ATI Stellram
Allegheny Technologies

Heavy Duty Machining

ATI Stellram® tooling solutions
for all your heavy duty
machining requirements.

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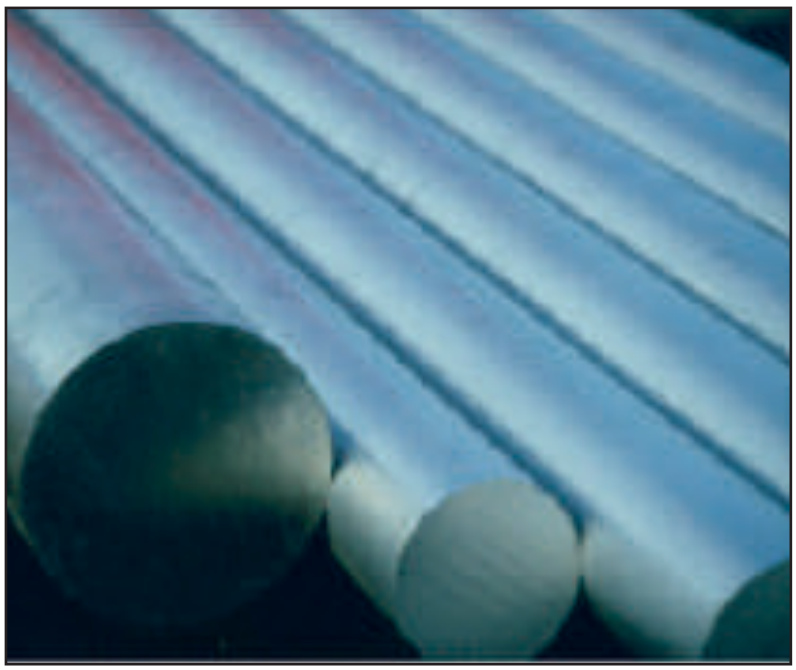
Please contact us for additional information on any of the products illustrated in this catalog or any other part of ATI Stellram's comprehensive tooling program.

www.atistellram.com



Allegheny Technologies

Building the World's Best Specialty Metals Company™

ATI Allegheny Ludlum
Allegheny Technologies
• Stainless steels, titanium and titanium alloys, nickel based alloys, silicon electrical steels, armor materials and tool steels.

ATI Allvac
Allegheny Technologies
• Titanium based alloys, nickel based and cobalt based alloys, specialty alloys.

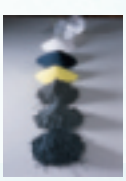
ATI Wah Chang
Allegheny Technologies
• Zirconium, hafnium, niobium, titanium alloys.

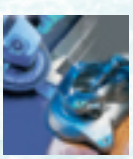
ATI Casting Service
Allegheny Technologies
• Gray and ductile iron casting.

ATI Portland Forge
Allegheny Technologies
• Carbon and alloy steel forgings.

ATI Rome Metals
Allegheny Technologies
• Specialised machining and finishing for titanium mill products.

ATI Metalworking Products
Allegheny Technologies





ATI Alldyne | ATI Firth Sterling | ATI Garryson | ATI Landis Threading | ATI Stellram
Allegheny Technologies

SOLUTIONS FOR DIFFICULT TO MACHINE MATERIALS

CONTENTS

HEAVY MACHINING AS DEFINED BY PROCESS:

- **Bar Peeling -** an extremely efficient method for sizing and finishing surfaces on round material stock.

- **General Purpose** - tooling for any of a group of applications utilizing heavy depths of cut or cuts that require greater than average horsepower draw.

- **Railway** - tooling built specifically for machining railway wheels and axles. In terms of wheel processing they are usually defined by group, such as “New” wheel tooling for machining newly cast or forged wheels; or “RWRT” (railway wheel re-turning) tooling for machining used wheels, and Form Milling tooling for milling the form of used railway wheels.

- **Roll Turning** - turning the hard surfaces of sheet metal or paper mill rolls. Where surface hardness can reach 65 HRc, these turning operations are often good candidates for ceramic cutting tools.

Machining Materials

8 star points represent each main group of machinable materials. Each segment has been color coded to identify the material group.

Unalloyed Steels — P

Alloyed Steels — P

Stainless Steels — M

PH Stainless — M

Cast Irons — K

Aluminum & Alloys — N

High Temperature Alloys — S

Hard Materials (52-56 HRC) — H

Star Guide Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

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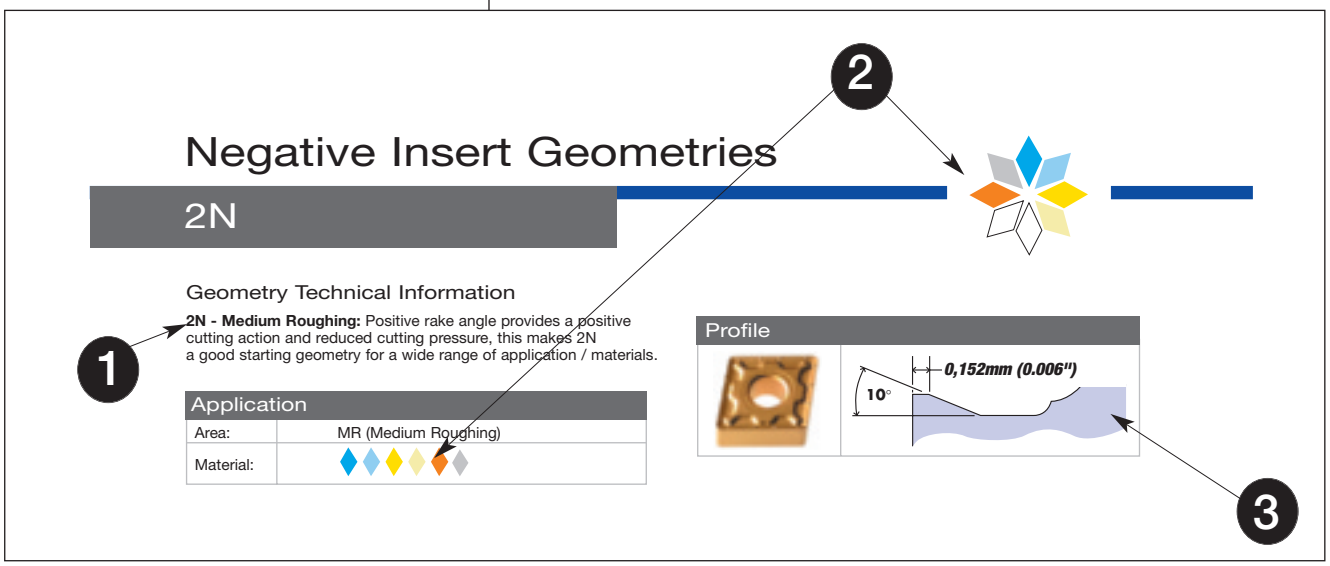
1st Choice

Star Point will indicate the recommended insert for each material. ATI Stellram's Star Guide™ enables you to find the right insert for your machining requirements.



1. **Application information**
2. **Star Guide™ information – star points indicate the recommended materials related to the geometry.**
3. **Detail outline of geometry profile.**

Negative Insert Geometries

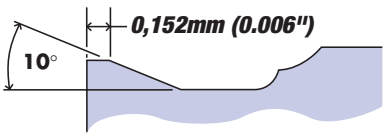
2N

Geometry Technical Information

2N - Medium Roughing: Positive rake angle provides a positive cutting action and reduced cutting pressure, this makes 2N a good starting geometry for a wide range of application / materials.

Application	
Area:	MR (Medium Roughing)
Material:	

Profile



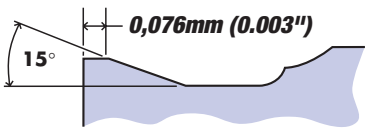
3G

Geometry Technical Information

3G - Light Roughing: Versatile all purpose geometry, used with light depths of cuts and feed rates for trouble free machining.

Application	
Area:	MR (Medium Roughing)
Material:	

Profile



Star Guide — Key to Recommended Inserts

Material Designations							
P	Unalloyed Steels	M	Stainless Steels	K	Cast Irons	S	High Temp. Alloys
P	Alloyed Steels	M	PH Stainless	N	Aluminum & Alloys	H	Hard Materials

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Negative Insert Geometries

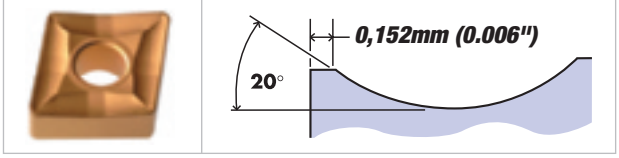
4M

Geometry Technical Information

4M - Medium to Heavy Roughing: Single sided inserts for stability and strength with a soft cutting action, which allows for high feed rates.

Application	
Area:	MR, HR (Medium Roughing, Heavy Roughing)
Material:	

Profile



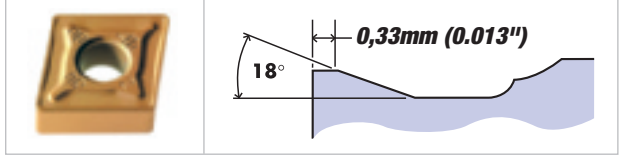
4T

Geometry Technical Information

4T - Roughing: The heavier edge condition of the 4T chip breaker lends itself to more demanding operations, for example; interrupted machining where the extra edge strength is needed.

Application	
Area:	MR, HR (Medium Roughing, Heavy Roughing)
Material:	

Profile



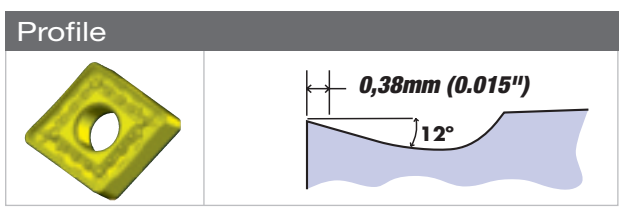
5R

Geometry Technical Information

5R - Heavy Roughing: Single sided insert with reinforced cutting edge and open face geometry, produces excellent chip control at high feed rates when machining Stainless Steels, High Nickel, High Cobalt and Titanium based alloys.

Application	
Area:	MR, HR (Medium Roughing, Heavy Roughing)
Material:	

Profile



Star Guide — Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Negative Insert Geometries

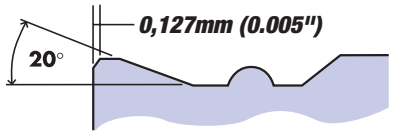
5V

Geometry Technical Information

5V - Heavy Roughing: Negative cutting action with extra edge support for superb roughing performance with very heavy feeds and depths of cut.

Application	
Area:	MR, HR (Medium Roughing, Heavy Roughing)
Material:	

Profile



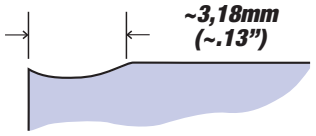
-91

Geometry Technical Information

-91 - Light Roughing: Open, positive geometry produces excellent chip control with low cutting forces in high temperature alloys like titanium and inconel.

Application	
Area:	MR (Medium Roughing)
Material:	

Profile



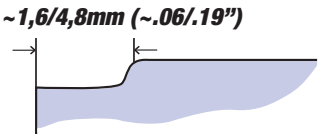
-81

Geometry Technical Information

-81 - Light to Medium Roughing: High feed bar peeling geometry having very open chip evacuation capability in combination with a very strong but sharp negative cutting edge for best productivity in most bar peeled materials.

Application	
Area:	MR (Medium Roughing)
Material:	

Profile



Star Guide Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

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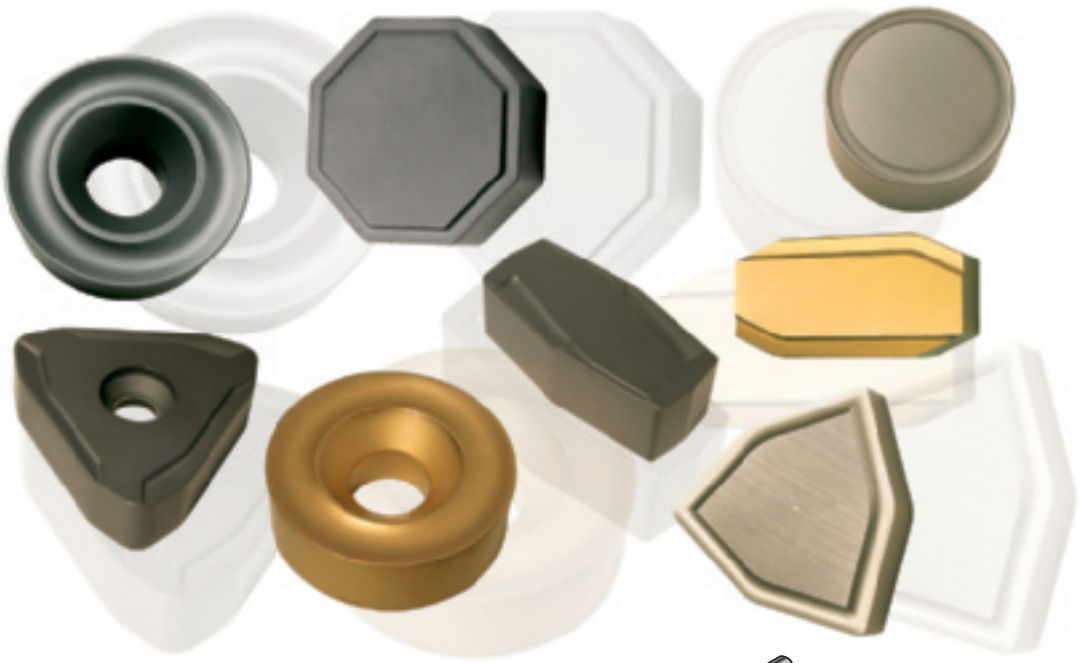
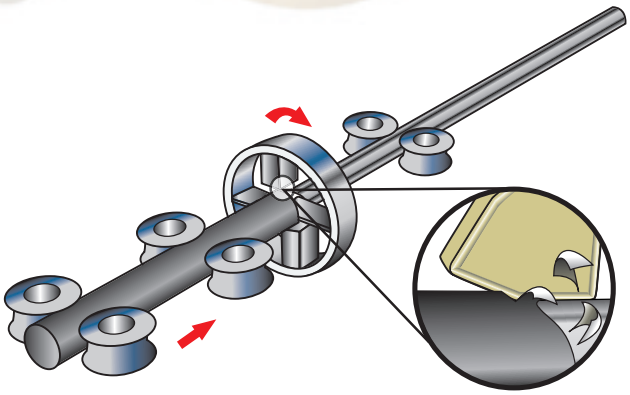
Bar Peeling





Bar peeling (bar turning) is the most efficient method for sizing and finishing surfaces on round material stock. Size of material can vary from 4mm (0.15”) to over 381mm (15”) in diameter. Bar peeling is also a process applied on thick walled tubing.

Materials commonly machined in bar peeling are carbon steel, spring steel, stainless steels, high temperature alloys, titanium, aluminum, copper, and uranium.

End users for bar peeled stock vary widely from automotive manufacturers to aerospace builders and tube manufacturers.

When compared to conventional turning, bar peeling is a process which provides high productivity at a low production cost due primarily to the extremely rapid throughput rate common to this process. Where a single point turning tool may operate at a healthy 2,286 mm feed (.09”) per revolution a bar turner often runs between 9,525 mm (.375”) and 15,875 mm (.625”) feed per revolution - almost 7 times faster.

The resulting surface finish and dimensional tolerancing from bar peeling often eliminates a requirement for further down stream processing.

Bar Peeling Economics

Whether investing in a new bar peeling lathe or considering a new job for an older machine or thinking of upgrading an older machine for your future demands, you will need to consider the requirements of your new opportunities in the way of surface finish, stock depth, dimensional tolerances and overall through put rates that will meet the increased productivity you require for your particular economic situation.

The following is a formula for determining power draw for each cutting head which will enable you to determine how many cutting edges are feasible for your machine's available horsepower – and therefore something about expected performance parameters.

To calculate power required per cutting head:

$$P_c = \frac{v_c \, x \, a_p \, x \, f_r \, x \, k_c}{33{,}000} \; X \; \left(\frac{.016}{f_r}\right)^{0.29} = \text{Hp x } 0.7457 = \text{KW}$$

Where:
- P_c = power required at the cutting edge
- V_c = cutting speed in ft/min
- a_p = max (total) radial cutting depth in inch
- f_r = feed in inch/ revolution
- k_c = "K" factor for work piece material (see page 35 for value)
- H_p = Resultant Power (Horsepower)
- KW = Kilo watts

For Hp to KW conversion multiply Horsepower (Hp) by 0.7457 to obtain Kilo Watts (KW).

For holders having more than one insert (a rough and finish for example), the depth of cut a_p is the sum of the cut depths from both inserts in the holder.

The feed (f_r) is considered to be that which provides the required surface condition.

The resultant power (H_p) calculated is then multiplied by the number of holders to achieve the total power output requirement.

This method of calculation affords a value having a 10% or less margin of error.

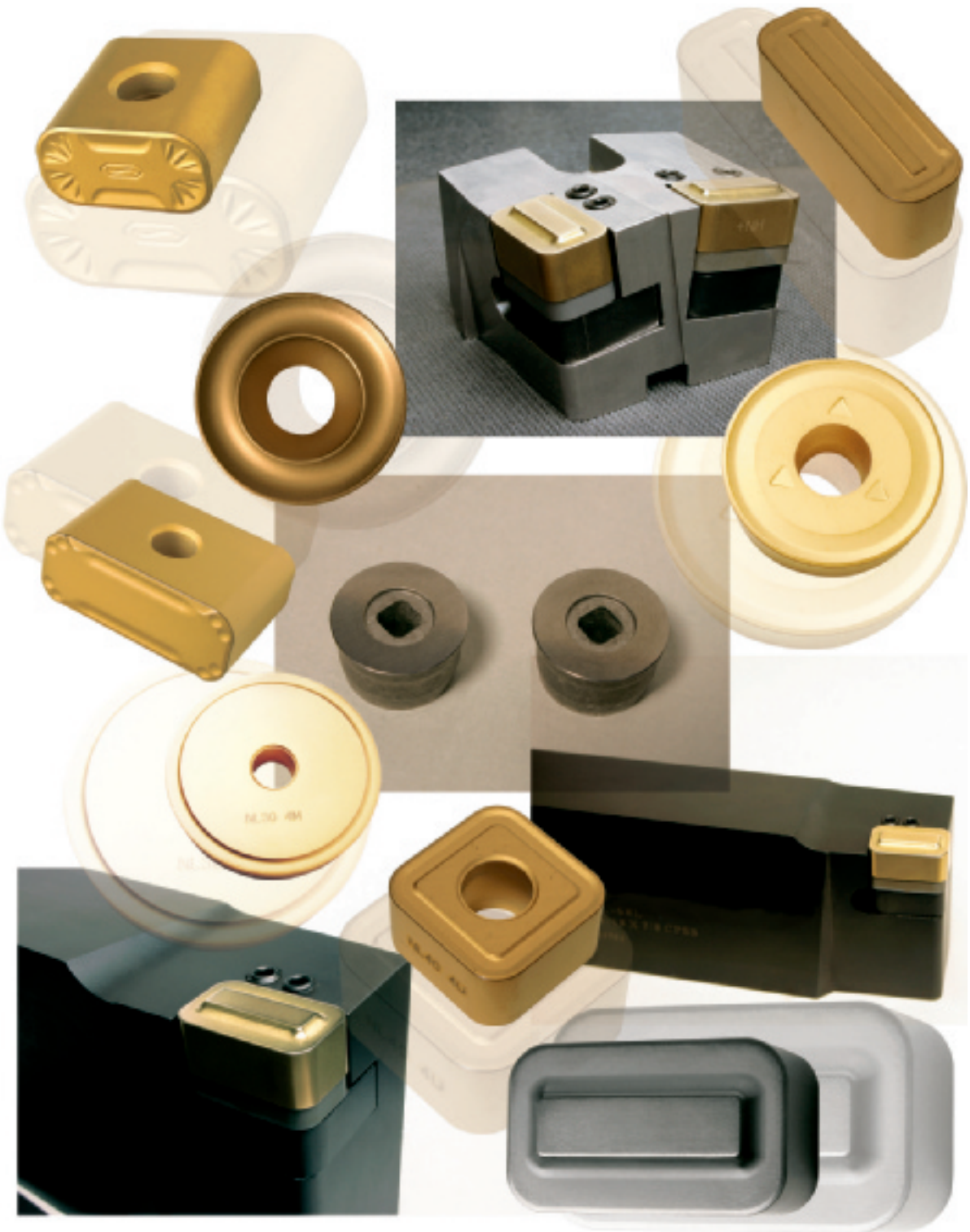
Considerations should also include:

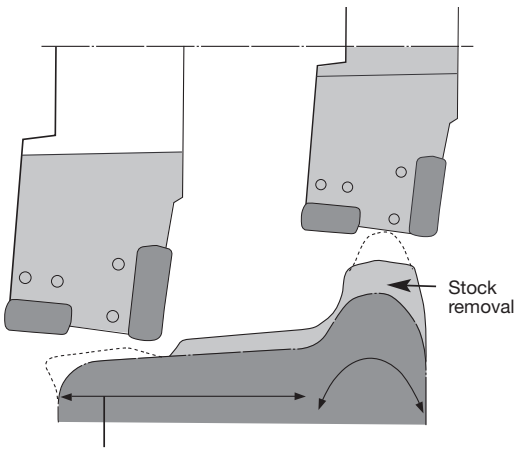
- Average cutting depth as insert geometries are developed for optimal chip formation within specific cut depth ranges. It is always best to choose the center (mean) of the range for an insert meant for a particular group of materials to achieve best chip generation.
- Radial step value between rough and finish inserts for those holders having both rough and finish inserts. A radial step of between 0,2 mm and 1,3 mm (.008" and .051") should be maintained for optimized tool life and finish.
- Proper holder/machine conditioning. If any or all of the components affecting the outcome of a bar peeling application "have seen better days" then it is highly likely that your desired outcome will not occur today.

Tooling for any group of applications, utilizing heavy depths of cut and requiring greater than average horsepower draw.

Railway

Tooling built specifically for machining railway wheels and axles. In terms of wheel processing they are usually defined by group, such as **'New'** wheel tooling for machining newly cast or forged wheels; or **'RWRT'** (railway wheel re-turning) tooling for machining used wheels, or **Form Milling** tooling for milling the form of used railway wheels.





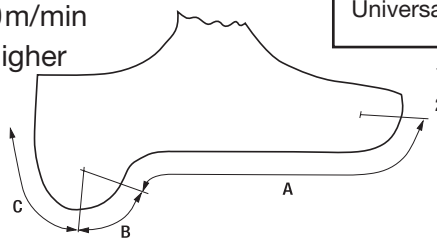
Example of re-turning with LNUX 30 19 40 - 6R NL40

Cutting depth	a_p = 5-12mm (.197-.472 inch)
Feed	f_r = 1,5mm/rev (.059 inch/rev)
Speed	v_c = 50m/min (165 ft/min)

Machine Type	Cutting Speed				Feed f_r	
	m/min		ft/min			
	v_c1	v_c2	v_c1	v_c2	mm/rev	inch/rev
Under-floor Lathe[1)]	50	90,5	165	297	0,3-1,5	.012-.059
Portal Lathe	50	90,5	165	297	0,51-1,80	.020-.071
Universal Lathe[2)]	40,5	71,6	133	235	0,51-1,80	.020-.071

[1)] Restricted by power supply and friction drive installed
[2)] Restricted by power supply installed

Use lower v_c of 40m/min (120ft/min) when higher surface hardness, skid flats and shelled tread are encountered.



Recommended values in v_c1 table are to be used when machining the tread (section A in diagram). Higher speed and feed values from table section v_c2 are to be used for flange copying (section B and C).

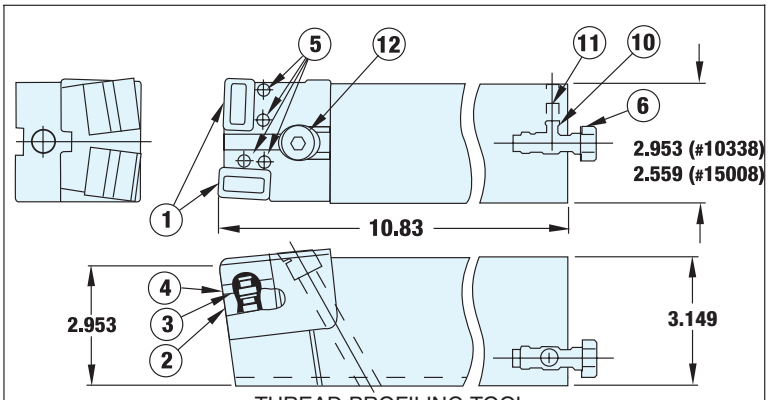
Application performance is dependant on many factors such as cutting speed, lead angle and work piece material quality and condition.

The adjacent diagram offers ‘general rule’ recommendations for speed and feed rates that should be followed for best performance on referenced types of machine tools.

Tabulated cutting data is recommended for machining usual railway wheel materials with ATI Stellram T22, SF30, NL30, or NL40 grades.

When skid flats, built-up tread, shelled tread conditions are extreme the lower cutting speeds are recommended. Lower cutting speeds (v_c1) are also recommended if wheels being returned are of a higher carbon content. Modifications to recommended feed rates should be kept to a minimum.

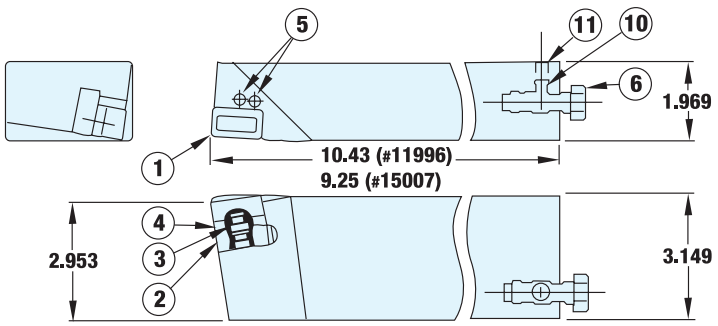
Table data is valid when turning the tread (Section A of the diagram). Flange copying operations are made at higher cutting speeds (v_c2) and feeds (Sections B & C of the diagram)



THREAD PROFILING TOOL

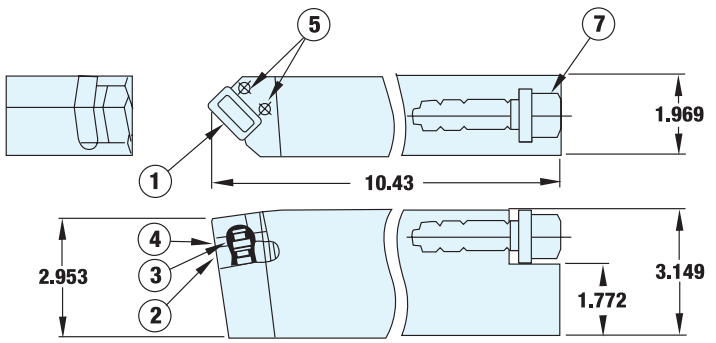
SHANK= #10338R (EDP #003699)
#10338L (EDP #003700)
#15008L (OPTIONAL)
#15008L(OPTIONAL)

CARTRIDGE= #10341R (EDP #005250)
#10341L (EDP #005251)
#15007R (OPTIONAL)
#10336L (OPTIONAL)



FLANGE TOPPING TOOL

SHANK= #11996R (EDP #003701)
#11996L (EDP #003702)
#15007R (OPTIONAL)
#15007L (OPTIONAL)



MUSHROOM TURNING TOOL

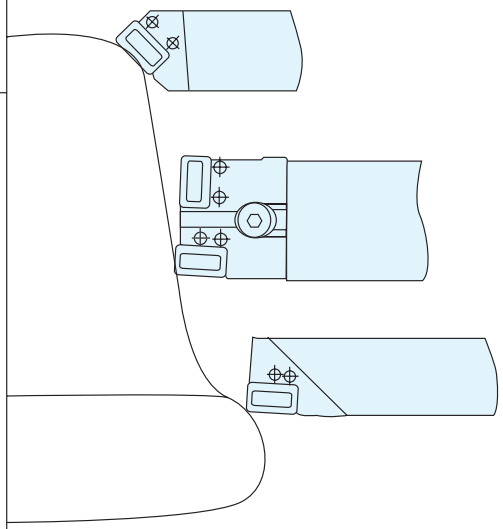
SHANK= #11997R
#11997L

TOOLHOLDER PARTS

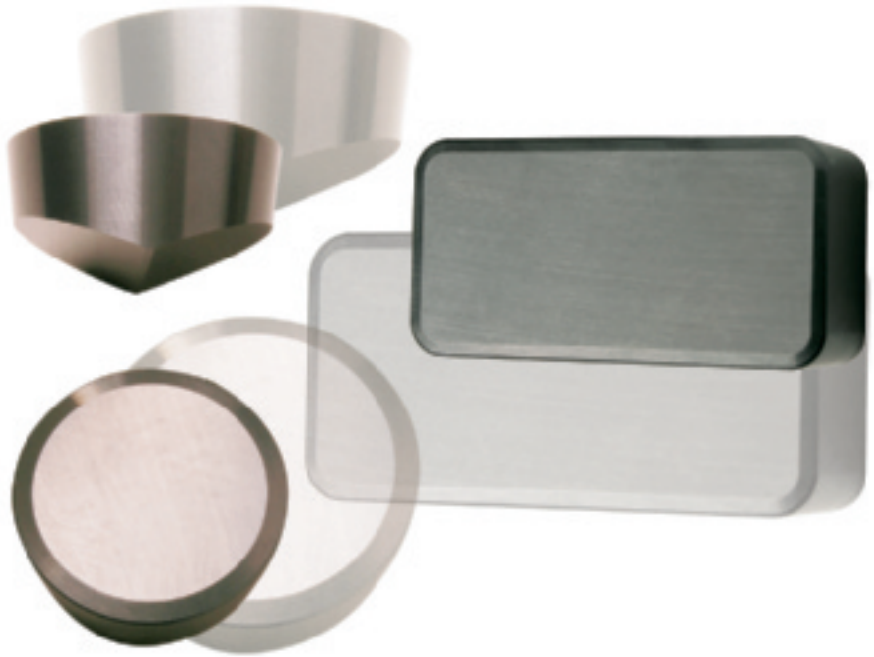
1-INSERT=RRCH-65812
2-RETAINING SHIM=#10339 (EDP #003724)
3-LOCK PIN= SNL-68L (EDP #004718)
4-SEAT=LSN-65812 (EDP #001666)
5-LOCK SCREW=5/16-18X7/8 CPSS (EDP #003723)
6-BACK-UP SCREW= SN-129 (EDP #003716)
7-BACK-UP SCREW= 3/4-10X2 SO.HO.COLLAR SCR. (EDP #003717)
8-T-HANDLE WRENCH= .TW-964 (EDP #003706)
9-T-HANDLE WRENCH= .TW-532 (EDP #003705)
10-LOCK PLUG= 1/40X1/4LG.COPPER (TOOL #15007 & #15006 ONLY)
11-LOCK PLUG SCR.=5/16-18X1/2555 (TOOL #15007 & #15006 ONLY)
12-CARTRIDGE SCREW=1/2-13X2-1/2 SHCS (EDP #003715)

PRODUCT INFORMATION

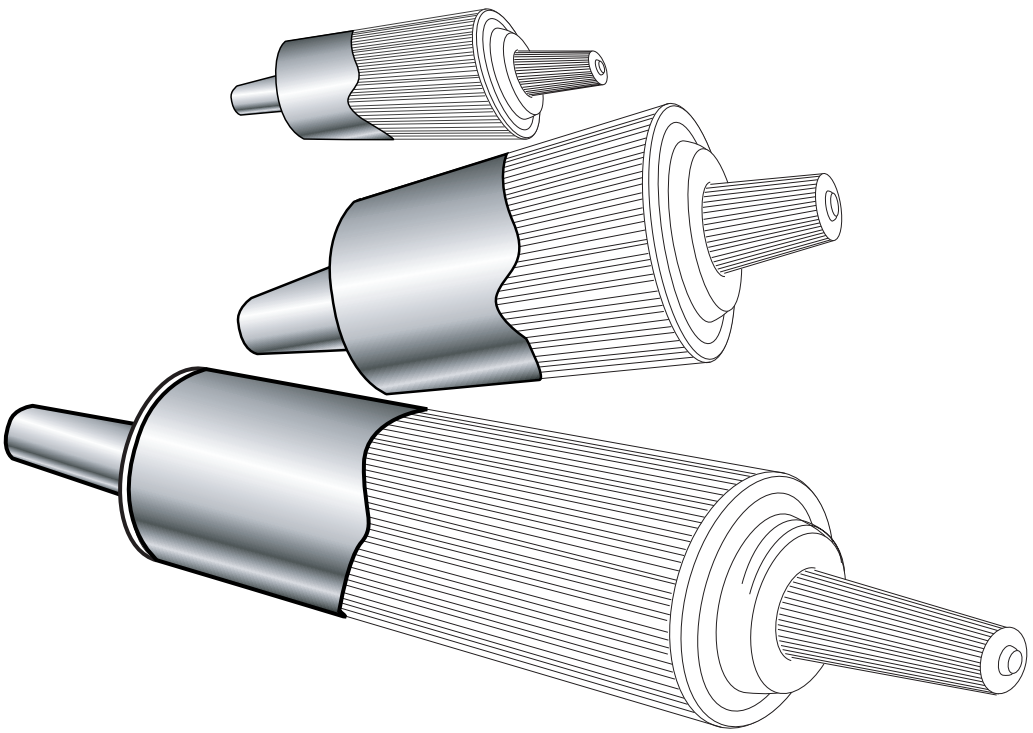
RAILROAD TOOLING FOR WHEEL MACHINING



The holders shown are for use in a Hegenscheidt Model 165 HP Wheel Lathe for reconditioning worn railroad car wheels. Toolholders for other machines are available on request. Inserts for these holders and other wheel and axle turning machines are also shown.



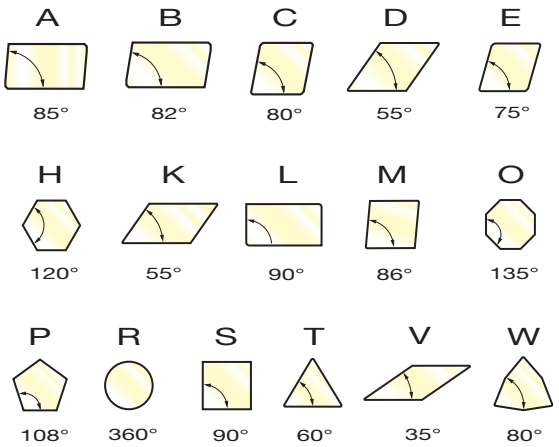
Turning the hard surfaces of steel and paper mill rolls. Where surface hardness can reach 65 HRc, these turning operations are often good candidates for ceramic cutting tools.



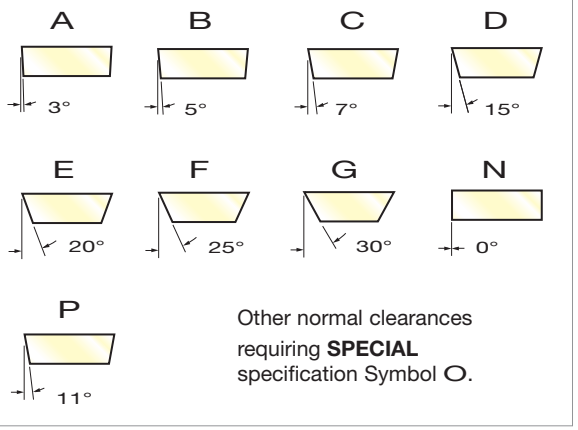
ISO Insert Designation

S	N	M	G	25
1	2	3	4	5

1 Shape

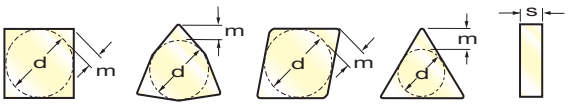


2 Clearance



Other normal clearances requiring **SPECIAL** specification Symbol O.

3 Tolerance



Class		d	m	s
A	mm	±0,025	±0,005	±0,025
C	mm	±0,025	±0,013	±0,025
E	mm	±0,025	±0,025	±0,025
F	mm	±0,013	±0,005	±0,025
G	mm	±0,025	±0,025	±0,13
H	mm	±0,013	±0,013	±0,025
J	mm	*	±0,005	±0,025
K	mm	*	±0,013	±0,025
L	mm	*	±0,025	±0,025
M	mm	*	*	±0,127
U	mm	*	*	±0,127
N	mm	*	*	±0,025

* See tables below.

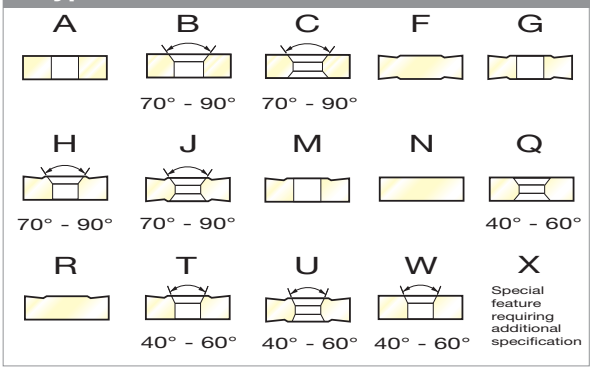
Valid for shape D only (M & N Tolerance)

IC	d	m
5,56	±0,05	±0,11
6,35	±0,05	±0,11
7,94	±0,05	±0,11
9,525	±0,05	±0,11
12,7	±0,08	±0,15
15,875	±0,10	±0,18
19,05	±0,10	±0,18

Valid for shapes: C, E, H, M, O, P, S, T, R, W

IC	d		m	
	J, K, L, M, N	**U**	**M, N**	**U**
4,76	±0,05	±0,08	±0,08	±0,13
5,56	±0,05	±0,08	±0,08	±0,13
6	±0,05	±0,08	±0,08	±0,13
6,35	±0,05	±0,08	±0,08	±0,13
7,94	±0,05	±0,08	±0,08	±0,13
8	±0,05	±0,08	±0,08	±0,13
9,525	±0,05	±0,08	±0,08	±0,13
10	±0,05	±0,08	±0,08	±0,13
12	±0,08	±0,13	±0,13	±0,2
12,7	±0,08	±0,13	±0,13	±0,2
15,875	±0,1	±0,18	±0,15	±0,27
16	±0,1	±0,18	±0,15	±0,27
19,05	±0,1	±0,18	±0,15	±0,27
20	±0,1	±0,18	±0,15	±0,27
25	±0,13	±0,25	±0,18	±0,38
25,4	±0,13	±0,25	±0,18	±0,38
31,75	±0,15	±0,25	±0,2	±0,38
32	±0,15	±0,25	±0,2	±0,38

4 Type



ISO Insert Designation

09 24 E - 4T

6 7 8 9

5 Size

Integers to be preceded by a **0** (zero).
Disregard any decimals. e.g. 9,525 = **09**

C, D, E, M, V — H — A, B, K

L — O — P — R

S — T — W

6 Thickness

Integers to be preceded by a 0 (zero) or the letter T.
Disregard any decimals.

A, B, C, N, O, W.

H, M, R, T.

F, G, J, U.

Examples:

01	=	1,588
T1	=	1,984
02	=	2,381
03	=	3,175
T3	=	3,969
04	=	4,763
05	=	5,556
06	=	6,350
07	=	7,938
09	=	9,525
11	=	11,113
12	=	12,700
14	=	14,288
15	=	15,875

7 Corner

Inserts with wiper edges

Cutting edge Angle (κ_r) 1st letter:			Wiper edge normal Clearance 2nd letter: (a_n)		
A	=	45°	**B**	=	5°
D	=	60°	**C**	=	7°
E	=	75°	**D**	=	15°
F	=	85°	**E**	=	20°
G	=	87°	**F**	=	25°
P	=	90°	**G**	=	30°
Z	=	ANY OTHER	**N**	=	0°
			P	=	11°
			Z	=	ANY OTHER

Major cutting edge
κ_r
Chamfered corner
Wiper edge
Minor cutting edge

7 Corner continued

Inserts with rounded corners. The corner radius is indicated in 0,1mm. Integers to be preceded by a 0 (zero). If the corner is not rounded, use the symbol of designation 00 (zero zero).

Examples:

00	=	SHARP CORNER	**24**	=	2,4
01	=	0,1	**28**	=	2,8
02	=	0,2	**32**	=	3,2
04	=	0,4	**40**	=	4,0
08	=	0,8	**48**	=	4,8
12	=	1,2	**56**	=	5,6
16	=	1,6	**64**	=	6,4
20	=	2,0	**X**	=	ANY OTHER

r_ε

8 Edge Condition

	Symbol
Sharp	**F**
Honed (Rounded)	**E**
Chamfered (Negative Land)	**T**
Chamfered + Honed	**S**

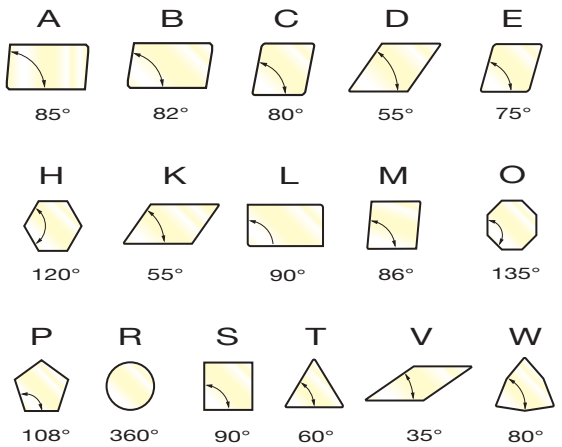
9 Geometry Designation

2N, 3G, 4M, 4T, 5R, 5V, -81, -91

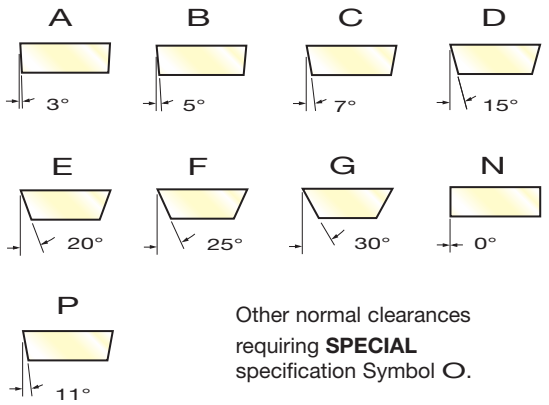
ANSI Insert Designation

S	N	M	G	8
1	2	3	4	5

1 Shape

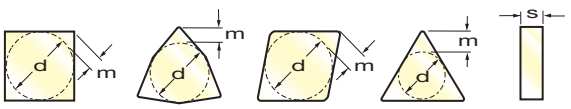


2 Clearance



Other normal clearances requiring **SPECIAL** specification Symbol O.

3 Tolerance



Class		d	m	s
A	inch	±0.0002	±0.0010	±0.001
B	inch	±0.0002	±0.0010	±0.005
C	inch	±0.0005	±0.0010	±0.001
D	inch	±0.0005	±0.0010	±0.005
E	inch	±0.0010	±0.0010	±0.001
F	inch	±0.0002	±0.0005	±0.001
G	inch	±0.0010	±0.0010	±0.005
H	inch	±0.0005	±0.0005	±0.001
J	inch	±0.0002	*	±0.001
K	inch	±0.0005	*	±0.001
L	inch	±0.0010	*	±0.001
M	inch	*	*	±0.005
U	inch	*	*	±0.005
N	inch	*	*	±0.001

* See tables below.

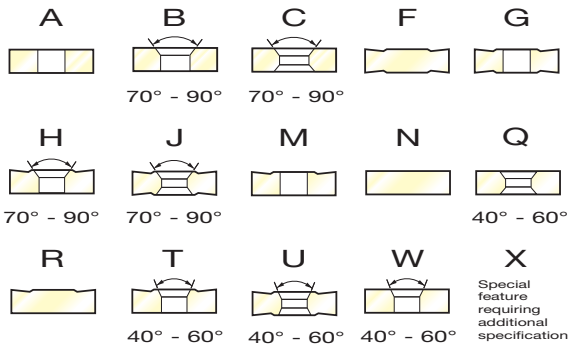
Valid for shape D only

IC	d	m
7/32	±0.002	±0.004
1/4	±0.002	±0.004
5/16	±0.002	±0.004
3/8	±0.002	±0.004
1/2	±0.003	±0.006
5/8	±0.004	±0.007
3/4	±0.004	±0.007

Valid for shapes: C, E, H, M, O, P, S, T, R, W

IC	d **J, K, L, M, N, U**		m **M, N, U**	
3/16	±0.002	±0.003	±0.003	±0.005
7/32	±0.002	±0.003	±0.003	±0.005
1/4	±0.002	±0.003	±0.003	±0.005
5/16	±0.002	±0.003	±0.003	±0.005
3/8	±0.002	±0.003	±0.003	±0.005
1/2	±0.003	±0.005	±0.005	±0.008
5/8	±0.004	±0.007	±0.006	±0.011
3/4	±0.004	±0.007	±0.006	±0.011
1	±0.005	±0.010	±0.007	±0.015
1 1/4	±0.006	±0.010	±0.008	±0.015

4 Type

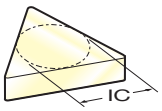


ANSI Insert Designation

6	6	B		
6	7	8	9	10

5 Size

For equal sided inserts, this indicates the inscribed circle (IC) in $^1/_8$".



For rectangles and parallelograms, 2 digits are necessary.

1st digit = Number of $^1/_8$" in width.

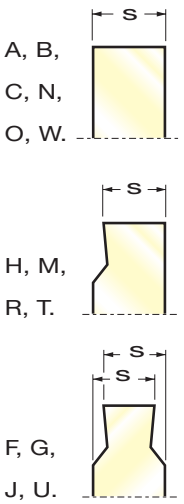
2nd digit = Number of $^1/_4$" in length.

Examples:

1	=	$^1/_8$
1-2	=	$^5/_{32}$
1-5	=	$^3/_{16}$
1-8	=	$^7/_{32}$
2	=	$^1/_4$
2-5	=	$^5/_{16}$
3	=	$^3/_8$
4	=	$^1/_2$
5	=	$^5/_8$
6	=	$^3/_4$
7	=	$^7/_8$
8	=	1
10	=	1 $^1/_4$

6 Thickness

This indicates the insert thickness in $^1/_{16}$" increments.

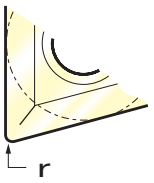


Examples:

1	=	$^1/_{16}$
1-5	=	$^3/_{32}$
2	=	$^1/_8$
2-5	=	$^5/_{32}$
3	=	$^3/_{16}$
3-5	=	$^7/_{32}$
4	=	$^1/_4$
5	=	$^5/_{16}$
6	=	$^3/_8$
7	=	$^7/_{16}$
8	=	$^1/_2$
9	=	$^9/_{16}$
10	=	$^5/_8$

7 Corner

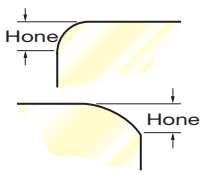
This indicates the form on the corner in $^1/_{64}$" increments for those with a corner radius.



Examples:

0	=	0.002	**6**	=	$^3/_{32}$
0-2	=	0.004	**7**	=	$^7/_{64}$
0-5	=	0.008	**8**	=	$^1/_8$
1	=	$^1/_{64}$	**10**	=	$^5/_{32}$
2	=	$^1/_{32}$	**12**	=	$^3/_{16}$
3	=	$^3/_{64}$	**14**	=	$^7/_{32}$
4	=	$^1/_{16}$	**16**	=	$^1/_4$
5	=	$^5/_{64}$	**X**	=	ANY OTHER

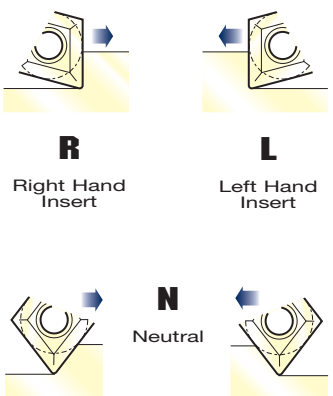
8 Edge Condition



Honed Edge (Rounded Corner):

A	B	C
0·0005 < 0·003	0·003 < 0·005	0·005 < 0·007

9 Hand

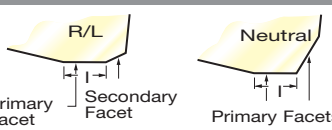


R Right Hand Insert

L Left Hand Insert

N Neutral

10 Facet Size



This indicates the length of the primary facet in increments of approximately $^1/_{64}$".

Used only following a double letter in the 7th position.

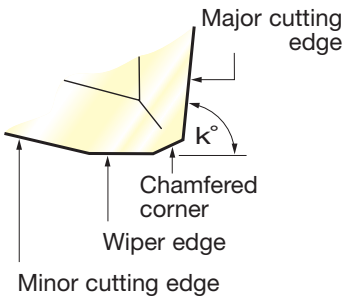
OPTIONAL:
This is not an ISO standard.

Examples:

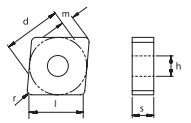
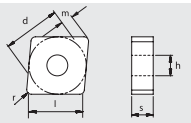
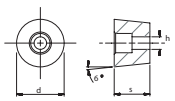
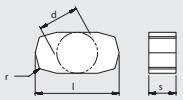
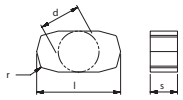
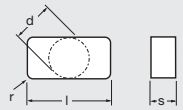
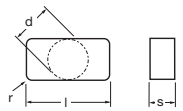
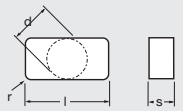
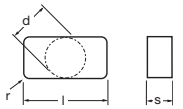
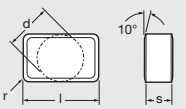
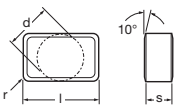
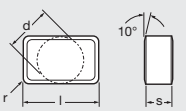
1	=	$^1/_{64}$
2	=	$^1/_{32}$
3	=	$^3/_{64}$
4	=	$^1/_{16}$
5	=	$^5/_{64}$
6	=	$^3/_{32}$
7	=	$^7/_{64}$
8	=	$^1/_8$
9	=	$^9/_{64}$
10	=	$^5/_{32}$

Faceted Inserts (A Style only)

Facet Angle (K) 1st letter:			Facet Clearance (Primary Facet) 2nd letter:		
A	=	45°	**A**	=	3°
D	=	60°	**B**	=	5°
E	=	75°	**C**	=	7°
F	=	85°	**D**	=	15°
G	=	87°	**E**	=	20°
P	=	90°	**F**	=	25°
Z	=	ANY OTHER	**G**	=	30°
			N	=	0°
			P	=	11°
			Z	=	ANY OTHER

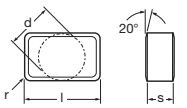
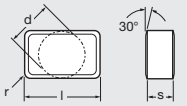
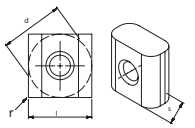
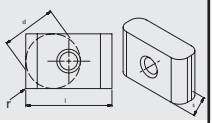
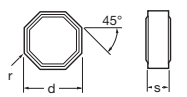
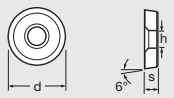
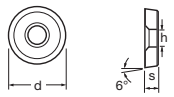
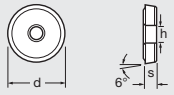
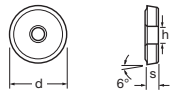
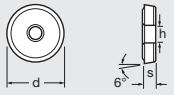
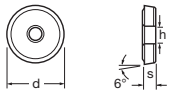
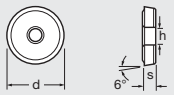
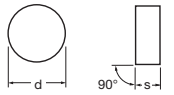


Heavy Duty Insert Range

	Dimensions (mm/*inch*)						Usage				
Part Number ISO/*ANSI*	d	l	s	r	m	h	Railway	Bar Peeling	Roll Turning	General Duty	
Carbide											
CNMG250924E-4T *CNMG866A-4T*	25,400 *1.000*	25,400 *1.000*	9,525 *0.375*	2,388 *0.094*	5,735 *0.2258*	9,119 *0.359*				X	
CNMG250924-5V *CNMG866-5V*	25,400 *1.000*	25,400 *1.000*	9,525 *0.375*	2,388 *0.094*	5,735 *0.2258*	9,119 *0.359*				X	
FDH-33	19,05 *0.750*		9,53 *0.375*			6,350 *0.250*				X	
LNGF-2010-BF-S1-08	18,03 *0.71*	36,51 *1.438*	12,19 *0.48*	0,794 *0.0312*				X			
LNGF4010	20 *0.787*	40 *1.575*	10 *0.394*	0.5 *0.02*				X			
LNM-5464T	19,050 *0.750*	38,100 *1.500*	9,525 *0.375*	1,588 *0.063*						X	
LNM6688T	19,050 *0.750*	38,100 *1.500*	12,700 *0.500*	3,175 *0.125*						X	
LNUN250716F *LNU-5444*	16,380 *0.645*	25,910 *1.020*	6,350 *0.250*	1,580 *0.062*						X	
LNU5464B	16,380 *0.645*	25,910 *1.020*	9,525 *0.375*	1,580 *0.063*					X	X	
LNU-68812T10	19,560 *0.770*	52,070 *2.050*	12,700 *0.500*	4,770 *0.188*					X	X	
LNUN381238TA10 *LNU6688TA10*	19,560 *0.770*	38,610 *1.520*	12,700 *0.500*	3,180 *0.125*					X	X	
LNU381232S *LNU6688TB10*	19,560 *0.770*	38,610 *1.520*	12,700 *0.500*	3,180 *0.125*					X	X	

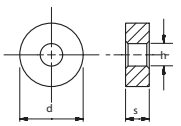
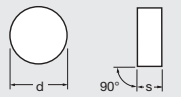
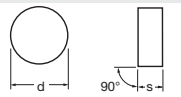
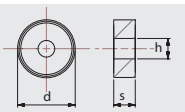
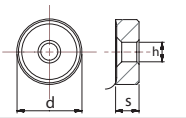
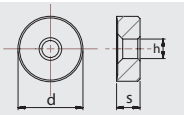
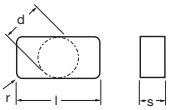
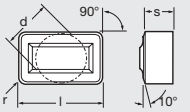
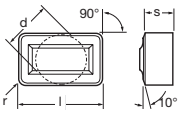
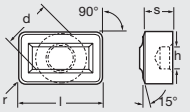
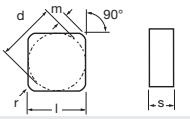
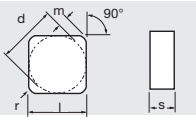
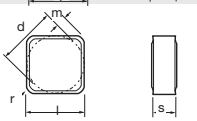
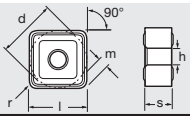
All inserts are available for quotation dependent on specific application.

Heavy Duty Insert Range

	Dimensions (mm/*inch*)						Usage				
Part Number ISO/*ANSI*	d	l	s	r	m	h	Railway	Bar Peeling	Roll Turning	General Duty	
LNUN381232S *LNU6688TB20*	19,560 *0.770*	38,610 *1.520*	12,700 *0.500*	3,180 *0.125*					X	X	
LNUR381232S *LNUR6688TC30*	19,560 *0.770*	38,610 *1.520*	12,700 *0.500*	3,180 *0.125*					X	X	
LNUX 191940-6R	19,050 *0.750*	19,050 *0.750*	10,000 *0.394*	4,000 *0.158*		6,350 *0.250*	X				
LNUX 301940-6R	19,050 *0.750*	30,000 *1.180*	12,000 *0.472*	4,000 *0.158*		6,350 *0.250*	X				
ONMF-542A	15,875 *0.625*	15,875 *0.625*	6,350 *0.250*	0,795 *0.031*				X			
RCMH-106TA15	31,623 *1.245*		9,525 *0.375*			9,754 *0.384*	X			X	
RCMH-106TC15	31,623 *1.245*		9,525 *0.375*			9,754 *0.384*	X			X	
RCMM500900E-4M *RCMM166B-4M*	50,800 *2.000*		9,140 *0.360*			9,930 *0.391*	X			X	
RCMM500900TS-4M *RCMM-166TC10-4M*	50,800 *2.000*		9,140 *0.360*			9,930 *0.391*	X			X	
RCMT2006MOA-3G	20,000 *0.787*		6,350 *0.250*			6,500 *0.256*	X			X	
RCMT2507MOS *RCMT85MOS*	25,400 *1.000*		7,930 *0.312*			7,188 *0.283*	X			X	
RCMT3209MOS *RCMT106MOS*	32,000 *1.260*		9,530 *0.375*			8,611 *0.339*	X			X	
RNGN250600E *RNG-84B*	25,400 *1.000*		6,350 *0.250*							X	

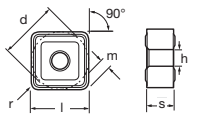
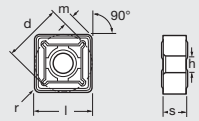
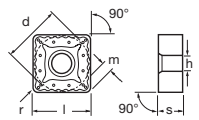
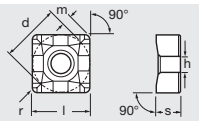
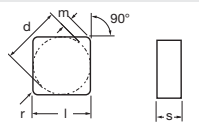
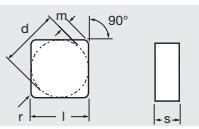
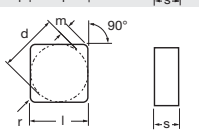
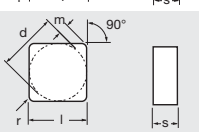
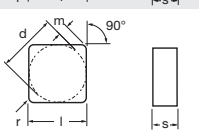
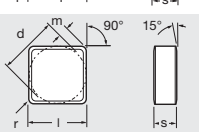
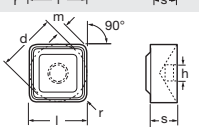
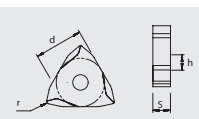
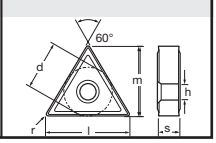
All inserts are available for quotation dependent on specific application.

Heavy Duty Insert Range

	Dimensions (mm/*inch*)						Usage				
Part Number ISO/*ANSI*	d	l	s	r	m	h	Railway	Bar Peeling	Roll Turning	General Duty	
RNMA-86	25,400 *1.000*		9,530 *0.375*			9,120 *0.359*				X	
RNMF86-91	25,400 *1.000*		9,530 *0.375*					X		X	
RNMF86B-3S	25,400 *1.000*		9,530 *0.375*					X			
RNMG250900E-4T *RNMG86A-4T*	25,400 *1.000*		9,530 *0.375*			9,120 *0.359*				X	
RNMH281000-5M	28,000 *1.125*		10,330 *0.407*			8,600 *0.339*		X		X	
RNMH381200	38,000 *1.500*		12,700 *0.500*			12,700 *0.500*		X		X	
RR-65612	*0.750*	19,050 *1.250*	31,750 *0.375*	9,525 *0.187*	4,750			X			
RRC-65612R	19,050 *0.750*	31,750 *1.250*	9,525 *0.375*	4,750 *0.187*			X				
RRC-65612T	19,050 *0.750*	31,750 *1.250*	9,530 *0.375*	4,750 *0.187*			X				
RRCH65812-T15	19,050 *0.750*	31,750 *1.250*	12,700 *0.500*	4,750 *0.187*		8.250 *0.325*	X				
SNGN150616E *SNG-544B*	15,875 *0.625*	15,875 *0.625*	6,350 *0.250*	1,588 *0.063*	2,6314 *0.1036*					X	
SNGN250720 *SNG855*	25,400 *1.000*	25,400 *1.000*	7,940 *0.312*	2,000 *0.079*	4,432 *0.174*					X	
SNMF150616E *SNMF-544A*	15,875 *0.625*	15,875 *0.625*	6,350 *0.250*	1,588 *0.063*	2,6314 *0.1036*					X	
SNMG190940E *SNMG-6610B-4U*	19,050 *0.750*	19,050 *0.750*	9,530 *0.375*	3,967 *0.156*	2,3010 *0.0906*	7,925 *0.312*	X				

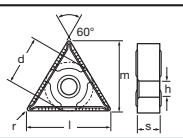
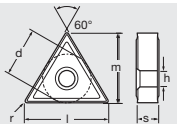
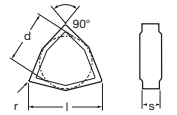
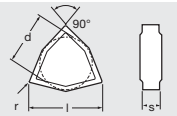
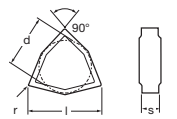
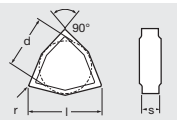
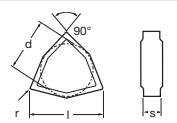
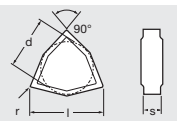
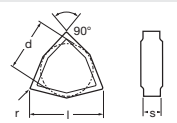
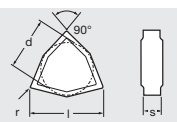
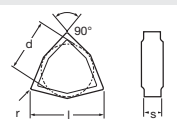
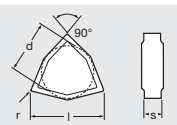
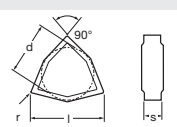
All inserts are available for quotation dependent on specific application.

Heavy Duty Insert Range

	Dimensions (mm/*inch*)						Usage				
Part Number ISO/*ANSI*	d	l	s	r	m	h	Railway	Bar Peeling	Roll Turning	General Duty	
SNMG250924E-3S *SNMG-866B-3S*	25,400 *1.000*	25,400 *1.000*	9,525 *0.375*	2,383 *0.094*	4,2750 *0.1683*	9,120 *0.359*				X	
SNMG250924E-4T *SNMG866B-4T*	25,400 *1.000*	25,400 *1.000*	9,530 *0.375*	2,381 *0.094*	4,2750 *0.1683*	9,120 *0.359*				X	
SNMG250924E-5V *SNMG-866B-5V*	25,400 *1.000*	25,400 *1.000*	9,530 *0.375*	2,381 *0.094*	4,2750 *0.1683*	9,120 *0.359*				X	
SNMM250924E-4M *SNMM866B-4M*	25,400 *1.000*	25,400 *1.000*	9,530 *0.375*	2,381 *0.094*	4,2748 *0.1683*	9,120 *0.359*				X	
SNUN250748E *SNU-8512TA (10 x .070)*	25,400 *1.000*	25,400 *1.000*	7,938 *0.313*	4,775 *0.188*	3,2766 *0.1294*					X	
SNUN250924E *SNU-866B*	25,400 *1.000*	25,400 *1.000*	9,525 *0.375*	2,388 *0.094*	4,2670 *0.1683*					X	
SNUN250924 SNU866T	25,400 1.000	25,400 1.000	9,530 0.375	2,381 0.094	4,2670 0.1683					X	
SNUN250948S *SNU-8612TA10*	25,400 *1.000*	25,400 *1.000*	9,525 *0.375*	4,763 *0.188*	3,2868 *0.1294*					X	
SNUN320924E *SNU1066T*	32,000 *1.250*	32,000 *1.250*	9,525 *0.375*	2,381 *0.094*	5,5880 *0.2200*					X	
SNU-1288TA15	38,100 *1.500*	38,100 *1.500*	12,700 *0.500*	3,175 *0.125*	6,5786 *0.2589*					X	
SNUX-8612	25,400 *1.000*	25,400 *1.000*	9,530 *0.375*	4,763 *0.188*	3,2770 *0.1294*	7,925 *0.313*				X	
TNGJ2010-BM-S1-07	28,575 *1.125*		10,16 *0.400*	3,97 *0.1562*		6,91 *0.272*		X		X	
TNMG330916E-3S *TNMG664B-3S*	19,050 *0.750*	33,320 *1.312*	9,530 *0.375*	1,588 *0.063*	27,0000 *1.0630*	7,925 *0.312*				X	

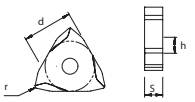
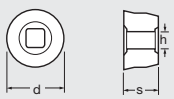
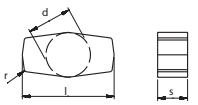
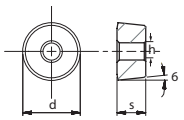
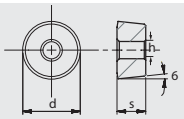
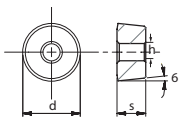
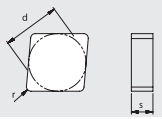
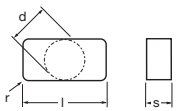
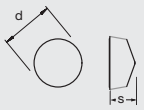
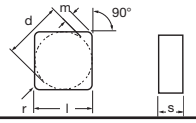
All inserts are available for quotation dependent on specific application.

Heavy Duty Insert Range

	Dimensions (mm/*inch*)						Usage				
Part Number ISO/*ANSI*	d	l	s	r	m	h	Railway	Bar Peeling	Roll Turning	General Duty	
TNMG330924E-3G *TNMG666A-3G*	19,050 *0.750*	33,320 *1.312*	9,530 *0.375*	2,382 *0.094*	26,1874 *1.0310*	7,925 *0.312*				X	
TNMG330924E-4T *TNMG666B-4T*	19,050 *0.750*	33,320 *1.312*	9,530 *0.375*	2,382 *0.094*	26,1874 *1.0310*	7,925 *0.312*				X	
WNMF 96-81	28,580 *1.125*		8,915 *0.351*	1,190 *0.047*				X			
WNMF 96A	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF 96A-91	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96A.1205CBK	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96B	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF 96B-91	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96B.120CBK	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96B.120CBKR	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96L10	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96L20	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			
WNMF96L30	28,580 *1.125*		8,966 *0.353*	1,190 *0.047*				X			

All inserts are available for quotation dependent on specific application.

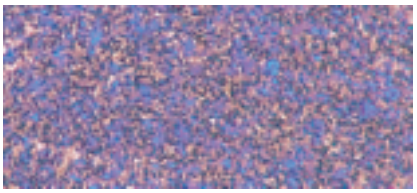
Heavy Duty Insert Range

	Dimensions (mm/*inch*)						Usage				
Part Number ISO/*ANSI*	d	l	s	r	m	h	Railway	Bar Peeling	Roll Turning	General Duty	
WNGJ220810ER	22,00 *0.866*		8,00 *0.315*	1,00 *0.039*		6,900 *0.272*		X			
WTT-10 *WTT-10*	15,880 *0.626*		9,530 *0.375*			4,37 sq *.172 sq*	X				
XNGX371218	18,00 *0.709*	36,520 *1.438*	12,120 *0.477*	1,191 *0.047*				X			
Ceramics											
*CDH251200 *CDH42*	25,40 *1.000*		12,70 *0.500*			6,760 *0.266*			X		
*CDH251900 *CDH43*	25,400 *1.000*		19,050 *0.750*			6,760 *0.266*			X		
*CDH321900 *CDH53*	31,750 *1.250*		19,050 *0.750*			9,980 *0.393*			X		
CNGN250724 *CNG856*	25,400 *1.000*	25,400 *1.000*	7,940 *0.312*	2,400 *0.094*					X		
LNJN381232 *LNJ6688*	19,050 *0.750*	38,100 *1.500*	12,700 *0.500*	3,200 *0.126*					X		
RCGX251200	25,400 *1.000*		11,850 *0.466*						X		
SNGN250720 *SNG855*	25,400 *1.000*	25,400 *1.000*	7,940 *0.312*	2,000 *0.079*	4,432 *0.174*					X	

*Also available in carbide grades

All inserts are available for quotation dependent on specific application.

Grade Descriptions



Grade GH1 - Uncoated

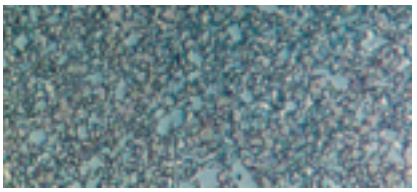
Uncoated micro-grain for cast iron, hardened steels to 60 HRC and non ferrous alloys. Low cutting pressure at high speeds due to sharp cutting edges.

Grade GH2 - Uncoated

Uncoated micro-grain for cast iron, stainless steels and exotic alloys. This grade is tough and able to handle high pressure, vibrations and shock.

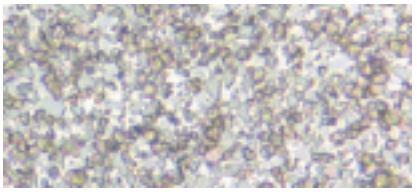
Grade H21 - Uncoated

Uncoated grade principally for cast iron, stainless steel, high temperature alloys and aluminum alloys. Use where interrupted cuts or scale are present.



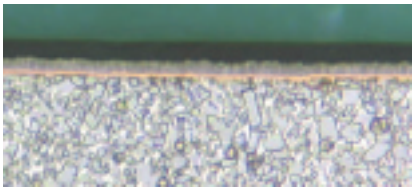
Grade T22 - Uncoated

Uncoated carbide for demanding form milling of railway wheels at slow speeds.



Grade SF30 - Uncoated

A tough grade intended for milling of steel, alloyed steel and stainless steel
The grade SF30 works well with or without coolant.

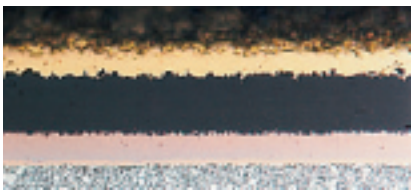


Grade SC6025

TiN-MT TiCN-Al_2O_3 by CVD
For use on steel, alloyed steel and cast iron. With its aluminum oxide coating, this grade is recommended every time wear characteristics are more important than toughness.

Grade SC5825 (NEW)

Thin Al_2O_3 CVD coated for improved thermal properties in heavy duty turning of High Temperature Alloys.



Grade NL25

A wear resistant grade for semi-finishing and finishing on steels, stainless steels and cast irons.
Coating structure - CVD TiN - TiCN - Al_2O_3 - TiN.

Grade NL30

A cobalt enriched grade for medium machining and roughing on steels, stainless steels and cast irons.
Coating structure - CVD TiN - TiCN - Al_2O_3 - TiN.

Grade NL37 (New)

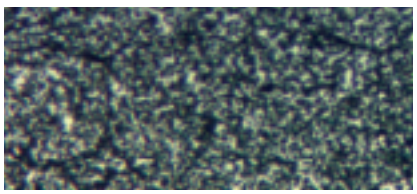
Coated grade TiN-MT TiCN-TiN Al_2O_3 MT TiCN-TiN by CVD. Principally for machining steels and alloy steels.The coating has excellent resistance to wear.

Grade NL40

A cobalt enriched grade for medium machining and roughing primarily on stainless steels and exotic alloys.
Coating structure - CVD TiN - TiCN - Al_2O_3 - TiN.

Grade NL92

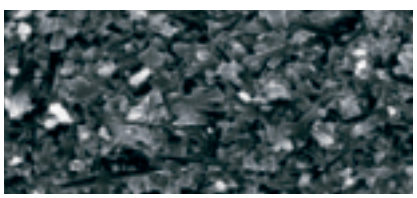
A tough grade with a high degree of edge security on steels and stainless steels.
Coating structure - CVD TiN - TiCN - Al_2O_3 - TiN.



Grade SA7402

A member of the Al_2O_3 + TiCN family (black) For use in: hardened steels and cast iron. For finishing to semi-finishing.

- This grade was specifically designed for hardened steels.
- Excellent wear resistance with higher cutting speeds.
- High toughness and thermal shock resistance.
- Alternative to CBN in stable conditions.



Grade SA8205

A grade having superior edge strength for general machining of nickel based alloys.

- Characteristics
  - Reinforced for extra hardness
  - Formation of alpha-Sialon
- Applications
  - Interrupted cutting for cast irons
  - High speed roughing of high temp. alloys
  - Inconel and Ni base alloy

Grade Classification Chart

Optimum Grade Performance

Materials	Code C	Code ISO	Coated CVD GRADE NL25	NL30	NL37	NL40	NL92	SC5825	SC6025	Uncoated GRADE H21	GH1	GH2	SF30	T22
	C8	P01												
Unalloyed and Alloyed Steels P		P05												
		P10												
	C7	P15												
		P20												
		P25												
	C6	P30												
		P35												
	C5	P40												
		P45												
		P50												
Stainless Steels M		M05												
		M10												
		M15												
		M20												
		M25												
		M30												
		M35												
		M40												
Cast Irons K	C4	K01												
		K05												
	C3	K10												
		K15												
	C2	K20												
		K25												
	C1	K30												
		K35												
		K40												
Aluminum & Alloys N		N01												
		N05												
		N10												
		N15												
		N20												
		N25												
		N30												
High Temperature Alloys S		S01												
		S05												
		S10												
		S15												
		S20												
		S25												
		S30												
Hard Materials H		H01												
		H05												
		H10												
		H15												
		H20												
		H25												
		H30												

Increasing, wear resistance - Increasing cutting speed

Increasing - shock resistance - Increasing - feed

Star Guide Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

ATI Stellram
Allegheny Technologies

Ceramic Grade Information

Physical Properties

Grade	Composition	Color	Density (g/cm^3) (lb/in^3)	Hardness (Hv)	Fracture Toughness ($N/mm^{3/2}$)	Thermal Conductivity (cal/cm.sec°C)
SA7402	Al_2O_3+TiCN	Black	4,3 0.15534	2200	4,5	0,08
SA8205	Si_3N_4	Black	3,2 0.11560	1,750-1,850	5,5-6,0	0,06

ISO Grade Chart

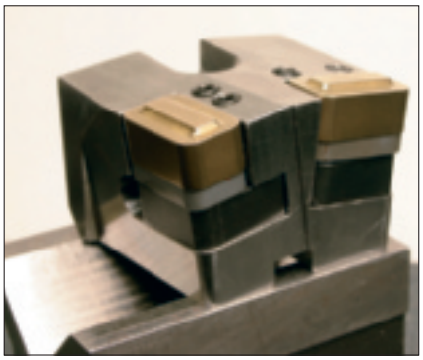
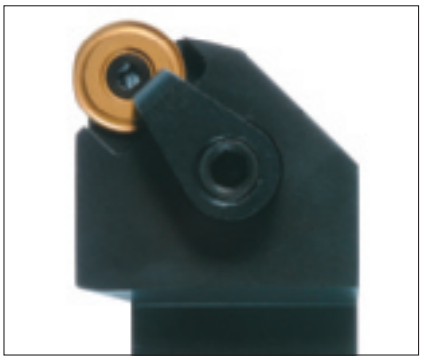
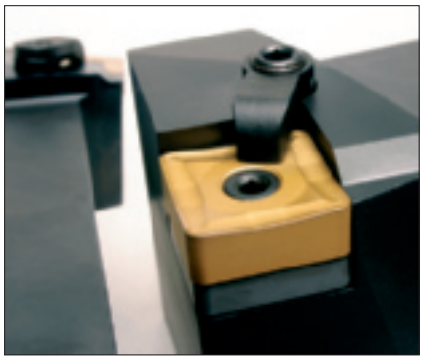
MATERIALS TO BE MACHINED	CODE		CERAMIC	
	C	ISO	SA7402	SA8205
Unalloyed and Alloyed Steels P	C8	P01	■	
		P05	■	
		P10	■	
	C7	P15		
		P20		
		P25		
	C6	P30		
		P35		
	C5	P40		
		P50		
Cast Irons K	C4	K01	■	■
		K05	■	■
	C3	K10	■	■
		K15	■	
	C2	K20		
		K25		
	C1	K30		
		K35		
		K40		
High Temperature Alloys S		S01		■
		S05		■
		S10		■
		S15		■
		S20		
		S25		
		S30		
Hard Materials H		H01	■	
		H05	■	
		H10	■	
		H15		
		H20		
		H25		
		H30		

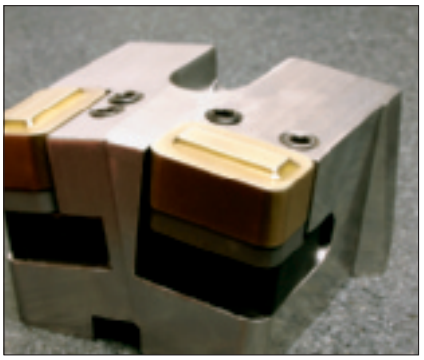
Star Guide Key to Recommended Inserts

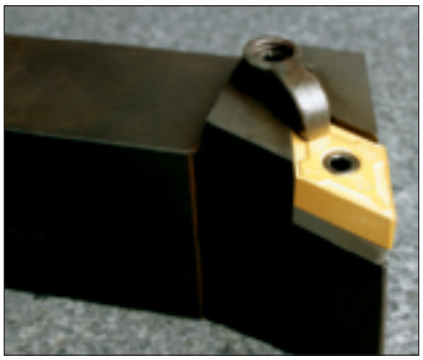
Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

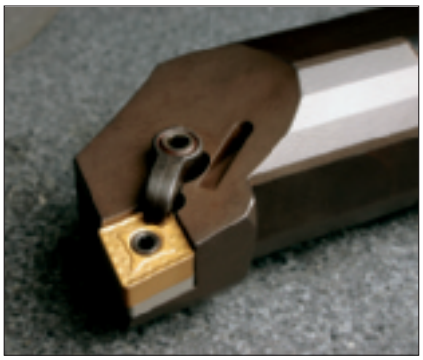
Heavy Duty Toolholders

Tool Holders to be quoted on demand






All ATI Stellram's products are supported by a confident technical sales team backed by an extensive customer care policy.

Please contact us for additional information on any of the products illustrated in this catalog or any other part of ATI Stellram's comprehensive tooling program.

Failure Analysis

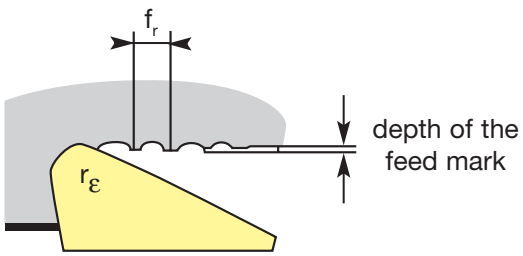
Cause	Correction	Failure
Intermittent heating of the cutting edge. High speed, high volume metal removal.	**A** Use heat resistant grades with increased TaC. **B** Use positive rake tools. **C** Increase nose radius. **D** Reduce speed, feed or depth of cut. **E** Avoid use of coolant.	 **Thermal Cracking**
Insert grade too hard for application conditions.	**A** Use a tougher grade with higher cobalt content. **B** Use negative rake angle inserts. **C** Use larger nose radius. **D** Use increased edge land. **E** Increase cutting speed.	 **Chipping**
Insert grade too soft. Machine speed too fast.	**A** Use a harder, more wear resistant grade. **B** Reduce cutting speed. **C** Increase feed. **D** Use coolant.	 **Excessive Flank Wear**
Notching occurs at depth of cut line. Usually due to work hardened surface, scale or abrasion.	**A** Increase approach angle to maximum. **B** Use a larger corner radius for shallow cuts. **C** Reduce cutting speed and feed. **D** Vary depth of cut.	 **Notching**
Cutting Speed too slow for material being machined.	**A** Increase cutting speed. **B** Use friction reducing PVD coated grade. **C** Use high lubricity coolant.	 **Built-Up-Edge**
Heavy feeds or higher cutting speeds.	**A** Reduce cutting speed. **B** Reduce feed. **C** Use a harder grade. **D** Use a more heat resistant grade.	 **Deformation**
Excessive heat and pressure welding of chip to rake.	**A** Use a harder grade. **B** Reduce speed. **C** Reduce feed.	 **Crater Wear**

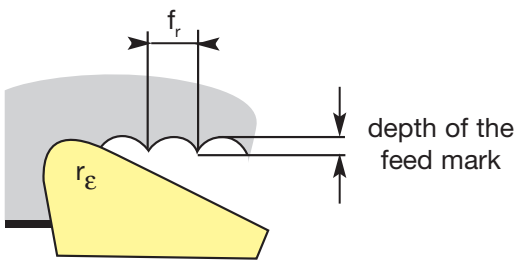
Surface Finish

The radius of the insert (r_ε) has a significant role to play in the quality of the surface finish, which is directly in relation to the feed rate (f_r). With a larger radius, better surface finish can be maintained at higher feeds. The use of a larger radius gives a greater surface contact area and causes an increase in power and cutting force.

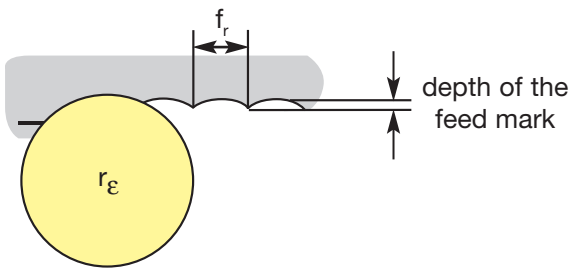
For roughing operations, it is preferable to choose a large radius to ensure corner strength of the insert, however, for some materials a smaller radius is recommended to maintain a softer cut. The insert is more fragile but can qualify for operations that are sensitive to vibrations.

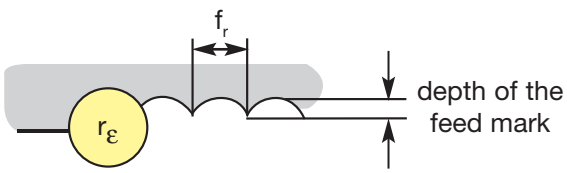
Generally an insert is used with a maximum feed equal to half its radius. The minimum feed is related to edge preparation or to the start of its chip control. An increase in cutting speed can also contribute to surface quality.





For a given radius:
The greater the waviness of machined surface, the greater the feed rate.





For a given feed rate:
The lower the waviness of machined surface, the greater the radius.

Metric

The formula to calculate the feed rate:

$$f_r = \sqrt{\frac{R_{max} \times 8\, r_\varepsilon}{1000}}$$

$$R_{max} = \frac{f_r^2 \times 50}{8 \times r_\varepsilon} \times 1000\ (\mu m)$$

The mean value Ra, can be calculated with following formula:

$$R_a = \frac{f_r^2 \times 50}{r_\varepsilon}$$

Rmax = profile depth (µm)
r_ε = nose radius (mm)
f_r = feed (mm/rev)

Surface finish Ra value (µm)	Nose radius, r_ε (mm)						
	0,2	0,4	0,8	1,2	1,6	2,4	3,2
	Feedrate, f_r (mm/rev)						
0,6	0,05	0,07	0,10	0,12	0,14	0,17	0,20
1,6	0,08	0,12	0,16	0,20	0,23	0,29	0,32
3,2	0,12	0,16	0,23	0,29	0,33	0,40	0,46
6,3	-	0,23	0,33	0,40	0,47	0,57	0,66
8,0	-	-	0,40	0,49	0,57	0,69	0,80

Imperial

The formula to calculate the feed rate:

$$f_r = \sqrt{\frac{R_{max} \times 8\, r_\varepsilon}{10^6}}$$

$$R_{max} = \frac{f_r \times 10^6}{8 \times r_\varepsilon}$$

The mean value Ra, can be calculated with following formula:

$$R_a = \frac{f_r^2 \times 50}{r_\varepsilon}$$

Rmax = profile depth (inches)
r_ε = nose radius (inches)
f_r = feed (inches/rev)

Surface finish Ra value (inches)	Nose radius, r_ε (inches)					
	0.008	0.016	0.031	0.047	0.0063	0.094
	Feedrate, f_r (inches/rev)					
26.1	0.002	0.003	0.004	0.005	0.006	0.007
70.0	0.003	0.005	0.006	0.008	0.009	0.011
140.0	0.005	0.006	0.009	0.011	0.013	0.016
274.0	-	0.009	0.013	0.016	0.019	0.022
350.0	-	-	0.016	0.019	0.022	0.027

Surface Finish Comparison Chart

R_{max}	R_a = CLA = AA		RMS		Operation
µm	µm	µinch	µm	µinch	
1,6	0,30	11.8	0,33	13.1	
1,8	0,35	13.8	0,39	15.3	
2,0	0,40	15.7	0,44	17.4	
2,2	0,44	17.5	0,49	19.4	
2,4	0,49	19.2	0,54	21.3	
2,6	0,53	20.8	0,59	23.1	
2,8	0,58	22.7	0,64	25.2	
3,0	0,63	24.6	0,70	27.3	
3,5	0,71	27.8	0,79	30.9	
4,0	0,80	31.4	0,89	34.8	
4,5	0,90	35.2	1,00	39.1	
5,0	0,99	38.8	1,10	43.1	
6,0	1,20	47.2	1,30	52.4	
7,0	1,40	55.1	1,50	61.2	
8,0	1,60	63.0	1,80	70.0	
9,0	1,80	71.0	2,00	78.8	
10,0	2,00	79.0	2,20	87.7	
15,0	3,20	126.0	3,10	140.0	
20,0	4,40	173.0	4,90	192.0	
25,0	5,80	238.0	6,40	264.0	
27,0	6,30	247.0	7,00	274.0	
30,0	7,40	292.0	8,20	324.0	
35,0	8,80	346.0	9,80	384.0	
40,0	10,70	422.0	11,00	468.0	
45,0	12,50	485.0	13,90	538.0	
50,0	14,00	552.0	15,50	613.0	

FINE FINISHING

MEDIUM

ROUGHING

Difference of hardness (HBN):
When the hardness of a workpiece is different from the value shown in the grade speed charts, multiply the cutting speed you have obtained by the factor below to calculate a new cutting speed.

Work-piece	Soft	(Hardness of workpiece)	Hard								
ISO/ANSI	120HBN	140HBN	160HBN	180HBN	200HBN	220HBN	240HBN	260HBN	280HBN	300HBN	320HBN	340HBN
P	1,42	1,25	1,13	1,0	0,93	0,86	0,75	0,71	0,66	-	-	-
M	1,40	1,22	1,10	1,0	0,93	0,86	0,80	0,70	0,69	-	-	-
K	1,40	1,34	1,30	1,25	1,20	1,10	1,05	1,0	0,94	0,90	0,85	0,82

Comparison Between Different Hardness Scales

Tensile strength	Vickers	Brinell	Rockwell	
N/mm²	HV	HBN	HRc	HRb
255	80	76.0	-	-
270	85	80.7	-	41.0
285	90	85.5	-	48.0
305	95	90.2	-	52.0
320	100	95.0	-	56.2
350	110	105	-	62.3
385	120	114	-	66.7
415	130	124	-	71.2
450	140	133	-	75.0
480	150	143	-	78.7
510	160	152	-	81.7
545	170	162	-	85.0
575	180	171	-	87.5
610	190	181	-	89.5
640	200	190	-	91.5
660	205	195	-	92.5
675	210	199	-	93.5
690	215	204	-	94.0
705	220	209	-	95.0
720	225	214	-	96.0
740	230	219	-	96.7
770	240	228	20.3	98.1
800	250	238	22.2	99.5
820	255	242	23.1	-
835	260	247	24.0	(101)
850	265	252	24.8	-
865	270	257	25.6	(102)
900	280	266	27.1	-
930	290	276	28.5	(105)
950	295	280	29.2	-
965	300	285	29.8	-
995	310	295	31.0	-

Tensile strength	Vickers	Brinell	Rockwell
N/mm²	HV	HBN	HRc
1030	320	304	32.2
1060	330	314	33.3
1095	340	323	34.4
1125	350	333	35.5
1155	360	342	36.6
1190	370	352	37.7
1220	380	361	38.8
1255	390	371	39.8
1290	400	380	40.8
1320	410	390	41.8
1350	420	399	42.7
1385	430	409	43.6
1420	440	418	44.5
1485	460	437	46.1
1555	480	450	47.7
1595	490	457	48.4
1630	500	465	49.1
1665	510	474	49.8
1700	520	482	50.5
1740	530	489	51.1
1775	540	496	51.7
1810	550	503	52.3
1845	560	511	53.0
1880	570	520	53.6
1920	580	527	54.1
1955	590	533	54.7
1995	600	538	55.2
2030	610	543	55.7
2070	620	549	56.3
2105	630	555	56.8
2145	640	561	57.3
2180	650	568	57.8

HV = Vickers hardness
HBN = Brinell hardness
HRc = Rockwell hardness, C scale
HRb = Rockwell hardness, B scale

Turning Terminology and Formulae

ISO	Material	Rm and Hardness	Kc: N/mm²	Kc: lbs/in²
P	Alloyed Steels	700-950 N/mm² 200-280 HBN	2599	377000
		950-1200 N/MM² 280-355 HBN	2851	413500
		1200-1400 N/mm² 355-415 HBN	3172	460000
P	Tool Steels	1200-1400 N/mm² 355-415 HBN	3895	565000
K	Cast Irons	Grey GG-Ft	1200	174000
		Spheroidal GGG-FGS	1500	217000
		Nodular GGGNi - L - N	1600	232064
		Malleable GTS - MN/MP	1050	152000
S	High Temperature Alloys	Iron Based	2999	435000
		Cobalt Based	3799	551000
		Nickel Based	3500	507600
		Titanium Based 425-456HBN	1500	218000

Metric Turning Terminology and Formulae

Formulae

$V_c = \frac{D_m \times \pi \times n}{1000}$	**Cutting speed (m/min)**
$n = \frac{V_c \times 1000}{D_m \times \pi}$	**Spindle speed (rev/min)**
$P_c = \frac{V_c \times a_p \times f_r \times K_c}{60 \times 1000 \times \eta}$	**Power demand (kW)**
$Q_z = V_c \times f_r \times a_p$	**Metal removal (cm^3/min)**
$T_c = \frac{l_m}{f_r \times n}$	**Period of engagement (min)**

Terminology

D_m	=	Machined diameter	mm
V_c	=	Cutting speed	m/min
n	=	Spindle speed	rev/min
T_c	=	Period of engagement	min
Q_z	=	Metal removal	cm^3/min
l_m	=	Machined length	mm
P_c	=	Power demand	kW
K_c	=	Specific cutting force	N/mm^2
f_r	=	Feed per revolution	mm/rev
K_r	=	Cutting edge angle	degree
R max	=	Profile depth	µm
r_ε	=	Insert nose radius	mm
a_p	=	Depth of cut	mm
η	=	Efficiency	

Imperial Turning Terminology and Formulae

Formulae

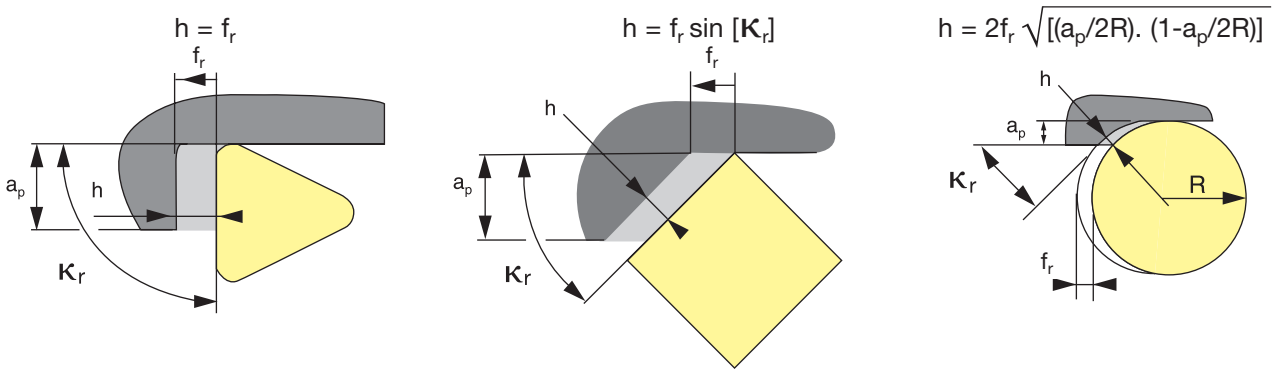
$V_c = 0.262 \times D \times n$	**Cutting speed (feet/min)**
$n = 3.82 \times \frac{V_c}{D}$	**Revolutions per minute (rev/min)**
$Q = 12 \times a_p \times f_r \times V_c$	**Metal removal rate (cu inch per min)**
$f_m = f_r \times n$	**Feed rate (inches/min, IPM)**
$t = \frac{L}{f_m}$	**Cutting time (min)**
$HPs = Q \times P$	**Horsepower required at spindle**
$HPm = \frac{Q \times P}{E}$	**Horsepower required at motor**

Terminology

D	=	Workpiece diameter	in
V_c	=	Cutting speed	SFM
n	=	RPM	rev/min
t	=	cutting time	min
Q	=	Metal removal rate	in^3/min
L	=	Length of cut	in
P	=	Unit power factor, Horsepower per cubic inch per minute	
f_m	=	Feed rate	in/min
f_r	=	Feed	in/rev
E	=	Efficiency of spindle drive	
R_t	=	Profile depth	µin
r	=	Nose radius	in
a_p	=	Depth of cut	in
HPs	=	Horsepower at spindle	
HPm	=	Horsepower at motor	

Maximum Depth of Cut and Chip Thickness

When deciding on the maximum depth of cut (a_p) for a given insert, the angle of the principal edge plays a significant role in the type of the chip formed. For an angle close to 90°, the thickness of the chip will be equal to the feed. In the other cases, it will be necessary to calculate it.



κ_r = 90° | κ_r < 90° | κ_r = cos-1. [1-a_p/R]

The type of insert used plays a significant role in the rigidity of the cutting edge. A cutting edge angle of κ_r 75° or 45° allows for difficult machining operations, i.e. interrupted and heavy roughing, but reduces the capacity to machine profiles. The most robust insert shape is round and the most fragile standard insert is the 35°diamond (V).

The size and type of insert determines the maximum depth of cut. In general, it is advisable to select a cutting edge length in relation to the maximum depth of cut to be machined.

Metric - Cutting Edge Length for a given depth of cut (a_p) and κ_r angle										
A low depth of cut can still generate a large edge engagement										
κ_r/a_p	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00
90	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00
75	1,04	2,06	3,10	4,14	5,18	6,20	7,24	8,28	9,32	10,34
60	1,14	2,31	3,45	4,62	5,77	6,93	8,08	9,25	10,39	11,56
45	1,42	2,82	4,24	5,66	7,06	8,48	9,91	11,30	12,73	14,15
30	2,00	4,00	6,00	8,00	10,00	12,00	14,00	16,00	18,00	20,00

Imperial - Cutting Edge Length for a given depth of cut (a_p) and κ_r angle										
A low depth of cut can still generate a large edge engagement										
κ_r/a_p	0.040	0.080	0.120	0.160	0.200	0.240	0.275	0.315	0.355	0.400
90	0.040	0.080	0.120	0.160	0.200	0.240	0.275	0.315	0.355	0.400
75	0.041	0.082	0.125	0.163	0.205	0.250	0.285	0.326	0.367	0.410
60	0.045	0.090	0.136	0.182	0.227	0.275	0.318	0.364	0.410	0.455
45	0.056	0.110	0.167	0.223	0.278	0.340	0.390	0.445	0.500	0.560
30	0.080	0.160	0.240	0.320	0.400	0.480	0.550	0.630	0.710	0.800

Materials Cross Reference Chart

Material Group	Country/Standard							
	Rm (N/mm^2)	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN	BS	AFNOR	AIS/SAE
Free cutting steel	390-710			1.0722	10SPb20		10PbF2	
Free cutting steel	410-710			1.0715	9SMn28	230M07	S250	1213
Free cutting steel	410-710			1.0718	9SMnPb28		S250Pb	12L13
Free cutting steel	430-740			1.0736	9SMn36	240M07	S300	1215
Free cutting steel	430-740			1.0737	9SMnPb36		S300Pb	12L14
Heat treatable steel	500-650			1.0402	C22	050A20	CC20	1020
Heat treatable steel	500-650			1.1158	Ck25			1025
Free cutting steel	510-740			1.0726	35S20	212M36	35MF4	1140
Superficial hardening steel	540-730			1.1183	Cf35	060A35	XC38TS	1035
Heat treatable steel	550-750			1.0501	C35	060A35	CC35	1035
Case hardening steel	590-780			1.0401	C15	080M15	CC12	1015
Case hardening steel	590-780			1.1141	Ck15	080M15	XC12	1015
Heat treatable steel	630-800			1.0503	C45	080M46	CC45	1045
Heat treatable steel	630-800			1.1191	Ck45	080M46	XC42	1045
Superficial hardening steel	640-830			1.1213	Cf53	060A52	XC48TS	1050
Carbon tool steel	640-830			1.1545	C105W1		Y1105	W.110
Heat treatable steel	640-840			1.1170	28Mn6	160M28	20M5	1330
Heat treatable steel	640-880			1.1167	36Mn5		40M5	1335
Heat treatable steel	690-930			1.1157	40Mn4	150M36	35M5	1039
Carbon tool steel	650-750			1.1663	C125W		Y2120	W.112
Heat treatable steel	700-900			1.0535	C55	070M55	1055	
Heat treatable steel	700-900			1.1203	Ck55	070M55	XC55	1055
Heat treatable steel	750-900			1.0601	C60	080A62	CC55	1060
Heat treatable steel	750-950			1.1221	Ck60	080A62	XC60	1060
Spring steel	1000-1100			1.1274	Ck101	060A96		1095
High temp. constructional steel	440-570			1.5415	15Mo3	1501-240	15D3	ASTM A20Gr.A
High temp. constructional steel	440-590			1.7335	13CrMo4 4	1501-620Gr.27	15CD3.5	ASTM A182
High temp. constructional steel	440-590			1.7380	10CrMo9 10	1501-622	12CD9;10	ASTM A182
High temp. constructional steel	450-590			1.5423	16Mo5	1503-245-420		4520
Tough at sub zero	490-640			1.5622	14Ni6		16N6	ASTM A350LF5
High temp. constructional steel	490-640			1.7715	14MoV6 3	1503-660-440		
Tough at sub zero	510-710			1.5680	12Ni19		Z18N5	2515
Case hardening steel	640-1080			1.7131	16MnCr5	(527M20)	16MC5	5115
Case hardening steel	640-1080			1.7262	15CrMo5		12CD4	
✵ **Cold work tool steel**	**640-670**		**O1**					**O1**
✵ **Hot / cold tool steel**	**640-720**		**S7**					**S7**
Tough at sub zero	640-840			1.5662	X8Ni9	1501-509;510		ASTM A353
Ball and roller bearing steel	650-750			1.3505	100Cr6	534A99	100C6	52100
Heat treatable steel	650-950			1.7218	25CrMo4	1717CDS 110	25CD4	4130
Case hardening steel	690-1080			1.6523	21NiCrMo2	805M20	20NCD2	8620
Case hardening steel	690-880			1.7015	15Cr3	523M15	12C3	5015
Heat treatable steel	690-930			1.5710	36NiCr6	640A35	35NC6	3135
Superficial hardening steel	700-750			1.7045	42Cr4			5140

✵ ATI Metal

Star Guide Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Materials Cross Reference Chart

Material Group	Country/Standard							
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				W.-Nr.	DIN	BS	AFNOR	AIS/SAE
Heat treatable steel	700-950			1.7033	34Cr4	530A32	32C4	5132
Cold work tool steel	**720-775**		**A6**					**A6**
Superficial hardening steel	740-1080			1.7223	41CrMo4	708M40	42CD4TS	4140;4142
Heat treatable steel	750-1100			1.7220	34CrMo4	708A37	35CD4	4137;4135
Cold work tool steel	**750-775**		**O7**					**O7**
Cold work tool steel	750-800			1.2542	45WSCrV7	BS1		S1
Cold work tool steel	750-850			1.2067	100Cr6	BL3	Y100C6	L3
Cold work tool steel	**750-850**		**A2**	**1.2363**	**X100CrMoV51**	**BA2**	**Z100CDV5**	**A2**
Cold work tool steel	750-850			1.2419	105WCr6		105WC13	
Cold work tool steel	750-850			1.2833	100V1	BW2	Y1105V	W210
High speed steel	**775-990**		**M2**	**1.3343**	**S 6-5-2**	**BM2**	**Z85WDCV 06-05-04-02**	**M2**
High speed steel	775-990			1.3348	S 2-9-2		Z100WCWV 09-04-02-02	m7
Heat treatable steel	780-1080			1.3401	X120Mn12	Z120M12	Z120M12	
Superficial hardening steel	780-1180			1.8159	50CrV4	735A50	50CV4	6150
High speed steel	**795-870**		**M3**					**M3**
Cold work tool steel	**795-910**		**A7**					**A7**
High speed steel	800-1050			1.3355	S 18-0-1	BT1	Z80WCV 18-04-01	T1
Heat treatable steel	800-1100			1.6511	36CrNiMo4	816M40	40NCD3	9840
Heat treatable steel	800-1100			1.7035	41Cr4	530M40	42C4	5140
Heat treatable steel	800-1200			1.7225	42CrMo4	708M40	42CD4	4140
Cold work tool steel	800-850			1.2713	55NiCrMoV6		55NCDV7	L6
High speed steel	820-1050			1.3243	S 6-5-2-5		Z85WDKCV 06-05-05-04-02	
High speed steel	820-1050			1.3255	S 18-1-2-5	BT4	Z80WKCV 18-05-04-01	T4
Case hardening steel	830-1180			1.5732	14NiCr10		14NC11	3415
Cold work tool steel	**850-900**		**D2**	**1.2379**	**X155CrVMo12-1**	**BD2**	**Z160CDV12**	**D2**
Cold work tool steel	850-900			1.2080	X210Cr12	BD3	Z200Cr12	D3
Cold work tool steel	850-900			1.2436	X210CrW12			
Cold work tool steel	850-900			1.2601	X165CrMoV12			
Case hardening steel	880-1230			1.5752	14NiCr14	655M13	12NC15	3415
Heat treatable steel	**900-1200**	**Nickelvac® 4340**		**1.6582**	**34CrNiMo6**	**817M40**	**35NCD6**	**4340**
Nitriding steel	950-1000			1.8509	41CrAlMo7	905M39	40CAD6, 12	
Spring steel	950-1050			1.0904	55Si7	250A53	55S7	9255
Case hardening steel	980-1320			1.6587	17CrNiMo6	820A16	18NCD6	
Heat treatable steel	980-1420			1.7361	32CrMo12	722M24	30CD12	
Spring steel	1050-1100			1.7176	55Cr3	527A60	55C3	5155
Spring steel	1050-1100			1.0961	60SiCr7		60SC7	9262
Nitriding steel	1080-1270			1.2606	39CrMoV13 9	BH12		H12
Hot work tool steel	1180-1570			1.2343		BH11		H11
Hot work tool steel	1180-1670			1.2365		BH10		H10
Hot work tool steel	**1180-1770**		**H13**	**1.2344**	**X40CrMoV51**	**BH13**	**Z40CDV5**	**H13**
Hot work tool steel	1180-1770			1.2581	X30WCrV9 3	BH21	Z30WCV9	H21
Hot work tool steel	1270-1670			1.2678		BH19		H19

ATI Metal

Star Guide Key to Recommended Inserts

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Materials Cross Reference Chart

Material Group	Country/Standard							
	Rm (N/mm^2)	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
Stainless steel	**400-600**	**Nickelvac® 410 / 403**	**AL 403**	**1.4000**	**X6Cr13**	**403S17**	**Z6C13**	**403**
Heat resistant steel casting	400-600			1.4865	G-X40NiCrSi38 18	330C11		
Stainless steel casting	440-640			1.4308	G-X6CrNi18 9	304C15	Z6CN18.10M	
Stainless steel casting	440-640			1.4408	G-X6CrNiMo18 10	316C16		
Stainless steel casting	440-640			1.4581	G-X7CrNiMoNb18 10	318C17	Z4CNNDNb18 12M	
Heat resistant steel	**450-650**		**AL 405**	**1.4724**	**X10CrAl13**	**403S17**	**Z10C13**	**405**
Stainless steel	**450-650**	**Nickelvac® 410 / 403**	**AL 410**	**1.4006**	**X10Cr13**	**410S21**	**Z10C14**	**410**
Stainless steel	**450-650**		**AL 430**	**1.4016**	**X6Cr17**	**430S15**	**Z8C17**	**430**
Stainless steel	**450-650**		**AL 434**	**1.4113**	**X6CrMo17**	**434S17**	**Z8CD17.01**	**434**
Stainless steel	**460-680**		**AL 304L**	**1.4306**	**X2CrNi19 11**	**304S12**	**Z3CN18.10**	**304L**
Stainless steel	**490-690**		**AL 305**	**1.4303**	**X5CrNi18 12**			**305**
Stainless steel	**490-690**	**Allvac® 316 L**	**AL 316L**	**1.4435**	**X2CrNiMo18 12**	**316S12**	**Z2CND17.13**	**316L**
Stainless steel	**490-690**		**AL 317L**	**1.4438**	**X2CrNiMo18 16**	**317S12**	**Z2CND19.15**	**317L**
Stainless steel	490-740			1.4583	X10CrNiMoNb18 12		Z6CNDNb17 13B	318
Stainless steel	**500-550**		**E-Brite® Alloy**					**ASTM A240**
Stainless steel	**500-700**		**AL 303**	**1.4305**	**X10CrNiS18 9**	**303S21**	**Z10CNF 18.09**	**303**
Stainless steel	**500-700**		**AL 304**	**1.4301**	**X5CrNi18 10**	**304S15**	**Z6CN18.09**	**304**
Stainless steel	**500-730**		**AL 321**	**1.4541**	**X6CrNiTi18 10**	**2337**	**Z6CNT18.10**	**321**
Stainless steel	500-730			1.4571	X6CrNiMoTi17 12 2	320S17	Z6NDT17.12	316Ti
Heat resistant steel	**500-750**		**AL 309**	**1.4828**	**X15CrNiSi20 12**	**309S24**	**Z15CNS20.12**	**309**
Heat resistant steel	**500-750**		**AL 310S**	**1.4845**	**X12CrNi25 21**	**310S24**	**Z12CN25 20**	**310S**
Stainless steel	**500-750**		**AL 904L**	**1.4539**				**ASTM B625**
Heat resistant steel	500-750			1.4878	X12CrNiTi18 9	321S320	Z6CNT18.12B	
Stainless steel	**510-710**		**AL 316**	**1.4401**	**X5CrNiMo18 10**	**316S16**	**Z6CND17.11**	**316**
Stainless steel	**510-740**		**AL 347**	**1.4550**	**X6CrNiNb18 10**	**347S17**	**Z6CNNb18.10**	**347**
Heat resistant steel	520-720			1.4762	X10CrAl 24		Z10CAS24	446
Stainless steel	550-760			1.4311	X2CrNiN18 10	304S62	Z2CN18.10	304LN
Heat resistant steel	550-800			1.4841	X15CrNiSi25 20			310
Heat resistant steel	550-800			1.4864	X12NiCrSi36 16		Z12NCS35.16	330
Stainless steel	**580-800**		**AL 316LXN**	**1.4429**	**X2CrNiMoN17 13 3**		**Z2CND17.13**	**316LN**
Stainless steel	**590-780**		**AL 416**	**1.4005**	**X12CrS13**			**416**
Stainless steel	640-840			1.4104	X12CrMoS17		Z10CF17	430F
Stainless steel	640-900			1.4460	X8CrNiMo27 5			329
Stainless steel	700-800			1.4034	X45Cr13	420S45	Z40CM Z38C13M	
Stainless steel	**700-950**		**AL 301**	**1.4310**	**X12CrNi17 7**		**Z12CN17.07**	**301**
Stainless steel	750-800			1.4027	G-X20Cr14	420C29	Z20C13M	
Stainless steel	**750-950**		**AL 420**	**1.4021**	**X20Cr13**			**420**
Stainless steel casting	760-960			1.4313	X5CrNi13 4	425C11	Z4CND13.4M	
Stainless steel	**800-900**		**AL 2205**					**ASTM A240**
Stainless steel	850-950			1.4057	X20CrNi172	431S29	Z15CNi6.02	431
Stainless steel	**1100-1200**		**AM 350™**					**ASTM A693**
Precipitation hardening stainless			**AL 13-8**					**13-8 PH**
Precipitation hardening stainless		**Nickelvac® 15-5**	**AL 15-5**	**1.4540**	**X4CrNiCuNb164**		**Z6CNU15.05**	**15-5 PH**
Precipitation hardening stainless			**AL 15-7**	**1.4532**	**X7CrNiMoAl157**		**Z8CNDA15.07**	**15-7 PH**
Precipitation hardening stainless		**Nickelvac® 17-4**	**AL 17-4**	**1.4542**	**X5CrNiCuNb174**		**Z6CNU17.04**	**17-4 PH**
Precipitation hardening stainless			**AL 17-7**	**1.4568**	**X7CrNiAl177**		**Z8CNA17.07**	**17-7 PH**

ATI Metal

Star Guide Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Materials Cross Reference Chart

Cr	Ni	C	Mn	Si	P	S	Mo	Cu	Ti	Others
12.0		**0.15**	**0.5**	**0.50**	**0.02**	**0.01**				
18.8	38.0	0.4	1.0	1.75	0.045	0.03				W 4.75
19.0	10.0	0.07	1.5	2.0	0.045	0.03				
19.0	11.0	0.07	1.5	1.5	0.045	0.03	2.5			
19.0	11.5	0.06	1.5	1.5	0.045	0.03	2.25			
12.0		**0.08**	**1.0**	**0.50**	**0.04**	**0.03**				**Al 0.10-0.30**
12.0		**0.15**	**0.5**	**0.50**	**0.02**	**0.01**	**0.5**	**0.5**		
16.0		**0.08**	**1.0**	**1.0**	**0.04**	**0.03**				
17.0		**0.08**					**0.75**			
19.0	**10.0**	**0.015**	**1.0**	**0.5**	**0.023**	**0.015**				
18.0	**11.5**	**0.12**	**2.0**	**1.0**	**0.04**	**0.03**				
17.0	**12.0**	**0.015**	**1.0**	**0.5**	**0.023**	**0.015**	**2.5**			
19.0	**13.0**	**0.015**	**1.0**	**1.0**	**0.023**	**0.015**	**3.5**			
18.0	14.0	0.08	2.0				2.0			
26		**0.003**					**1**			
19.5	**10.5**	**0.16**	**1.5**	**2.0**	**0.04**	**0.3**	**0.6**			
19.5	**9.0**	**0.08**	**1.5**	**2.0**	**0.04**	**0.04**				
18.0	**9.5**	**0.08**	**2.0**	**1.0**	**0.04**	**0.03**			**0.40**	
17.5	12.0	0.08	2.0	1.0	0.045	0.03	2.25		5.0	
23.5	**14.0**	**0.20**	**1.5**	**2.0**	**0.04**	**0.04**				
25.0	**20.5**	**0.15**	**2.0**	**0.75**	**0.045**	**0.03**				
20.5							**4.5**	**1.5**		
18.0	10.5	0.12	2.0	1.0	0.045	0.03			0.40	Al 0.40
17.0	**13.0**	**0.08**	**2.0**	**0.75**	**0.04**	**0.03**	**1.5**	**0.50**		
18.0	**11.0**	**0.08**	**2.0**	**1.0**	**0.045**	**0.03**				
25.0		0.12	1.0	1.0	0.04	0.03				Al 1.50
18.0	10.0	0.03	2.0	1.0	0.045	0.03				N 0.16
24.5	20.5	0.18	2.0	1.5	0.04	0.03	0.5	0.5		
15.0	35.0	0.15	1.0	2.5	0.04	0.04				
17.5	**13.0**	**0.03**	**2.0**	**1.0**	**0.045**	**0.025**	**2.75**			**N 0.16**
13.0		**0.15**	**1.25**	**1.0**	**0.07**	**0.07**	**0.60**			
17.0		0.12	1.25	1.0	0.06	0.15	0.5			
25.5	3.5	0.1			0.04	0.03	1.0			
13.5		0.5	1.0	1.0	0.045	0.03				
17.0	**7.0**	**0.14**	**2.0**	**1.0**	**0.045**	**0.03**				
13.5	1.0	0.2	1.0	1.0	0.045	0.03				
12.5		**0.20**	**1.0**	**1.0**	**0.04**	**0.04**				
13.0	4.5	0.07	1.5	1.0	0.035	0.025	0.7			
22	**5.5**						**3**			**N 0.16**
16.0	2.0	0.20	1.0	1.0	0.04	0.03				
16.5	**4.3**	**0.08**					**2.8**			
13	**8**						**2.2**			**Al 1.2**
14.8	**4.5**	**0.03**	**0.5**	**0.5**	**0.02**	**0.015**		**3.5**		**Cb 0.3**
15.0	**7.0**	**0.045**	**0.5**	**0.5**	**0.02**	**0.015**	**2.5**			**Al 1.15**
16.3	**4.0**	**0.035**	**0.5**	**0.5**	**0.02**	**0.015**		**4.0**		**Cb 0.3**
17.0	**7.0**	**0.045**	**0.5**	**0.5**	**0.02**	**0.02**				**Al 1.15**

Star Guide Key to Recommended Inserts

Material Designations

P Unalloyed Steels	**M** Stainless Steels	**K** Cast Irons	**S** High Temp. Alloys
P Alloyed Steels	**M** PH Stainless	**N** Aluminum & Alloys	**H** Hard Materials

Materials Cross Reference Chart

Material Group	Country/Standard							
	HBN	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN	BS	AFNOR	ASTM/SAE
Grey cast iron	175			0.6010	GG 10	Grade 100	Ft 10 D	No 20 B
Grey cast iron	185			0.6015	GG 15	Grade 150	Ft 15 D	No 25 B
Grey cast iron	205			0.6020	GG 20	Grade 220	Ft 20 D	No 30 B
Grey cast iron	220			0.6025	GG 25	Grade 260	Ft 25 D	No 35 B
Grey cast iron	230			0.6030	GG 30	Grade 300	R 30 D	No 45 B
Grey cast iron	235			0.6035	GG 35	Grade 350	Ft 35 D	No 50 B
Grey cast iron	250			0.6040	GG 40	Grade 400	Ft 40 D	No 55 B
Spheroidal / nodular/ ductile cast iron	150-180				GGG 35.3	350/22	FGS 350-22	60-40-18
Spheroidal / nodular/ ductile cast iron	155-220			0717-02	GGG 40	420/12		65-45-12
Spheroidal / nodular/ ductile cast iron	190-255			0727-02	GGG 50	500/7	FGS 500-7	80-55-06
Spheroidal / nodular/ ductile cast iron	200-260			0732-03	GGG 60	600/3	FGS 600-3	80-60-03
Spheroidal / nodular/ ductile cast iron	240-300			0737-01	GGG 70	700/2	FGS 700-2	100-70-03
Spheroidal / nodular/ ductile cast iron	265-300				GGG 80	900/2	FGS 900-2	120-90-02
Malleable cast iron	150				GTS-35-10	B 340/12	MN 35-1	32510
Malleable cast iron	175			0.8145	GTS-45-06	P 440/7		40010
Malleable cast iron	205			0.8155	GTS-55-04	P 510/4	MP 50-5	50005
Malleable cast iron	230			0.8165	GTS-65-02	P 570/3	Mn 650-3	A220-70003
Malleable cast iron	265			0.8170	GTS-70-02	P 690/2	Mn 700-2	A220-80002
Aluminium alloys				3.0255	Al99,9	1B	A5	1050
Aluminium alloys				3.0515	AlMn	N3		
Aluminium alloys				3.0615	AlMgSiPb			
Aluminium alloys				3.1325	AlCuMg1		A-U4G	2017
Aluminium alloys				3.1355	AlCuMg2	L97	A-U4G1	2024
Aluminium alloys				3.1645	AlCuMgPb			
Aluminium alloys				3.1655	AlCuBiPb	FC1	A-U5PbBi	2011
Aluminium alloys				3.2245	AlSi5			
Aluminium alloys				3.2305	AlRMgSi			
Aluminium alloys				3.2315	AlMgSi1	H30		6351
Aluminium alloys				3.3206	AlMgSi0,5	H9		6063
Aluminium alloys				3.3309	AlRMg0,5			
Aluminium alloys				3.3315	AlMg1	N41	A-G0,6	5005
Aluminium alloys				3.3316	AlMg1,5	3L44	A-G1,5	5050
Aluminium alloys				3.3319	AlRMg1			
Aluminium alloys				3.3523	AlMg2,5	2L56	A-G2,5C	5052
Aluminium alloys				3.3535	AlMg3	N5	A-G3M	5754
Aluminium alloys				3.3545	AlMg4Mn		A-G4MC	5086
Aluminium alloys				3.3547	ASlMg4,5Mn	N8	A-G4,5MC	5083
Aluminium alloys				3.3549	AlMg5	N6		5056
Aluminium alloys				3.4365	AlZnMgCu1,5	DTD5074	A-Z5GU	7075
Aluminium alloys					AlZnMg1			7005
Aluminium alloys					AlMg2,5Mn	N51	A-G2,5MC	5454
Aluminium alloys					AlSi3,5			

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Materials Cross Reference Chart

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti			
0.25	0.4	0.05	0.05	0.05		0.07	0.05			
0.5	0.7	0.1	1.2	0.3	0.1	0.2	0.1			
1.0	0.5	0.1	0.7	0.9	0.3	0.3	0.2			
0.5	0.7	4.0	0.7	0.7	0.1	0.25				
0.5	0.5	4.3	0.6	1.5	0.1	0.25	0.15			
0.8	0.8	4.0	0.75	1.1	0.1	0.8	0.2			
0.4	0.7	5.5				0.3				
5.0	0.4	0.05	0.1	0.1		0.2	0.25			
0.55	0.15	0.02		0.45		0.15				
1.0	0.5	0.1	0.6	0.9	0.25	0.2	0.1			
0.45	0.15	0.1	0.1	0.45	0.05	0.15	0.1			
0.01	0.008			0.35		0.01	0.008			
0.3	0.45	0.05	0.15	0.9	0.1	0.2				
0.4	0.45	0.05	0.15	1.5	0.1	0.2				
0.1	0.008			1.00		0.01	0.008			
0.25	0.4	0.1	0.1	2.5	0.2	0.1				
0.4	0.4	0.1	0.5	3.1	0.3	0.2	0.15			
0.4	0.5	0.1	0.45	4.0	0.15	0.25	0.15			
0.4	0.4	0.1	0.7	4.5	0.15	0.25	0.15			
0.2	0.35	0.15	0.35	4.5	0.1	0.25	0.1			
0.4	0.5	1.6	0.3	2.5	0.23	5.5	0.2			
0.35	0.4	0.1	0.45	1.4	0.13	4.5	0.03			
0.4	0.4	0.05	0.75	2.7	0.1	0.1	0.15			
4.5				0.04						

Star Guide Key to Recommended Inserts

Material Designations			
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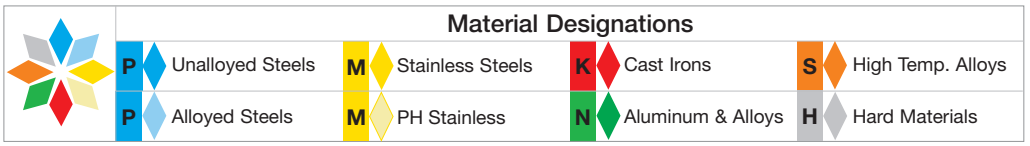
Materials Cross Reference Chart

Material Group	Country/Standard							
	Commercial Designation	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
✵ Iron based alloys	C-250	VascoMax® C-250						6501, 6512, 6520
✵ Iron based alloys	C-350	VascoMax® C-350						
✵ Iron based alloys	C-200	VascoMax® C-200						
✵ Iron based alloys	C-300	VascoMax® C-300						6514
✵ Iron based alloys	T-200	VascoMax® T-200						
✵ Iron based alloys	T-250	VascoMax® T-250						6518, 6519, 6591
✵ Iron based alloys	Greek Ascoloy		AL 418					5508
Iron based alloys	Jethete M-152						Z12 CND 12	5718, 5719
Iron based alloys	Haynes® 556				X12CrCoNi2120			5768
Iron based alloys	N 155						Z12 CNKDW 20	5768
Iron based alloys	S 590				X40CoCrNi2020		Z42 CKNDW	5533
✵ Iron based alloys	A286		ALTEMP® A 286	1.4980		HR 5152	Z06 NCT 25	ASTM 368
Iron based alloys	Discaloy 16/25/6						Z3 NCT 25	5725
✵ Iron based alloys	AL-6XN Alloy		AL-6XN® Alloy					ASTM SB688
Iron based alloys	Discaloy 24						Z3 NCT 25	ASTM A638
Iron based alloys	Armco® 18							
Iron based alloys	Incoloy® 801				G-X50CrNi3030			5552
✵ Iron based alloys	Incoloy 800	Nickelvac® 800	AL 800		X10NiCrAlTi3220	3082-76	25 NC 3520	ASME SB 409
Iron based alloys	Incoloy 802							
Iron based alloys	N 156							
✵ Iron based alloys	20CB-3®		AL 20					ASTM B463
Iron based alloys	Sanicro 30				X2NiCrAlTi3220			
Iron based alloys	Incoloy 803							
✵ Iron based alloys	Allvac 330	Allvac® 330						5592, 5716
✵ Iron based alloys	Alloy 36		AL 36					ASTM F1684
Iron based alloys	Incoloy DS				X12NiCrSi3616	3072-76		
✵ Iron based alloys	Alloy 42		AL 42					ASTM F30
Iron based alloys	Armco 20-45-5							
✵ Iron based alloys	4750		AL 4750					ASTM B753
✵ Iron based alloys	Alloy 21-6-9		ALLOY 21-6-9					ASTM A666
✵ Iron based alloys	13-8 Mo	Vasco® 13-8 Mo						5629

Material Group	Country/Standard							
	Commercial Designation	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
✵ Cobalt based alloys	MP35N	Allvac® 35N						
✵ Cobalt based alloys	L 605	Nickelvac® L-605			CoCr20W15Ni		KC 20 WN	5759
✵ Cobalt based alloys	TJA-1537®	Nickelvac® TJA-1537						ASTM F1537
Cobalt based alloys	S 816		ALTEMP® S 816		CoCr20Ni20W			5534
Cobalt based alloys	HS 21				CoCr28Mo	3531		ASTM F-75
Cobalt based alloys	HS 25				CoCr20W15Ni		KC 20 WN	AISI 670
Cobalt based alloys	HS 30				CoCr26Ni14Mo			
Cobalt based alloys	HS 31				CoCr25NiW	3146	KC 25 NW	ASTM A567
Cobalt based alloys	HS 36				CoCr19W14NiB			
Cobalt based alloys	Jetalloy 209							
Cobalt based alloys	L 251							
Cobalt based alloys	M 203							

✵ ATI Metal

Star Guide Key to Recommended Inserts



Materials Cross Reference Chart

Ni	Co	Cr	Mo	W	Si	Mn	C	Al	Ti	P	S	Others
18.5	**7.8**		**4.8**		**0.05**	**0.05**	**0.02**	**0.1**	**0.4**	**0.005**	**0.005**	
18.5	**12.0**		**4.8**		**0.05**	**0.05**	**0.02**	**0.1**	**1.4**	**0.005**	**0.005**	
18.5	**8.5**		**3.25**		**0.05**	**0.05**	**0.01**		**0.2**	**0.005**	**0.005**	
18.5	**8.8**		**4.8**		**0.05**	**0.05**	**0.02**	**0.1**	**0.73**	**0.005**	**0.005**	
18.5			**3.0**		**0.05**	**0.05**	**0.01**		**0.7**	**0.005**	**0.005**	
18.5			**3.0**		**0.03**	**0.05**	**0.02**	**0.1**	**1.4**	**0.005**	**0.005**	
2		**12**		**2.5**			**0.19**					
2.5		12	1.7				0.15					V 0.3
20	20	21	3	2.5			0.1					Nb + Ta
20	20	21	3	2.5	0.5	1.5	0.15					Nb 1.0
20	20	21	4	4			0.43					
25		**14**	**1.3**		**0.5**	**1.3**	**0.05**	**0.2**	**2.1**			
25		16	6		0.7	1.35	0.12		0.3			Nb 0.4
25		**20.5**	**6.5**				**0.02**					**N 0.2**
26		13.5	2.7		0.8	0.9	0.04	0.1	1.7			
3.7		17.2			0.47	12.5	0.06					
32		20.5			0.5	0.8	0.05		1.1			
32.5		**21.0**			**0.5**	**0.75**	**0.05**	**0.37**	**0.37**		**0.007**	**Cu 0.37**
32.5		21.5			0.4	0.8	0.4					
33	24	17	3	2			0.33					
33		**20**	**2.2**									**Cu 3.3**
34		22			0.55	0.55	0.03	0.3	0.5			Cu 0.1
35		25					0.08	0.15	0.15			
35.5		**18.5**			**1.13**	**1.0**	**0.04**			**0.01**	**0.01**	**Cu 0.5**
36												
37		18			2.3	1.0	0.06					
41												
46		20	2.3		1.0	5	0.08					Nb 0.4
49												
6.5		**21**				**6.0**						**No 0.3**
8.0		**12.8**	**2.3**		**0.05**	**0.10**	**0.03**	**1.05**		**0.005**	**0.004**	

Ni	Fe	Cr	Mo	W	Si	Mn	C	Al	Ti	P	S	Others
35		**20**	**9.8**				**0.013**					
10	**0.5**	**20**		**15**		**1.7**	**0.1**					
0.2	**0.25**	**28**	**6**		**0.5**	**0.5**	**0.06**					**N 0.2**
20	4	20	4	4	0.4	1.2			0.38			
3	1	27	5		0.6	0.6			0.25			
10	3	20		15	2	1.5			0.1			
16	1	24	6		0.6	0.6			0.4			
10	1.5	25		8	0.75	0.6			0.4			
10	2	18		15		1.5			0.4			
10	1	20		15				2.0	0.02			
10	1	19		14					0.4			
24.5	1	19.5		12	1	0.8	2.15	24.5	0.07			

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Materials Cross Reference Chart

Material Group	Country/Standard							
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				W.-Nr.	DIN		AFNOR	AMS
Cobalt based alloys	M 204							
Cobalt based alloys	M 205							
Cobalt based alloys	MAR-M 302				CoCrW10TaZrB			
Cobalt based alloys	MAR-M 322				CoCr22W9TaZrNb			
Cobalt based alloys	MAR-M 509				CoCr24Ni10WtaZrB	3146-3		
Cobalt based alloys	MAR-M 905							
Cobalt based alloys	MAR-M 918				CoCr20Ni20Ta			
Cobalt based alloys	Stellite 1						KC 33 W13	
Cobalt based alloys	Stellite 6						KC 26 NW	
Cobalt based alloys	Stellite 12						KC 28 W8	
Cobalt based alloys	V-36				CoCr25Ni20M0WNb			
Cobalt based alloys	WI-52				CoCr21Mo11W			
Cobalt based alloys	X 40				CoCr25NiW	3146-2		ASTM A567
Cobalt based alloys	X 45							
Cobalt based alloys	X 50							

Material Group	Country/Standard							
	Commercial Designation	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
Nickel based alloys	**Alloy 22**		**AL 22**					**ASME SB575**
Nickel based alloys		**Allvac® Allcorr®**						
Nickel based alloys	**Astroloy**	**Allvac Astroloy**						
Nickel based alloys	Duranickel 310							
Nickel based alloys	GMR 235							AISI:686
Nickel based alloys	GMR 235-D				NiCr16MoAl			
Nickel based alloys	**Hastelloy® B**	**Nickelvac® H-B**			**S-NiMo30**		**ND27FeV**	**5396A**
Nickel based alloys	**Hastelloy B-2**	**Nickelvac H-B-2**						
Nickel based alloys	Hastelloy C				NiCr17Mo17FeW		NC17DWY	5388C
Nickel based alloys	Hastelloy D							
Nickel based alloys	**Hastelloy N**	**Nickelvac H-N**						
Nickel based alloys	Hastelloy R235							
Nickel based alloys	**Hastelloy W**	**Nickelvac H-W**						
Nickel based alloys	**Hastelloy X**	**Nickelvac H-X**	**ALTEMP® HX**	**2.4665**	**NiCr22FeMo**	**HR6,204**	**NC22FeD**	**5536**
Nickel based alloys	Haynes 75							
Nickel based alloys	HS 27				NiCo32Cr26Mo		KC20WN	
Nickel based alloys	IN 100				NiCo15Cr10MoAlTi		NK15CAT	5397
Nickel based alloys	IN 713							
Nickel based alloys	Incoloy® 020			2.4660				ASME SB463
Nickel based alloys	Incoloy 804							
Nickel based alloys	**Incoloy 825**	**Nickelvac 825**	**AL 825**	**2.4858**	**NiCr21Mo**	**3072-76**	**NC21FeDU**	**ASME SB424**
Nickel based alloys	Incoloy 901				NiFe35Cr14MoTi		Z8NCDT42	5660
Nickel based alloys	Incoloy 903							
Nickel based alloys	Incoloy 925							
Nickel based alloys	**Inconel® 600**	**Nickelvac 600**	**AL 600**	**2.4816**	**NiCr15Fe**	**3072-76**	**NC15Fe**	**5540**
Nickel based alloys	**Inconel 601**	**Nickelvac 601**	**AL 601**	**2.4851**				**5715**
Nickel based alloys	**Inconel 617**	**Nickelvac 617**		**2.4663**				
Nickel based alloys	Inconel 622			2.4602				
Nickel based alloys	**Inconel 625**	**Nickelvac 625**	**ALTEMP 625**	**2.4856**	**NiCr22Mo9Nb**		**NC22FeDNB**	**ASME SB443**

ATI Metal

Star Guide Key to Recommended Inserts

	Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Materials Cross Reference Chart

Ni	Fe	Cr	Mo	W	Si	Mn	C	Al	Ti	P	S	Others
24.5		18.5		12	1	1			0.07			
24.5		18.5		12			2.75		0.07			
		21.5		10					0.85			Ta 9.0
		21.5		9	0.1	0.1		0.75	1.0			Ta 4.5, Zr 2.25
10	1	23.5		7	0.1	0.1		0.2	0.6			Ta 3.5, Zr 0.5
20		20						0.5	0.05			Ta 7.5, Zr 0.1
20	0.4	20			0.1	0.1			0.05			Ta 7.5, Zr 0.1
		33		13			2.5					
		26		5			1.0					Nb 6.0
		29		9			1.8					
20	3	25	4	2	0.4	1			0.26			Nb 2.0
1	2	21		11	0.25				0.45			Nb 2.0
10.5	1.5	25.5		7.5	0.75	0.75			0.5			
10.5	2	25.5		7		0.7			0.25			B 0.01
20.5	4	22.5		12					0.75			

Fe	Co	Cr	Mo	W	Si	Mn	C	Al	Ti	P	S	Others
2.5		**20.6**	**13.9**	**2.65**								
		31.0	**10.0**	**2.0**			**0.02**	**0.25**	**0.25**			**Nb 0.4**
	17.0	**15.0**	**5.0**				**0.04**	**4.0**	**3.5**			**B 0.025**
0.6			0.5		1.0	0.5		4.4	0.6			
10.0		15.5	5.2		0.4	0.2	0.15	3.0	2.0			
4.5		15.5	5.0				0.15	3.5	2.5			B0.05
5.0	**2.0**	**1.5**	**28.0**		**0.05**	**0.5**	**0.02**					**V 0.4**
1.0	**0.5**	**0.5**	**16.0**		**0.05**	**0.5**	**0.01**			**0.02**	**0.015**	
6.0	2.0	15.0	17.0	5			0.04					
2.0		1.0			9.0	1.0	0.1					Cu 3.0
4.0		**7.0**	**16.5**				**0.02**					
10.0	2.5	15.5	5.5				0.15	2	2.5			
4.0		**5.0**	**24.5**				**0.02**					
18	**1.5**	**22**	**9.0**	**0.6**			**0.1**					
5.0		20.0					0.12	0.25	0.4			Cu 0.5
2.0	31.5	26.0	6.0				0.4					
	15.0	10.0	3.0				0.18	5.5	4.7			V 1.0
2.5		13.0	4.6		0.4	0.2	0.18	6.0	0.8			Nb 2.6
37		20	2.5									Nb 0.6 Cu 3.5
25.4		29.5			0.5	0.75	0.06	0.25	0.6			Cu 0.4
30		**21.5**		**3.0**	**0.5**	**0.65**	**0.03**	**0.2**	**0.9**			**Cu 2.25**
35.3		13.45	6.20		0.22	0.48	0.05		2.5			
42.0	15.0							0.7	1.4			Nb3.0
28		21	3					0.3	2.1			Cu 1.8
8.0		**15.5**					**0.075**					
14.0		**23.0**			**0.2**	**0.5**	**0.05**	**1.3**			**0.008**	**Cu 0.5**
	12.5	**22**	**9.0**				**0.07**	**1.0**				
2.3		20.5	14.2	3.2								
2.5		**21.5**	**9.0**				**0.05**	**0.3**	**0.3**			**Cb 3.7**

Star Guide Key to Recommended Inserts

Materials Cross Reference Chart

Material Group	Country/Standard							
	Commercial Designation	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
Nickel based alloys	**Inconel® 690**	**Nickelvac® 690**		**2.4642**				
Nickel based alloys	Inconel 700				NiCo28Cr15MoAlTi		NK27CADT	
Nickel based alloys	Inconel 702							5550
Nickel based alloys	**Inconel 706**	**Allvac® 706**						**57-2**
Nickel based alloys	Inconel 713				G-NiCr13Al16MoNb	3146.3	NC13AD	5391
Nickel based alloys	**Inconel 718**	**Allvac 718**	**ALTEMP® 718**	**2.4668**	**NiCr19Fe19NbMo**	**HR8**	**NC19FeNb**	**5383**
Nickel based alloys	**Inconel 718-OP**	**Allvac 718-OP**						
Nickel based alloys	**Inconel 720**	**Allvac 720**						
Nickel based alloys	Inconel 721							
Nickel based alloys	**Inconel 722**	**Nickelvac W-722**			**NiCr16FeTi**		**NC16Feti**	**5541**
Nickel based alloys	Inconel 725							
Nickel based alloys	**Inconel 751**	**Nickelvac X-751**		**2.4694**				
Nickel based alloys	**Inconel X-750**	**Nickelvac X-750**	**ALTEMP 750**	**2.4669**	**NiCr16FetTi**		**NC15FeTNb**	**5542**
Nickel based alloys	Jessop G 81				NiCr20Co18Ti			
Nickel based alloys	**Jethete M-252**	**Allvac M-252**			**G-NiCr19Co**			**5551**
Nickel based alloys	MAR-M 200				NiW13Co10Cr9AlTi		NKW10CATaHf	
Nickel based alloys	MAR-M 246				NiCo10W10Cr9AlTi			
Nickel based alloys	MAR-M 421				NiCr16Co10WalTi			
Nickel based alloys	MAR-M 432				NiCo20Cr16WAlTi			
Nickel based alloys	**Monel 400**	**Nickelvac 400**	**AL 400**	**2.4360**	**NiCu30Fe**	**3072-76**	**NU30**	**4544**
Nickel based alloys	**Monel K 500**	**Nickelvac K-500**		**2.4375**	**NiCu30Al**	**3072-76**		**4676**
Nickel based alloys	Monel R 405							4674
Nickel based alloys	Nimocast 713				G-NiCr13A16MoNb	HC203	NC13AD	5391A
Nickel based alloys	Nimocast PD 16				NiFe33Cr17Mo			
Nickel based alloys	Nimocast PE 10					HC202	NC20N13	
Nickel based alloys	Nimonic® 105			2.4634	NiCo20Cr15MoAlTi	HR3	NCKD20ATV	
Nickel based alloys	Nimonic 115			2.4636	NiCo15Cr15MoAlTi	HR401, 601	NCVK15ATD	
Nickel based alloys	Nimonic 75			2.4630	NiCr20Ti	HR5, 203-4	NC20T	
Nickel based alloys	**Nimonic 80A**	**Nickelvac 80 A**		**2.4631**	**NiCr20TiAl**	**HR401, 601**	**NC20TA**	
Nickel based alloys	Nimonic 86							
Nickel based alloys	**Nimonic 90**	**Nickelvac N-90**		**2.4632**	**NiCr20Co18Ti**	**HR2,202**	**NCK20TA**	
Nickel based alloys	**Nimonic 901**	**Nickelvac 901**		**2.4662**	**NiCr15MoTi**		**Z8NCDT42**	**5660, 5661**
Nickel based alloys	Nimonic 95							
Nickel based alloys	**Nimonic C-22**	**Nickelvac C-22**						
Nickel based alloys	**Nimonic C-263**	**Nickelvac C-263**	**ALTEMP 263**	**2.4650**	**NiCr20CoMoTi**	**HR10**	**NCK20D**	
Nickel based alloys	**Nimonic C-276**	**Nickelvac C-276**	**AL 276**	**2.4819**				**ASME SB575**
Nickel based alloys	Nimonic PE 13				NiCr22Fe18Mo	HR6,204	NC22FeD	5536E
Nickel based alloys	Nimonic PE 16				NiFe33Cr17Mo	HR207	NW11AC	
Nickel based alloys	Nimonic PK 25						NKCD20ATU	5751A
Nickel based alloys	Nimonic PK 31							
Nickel based alloys	Nimonic PK 33				NiCr20Co16MoTi	5057	NC19KDU/V	
Nickel based alloys	R-235							
Nickel based alloys	Refractaloy 26						Z6NKCDT38	AISI:690
Nickel based alloys	René 100				NiCo15Cr10MoAlTi			
Nickel based alloys	René 125							
Nickel based alloys	**René 41**	**Rene 41**			**NiCr19Co11MoTi**	**NC19KDT**		**5712, 5713**
Nickel based alloys	René 63							

ATI Metal

Star Guide Key to Recommended Inserts

	Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Materials Cross Reference Chart

Fe	Co	Cr	Mo	W	Si	Mn	C	Al	Ti	P	S	Others
9.0		**29.0**			**0.2**	**0.2**	**0.25**				**0.007**	**Cu 0.2**
0.7	28.5	15	3.7		0.3	0.1	0.12	3.0	2.2			
0.4		15.6			0.2	0.05	0.04	3.4	0.7			
		16.0					**0.03**		**1.8**			**Cb 2.9**
		12	4.5				0.13	6	0.6			
17.2		**19.0**	**3.1**				**0.02**	**0.5**	**0.9**			**Cb 5.2**
17.2		**19.0**	**3.1**				**0.02**	**0.5**	**0.9**			**Cb 5.2**
	14.7	**18**	**3**	**1.25**				**2.5**	**5**			
8.0		16			0.15	2.25	0.07	0.1	3.0			Cu0.2
7.0		**15.5**					**0.04**	**0.7**	**2.4**			
7.5		21	8					0.3	1.5			Nb 3.5
7.0		**15.5**			**0.2**	**0.5**	**0.05**	**1.2**	**2.3**		**0.005**	**Cb 1.1, Cu 0.2**
7.0		**15.5**					**0.04**	**0.7**	**2.5**			**Cb 0.95**
0.5	16.9	20.6			0.2	0.5	0.08	1.5	2.5			
2.5	**10.0**	**19.0**	**9.75**				**0.15**	**1.0**	**2.5**			**B 0.007**
	10.0	9.0		12.5			0.15	5.0	2.0			Nb1.0
	10.0	9.0	2.5	10.0			0.15	5.5	1.5			Ta1.5
	10.0	15.5	1.7	3.5			0.15	4.25	1.75			Nb1.75
	20.0	15.5		3			0.15	2.5	4.3			Nb2.0
1.2					**0.25**		**0.15**				**0.01**	
1.0					**0.25**	**0.7**	**0.1**	**2.7**	**0.6**		**0.01**	
1.25					0.25	1.0	0.15					Cu31.5
		13.5	4.5				0.12	6.0	0.9			
34.0		16.5	3.3				0.06	1.2	1.2			
3.0		20.0	6.0	2.5			0.03					
0.5	20	14.75	5		0.5	0.5	0.1	4.7	1.2			Cu
	13.2	14.2	4				0.16	5	4			Zr
4		20			0.45	0.45	0.45	0.1	0.35			Cu+S
0.55		**19.5**			**0.2**	**0.55**	**0.08**	**1.4**	**2.4**			**Cu+S**
		25	10									Ce 0.03
0.3	**18.0**	**19.5**					**0.065**	**1.4**	**2.4**			
35.0		**12.5**	**6.0**				**0.05**		**2.8**			**B 0.015**
5.0	18.0	19.5			1.0	1.0	0.1	2.0	3.5			
4.0	**1.2**	**21.2**	**13.5**	**3.0**	**0.04**	**0.2**	**0.07**			**0.01**		**V 0.17**
	20.0	**20.0**	**5.85**				**0.06**	**0.45**	**2.15**			
5.0	**0.5**	**15.5**	**16.0**	**3.5**			**0.01**					
18.5	1.5	21.75	9	0.6	0.5	0.5	0.1					
1.2		16.5	3.5				0.05	1.2	1.2			
	19.5	19	4		0.75	0.75	0.08	2.9	2.9			B 0.01
	14	20	4.5					0.4	2.3			Nb5
0.5	14	18	7		0.25	0.25	0.05	2.1	2			
10.0	1.15	15.0	5.5		0.3	0.1	0.12	20	2.5			
16.0	20.0	18.0	3.2		1.0	0.8	0.03	0.2	2.8			
	15.0	10.0	3.0				0.18	5.5	4.7			V1.0
	10.0	8.9	2.0	7.0			0.1	4.7	2.5			Hf1.05, Ta3.0
3.0	**11.0**	**19.0**	**9.75**				**0.06**	**1.6**	**2.5**			**B 0.007**
3.5	15.0	14.0	6.0	3.5	0.2	0.1	0.05	3.8	2.5			

Star Guide Key to Recommended Inserts

Material Designations

P Unalloyed Steels	**M** Stainless Steels	**K** Cast Irons	**S** High Temp. Alloys
P Alloyed Steels	**M** PH Stainless	**N** Aluminum & Alloys	**H** Hard Materials

Materials Cross Reference Chart

Material Group	Country/Standard							
	Commercial Designation	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
Nickel based alloys	René 77							
Nickel based alloys	René 80							
Nickel based alloys	René 95						NC14K8	
Nickel based alloys	TRW VIA				NiTa9Co8W6CrAl			
Nickel based alloys	Udimet® 500				NiCr18CoMoAlTi		NCK19DAT	AISI:684
Nickel based alloys	**Udimet 520**	**Allvac® 520**						
Nickel based alloys	Udimet 630				NiCr19NbMo			
Nickel based alloys	Udimet 700				NiCo15Cr15MoAlTi		NCKD20AT	AISI:687
Nickel based alloys	Udimet 710						NCK18TDA	
Nickel based alloys	Udimet 718				NiCr19Fe19NbMo	HR8	NC19FeNb	5583
Nickel based alloys	**Waspaloy**	**Allvac Waspaloy**		**2.4654**	**NiCr20Co14MoTi**		**NC20K14**	**5544**

Material Group	Country/Standard							
	Commercial Designation	ATI Allvac Designation	ATI Allegheny Ludlum Designation	GERMANY/ITALY		U.K.	FRANCE	USA
				W.-Nr.	DIN		AFNOR	AMS
Alpha Titanium alloys	**Ti-5Al-2.5Sn**	**Allvac® 5-2.5**			**TiAl5Sn2**	**TA 14,17**	**T-A5E**	**ASTM: B 265**
Alpha Titanium alloys	Ti-7Al-4Mo				TiAl7Mo4			ASTM: B 381
Alpha Titanium alloys	**Ti-8Al-1Mo-1V**	**Allvac 8-1-1**			**TiAl8Mo1V1**			**4915, 4933, 4972**
Alpha Titanium alloys	**Ti-6Al-4Zr-2Mo-2Sn**	**Allvac 6-2-4-2**			**TiAl6Zr4Mo2Sn2**			**4919, 4975, 4976**
Alpha Beta Titanium alloys	**Ti-6Al-4V**	**Allvac 6-4**			**TiAl6V4**	**TA 10-13 TA 28**	**T-A6V**	**4906, 4920,4928, 4965, 4967**
Alpha Beta Titanium alloys	**Ti-6Al-6V-2Sn**	**Allvac 6-6-2**			**TiAl6V6Sn2**			**4971**
Alpha Beta Titanium alloys	**Ti-4Al-4Mo-2Sn-0.5Si**	**Allvac 4-4-2**			**TiAl4Mo4Sn2Si0.5**	**5103**	**T-A4DE**	
Alpha Beta Titanium alloys	Ti-4Al-4Mo-4Sn-0.5Si				TiAl4Mo4Sn4Si0.5	5203		
Alpha Beta Titanium alloys	Ti-7Al-4Mo				TiAl7Mo4			ASTM: B 381
Alpha Beta Titanium alloys	Ti-6Al-5Zr-0.5Mo-0.25Si				TiA6Zr5Mo0.5Si0.25		T-AGZ-50	
Alpha Beta Titanium alloys	Ti-6Al-5Zr-4Mo-Cu-0.2Si				TiAl6Zr5Mo4CuSi0.2	M201		
Alpha Beta Titanium alloys	**3-2.5**	**Allvac 3-2.5**						**4943, 4944**
Alpha Beta Titanium alloys	**6-4ELI**	**Allvac 6-4ELI**						**4907, 4930, 4931**
Alpha Beta Titanium alloys	**6-2-4-6**	**Allvac 6-2-4-6**						**4981**
Alpha Beta Titanium alloys	**Ti-17**	**Allvac Ti-17**						**4995**
Beta Titanium alloys	**Ti-13V-11Cr-3Al**	**Allvac 13-11-3**			**TiV13Cr11Al3**			**4917**
Beta Titanium alloys	Ti-8Mo-8V-2Fe-3Al							
Beta Titanium alloys	**Ti-3Al-8V-6Cr-4Mo-4Zr**	**Allvac 38-644**						
Beta Titanium alloys	Ti-11.5Mo-6Zr-4.5Sn							
Pure Titanium	**Ti 99.5**	**Allvac 70, Ti CP-4**			**Ti 99.5**	**TA 6**	**AIR: 9182 T60**	**ASTM: B381F4**
Pure Titanium	**Ti 99.6**	**Allvac 55, Ti CP-3**			**Ti 99.6**		**AIR: 9182 T50**	**ASTM: B381F3**
Pure Titanium	**Ti 99.7**	**Allvac 40, Ti CP-2**			**Ti 99.7a**	**TA 2-5**	**AIR: 9182 T40**	**ASTM: B381F2**
Pure Titanium	**Ti 99.8**	**Allvac 30, Ti CP-1**			**Ti 99.8**	**TA 1**	**AIR: 9182 T35**	**ASTM: B381F1**
Austempered ductile iron	269-321				EN-GJS-800-8			125/80/10 (grade 1)
Austempered ductile iron	269-321				EN-JS1100			850/550/10 (grade 1)
Austempered ductile iron	302-363				EN-GJS-1000-5			150/100/7 (grade 2)
Austempered ductile iron	302-363				EN-JS1110			1050/700/7 (grade 2)
Austempered ductile iron	341-444				EN-GJS-1200-2			175/125/4 (grade 3)
Austempered ductile iron	341-444				EN-JS1120			1200/850/4 (grade 4)
Austempered ductile iron	444-555				EN-GJS-1400-1			230/185/--- (grade 5)
Austempered ductile iron	444-555				EN-JS-1130			1600/1300/-- (grade 5)

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Star Guide Key to Recommended Inserts

Material Designations				
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Materials Cross Reference Chart

Fe	Co	Cr	Mo	W	Si	Mn	C	Al	Ti	P	S	Others
0.4	15.0	15.0	4.2		0.1	0.1	0.07	4.3	3.3			
	9.5	14.0	4.0	4.0			0.17	3.0	5.0			
	8.0	14.0	3.5	3.5			0.15	3.5	2.5			Nb3.5
	7.5	6.0	2.0	5.8			0.13	5.4	1.0			Nb0.5, Ta9.0
	19.0		4.0		0.1	0.1	0.07	3.0	3.0			
	12	**19**	**6**	**1**				**2**	**3**			
18.0	18.0		3.0				0.03	0.5	1.0			Nb6.5
	16.5	15.0	5.0				0.07	4.4	3.4			
	15.0	18.0	3.0	1.5			0.07	2.5	5.0			
18.0		18.0	3.0				0.05	0.6	1.0			Nb+Ta5.2
	13.0	**19.5**	**4.3**				**0.05**	**1.40**	**3.0**			**Zr .07**

Al	Sn	Mo	V	Zr	Si							Others
5.0	**2.5**											
7.0		4.0										
8.0		**1.0**	**1.0**									
6.0	**2.0**	**2.0**		**4.0**								
6.0			**4.0**									
5.5	**2.0**		**5.5**									
4.0	**2.0**	**4.0**			**0.55**							
4.0	4.0	4.0			0.5							
7.0		4.0										Fe 0.3
6.0		0.5		5.0	0.25							
6.0		4.0		5.0	0.2							Cu 1.0
3.0			**2.5**									**Fe 0.13**
6.0												**Fe 0.2**
6.0	**2.0**	**6.0**		**4.0**								**Fe 0.10**
5.0	**2.0**	**4.0**		**2.0**								**Cr 4.0**
3.0			**13.0**									**Cr 11.0**
3.0		8.0	8.0									
3.0		**4.0**	**8.0**	**4.0**								**Cr 6.0**
	4.5	11.5		6.0								

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Star Guide Key to Recommended Inserts

Material Designations			
P Unalloyed Steels	M Stainless Steels	K Cast Irons	S High Temp. Alloys
P Alloyed Steels	M PH Stainless	N Aluminum & Alloys	H Hard Materials

Notes

Answering Your Tooling Needs

ATI Stellram's comprehensive tooling program is supported by a wealth of technical knowledge and development across all products.

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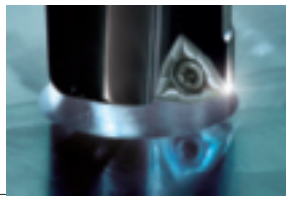
Drilling



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