a high level (0.15-0.35 mm/rev). It is, however, of paramount importance to have a stable set-up and a correctly applied coolant supply (volume is more important than pressure). The first choice for maximum productivity is CC6600; for more unstable conditions, select CC9605.
Titanium

Cubic insert grades

Cubic grades should be selected according to the table below, depending on the operation (finishing, medium, roughing), and the machining conditions (good, average, difficult).

Ceramics are not recommended for titanium.

Geometry and grade recommendations for titanium

<table>
<thead>
<tr>
<th>Workpiece material</th>
<th>F (Finishing)</th>
<th>M (Medium)</th>
<th>R (Roughing)</th>
<th>Insert basic shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insert geometry</td>
<td>Insert grade</td>
<td>Insert geometry</td>
<td>Insert grade</td>
</tr>
<tr>
<td>S</td>
<td>.NM</td>
<td>SCOF</td>
<td>.NM</td>
<td>SCOF</td>
</tr>
<tr>
<td>Titanium MC S4.x</td>
<td>.NM</td>
<td>GC1005</td>
<td>.NM</td>
<td>GC1005</td>
</tr>
<tr>
<td></td>
<td>.NM</td>
<td>GC1105</td>
<td>.NM</td>
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<tr>
<td></td>
<td>.NM</td>
<td>GC1105</td>
<td>.NM</td>
<td>GC1105</td>
</tr>
</tbody>
</table>

Machining conditions:
- Good conditions
- Average conditions
- Difficult conditions

For detailed information about grades and geometries, see product section.
For cutting data recommendations, see main catalogue.
Coolant requirements

Coolant should always be applied when turning HRSA or titanium alloys regardless of whether carbide or ceramic inserts are used. The coolant volume should be high and well directed.

High pressure coolant (with coolant pressures up to 80 bars) is now common in modern machines and, together with the CoroTurn HP coolant supply technology (see page A 124), cutting speed can be increased by up to 20%, tool life by up to 50% and, last but not least, chip breaking can be considerably improved.

Jet-break technology, using ultra high pressure coolant (with coolant pressures from 80 to 1000 bars) can be applied when using vertical turning lathes (VTL).

Please contact your Sandvik Coromant representative for more information.

Titanium – Ti6Al4V (30 HRc)

CoroTurn® 107 conventional

CoroTurn® 107 with HP-technology

Similar improvements can also be achieved in HRSA materials.
Avoiding notch wear when machining HRSA-materials

Notch wear can never be eliminated, but it can be minimized through good planning and by following some general rules:

- Use round inserts,
- Use the smallest possible entering angle,
- Use the correct relationship between the insert diameter and depth of cut (see figure).

Roll over action is possible in programming, which can eliminate the need for pre-chamfering and it also minimizes notch wear. There will be one contact point, where the insert hits the hard scale/surface at the corner of the component, and one contact point at the depth of cut line.

- Ramping is ideally suited for CNC lathes. It ensures that any damage is spread out along the cutting edge. It is the best solution with varying depths of cut. Multiple passes with varying depths of cut can also be a good alternative.

When using ramping or multiple passes, the depth of cut should never be less than 0.25 mm; otherwise there is risk of chipping.

Depth of cut

In order to minimize notch wear, the best results are obtained by using a depth of cut that is a maximum of 15% of the diameter of a round insert, or 15% of the nose radius of a non-round insert.

Larger depths of cut can be used, but never greater than 25% of the insert diameter.

If these types of large depths of cut are being used, the workpiece must be free of forging scale/hard skin.

Pre-chamfering

Recommended when using ceramics.

- Pre-chamfering minimizes the risk of burrs when the insert exits the cut. It also has a positive effect on the insert when it enters.
- To avoid notch wear when chamfering, use a direction feed of 0.5° to the chamfer that is being produced.
First choice geometry and grade recommendations

Hardened steel.

Material classification: H1x

<table>
<thead>
<tr>
<th>Workpiece material</th>
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<th>Insert grade</th>
<th>Insert basic shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>WY .N8A</td>
<td>CE7025, CE7015</td>
<td>Negative</td>
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<tr>
<td>H</td>
<td>WY .D8A</td>
<td>CE7015</td>
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<tr>
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Machining conditions

- Good conditions
- Average conditions
- Difficult conditions

For detailed information about grades and geometries, see product section.
For cutting data recommendations, see main catalogue.
APPENDIX–V CNC MACHINE PART PROGRAMME

N10 G90 G71
N20 T4
N30 M16
M40 D1
N50 G00 X200 Z15
N60 S2200 M03
N70 G00 X30 Z1 M08
N80 G01 X26 Z1 F0.2
N90 Z-45
N100 X26
:N110 Z-175
N110 G00 X26.5
N120 Z1
N130 G01 X23 Z0.5
N140 G01 X23 Z-45
N150 G01 X24
N160 G00 Z0.5
N170 G01 X20.5 Z0.5
N180 G01 X20.5 Z-45
N190 G01 X21
N200 G0 Z1
N210 G01 X18.5
N220 G01 Z-21.5
N230 G01 X19
N240 G0 Z1
N250 G00 Z1
N270 X15.8 Z-3.9
N280 X15.8 Z-21.5
N290 X15.7
N300 G01 X19.965 Z-21.5 CHF=1.4
N310 G01 X19.940 Z-45
N320 X19.6
N330 G01 X25.005 Z-45 CHF=1.4 F0.18
N340 G01 X24.945 Z-124
N350 G01 X24.6
N360 G01 X24.990 Z-124
N370 G01 X24.990 Z-175
N380 G01 X24.6
N390 G01 X27.80 Z-175 CHF=1.2
N400 G01 X27.80 Z-175.5 M09
N410 X29

N420 M04 S1200
N430 G00 X250 Z15

N440 T5
N450 M16
N460 D1
N470 S1200 M04 M08
N480 G00 X200 Z15
N490 G00 X30 Z-20 M08
N500 CYCLE97 (2.3010, 0, -20.00000, 0.50000, 15.87500, 15.87500, 0.00000, 0.00000, 1.58750, 0.05000, 30.00000, 0.00000, 11, 2, 1, 1,)

N510 G00 X30
N520 M09 M05
N530 G00 X200 Z15
N540 M26
N550 M11 M0

N560 G90 G71
N570 T4
N580 M16 M08
N590 D2
N600 S2200 M03
N610 G00 X200 Z15
N620 G00 X30 Z1 M08
N630 G01 X26 Z1 F0.22
N640 Z-58
N650 X27
N660 G00 Z0

N670 G01 X23 Z0.5
N680 G01 X23 Z-35
N690 G01 X24
N700 G00 Z0.5
N710 G01 X18.0 Z1.0 F0.20
N720 X20.005 Z0.0
N730 X19.970 Z-35
N740 G01 X22.0 Z-35
N750 X24.75 Z-37 F0.20
N760 X24.75 Z-43
N770 G01 X25.145 Z-43
N780 G01 X25.130 Z-58
N790 X24.6
N800 G01 X28.3 Z-58 CHF=1.3
N810 G01 X28.3 Z-65
N820 G01 X28.3 Z-65
N830 M04 S1200
; N730 G00 X28 Z0
N840 G00 X200 Z15

N850 T5
N860 M16
N870 D2
N880 S1200 M04 M08

N850 T5
N860 M16
N870 D2
N880 S1200 M04 M08
N890 G00 X200 Z15
N900 G00 X30 Z-35 M08
N910 CYCLE 97 (1.59000, 0, -35.00000, -43.00000, 24.64000, 24.64000, 0.00000, 0.00000, 0.99875, 0.05000, 30.00000, 0.00000, 4, 2, 3, 1,)
N920 G00 X35.00 M09 M05

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