MITSUBISHI
MITSUBISHI MATERIALS

A610G

AEROSPACE
APPLICATIONS

MITSUBISHI MATERIALS CORPORATION

INDEX AEROSPACE

AIR FRAME

■ CFRP ■ CF/Al ■ CF/Ti

ENGINE

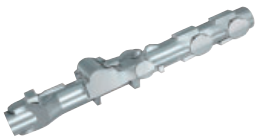
Ni-based Superalloy

Titanium Alloy

Maraging Steel

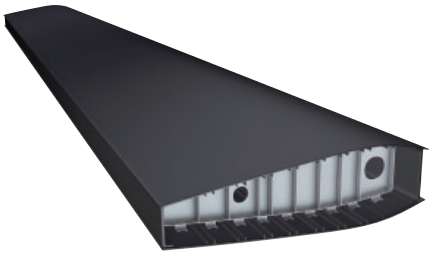
LANDING GEAR

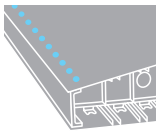
Titanium Alloy



AIR FRAME

Work Materials [CFRP, CF/Al]





Drilling

MCS Drill
(TOOLS NEWS B184G)

S-TAW Drill
(Special insert)

New CVD diamond coated drills

Optimized cutting geometry

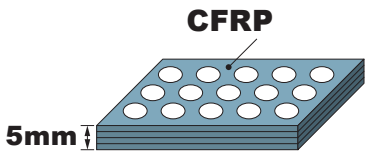
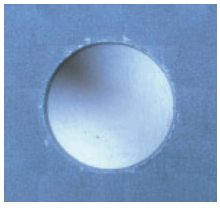
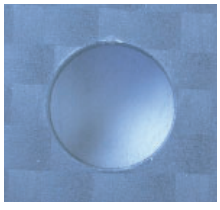
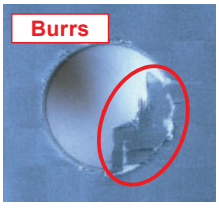
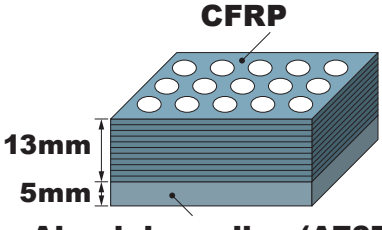
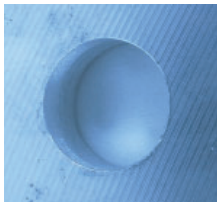
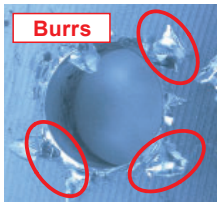
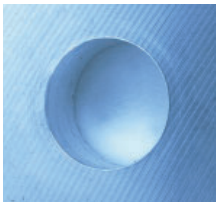
Key Point on Machining

- Tool life is extremely short because carbon fibre has high strength and when drilling composite materials, burrs and delamination are easily generated. It is effective to use a tool that has a high wear resistance coating. The MCS drill and S-TAW drills (special order) decrease burrs and delamination due to the CVD diamond coating and their optimized geometry. Long tool life and high-quality drilling became possible.

Application Example

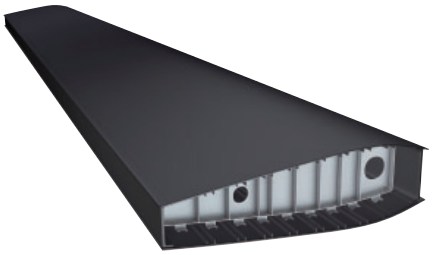
- **CVD diamond coated drills with optimized cutting geometry for composite materials reduce burr formation and delamination.**

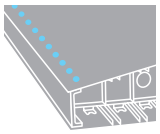
Drill	ø 6.375
Cutting Speed	vc100 m/min (4995 min^{-1})
Feed	f0.04 mm/rev
Machine	Vertical type M/C
Coolant	Internal air blow

Work Material	MCS	Conventional A for CFRP	Conventional B for CFRP + Al
 **CFRP** Bottom side of CFRP			
 **CFRP + Al** Bottom side of aluminium alloy Aluminium alloy (A7075)			

AIR FRAME

Work Materials [CFRP, CF/Ti]





Drilling

PCD Drill
(Special)

PCD drills

Optimized cutting geometry

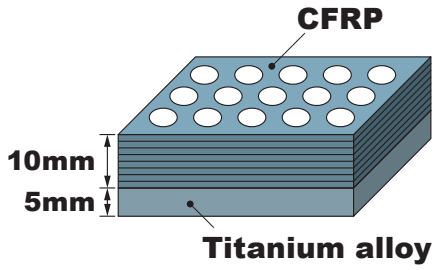
Key Point on Machining

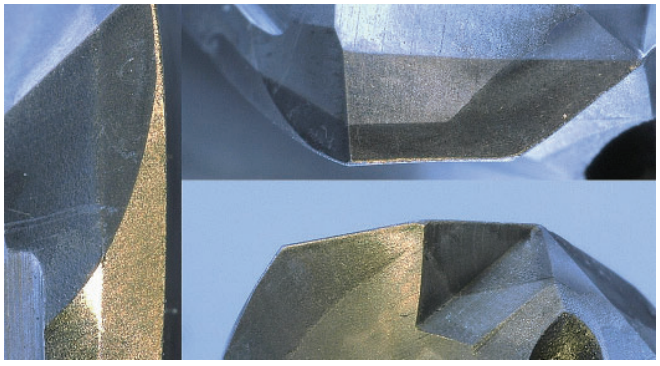
- Tool life is extremely short because carbon fibre has high strength and when drilling composite materials, burrs and delamination are easily generated. It is effective to use a tool that has PCD (sintered diamond) with high wear resistance. A PCD drill (special order) with optimized geometry and PCD coating (sintered diamond) decreases burrs and delamination. Long tool life and high-quality drilling became possible.

Application Example

- **PCD drills with optimized cutting geometry for composite materials reduces burr formation and delamination.**

Drill	ø 6.375
Work Material	CFRP + Titanium alloy (Ti-6Al-4V)
Cutting Speed	vc10 m/min (500 min^{-1})
Feed	f0.05 mm/rev
Machine	Vertical type M/C
Coolant	Internal mist

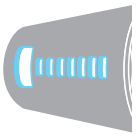




Good edge condition (120 hole machined)

AIR FRAME

Work Materials [CFRP]



Trimming

DFC End mill
(TOOLS NEWS B189G)

New CVD diamond coated end mills

Optimized cutting geometry

Key Point on Machining

- **Tool life is extremely short because carbon fibre has high strength and when drilling composite materials, burrs and delamination are easily generated. It is effective to use a tool that has high wear resistance coating. DFC end mills decrease the burrs and the delamination due their CVD diamond coating and optimized cutting geometry.**
  Long tool life, high-quality milling became possible.

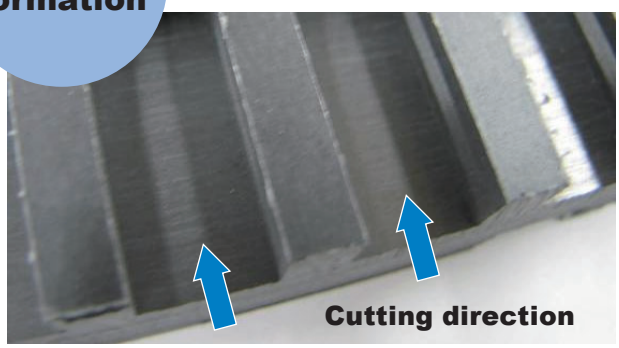
Application Example

- **CVD diamond coated end mills with optimized cutting geometry for composite materials reduce burr formation and delamination.**

End mill	DFC4JCD1000 (ø 10)
Work Material	CFRP
Revolution	n6000 min^{-1} (vc188 m/min)
Feed	vf750 mm/min (fz0.03 mm/tooth)
Depth of Cut	ap5 mm
Coolant	Air blow

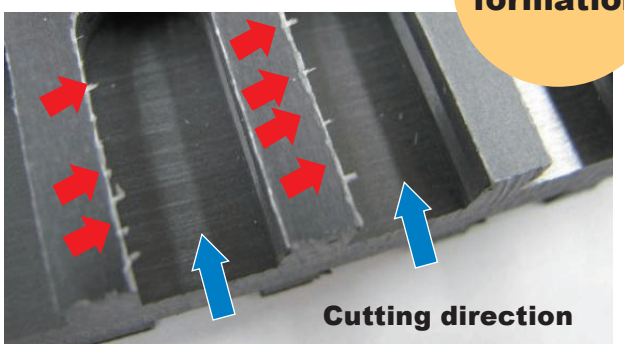
No burr formation

DFC4JCD1000



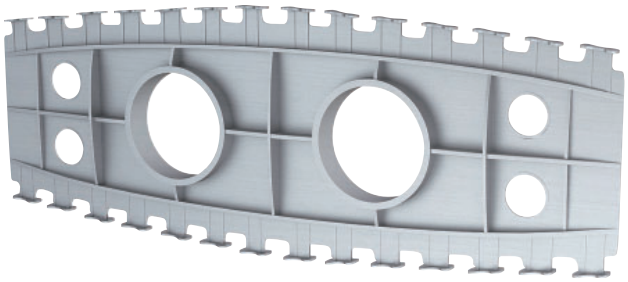
Conventional

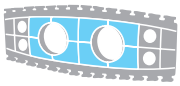
Many burr formation



AIR FRAME

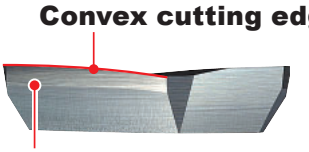
Work Materials [Aluminium Alloy]





Face Milling, Pocket Milling

AXD Series
(TOOLS NEWS B116G)



Low cutting resistance

Key Point on Machining

- **When milling rib type components where stock material removal is over 90%, high speed and high efficiency machining is necessary to reduce costs. The AXD series achieves low cutting resistance without lowering the insert edge strength due to a helical flank and optimized of the relief angle. Additionally, the convex cutting edge allowed good chip removal, resulting in high speed, high efficiency machining.**

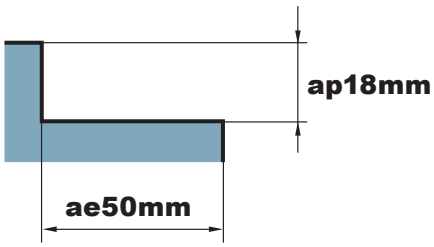
Application Example

- **Chip removal 10000cm³/min. is achieved by the super-high efficiency machining of the AXD7000-HSK type.**

Holder	**AXD7000R05003A-H63A**
Insert (Grade)	**XDGX227030PDFR-GL (TF15)**
Work Material	**A7075**
Cutting Speed	**vc2830 m/min (n18000 min^{-1})**
Feed	**fz0.21 mm/tooth (vf11340 mm/min)**
Depth of Cut	**ap18 mm, ae50 mm**
Coolant	**Emulsion**

Point

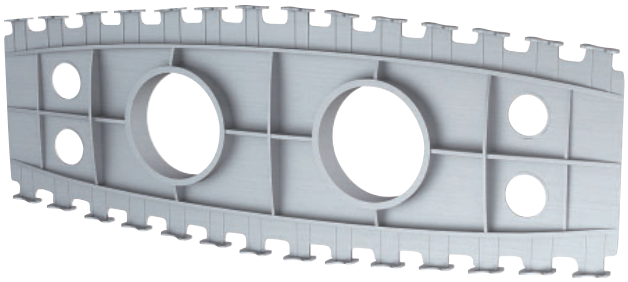
Avoids poor wall surface finishes because the tool is designed to Interpolate corners of the pocket, thereby also preventing vibration.

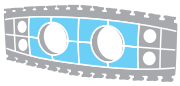


***Overseas major aerospace manufacturers using 50 pieces or more.**

AIR FRAME

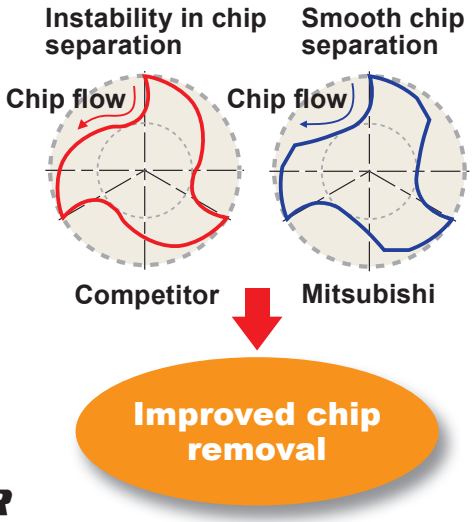
Work Materials [Aluminium Alloy]





Face Milling, Pocket Milling

ALIMASTER
(TOOLS NEWS B118G)



Key Point on Machining

- When milling rib type components where stock material removal is over 90%, high speed and high efficiency machining is necessary to reduce costs. The ALIMASTER series achieves good chip removal due to the unique cross-sectional shape of the flute geometry shape. This enabled high speed, high efficiency machining.

Application Example

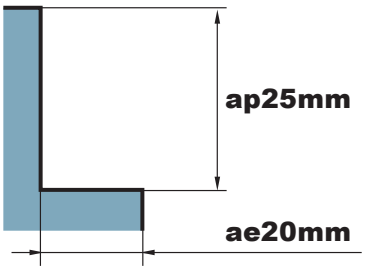
- **Chip removal 5000cm³/min. is achieved when using the high power main machine axis at high-speeds.**

End mill	CSRARBD2500R300 (ø 25/R3)
Work Material	A7075
Cutting Speed	vc1178 m/min (n15000 min^{-1})
Feed	fz0.22 mm/tooth (vf10000 mm/min)
Depth of Cut	ap25 mm, ae20 mm
Coolant	Emulsion

Point

Avoids poor wall surface finishes because the tool is designed to Interpolate corners of the pocket, thereby also preventing vibration.

<Machine specification>
15000min^{-1}/75kW, BT50

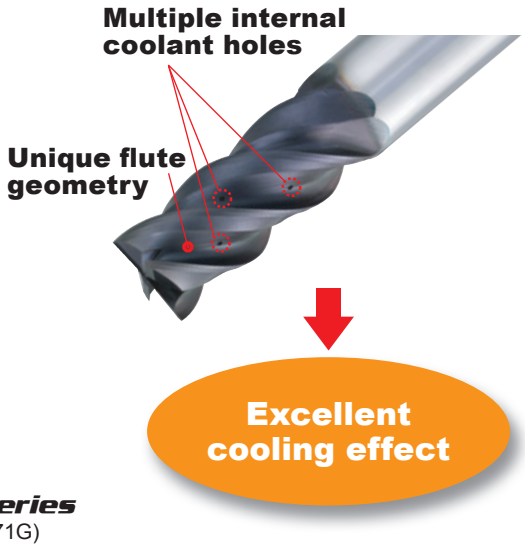


AIR FRAME

Work Materials [Titanium Alloy]

Side Milling, Pocket Milling

Coolstar Series
(TOOLS NEWS B171G)



Key Point on Machining

- When milling titanium alloys adhesion is easily generated, thermal conductivity is low and heat concentrates on the cutting edge, it is important to remove heat at the cutting edge efficiently and also to evacuate chips smoothly. The Coolstar series achieves optimum cooling effect and chip removal due to the multi coolant holes and unique flute shape. Stable machining became possible for difficult-to-cut material applications.

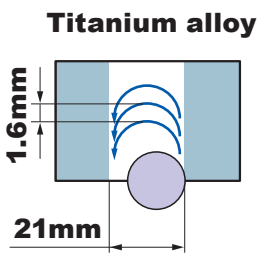
Application Example

- **No adhesion due excellent cooling effect of the multi coolant holes.**

End mill	VF6MHVCHD1600 (ø 16)
Work Material	Ti-6Al-4V
Cutting Speed	vc150 m/min (n3000 min^{-1})
Feed	fz0.1 mm/tooth (vf1800 mm/min)
Depth of Cut	ap24 mm, ae1.6 mm (Trochoid)
Coolant	Emulsion (0.7 MPa)

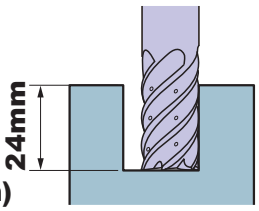
VF-6MHV-CH

Feed rate:1800mm/min (0.1mm/tooth)



Conventional
(External coolant)

Feed rate:1350mm/min (0.075mm/tooth)



ENGINE

Work Materials [Ni-based Superalloy]

Copy Turning

GY Series
(TOOLS NEWS B140G)

GS Breaker
(Low feeds)

Good cutting performance

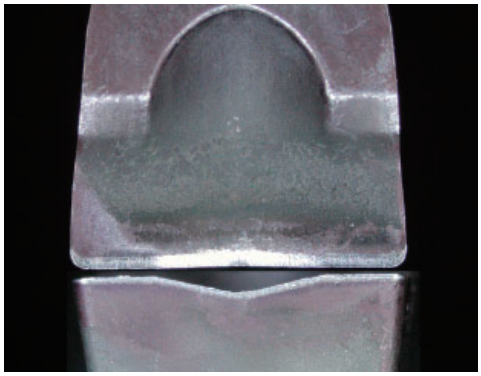
Key Point on Machining

- Ni-based alloy machining requires a sharp edge geometry.
  An increase in tool life can be achieved by using GS breaker that is designed to decrease the cutting resistance.

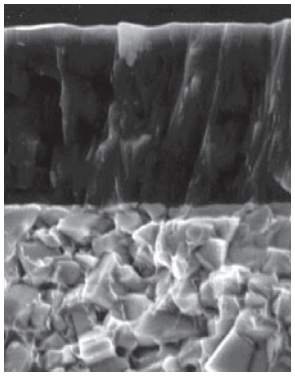
Application Example

- **Stable machining is possible on super heat-resistant alloys.**

Holder	GYHL2525M00-M25L
Insert (Grade)	GY2M0600J040N-GS (VP10RT)
Work Material	Waspaloy
Cutting Speed	vc35 m/min
Feed	f0.05 mm/rev
Depth of Cut	ap10 mm
Coolant	Emulsion



VB: 0.122mm



VP10RT

MIRACLE® coating

Carbide substrate
(HRA92.0)

Further use is possible because of small wear. (after 25 min. machining)

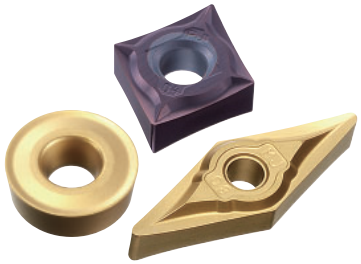
ENGINE

Work Materials [Ni-based Superalloy]

External and Internal Turning

HSK-T Tools
(TOOLS NEWS B134G)

Good cutting performance



FJ/MS/GJ
US905/VP05RT/VP10RT
(TOOLS NEWS B036G)

Key Point on Machining

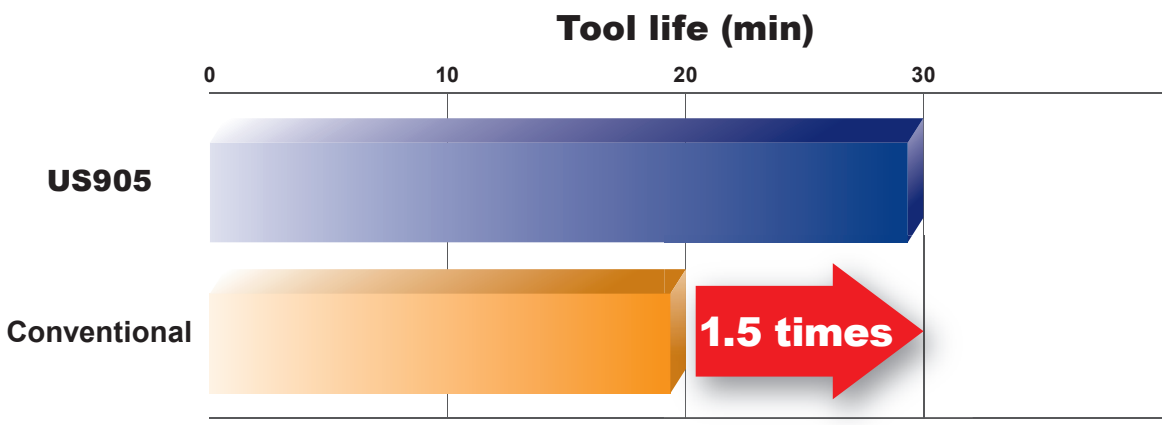
- US905 grade for finish-machining of Ni-based alloys. Can be used at higher-speeds when machining Ni-based alloys than VP05RT and VP10RT with PVD coating that are usually used at 50m/min. machining speeds or less.

Application Example

- **Possible to use for high speed finish machining of super heat resistant alloys.**

Holder	DCLNL3225P32
Insert (Grade)	CNMG120408-MS (US905)
Work Material	Inconel® 718
Cutting Speed	vc80 m/min
Feed	f0.15 mm/rev
Depth of Cut	ap0.25 mm
Coolant	Emulsion

MS Breaker



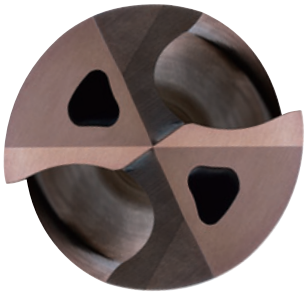
ENGINE

Work Materials [Ni-based Superalloy]

Drilling

MMS Drill
(TOOLS NEWS B180G)

Excellent cooling effect



"TRI-Cooling Technology"

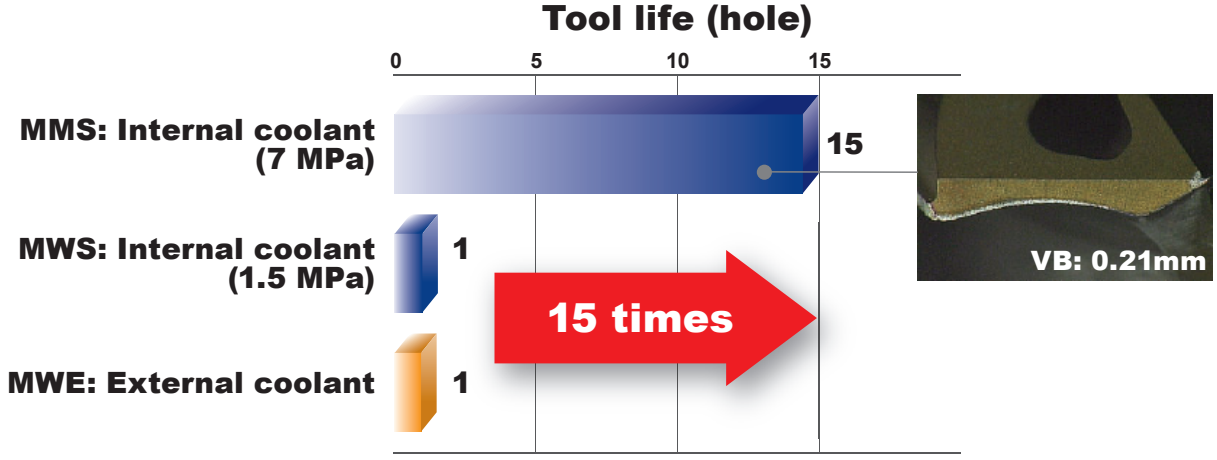
Key Point on Machining

- When drilling Ni-based alloys, a major factor is how to cool the cutting edge. It is possible to extend tool life greatly by using a solid carbide drill that uses TRI-Cooling through coolant technology together with a high-pressure coolant supply.

Application Example

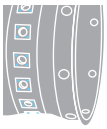
- **15 times tool life is achieved when using high-pressure internal coolant and TRI-cooling technology.**

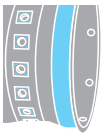
Drill (Grade)	MMS0610X3D (DP7020)
Work Material	Inconel® 718
Cutting Speed	vc14 m/min
Feed	f0.06 mm/rev
Hole Depth	15 mm
Coolant	Emulsion



ENGINE

Work Materials [Ni-based Superalloy]





Helical Cutting,
Profile Milling

Multifunction

ARX
(TOOLS NEWS B066G)

Key Point on Machining

- For machining of holes on the outer side of the engine cases, helical machining with a small diameter radius insert end mill is effective. Additionally it delivers an excellent machining performance when profile machining on the outer faces.

Application Example

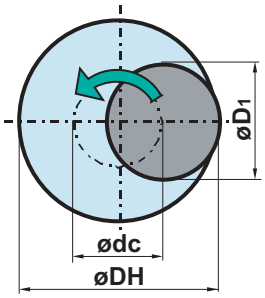
- **Large hole machining of super heat-resistant alloys is achieved by helical machining with a small diameter, indexable insert, radius end mill.**

Holder	ARX35R142SA12S
Insert (Grade)	RDMW0724M0E (VP15TF)
Work Material	Inconel® 718
Cutting Speed	vc30 m/min
Feed	f0.2 mm/rev (Helical Cutting)
Hole Depth	20 mm (1 mm/rev), Hole dia. 25 mm
Coolant	Emulsion

VB: 0.08mm

Further use is possible because of small wear. (after 7 min. machining)

■ **Helical Cutting**



● **Setting a tool's centre excursion**

ødc = øDH - øD1

ødc	øDH	øD1
Tool's center excursion	Required bore diameter	Tool's cutting diameter

ENGINE

Work Materials [Titanium Alloy]

External and
Internal Turning

Good cutting performance

HSK-T Tools
(TOOLS NEWS B134G)

FJ/MS/GJ
RT9010
(TOOLS NEWS B036G)

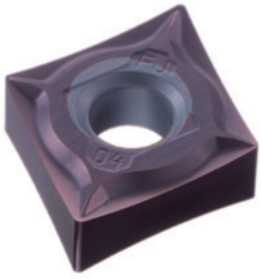
Key Point on Machining

- Rough estimate of the tool life is 120 minutes at 80m/min, 60 minutes at 120m/min, when finish-machining titanium-alloy. Non-coated grades are the first recommendation.

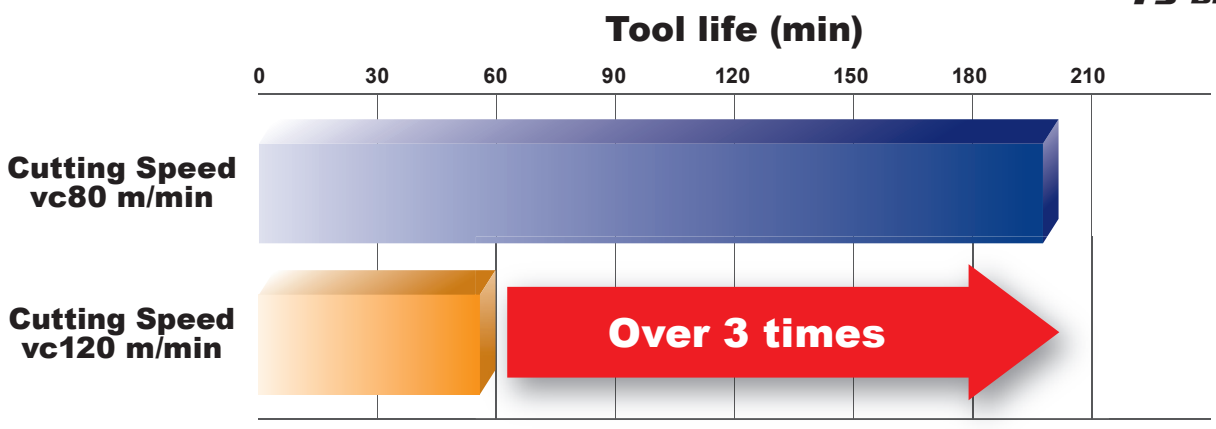
Application Example

- **Over 3 times tool life is achieved by setting appropriate cutting conditions.**

Holder	H63T-DCLNR-DX12
Insert (Grade)	CNGG120408-FJ (RT9010)
Work Material	Ti-6Al-4V
Cutting Speed	vc80, 120 m/min
Feed	f0.15mm/rev
Depth of Cut	ap0.25 mm
Coolant	Emulsion



FJ Breaker



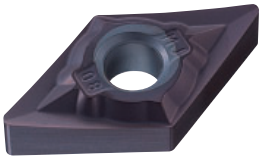
ENGINE

Work Materials [Maraging Steel]

External and
Internal Turning

HSK-T Tools
(TOOLS NEWS B134G)

Good cutting performance



FJ/MS/GJ
VP05RT/VP10RT
(TOOLS NEWS B036G)

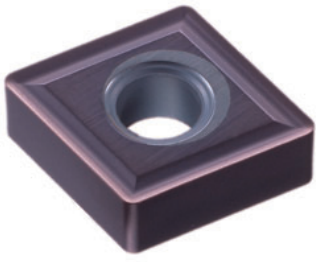
Key Point on Machining

- When rough machining engine shafts made from maraging steel, the use of grades for hard materials such as VP05RT through to the use of the CBN is recommended.

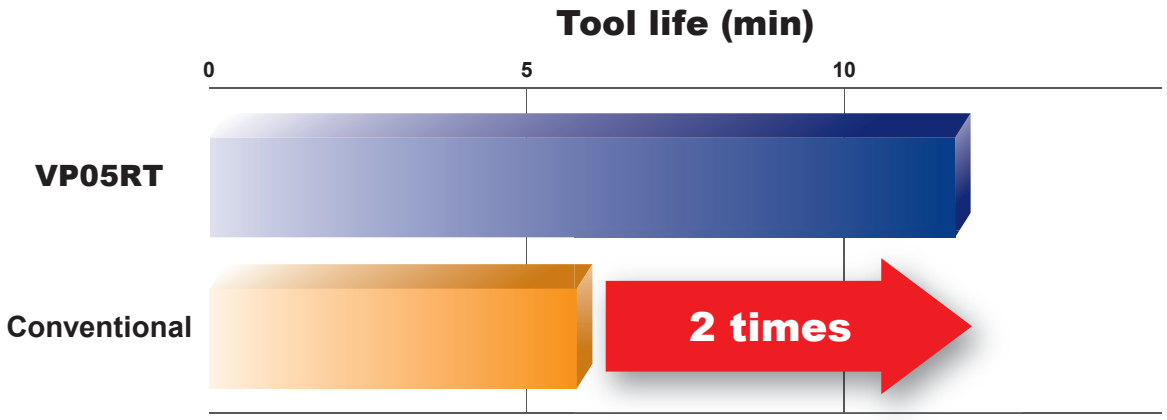
Application Example

• 2 times tool life is achieved by using VP05RT.

Holder	PSC63-DDJNR
Insert (Grade)	DNMG150412-MS (VP05RT)
Work Material	Maraging Steel (48-50HRC)
Cutting Speed	vc90 m/min
Feed	f0.23 mm/rev
Depth of Cut	ap2 mm
Coolant	Emulsion

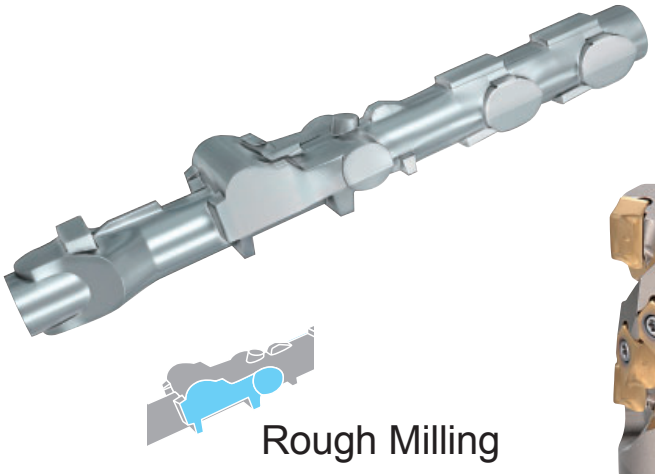


MS Breaker

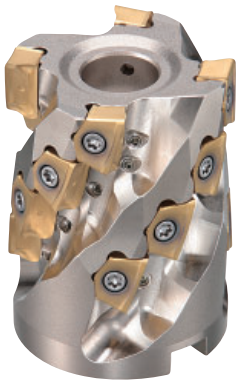


LANDING GEAR

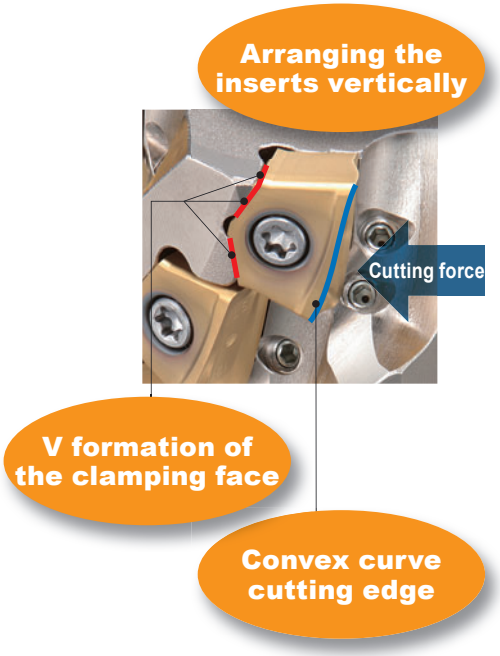
Work Materials [Titanium Alloy]



Rough Milling



VFX6
(TOOLS NEWS B182G)



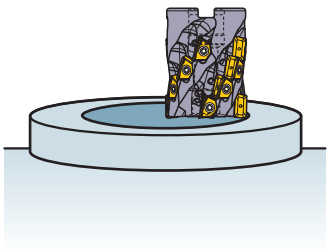
Key Point on Machining

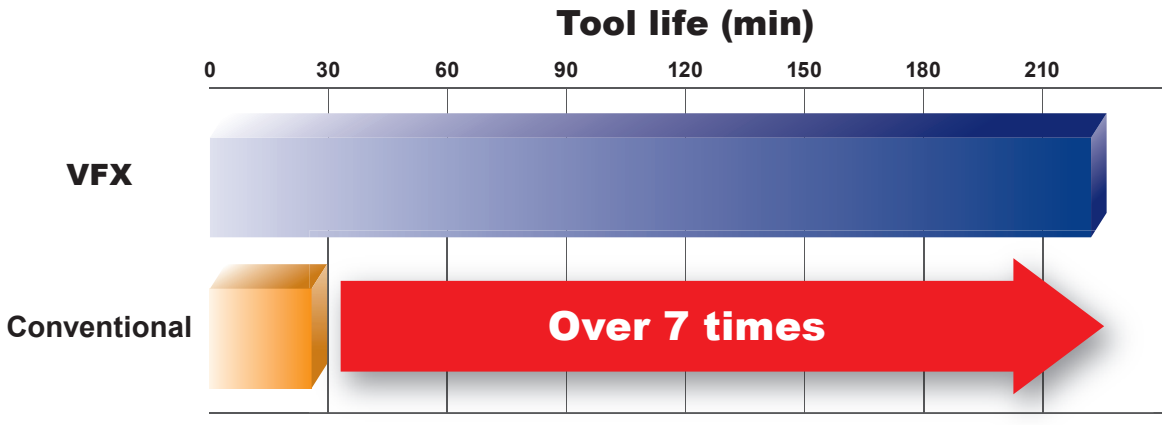
- When rough machining titanium alloy, chipping and abnormal damage of the cutting edge easily occurs if low rigidity tools are used. Using high rigidity tools and low cutting resistance inserts is recommended. Stable machining is possible because the VFX series is a high rigidity design and cutting resistance is lower due to the convex curve cutting edge and the V-formation of the clamping face.

Application Example

- **Over 7 times tool life is achieved in combination with high-pressure internal coolant.**

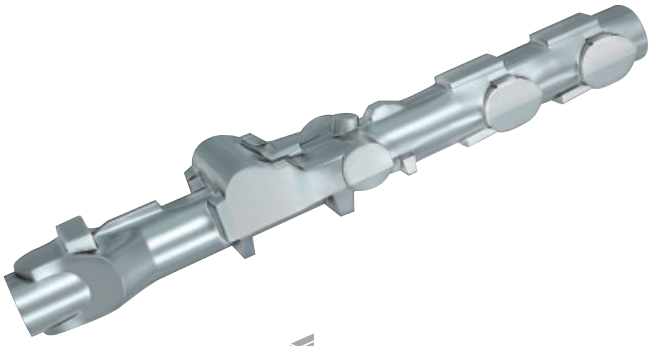
Holder	VFX6-080A05A075R
Insert (Grade)	XNMU190912R-MS (MP9030)
Work Material	Ti-5Al-5Mo-5V-3Cr
Cutting Speed	vc40 m/min (n160 min^{-1})
Feed	fz0.1 mm/tooth (vf80 mm/min)
Depth of Cut	ap65 mm, ae5 mm
Coolant	Emulsion (8 MPa)

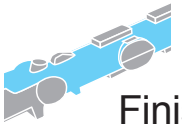




LANDING GEAR

Work Materials [Titanium Alloy]

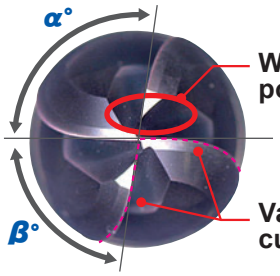




Finish Profile Milling

Vibration Control
End Mill Series
(TOOLS NEWS B178G)

$\alpha° \neq \beta°$
Variable pitch



Variable pitch

Newly designed radius cutting edges reduce vibration

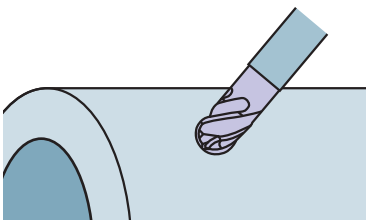
Key Point on Machining

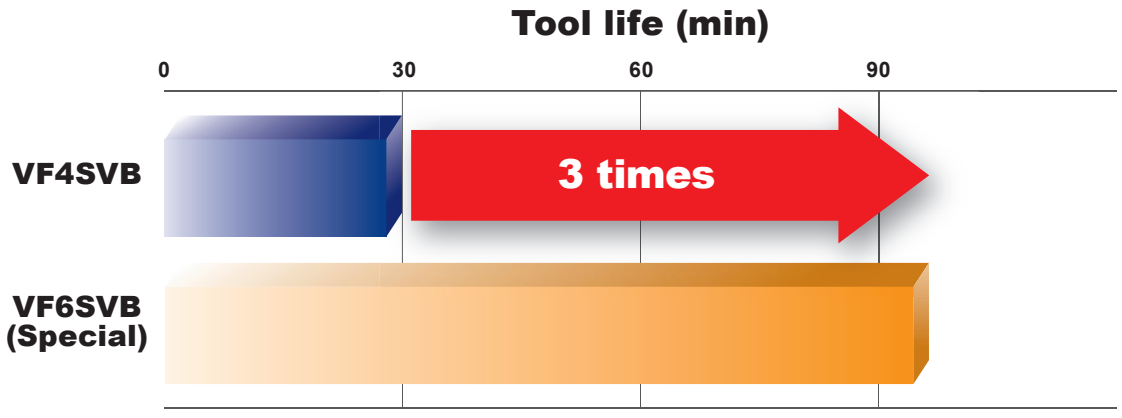
- When profile machining titanium alloy, chipping and abnormal damage of the cutting edge can occur and vibration is easily generated.
  Use of a tool which is designed for vibration control is effective.
  The latest vibration control series end mills have variable pitch geometry with newly designed radius-cutting-edges that reduce vibration.

Application Example

- **3 times tool life and stable machining is achieved when no vibration occurs.**

End mill	VF4SVBR1000
Work Material	Ti-10V-2Fe-3Al
Cutting Speed	vc200 m/min (n3400 min^{-1})
Feed	vf1020 mm/min
Depth of Cut	ap1.0 mm, ae0.5 mm
Coolant	Emulsion

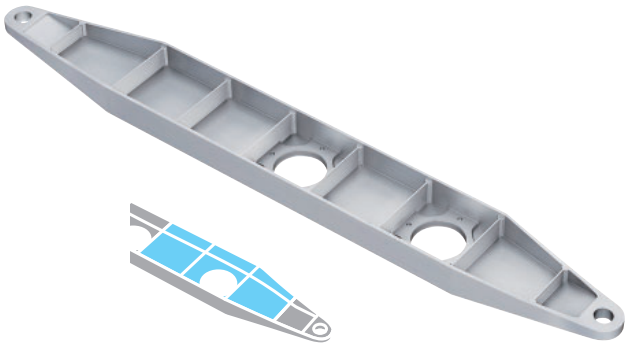




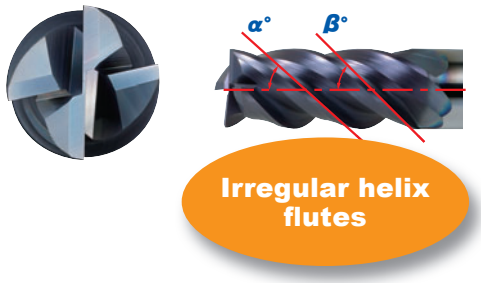
Special: increased number of teeth

LANDING GEAR

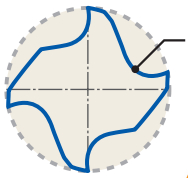
Work Materials [Titanium Alloy]



Finish Pocket Milling



Irregular helix flutes



Improved chip disposal
New flute geometry suitable for irregular helix angles.

Special flute geometry

Vibration Control
End Mill Series
(TOOLS NEWS B133G)

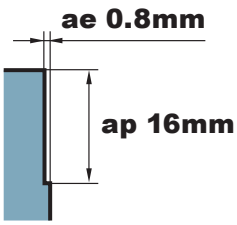
Key Point on Machining

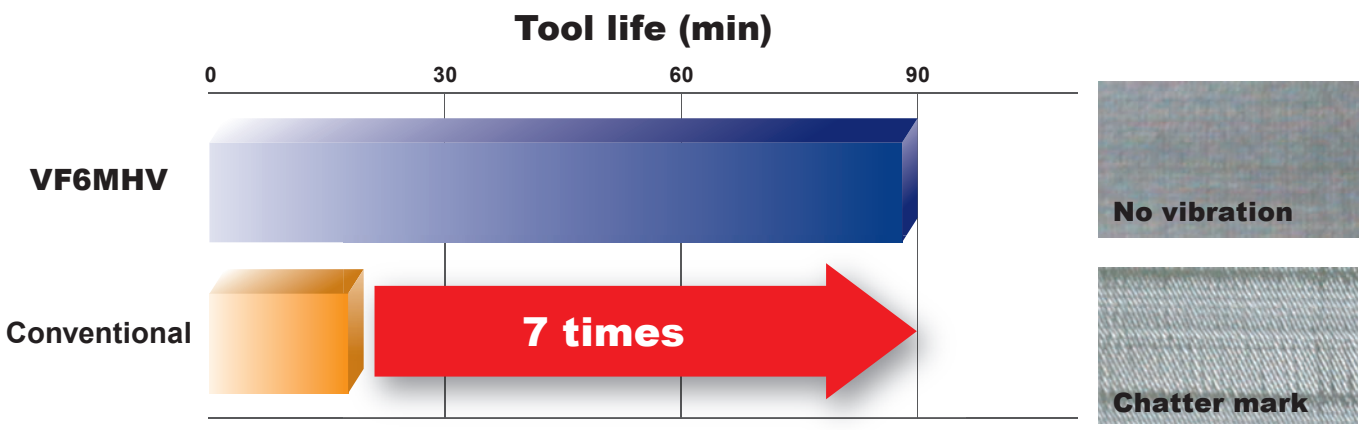
- When finish machining titanium alloy, chipping and abnormal damage of the cutting edge can occur and vibration is easily generated.
  Use of a tool which is designed for vibration control is effective.
- The latest vibration control series end mills promote stable machining with variable pitch geometry and irregular helix flutes for improved chip disposal and reduced vibration.

Application Example

- **7 times tool life and stable machining is achieved when no vibration occurs.**

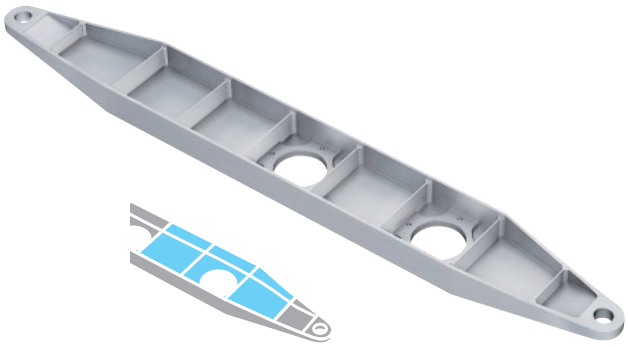
End mill	VF6MHVR1600 (ø 16)
Work Material	Ti-6Al-4V
Cutting Speed	vc150 m/min (n3000 min^{-1})
Feed	fz0.075 mm/tooth (vf1350 mm/min)
Depth of Cut	ap16 mm, ae0.8 mm
Coolant	Emulsion



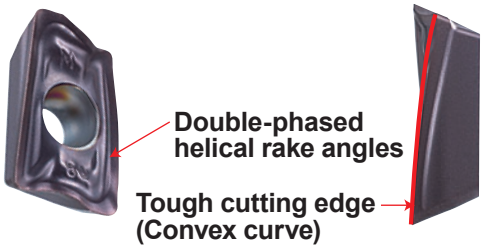


LANDING GEAR

Work Materials [Titanium Alloy]



Rough Pocket Milling



High rigidity cutter bodies

Low cutting resistance insert

APX Series
(TOOLS NEWS B055G)

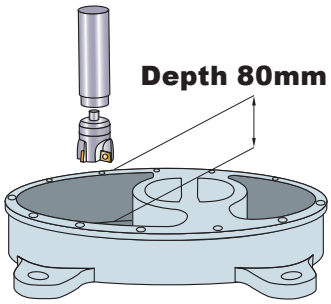
Key Point on Machining

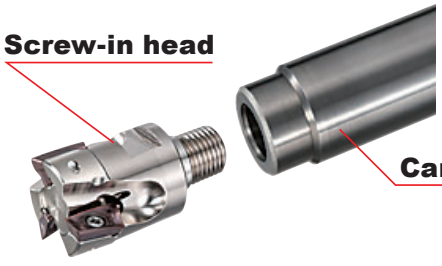
- When rough machining titanium alloy, chipping and abnormal damage of the cutting edge can and vibration is easily generated.
- The APX series offers stability with low cutting resistance inserts that have unique a convex curve shaped cutting edged and a high rigidity cutter body with internal coolant holes.

Application Example

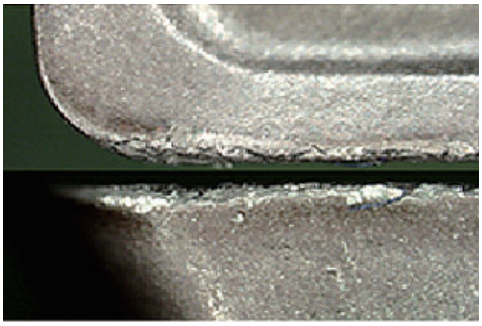
- **Long tool life is achieved even on long reach applications by combining a screw-in head and carbide shank.**

Holder (Screw-in type)	APX3000R254M12A35 SC25M12S125SW
Insert (Grade)	AOMT123620PEER-M (VP20RT)
Work Material	Ti-6Al-4V
Cutting Speed	vc40 m/min (n510 min^{-1})
Feed	fz0.08 mm/tooth (vf160 mm/min)
Depth of Cut	ap6 mm, ae25 mm
Coolant	Emulsion

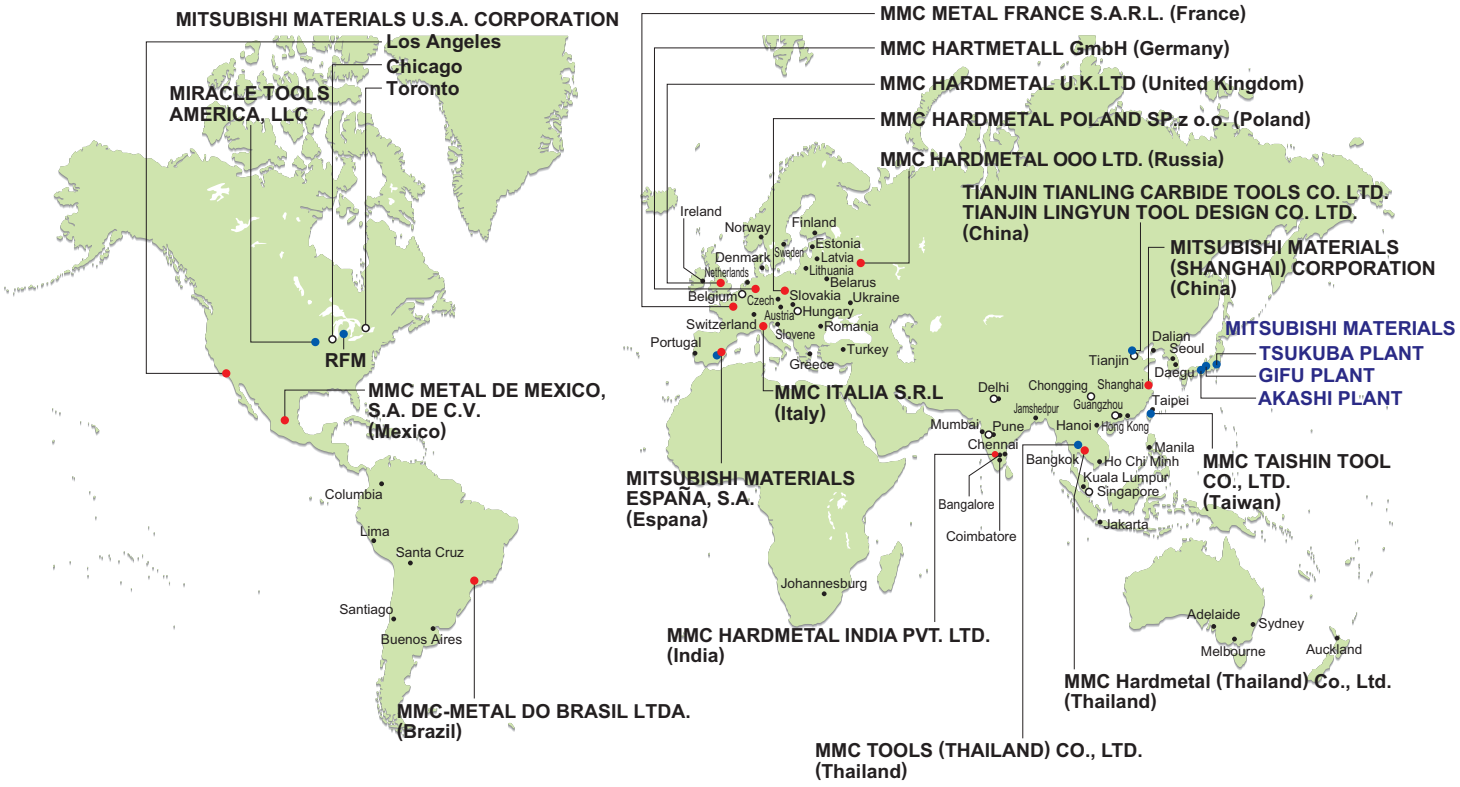




Edge condition (85min.)



Global Network



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