HIGH-FEED MILLING SOLUTIONS
HIGH-FEED MILLING

the Go-to Solution for Accelerated Machining
Three decades of know-how developing the most efficient solutions for **High-Feed Milling (HFM)**

1990

Tungaloy quickly detects the emerging needs for higher efficiency in face milling in the late 1990s and introduces the **MillFeed TXP** series to the market.

2010

Tungaloy introduces its **DoFeed** line in 2010 as the market starts to prefer more compact but faster machines. **DoFeed** revolutionized the concept of high-feed milling, offering large diameter cutters with higher feed rates.

2020

**TungForceFeed**, **MillQuadFeed**, and **DoTwistBall** continue Tungaloy’s legacy of offering highly efficient products to the market, reflecting the company’s core concept of accelerated machining.
GET STARTED!

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**WHY HFM?**

HFM is the go-to solution for accelerated machining!

In today’s hypercompetitive machining market, **cycle time plays a major role in determining the productivity** and profitability of any given job.

Simply increasing the speed or revolutions per minute (RPM) may appear to decrease the cycle time at a glance. A reduction in cycle time, however, is minimized by the time spent on changing inserts as the increase in speed or RPM shortens tool life. This additional job also increases the overall tool cost.

High-feed milling (HFM) is the solution for this problem. The tool works at elevated feed rates with modest speed or RPM, which reduces cycle time while extending tool life.

Thus, HFM has drastically transformed the world of milling. These flexible and versatile tools offer incomparable advantages over other milling products: dramatically reduced cycle time and cost, longer tool life, and higher quality of finished parts.

**Machining faster and more efficiently** - Long overhang and large components

HFM specializes in long-reach applications, such as deep-hole and pocket machining. Combined with its capability of ramping, Tungaloy’s high-feed cutters perform well in helical interpolation, where the tool moves in a circular motion to X and Y axes while simultaneously moving downward on the Z axis.

HFM is also the most suitable operation for machining large components. However, an additional finishing pass is usually required to clean up the rough surface. Using wiper inserts on Tungaloy’s HFM cutters helps customers achieve outstanding surface finish with no reduction in feed rate, thereby drastically making the overall machining process more efficient.
**Simplifying the processes** for near net shape

HFM provides high metal removal rate despite its small depth of cut. As this feature makes workpiece materials closer to the desired shape in one operation, semi-finishing operations can often be eliminated, and the finishing process can be simplified.

**Versatility**

Versatility is another advantage of HFM. Tungaloy offers HFM inserts with very positive cutting edges, which easily shear the material without work hardening.

For an example, DoFeed cutters can machine multiple hole diameters and produce counterbore and countersink in the same operation with no need to change or purchase multiple tools. This versatility helps customers save both cost and time.
HIGH-FEED MILLING MECHANISM

The HFM mechanism is based on the “chip thinning” principle

First utilized in the die and mold industry, high-feed milling is a machining method that pairs shallow depth of cut (DOC) with high feed rate up to 2.0 mm per tooth. This combination maximizes the amount of metal being removed from a part and increases the number of finished parts in a given time.

The HFM mechanism is based on the “chip thinning” effect. The thickness of a chip depends on the entry angle of a milling cutter. A cutter with a 90° entry angle has no benefit of chip thinning as the feed per tooth at 0.2 mm only creates chips 0.2 mm thick (Fig. 1). In the case of a cutter with a 45° entry angle, feed per tooth at 0.28 mm creates chips 0.2 mm thick (Fig. 2), which allows the feed to be increased, resulting in reduced cycle time. Fig. 3 shows the chip thinning effect of DoFeed, Tungaloy’s best selling HFM line, where the feed per tooth at 0.77 mm also provides chips 0.2 mm thick. Such an increase in the feed per tooth helps customers cut the cycle time by half or even more.

Low cutting force is another advantage of HFM. The entry angle on a cutter decides the direction of the cutting force. A 90° cutter (Fig. 1) will produce cutting force that acts perpendicular to the spindle, putting incredible pressure on the tool. As for a 45° cutter (Fig. 2), cutting force acts against the spindle at a 45° angle. With DoFeed, cutting force is almost parallel to the spindle due to its acute entry angle (Fig. 3), which means there is less pressure on the spindle.

Fig. 1
Chip thickness: 0.2 mm
Feed per tooth: 0.2 mm/t

Fig. 2
Chip thickness: 0.2 mm
Feed per tooth: 0.28 mm/t

Fig. 3
Chip thickness: 0.2 mm
Feed per tooth: 0.77 mm/t

DoFeed series

Tungaloy

www.tungaloy.com
Selecting the right tool to maximize profitability

Tungaloy’s High-Feed MillLines is shown on this chart in relation to tool diameter and depth of cut.

In principle, if the spindle power increases, higher cutting parameters, including higher feed per tooth, larger cutting diameter, and denser tooth pitch, can be used on a machine. However, if the parameters are set too high, the cutting force may exceed the spindle capacity and suddenly stop the machine. To prevent such a problem from happening, it is recommended to calculate the theoretical cutting force prior to machining and ensure that the cutting parameters are set within the limits.
### Tool and application choices

<table>
<thead>
<tr>
<th>Spindle size</th>
<th>BT30 / SK30 / CAT30</th>
<th>BT40 / SK40 / CAT40</th>
<th>BT50 / SK50 / CAT50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Facing</td>
<td>Shouldering</td>
<td>Shouldering R</td>
</tr>
<tr>
<td>TungForceFeed</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>DoFeed</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>MillQuadFeed</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>DoTwistBall</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>DoFeedQuad</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>TungMeister</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
</tbody>
</table>

- **Tool diameter**
  - ø8 - ø25
  - ø16 - ø200
  - ø25 - ø160
  - ø20 - ø63
  - ø50 - ø125
  - ø10 - ø20
- **Depth of cut (APMX)**
  - 0.5
  - 1 / 1.5
  - 1 / 1.5 / 2 / 2.5
  - 1.3 / 2
  - 2
  - 0.6 - 1.5
- **Entry angle**
  - 12°
  - 17° / 15°
  - 7° / 12° / 10° / 14°
  - 20° / 25°
  - 13°
  - R
- **No. of corners (insert)**
  - 2
  - 4
  - 4
  - 4
  - 8
  - 1
- **Applications**
  - Facing ★
  - Shouldering ★
  - Shoulderling R ★
  - Slotting ★
  - Slotting R ★
  - Profiling ★
  - Pocketing ★
  - Ramping ★
  - Plunging ★
  - Long overhang ★
  - Interrupted surface ★
  - Thin workpiece ★

- ★: Most suitable
- ★: Suitable
- ★: Usable
### Insert grade choices for each workpiece material

<table>
<thead>
<tr>
<th>ISO</th>
<th>Workpiece material</th>
<th>Hardness</th>
<th>1st choice</th>
<th>Wear resistance</th>
<th>Fracture resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Carbon steels</td>
<td>- 300HB</td>
<td><strong>AH3225</strong></td>
<td><strong>AH8015</strong></td>
<td><strong>AH3135</strong></td>
</tr>
<tr>
<td></td>
<td>Alloy steels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Austenitic stainless steels</td>
<td>- 200HB</td>
<td><strong>AH130</strong></td>
<td><strong>AH3135</strong></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ferritic stainless steels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Martensitic stainless steels</td>
<td>- 200HB</td>
<td><strong>AH130</strong></td>
<td><strong>AH3135</strong></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Precipitation hardening stainless steels</td>
<td>- 40HRC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Gray cast irons</td>
<td>- 250HB</td>
<td><strong>AH120</strong></td>
<td><strong>AH8015</strong></td>
<td><strong>AH3225</strong></td>
</tr>
<tr>
<td></td>
<td>Ductile cast irons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Titanium alloys</td>
<td>- 40HRC</td>
<td><strong>AH130</strong></td>
<td><strong>AH3135</strong></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Supper alloys</td>
<td>- 40HRC</td>
<td><strong>AH8015</strong></td>
<td>-</td>
<td><strong>AH120</strong></td>
</tr>
<tr>
<td></td>
<td>Plastic mold steels</td>
<td>- 45HRC</td>
<td><strong>AH3225</strong></td>
<td><strong>AH8015</strong></td>
<td><strong>AH3135</strong></td>
</tr>
<tr>
<td>H</td>
<td>Hot mold steels</td>
<td>45 - 55HRC</td>
<td><strong>AH8015</strong></td>
<td><strong>AH8005</strong></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Cold mold steels</td>
<td>55 - 60HRC</td>
<td><strong>AH8005</strong></td>
<td>-</td>
<td><strong>AH8015</strong></td>
</tr>
</tbody>
</table>
MILESTONE PRODUCTS

Offering a wide range of HFM tools and inserts, covering the vast application needs in the market

Versatility at its finest

- Perfect for ramping, plunging, hole enlarging, slotting, drilling, and shoulder milling in a wide range of industries
- Smooth chip evacuation and minimal chattering
- High productivity due to close-pitch design
- Maximum feed rate: 1.5 mm/z

See Tungaloy Report "DoFeed"

Highly versatile series with the unique insert design that allows changing entry angles

- Two types of inserts fit on one cutter body, providing two different entry angles
- ZER type: For general application with low cutting force
- UER type: Suitable for difficult-to-cut materials and long overhang machining
- Maximum feed rate: 2 mm/z

See Tungaloy Report "MillQuadFeed"
**TUNG FEED**

HFM cutter with robust design in small diameters
- Strong insert corner for high-feed operations
- Incredible productivity thanks to extra close-pitch tool
- R2 round insert is also mountable
- Maximum feed rate: 0.8 mm/z

See Tungaloy Report "TungForceFeed"

![Image](image1)

**DO TWIST BALL**

Unique twist on the insert ensures stability and maximizes productivity
- R4,5,6 round inserts are also mountable
- High machining efficiency with 30% greater D.O.C
- Maximum feed rate: 1.3 mm/z

See Tungaloy Report "DoTwistBall"

![Image](image2)

**DO FEED QUAD**

Economical tool for rough operations
- Dovetail clamping prevents inserts from lifting up during heavy roughing operations
- Maximum feed rate: 2 mm/z

See Tungaloy Report "DoFeedQuad"

![Image](image3)

**TUNG MEISTER** VFX

Indexable solid carbide head
- Highly accurate repeatability
- Drastically reduces tool changeover time
- Maximum feed rate: 1 mm/z

See Tungaloy Report "TungMeister"

![Image](image4)
INDUSTRY SEGMENTS
The right tool for each application

The die and mold industry requires machining complex 3D forms. Stamping, forming, forging dies, as well as injection and blow molds are all examples of processes in the industry that may require the final product to precisely meet the required dimensions for mass production. HFM is an important topic for die and mold machining because of the need to take light milling passes in order to obtain both the required geometry and the surface finish.

DoFeed features a close-pitch design to allow increased feed rate in profiling operations.

MillQuadFeed provides high metal removal rate, especially in face milling.

DoTwistBall offers stable chip evacuation in pocketing operations.

TungForceFeed specializes in machining narrow work areas with its small diameters.
The power generation industry is known for using components made of complex structures in stainless steel or heat-resistant alloys. Machining such parts requires cutters that not only feature sharp cutting edges but also offer high metal removal rate at low depth of cut. With well-balanced toughness and cutting edge sharpness, Tungaloy’s high-feed mills assure stable machining even in delicate operations.

Many components in the aerospace industry are made of tough materials, such as precipitation hardened stainless steel and titanium alloy. Standard tools quickly wear out while machining such parts, making it difficult to balance tool life and machining performance. Tungaloy’s close-pitched high-feed mills guarantee accelerated machining even in aerospace manufacturing.

TungForceFeed specializes in machining narrow work areas with its small diameters.

DoFeed’s low cutting force prevents chattering even with long overhang.

MillQuadFeed provides long tool life in machining difficult-to-cut materials due to its low entry angle.

DoFeed can machine titanium alloys with high feed and speed because of its close-pitch design.

Priority on productivity

Priority on tool life
For maximum performance

**DC and DCX**

Effective diameter DC is usually smaller than tool diameter DCX.

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**Theoretical radius and programming**

CAD/CAM systems require a defined radius dimension to program wall/shoulder machining. The parameters shown below are used for programming DoFeed’s EXN06/TXN06 inserts. The “R” noted below is defined as the theoretical radius used for programming.

When programming the machining process, the theoretical radius (R) and the actual profile left uncut on the machined surface (t1) should be noted. Here, R = 3 mm is recommended for a EXN06/TXN06 insert. If a larger radius (such as R = 4 mm) is programmed, an overcut (t2) of 0.26 mm may occur and the dimensional accuracy may deviate from the requirement.

<table>
<thead>
<tr>
<th>Corner R when programming</th>
<th>Amount left as uncut t₁</th>
<th>Amount left as overcut t₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>0.77</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>0.54</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Each value above is calculated theoretically at the maximum condition.
Long overhang and chattering

HFM offers chatter-free, stable machining with long overhang settings because the cutting force directs axially towards the spindle. However, vibration may still occur with long-reach tools of 5xD or greater. The following measures are recommended to eliminate chattering in such conditions.

Change the cutting tool

1. Use inserts with a small entry angle

If the entry angle of the insert is small, the cutting force is directed axially towards the machine spindle during HFM operations, which minimizes tool vibration. Use inserts with an entry angle as small as possible to minimize chatter and maximize machining stability.

2. Use a coarse-pitched tool

Using a coarse-pitched tool will decrease the number of cutting edges simultaneously in contact with the workpiece and reduce chattering. If additional stability is needed, use a sharper chipbreaker after selecting a coarse-pitched tool.

Change the cutting parameters

Optimizing the cutting parameters to 70% of the recommended values may minimize vibration. Adjust the parameters in the following order:

1: Reduce the cutting speed (Vc)
2: Reduce the DOC (ap)
3: Reduce the feed rate (fz)

(Note: Using a feed rate of 0.5 mm/z or lower may adversely increase vibration.)
Machining thin workpieces with weak fixture

Workpieces in a thin, flat structure with weak fixture setting are prone to chatter. To minimize vibration, reduce thrust force by decreasing D.O.C. or feed rate. Another option is to use a cutter with a bigger entry angle for reduced thrust force.

Milling unstable surfaces

Milling unstable surfaces, including scale removal, is a troublesome operation. Insert damage is common in these operations, hindering unmanned machine operations. Many customers choose a high-feed cutter as a safe and productive machining solution. However, due to surface unevenness, a high-feed cutter is forced to make unproductive "air cut" passes before the surfaces reach a quality high enough for the finishing operations to follow.

MillQuadFeed is an extremely efficient milling solution for unstable surfaces. With its high-feed capability of 2 mm per tooth at 2.5 mm depth of cut, MillQuadFeed ensures high stability and metal removal rates. Face milling cutter with round inserts, for example DoTripleMill with round inserts, is another solution. One single set of inserts can be used for both highly efficient scale removal and follow-up high-feed milling.
Success stories with Tungaloy's HFM products

**Part:** Stamping die part
**Material:** SKD61 / x40CrMoV5-1 (45HRC)
**Cutter:** EXLS02M012C12.0LH50R02 (ø12, z = 2)
**Insert:** LSMT0202ZER-HM
**Grade:** AH3225

**Cutting conditions:**
- \( V_c = 113 \text{ m/min} \)
- \( f_z = 0.5 \text{ mm/z} \)
- \( V_f = 3000 \text{ mm/min} \)
- \( a_p = 0.3 \text{ mm} \)
- \( a_e = 12 \text{ mm} \)

**Process:** Face milling
**Machine:** Vertical MC, BT50

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**Part:** Mold
**Material:** S50C
**Cutter:** EXLS02M012C12.0LH50R02 (ø12, z = 2)
**Insert:** LSMT0202ZER-HM
**Grade:** AH3225

**Cutting conditions:**
- \( V_c = 200 \text{ m/min} \)
- \( f_z = 0.6 \text{ mm/z} \)
- \( V_f = 6370 \text{ mm/min} \)
- \( a_p = 0.3 \text{ mm} \)
- \( a_e = 12 \text{ mm} \)

**Process:** Shouldering, Air blow
**Machine:** Vertical M/C, BT30

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**Productivity:**
- 5 times!
- 4 times!
### Part: Linear guide part
- **Material:** S50C
- **Cutter:** HXLS02M016M08R05 (ø16, z = 8)
- **Insert:** LSMT0202ZER-HM
- **Grade:** AH3225
- **Cutting conditions:**
  - $V_c = 181$ m/min
  - $f_z = 0.5$ mm/z
  - $V_f = 9000$ mm/min
  - $a_p = 0.4$ mm
  - $a_e = 16$ mm
- **Process:** Slotting, Wet
- **Machine:** Vertical M/C, BT50

### Part: Back block
- **Material:** Prehardened steel HPM7 (HRC30)
- **Cutter:** TXN06R080M31.7-08 (ø80, z = 8)
- **Insert:** LNMU06X5ZER-MJ
- **Grade:** AH3035
- **Cutting conditions:**
  - $V_c = 115$ m/min
  - $f_z = 0.7$ mm/z
  - $V_f = 2564$ mm/min
  - $a_p = 1.1$ mm
  - $a_e = 42$ mm
- **Process:** Contour milling, Air blow
- **Machine:** Vertical M/C, BT50

### Part: Turbine blade
- **Material:** Heat resistant cast steel
- **Cutter:** EXN03R035M32.0-05 (ø35, z = 5)
- **Insert:** LNMU0303ZER-ML
- **Grade:** AH725
- **Cutting conditions:**
  - $V_c = 70$ m/min
  - $f_z = 0.5$ mm/z
  - $V_f = 1590$ mm/min
  - $a_p = 0.5$ mm
  - $a_e = 30$ mm
- **Process:** Shoulder milling, Wet
- **Machine:** Vertical M/C, BT50
**HIGH-FEED MILLING**

**Part:** Airplane component  
**Material:** Ti-6Al-4V (36HRC)  
**Cutter:** EXN03R025M25.0-05 (ø25, z = 5)  
**Insert:** LNMU0303ZER-ML  
**Grade:** AH130  
**Cutting conditions:**  
\[
V_c = 50 \text{ m/min} \\
f_z = 0.7 \text{ mm/z} \\
V_f = 2230 \text{ mm/min} \\
ap = 0.5 \text{ mm} \\
a_e = 25 \text{ mm} \\
\]

**Process:** Pocket milling, Wet  
**Machine:** Vertical M/C, BT40

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**Part:** End fitting  
**Material:** Ti-6Al-4V  
**Cutter:** EXN03R025M25.0-05 (ø25, z = 5)  
**Insert:** LNMU0303ZER-ML  
**Grade:** AH130  
**Cutting conditions:**  
\[
V_c = 40 \text{ m/min} \\
f_z = 0.7 \text{ mm/z} \\
V_f = 1800 \text{ mm/min} \\
ap = 0.8 \text{ mm} \\
a_e = \text{ variable} \\
\]

**Process:** Rough pocket milling, Wet  
**Machine:** Horizontal M/C

---

**Part:** Body  
**Material:** FCMP45-06  
**Cutter:** TXN06R050M22.0E05 (ø50, z = 5)  
**Insert:** LNMU06X5ZER-MJ  
**Grade:** AH130  
**Cutting conditions:**  
\[
V_c = 170 \text{ m/min} \\
f_z = 1 \text{ mm/z} \\
V_f = 5410 \text{ mm/min} \\
ap = 1.3 \text{ mm} \\
a_e = 38 \text{ mm} \\
\]

**Process:** Plunging / Helical milling, Dry  
**Machine:** Horizontal M/C, BT50
**Part:** Automotive parts  
**Material:** DHA WORLD (X40CrMoV5-1) 44HRC  
**Cutter:** TXN06R080M31.7-08 (ø80, z = 8)  
**Insert:** LNMU06X5ZER-MJ x7  
**LNGU06X5ZER-W x1 (Wiper)**  
**Grade:** AH725  
**Cutting conditions:**  
\[
\begin{align*}
V_c &= 151 \text{ m/min} \\
f_z &= 0.11 \text{ mm/z} \\
V_f &= 629 \text{ mm/min} \\
ap &= 0.1 \text{ mm} \\
a_e &= 60 \text{ mm}
\end{align*}
\]  
**Process:** Face milling, Air blow  
**Machine:** Vertical M/C, BT50

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**Part:** Discharge casing  
**Material:** Duplex stainless steel  
**Cutter:** TXN06R200M47.6-12 (ø200, z = 12)  
**Insert:** LNMU06X5ZER-MJ  
**Grade:** AH3035  
**Cutting conditions:**  
\[
\begin{align*}
V_c &= 75 \text{ m/min} \\
f_z &= 0.97 \text{ mm/z} \\
V_f &= 14.00 \text{ mm/min} \\
ap &= 0.5 \text{ mm} \\
a_e &= 160 \text{ mm}
\end{align*}
\]  
**Process:** Face milling: Interrupted, Dry  
**Machine:** Vertical M/C, BT50

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**Part:** Impeller wing  
**Material:** SRUD, SUS630  
**Cutter:** TXN06R080M31.7E08 (ø80, z = 8)  
**Insert:** LNMU06X5ZER-MJ  
**Grade:** AH3035  
**Cutting conditions:**  
\[
\begin{align*}
V_c &= 46.7 \text{ m/min} \\
f_z &= 0.67 \text{ mm/z} \\
V_f &= 997 \text{ mm/min} \\
ap &= 0.7 \text{ mm} \\
a_e &= \text{ variable}
\end{align*}
\]  
**Process:** Pocketing, Wet  
**Machine:** Vertical M/C, BT50
### Part: Stamping die
- **Material:** S45C / C45 (28HRC)
- **Cutter:** TXSW09M050B22.0R07 (ø50, z = 7)
- **Insert:** SWMT0904ZER-MM
- **Grade:** AH3135

**Cutting conditions:**
- \( V_c = 204 \text{ m/min} \)
- \( f_z = 0.84 \text{ mm/z} \)
- \( V_f = 7600 \text{ mm/min} \)
- \( a_p = 0.9 \text{ mm} \)
- \( a_e = 50 \text{ mm} \)

**Process:** Pocketing, Air blow
**Machine:** Vertical M/C, BT50

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### Part: Gearwheel
- **Material:** SUS316Ti
- **Cutter:** TXSW09M040B16.0R05 (ø40, z = 5)
- **Insert:** SWMT0904UER-MM
- **Grade:** AH3135

**Cutting conditions:**
- \( V_c = 100 \text{ m/min} \)
- \( f_z = 0.6 \text{ mm/z} \)
- \( V_f = 2400 \text{ mm/min} \)
- \( a_p = 0.7 \text{ mm} \)
- \( a_e = 40 \text{ mm} \)

**Process:** Face milling, Air blow
**Machine:** Horizontal M/C, BT50

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### Part: Vacuum valve
- **Material:** SUS316L
- **Cutter:** TXSW09M050B22.0R07 (ø50, z = 7)
- **Insert:** SWMT0904UER-MM
- **Grade:** AH3135

**Cutting conditions:**
- \( V_c = 100 \text{ m/min} \)
- \( f_z = 1.2 \text{ mm/z} \)
- \( V_f = 5350 \text{ mm/min} \)
- \( a_p = 0.5 \text{ mm} \)
- \( a_e = -50 \text{ mm} \)

**Process:** Pocketing, Dry
**Machine:** Horizontal M/C, BT50
Part: Ship crankshaft
Material: SCM440
Cutter: TXSW15J100B31.7R06 (ø100, z = 6)
Insert: SWMT1506ZER-MJ
Grade: AH120

Cutting conditions:

\[
\begin{align*}
V_c &= 150 \text{ m/min} \\
F_z &= 2 \text{ mm/z} \\
V_f &= 5730 \text{ mm/min} \\
ap &= 2.0 \text{ mm} \\
a_e &= 44 \text{ mm}
\end{align*}
\]

Process: Face milling, Air blow
Machine: Horizontal M/C, BT50

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Part: Windmill housing
Material: Ductile cast iron 450 (GGG40)
Cutter: TXSW15J125B40.0R07 (ø125, z = 7)
Insert: SWMT1506ZER-MJ
Grade: AH120

Cutting conditions:

\[
\begin{align*}
V_c &= 220 \text{ m/min} \\
F_z &= 1.3 \text{ mm/z} \\
V_f &= 5020 \text{ mm/min} \\
ap &= 2.5 \text{ mm} \\
a_e &= 125 \text{ mm}
\end{align*}
\]

Process: Face milling, Air blow
Machine: Horizontal M/C, BT50
HIGH-FEED MILLING

Part: Turbine blade
Material: 12CrMo
Cutter: TXLN04M050B22.0R07 (ø50, z = 7)
Insert: LNMX0405R4-MJ
Grade: AH3135
Cutting conditions:
- $V_c = 270 \text{ m/min}$
- $f_z = 0.23 \text{ mm/z}$
- $V_f = 2767 \text{ mm/min}$
- $a_p = 0.8 \text{ mm}$
- $a_e = 25 \text{ mm}$
Process: Profiling, Wet
Machine: Vertical M/C, BT50

Part: Slide Core
Material: NAK80 (HRC40)
Cutter: EXLN04M025C25.0R03 (ø25, z = 3)
Insert: LNMX0405R4-MJ
Grade: AH3135
Cutting conditions:
- $V_c = 150 \text{ m/min}$
- $f_z = 0.3 \text{ mm/z}$
- $V_f = 1719 \text{ mm/min}$
- $a_p = 4 \text{ mm}$
- $a_e = 7 \text{ mm}$
Process: Shoulder milling, Wet
Machine: Vertical M/C

Part: Arm
Material: SC480
Cutter: EXLN04M032C32.0R04 (ø32, z = 4)
Insert: LNMX0405ZER-HJ
Grade: AH3135
Cutting conditions:
- $V_c = 200 \text{ m/min}$
- $f_z = 0.36 \text{ mm/z}$
- $V_f = 2865 \text{ mm/min}$
- $a_p = 1.2 \text{ mm}$
- $a_e = 10 \text{ mm}$
Process: Hole enlarging
Machine: Horizontal M/C
Part: Die
Material: DAC10 (Tool steel, 48HRC)
Cutter: TXLN04M040B16.0R06 (ø40, z = 6)
Insert: LNMX0405ZER-HJ
Grade: AH120
Cutting conditions:
- \( V_c = 100 \text{ m/min} \)
- \( f_z = 0.44 \text{ mm/z} \)
- \( V_f = 2100 \text{ mm/min} \)
- \( a_p = 1.96 \text{ mm} \)
- \( a_e = \text{variable} \)
Process: Contouring, Air blow
Machine: Vertical M/C, BT50

Part: Body and frame
Material: Super-duplex stainless steel
Cutter: TXQ12R080M27.0E05 (ø80, z = 5)
Insert: SQMU1206ZSR-MJ
Grade: AH130
Cutting conditions:
- \( V_c = 80 \text{ m/min} \)
- \( f_z = 0.6 \text{ mm/z} \)
- \( V_f = 960 \text{ mm/min} \)
- \( a_p = 0.8 \text{ mm} \)
- \( a_e = 70 \text{ mm} \)
Process: Face milling, Dry
Machine: Multi-axis M/C

Part: Herringbone gear
Material: SCM440 / 42CrMo4 (34HRC)
Shank: VTSD12L110S06-W-A
Head: VFX120L01.0R25-02S08 (ø12, z = 2)
Grade: AH125
Cutting conditions:
- \( V_c = 120 \text{ m/min} \)
- \( f_z = 0.8 \text{ mm/z} \)
- \( V_f = 5093 \text{ mm/min} \)
- \( a_p = 0.6 \text{ mm} \)
- \( a_e = 12.7 \text{ mm} \)
Process: Slot milling, 1000 PSI
Machine: Horizontal M/C

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