Ultra-met®
carbide technologies

FABRICATOR & TOOLMAKER
Capabilities Catalog

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Grade Technology

With literally dozens of grades or formulations in its repertoire, the Ultra-met Company maintains an active grade development program and the capability to produce custom tungsten carbide grade powders “in house”. Why?... Because like many other materials technologies, the laws of chemistry and physics continually force tradeoffs to achieve a particular balance of properties. Increasing the cobalt binder content increases apparent toughness at the sacrifice of wear resistance. Finer tungsten carbide grains increase hardness and finish capability but increase brittleness as well. This section is intended to enhance your understanding of the tradeoffs one must consider when selecting a grade or formulation to fulfill an application need.

Cemented Tungsten Carbide is the resultant product of a powder metallurgical process that sinters or binds grains or crystals of hard tungsten carbide together with cobalt as a binder or “glue”. Adding or blending in carbides of other elements of the groups 4, 5 and 6 of the periodic table, and perhaps with other binders from the iron group enhances specific characteristics of the resultant hard metal.

The term straight grades refers to blends of tungsten carbide with from three to twenty-five percent cobalt. Wear resistance decreases and toughness increases as cobalt content increases. Six to ten percent cobalt content is most cost effective (the cost of cobalt is several times that of tungsten carbide) and is commonly used in metalworking applications. In the sintering process, liquefied cobalt flows to bind the grains of tungsten carbide. Larger grains improve transverse rupture strength and impact resistance but tend to dislodge easier while metalworking or being finish ground. Finer grain materials tend to be harder and more brittle and do not fare well when subjected to adverse machining conditions such as interrupted cuts or less rigid set-ups. The following terms are commonly utilized to describe WC grain size.

Description	Range of Grain Sizes
Extra Coarse	over 5.0 microns
Coarse	3.5 up to 5.0 microns
Medium Coarse	2.0 up to 3.5 microns
Medium	1.5 up to 2.0 microns
Fine	1.1 up to 1.4 microns
Extra Fine or Micrograin	0.6 up to 1.0 microns
Ultra Fine or Nanograin	below 0.6 microns


Ultra Fine


Extra Fine


Fine


Medium


Medium Course


Coarse

Grade Technology

Carbides of other metals are often alloyed with tungsten carbide and are referred to as complex grades. Although tantalum carbide is quite expensive, it is often employed to enhance high temperature wear resistance as required in steel machining applications. Often titanium carbide can be included in steel cutting grades to achieve a more cost effective balance of properties.

Lesser quantities of these and other carbides such as vanadium, niobium and chromium are used to control WC grain growth during sintering, or to enhance other characteristics such as corrosion resistance.

Cobalt is the preferred binder for optimum strength. Nickel is alloyed with cobalt when corrosion resistance is to be optimized, or in some cermet or high titanium carbide formulations.

Numerous coatings and coating processes are available to improve the usable life of tungsten carbide metalworking tools. Thin single or multiple layers of titanium carbide, titanium nitride, aluminum oxide, titanium carbonitride or various other materials enhance lubricity and protect the cutting edge from thermal and corrosive wear. With the degree of protection afforded by coating, it is often not necessary to alloy the tungsten carbide to the same extent as uncoated steel grades and thus one may opt for stronger, less expensive so called “substrate grades”. Generally these formulations have a stronger edge strength and better resist surface degradation inherent in most coating processes.

“Substrate Grade”	Suggested Application (All Standard Steels*)
ZS-16	Roughing, Difficult Conditions
ZS-17	General Purpose / Finishing
ZS-19	Preferred for PVD Coatings (milling & turn broaching)

* Can also be used for cast irons when aluminum oxide coated.

There exists the potential for metallurgical damage in the processing of parts subsequent to the sintering operations. Aside from obvious physical damage, allowing a part to stand in water or coolant may result in cobalt being leached from the surface of the part (sometimes referred to as corrosion). Also there is the potential for the surface of a part to be decarbonized during the CVD coating process. Any of the above situations would be manifest in a loss of expected service life.

Grade Application

	Ultra-met Grade	A.N.S.I. Code	ISO Code	Percent (%)					Density (g/cc)	TRS (KSI)	Grain Size
				CO	TIC	TA/NBC	WC	HRA			
CERMET	ZC3	C7/C8	P01-P05					93.0	6.10	225	
CERMET	ZC14	C6/C7	P05-P25					92.0	6.70	325	
STEEL (P)	UF110	C2	K25	10.00			90.00	92.3	14.44	525	Ultra Fine
STEEL (P)	Z76	C8	P05	5.00	12.00	15.75	67.25	91.7	11.80	240	Extra Fine
STEEL (P)	Z72	C7	P15/M10	10.00	8.13	6.50	75.38	91.8	12.27	300	Fine
STEEL (P)	Z60	C6	P20/M15	8.00	6.00	4.50	81.50	92.1	12.95	325	Fine
STEEL (P)	Z50	C5	P30	8.70	8.25	8.80	74.25	91.3	12.27	310	Medium
STEEL (P)	ZS17	C5/C6 *	P25/K30	6.50	4.50	6.50	82.50	91.8	13.35	250	Medium
STEEL (P)	ZS16	C5/C6 *	P30/K30	5.50	3.00	5.00	86.50	91.3	13.84	270	Medium
STEEL (P)	Z1	C1/C2	K25	8.00			92.00	91.7	14.70	450	Extra Fine
STEEL (P)	Z9	C1/C2	K30	10.00			90.00	91.3	14.50	480	Extra Fine
STEEL (P)	Z14	C5/C6	P40/M30	12.00	0.50	2.50	85.00	90.2	14.07	540	Fine/Medium
STEEL (P)	Z56	C5	P35/M35	10.10	7.05	12.70	70.15	91.4	12.22	330	Medium/Coarse
STEEL (P)	Z55	C5	P35/M25	10.50	6.00	14.50	66.00	91.3	12.38	350	Fine/Medium
STEEL (P)	Z52	C5	P40/M30	11.50	4.50	5.50	78.50	91.2	12.99	350	Fine/Medium
STEEL (P)	Z54	C5	P50/M50	12.50	4.00	9.00	74.50	90.3	12.79	380	Medium
STAINLESS STEELS (M)	Z72	C7	P15/M10	10.00	8.13	6.50	75.38	91.8	12.27	300	Fine
STAINLESS STEELS (M)	Z60	C6	P20/M15	8.00	6.00	4.50	81.50	92.1	12.95	325	Fine
STAINLESS STEELS (M)	Z23	C3	K10	6.00			94.00	92.8	14.94	360	Extra Fine
STAINLESS STEELS (M)	Z22	C2	K20	6.00			94.00	91.8	14.94	350	Fine
STAINLESS STEELS (M)	Z1	C1/C2	K25	8.00			92.00	91.7	14.70	450	Extra Fine
STAINLESS STEELS (M)	UF110	C2	K25	10.00			90.00	92.3	14.44	525	Ultra Fine
STAINLESS STEELS (M)	Z9	C1/C2	K30	10.00			90.00	91.3	14.50	480	Extra Fine
STAINLESS STEELS (M)	Z55	C5	P35/M25	10.50	6.00	14.50	66.00	91.3	12.38	350	Fine/Medium
STAINLESS STEELS (M)	Z13	C1	K40	11.00		0.50	88.50	89.8	14.26	360	Medium/Coarse
STAINLESS STEELS (M)	Z14	C5/C6	P40/M30	12.00	0.50	2.50	85.00	90.2	14.07	540	Fine/Medium
STAINLESS STEELS (M)	Z52	C5	P40/M30	11.50	4.50	5.50	78.50	91.2	12.99	350	Fine/Medium
STAINLESS STEELS (M)	Z56	C5	P35/M35	10.10	7.05	12.70	70.15	91.4	12.22	330	Medium/Coarse
STAINLESS STEELS (M)	Z54	C5	P50/M50	12.50	4.00	9.00	74.50	90.3	12.79	380	Medium
NON-FERROUS (K) CAST IRON / ALUMINUM	Z4	C3/C4	K01	3.75			96.25	92.8	15.18	275	Extra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	UF306	C2/C3	K10	6.00			94.00	93.5	14.82	400	Ultra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	Z23	C3	K10	6.00			94.00	92.8	14.94	360	Extra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	UF108	C1/C2	K20	8.00			92.00	92.6	14.65	475	Ultra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	Z1	C1/C2	K25	8.00			92.00	91.7	14.70	450	Extra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	Z20	C2	K20	6.25		4.25	89.50	92.0	14.73	340	Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	Z22	C2	K20	6.00			94.00	91.8	14.94	350	Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	UF110	C2	K25	10.00			90.00	92.3	14.44	525	Ultra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	Z1	C1	K25	8.00			92.00	91.7	14.70	450	Extra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	UF112	C1	K30	12.00			88.00	91.8	14.20	550	Ultra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	Z9	C1/C2	K30	10.00			90.00	91.3	14.50	480	Extra Fine
NON-FERROUS (K) CAST IRON / ALUMINUM	UF115	C1	K35	15.00			85.00	91.2	13.94	600	Ultra Fine
HIGH TEMP ALLOY (S)	Z23	C3	K10	6.00			94.00	92.8	14.94	360	Extra Fine
HIGH TEMP ALLOY (S)	UF110	C2	K25	10.00			90.00	92.3	14.44	525	Ultra Fine
HIGH TEMP ALLOY (S)	Z9	C1/C2	K30	10.00			90.00	91.3	14.50	480	Extra Fine

WEAR RESISTANCE ↕ TOUGHNESS

Grade Properties

TUNGSTEN CARBIDE GRADES

Ultra-met Grade	A.N.S.I. Code	ISO Code	Percent (%)				HRA	Density (g/cc)	TRS (KSI)	Grain Size
			CO	TIC	TA/NBC	WC				
Z1	C2/C3	K15-K30	8.00			92.00	91.7	14.70	450	Extra Fine
Z4	C4/C9	K05-K10	3.75			96.25	92.8	15.18	275	Extra Fine
Z9	C2/C3	K20-K40	10.00			90.00	91.3	14.50	480	Extra Fine
Z13	C5/C6	P30-P40/K40	11.00		0.50	88.50	89.8	14.26	360	Medium/Coarse
Z14	C5/C6	P35-P40/M40	12.00	0.50	2.50	85.00	90.2	14.07	540	Fine/Medium
Z20	C7/C8	P05-P15	6.25		4.25	89.50	92.0	14.73	340	Fine
Z22	C2	K15-K20	6.00			94.00	91.8	14.94	350	Fine
Z23	C2/C3	K10-K30	6.00			94.00	92.8	14.90	360	Extra Fine
Z50	C6	P20-P30	8.70	8.25	8.80	74.25	91.3	12.23	310	Medium
Z52	C5	P35-P40/M40	11.50	4.50	5.50	78.50	91.2	12.96	350	Fine/Medium
Z54	C5	P35-P50/M50	12.50	4.00	9.00	74.50	90.3	12.85	380	Medium
Z55	C5	P35-P40	10.50	6.00	14.50	69.00	91.3	12.36	350	Fine/Medium
Z56	C5	P35-P40/M40	10.10	7.05	12.70	70.15	91.4	12.22	330	Medium/Coarse
Z57	C15	C15A	14.00		20.00	66.00	87.8	13.22	380	Medium/Coarse
Z60	C6	P20-P30/M20	8.00	6.00	4.50	81.50	92.1	12.95	325	Fine
Z72	C6	P20-P35/M40	10.00	8.130	6.50	75.380	91.8	12.27	300	Fine
ZS16	C8*	P05-P10/M10	5.50	3.00	5.00	86.50	91.3	13.84	270	Medium
ZS17	C6*	P20-P25/M10	6.50	4.50	6.50	82.50	91.8	13.35	250	Medium
ZS19	C1/C6 *	K30-K40/P20-P35	9.75		7.60	82.65	90.9	14.15	370	Fine
ZC9	C14		9.50			90.50	87.5	14.57	400	Coarse
ZM6	C9/C12		6.00			94.00	90.0	14.94	350	Coarse
ZM12	C14		12.00			88.00	88.3	14.31	390	Medium/Coarse
ZM15	C14		15.00			85.00	87.0	14.02	450	Medium/Coarse
ZM18	C14		18.00			82.00	85.5	13.74	475	Coarse
UF306	C3/C4	K5-K10	6.00			94.00	93.5	14.82	400	Ultra Fine
UF108	C2/C4	K10-K20	8.00			92.00	92.6	14.60	475	Ultra Fine
UF110	C1/C2	K15-K40	10.00			90.00	92.3	14.40	525	Ultra Fine
UF112	C1/C2	K20-K40	12.00			88.00	91.8	14.18	550	Ultra Fine
UF115	C1	K30-K40	15.00			85.00	91.2	13.88	600	Ultra Fine
Z15	Wear	Wear	6.0-10.0	0-3.0	0-3.0	Balance	91.4	14.10	N/A	Fine/Coarse
ZW12	Wear	Wear	10.0-14.0	0-3.0	0-3.0	Balance	88.3	14.30	N/A	Fine/Coarse

CERMET AND NICKEL GRADES

Ultra-met Grade	A.N.S.I. Code	ISO Code	Percent (%)				HRA	Density (g/cc)	TRS (KSI)	Grain Size
			Ni	TiMoCn	Mo	WC				
ZC3	C7/C8	P05-P10	11.90	87.00	1.10		93.0	6.10	285	Medium
ZC14	C6/C7	P05-P25	13.05	85.00	1.95		92.5	6.13	290	Medium
ZN8		K10	8.00		1.15	90.85	91.8	14.65	325	Medium

ANSI Designations

SHAPE

A-Parallelogram 85°
B-Parallelogram 82°
C-Diamond 80°
D-Diamond 55°
E-Parallelogram 55°
F-Coffin
H-Hexagon 120°
L-Rectangle 90°
M-Diamond 86°
O-Octagon 135°
P-Pentagon 108°
R-Round
S-Square 90°
T-Triangle 60°
V-Diamond 35°
W-Trigon 80°

TOLERANCES

INSERT BLANKS

R=Blank with grind Stock on all surfaces

S=Blank with grind stock on top and bottom surfaces only

INSERTS GROUND TO TOLERANCES FROM BLANKS

	I.C.	Thick.
A	±.001	±.001
B	±.001	±.005
C	±.001	±.001
D	±.001	±.005
E	±.001	±.001
G	±.001	±.005
H	±.005	±.001
M	±.002-.004	±.005

SIZE I.C.

Regular Polygons and Diamonds -Number of eighths of an inch in the inscribed circle as follows:

Examples

5/32 inch I.C. =1.2
3/16 inch I.C. =1.5
7/32 inch I.C. =1.8
1/4 inch I.C. =2
5/16 inch I.C. =2.5
3/8 inch I.C. =3
1/2 inch I.C. =4
5/8 inch I.C. =5
3/4 inch I.C. =6
1 inch I.C. =8

Rectangles and Parallelograms- Use two digits to size:

First digit-Number of eighths Of an inch in width

Second digit-Number of fourths of an inch in length.

CUTTING POINTS RADIUS

0 = Sharp Corner
1 = 1/64 Radius
2 = 1/32 Radius
3 = 3/64 Radius
4 = 1/16 Radius
6 = 3/32 Radius
8 = 1/8 Radius

T	N	R	A	4	3	0
SHAPE	RELIEF ANGLE	TOLERANCES	TYPE	SIZE I.C.	THICKNESS	RADIUS

RELIEF ANGLE

N-0°
A-3°
B-5°
C-7°
P-11°
D-15°
E-20°
F-25°
G-30°

INSERT TYPE

A - With hole
B - With hole and one countersink (70° - 90°)
C - With hole and two countersinks (70° - 90°)
D - Smaller than 1/4" I.C. With hole
E - Smaller than 1/4" I.C. Without hole
F - Without hole with chip grooves on two rake faces
G - With hole and chip grooves on two rake faces
H - With hole, one c'sink (70° - 90°) and chip groove on one rake face
J - With hole, two c'sinks (70° -90°) and chip grooves on two rake faces
K - Smaller than 1/4" I.C. With hole and chip groove
L - Smaller than 1/4" I.C. Without hole and chip groove
M - With hole and chip groove on one rake face
N - Without hole
P - 10° Positive surface contour with hole and chip groove
Q - With hole and two countersinks (40°-60°)
S - 20° Positive surface contour with hole and chip groove
T - Hole, one c'sink (40° - 60°) and chip groove on rake face
W - With hole and one countersink (40° - 60°)
X - Special design

INSERT THICKNESS

Regular Polygons, Diamonds, Rectangles and Parallelograms - Number of sixteenths of an inch in thickness as follows:

Examples

- = variable
1/16 inch = 1
3/32 inch = 1.5
1/8 inch = 2
5/32 inch = 2.5
3/16 inch = 3
7/32 inch = 3.5
1/4 inch = 4
5/16 inch = 5
3/8 inch = 6
7/16 inch = 7
1/2 inch = 8

Generally variable thickness available on all tooling listed.
Call 1-800-543-9952 for quote request.

THICKNESS GRIND STOCK *

FOR I.C. SMALLER THAN 1" = .010 / .018
FOR 1" I.C. AND LARGER = .017 / .023

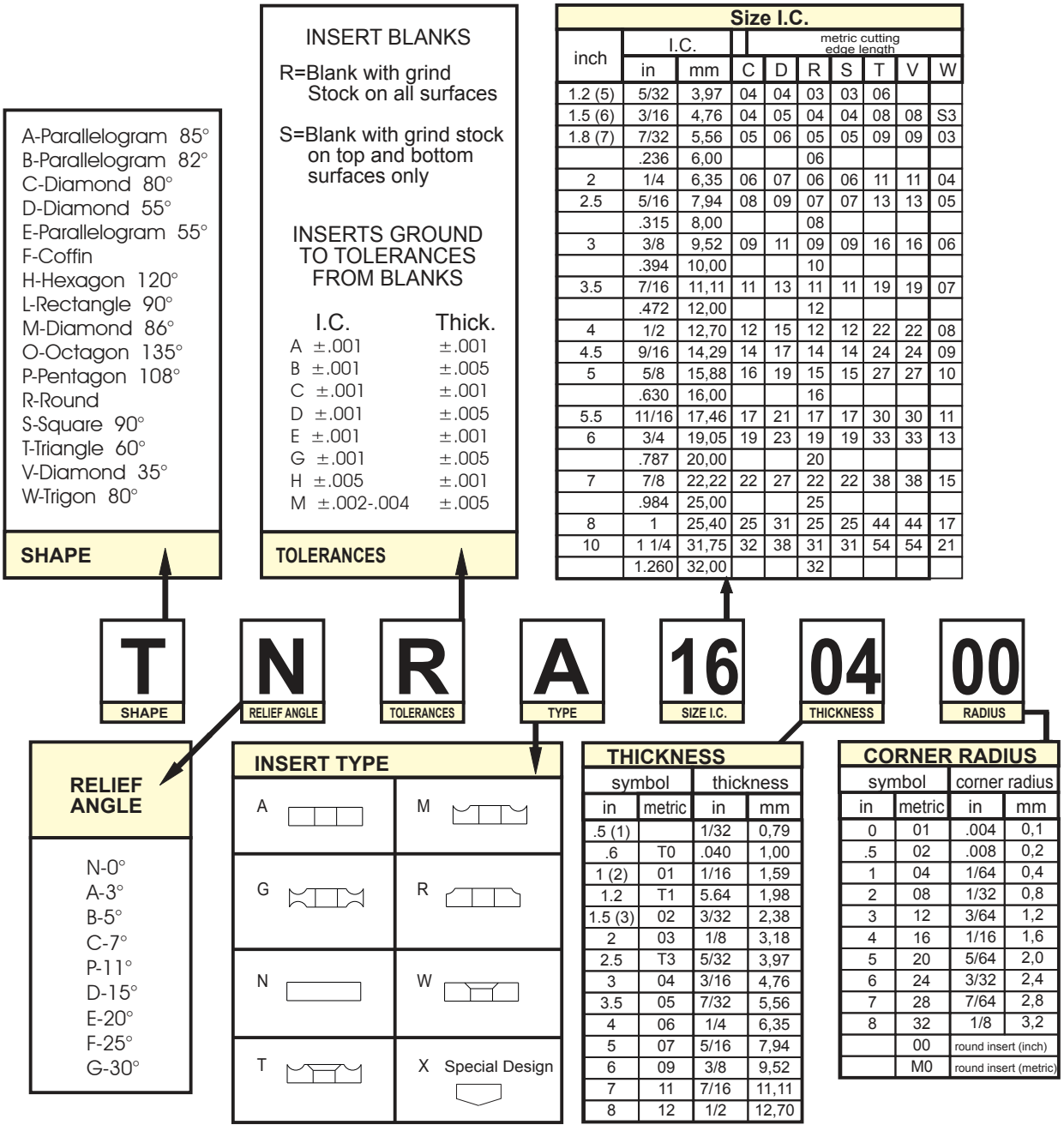
NOTE: BLANKS WITH GRIND STOCK ON TOP AND BOTTOM

I.C. GRIND STOCK

FOR I.C. SMALLER THAN 1" = .014 / .020
FOR 1" I.C. AND LARGER = .020 / .030
TRIANGLES = .017 / .030

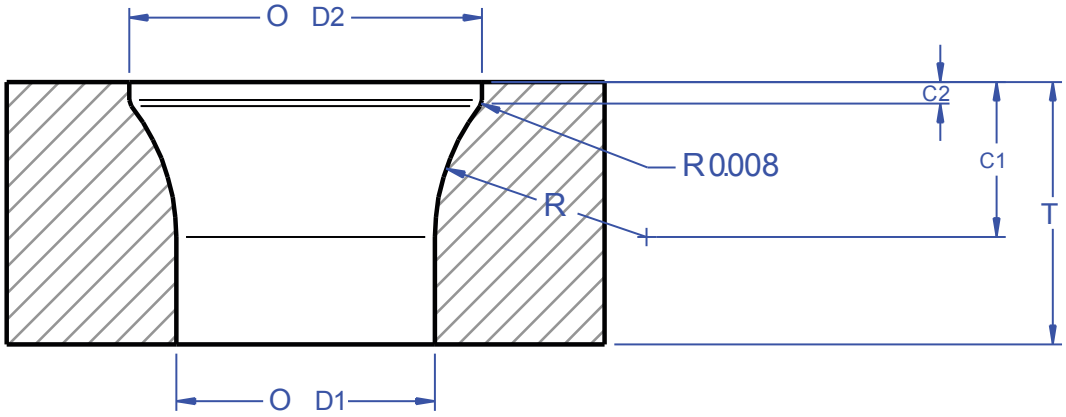
I.C. TOLERANCES = ±.002 - ±.010

ISO Designations



ISO Holes

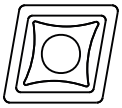
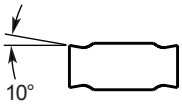
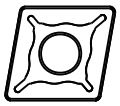
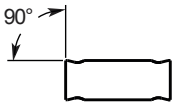
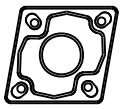
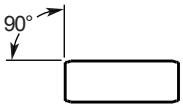
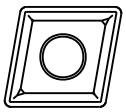
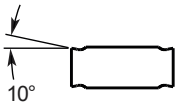
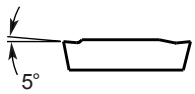
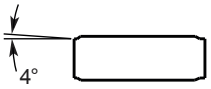
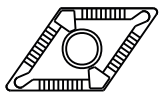
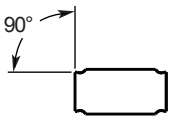
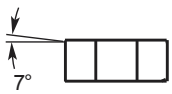
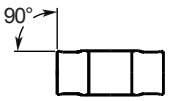
ISO Partly cylindrical hole, in order to guarantee interchangeability when mounting the insert by a countersunk head screw having a head taper angle between 40° and 60°, the form of the hole is partly cylindrical and its dimensions are related to the diameter of the inscribed circle (I.C.) of the insert. The Figure and Table below give the elements of definition of the fixing hole.



ISO 6987 PARTLY CYLINDRICAL HOLE (200-120E)							
I.C.	T	SCREW THREAD	D1	D2	C1	C2	R
0.187	0.078	M 1.8	0.085	0.114	0.070	0.008	0.106
0.219	0.094	M 2.2	0.100	0.130	0.054	0.008	0.079
0.250	0.094	M 2.5	0.110	0.146	0.057	0.008	0.079
0.312	0.125	M 3	0.134	0.177	0.071	0.012	0.098
0.375	0.125 / 0.156	M 3.5	0.173	0.236	0.106	0.018	0.138
0.500	0.187	M 4.5	0.216	0.295	0.129	0.018	0.177
0.625	0.219	M 4.5	0.216	0.295	0.129	0.018	0.177
0.750		M 6	0.256	0.354			0.197

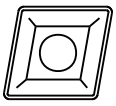
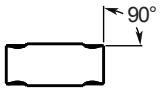
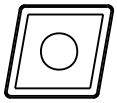
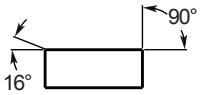
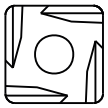
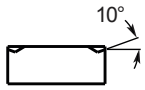
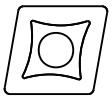
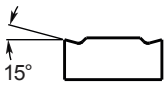
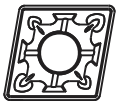
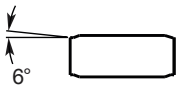
Chipbreaker Details

Topography after grinding.

Operation	Geometries	Chipbreaker profile	Designation	Description
General Purpose			GP1	Double Sided Chipbreaker: ("V" & "D" Styles Single Sided) IPR = .006 - .020 DOC = .040 - .175
General Purpose			GP2	Double Sided Chipbreaker: IPR = .010 - .025 DOC = .075 - .200
General Purpose			GP3	Double Sided Chipbreaker: IPR = .006 - .022 DOC = .050 - .185
General Purpose			GP4	Double Sided Chipbreaker: IPR = .006 - .020 DOC = .040 - .200
General Purpose			GP5	Single Sided Chipbreaker: IPR = .006 - .022 DOC = .040 - .175
General Purpose			GP6	Double Sided Chipbreaker: IPR = .006 - .020 DOC = .040 - .240
General Purpose			GP8	Double Sided Chipbreaker: IPR = .006 - .025 DOC = .075 - .200
General Purpose			SA	Double Sided Chipbreaker: IPR = .006 - .024 DOC = .025 - .250
General Purpose			EXA	Double Sided Chipbreaker: IPR = .010 - .025 DOC = .075 - .300

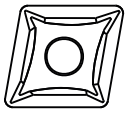
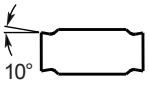
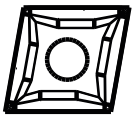
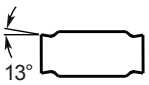
Chipbreaker Details

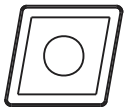
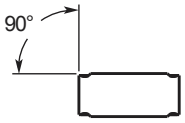
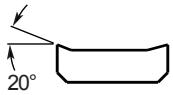
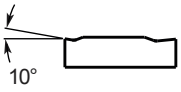
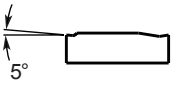
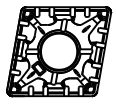
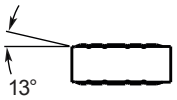
Topography after grinding.

Operation	Geometries	Chipbreaker profile	Designation	Description
Roughing			R1	Double Sided Chipbreaker: IPR = .008 - .028 DOC = .090 - .220
Roughing			R3	Single Sided Chipbreaker: IPR = .008 - .032 DOC = .050 - .300
Roughing			R4	Single Sided Chipbreaker: IPR = .008 - .032 DOC = .100 - .300
Roughing			R5	Single Sided Chipbreaker: IPR = .006 - .020 DOC = .040 - .175
Roughing			RA	Double Sided Chipbreaker: IPR = .010 - .030 DOC = .085 - .300

Chipbreaker Details

Topography after grinding.

Operation	Geometries	Chipbreaker profile	Designation	Description
Semi Finishing			F2	Double Sided Chipbreaker: IPR = .004 - .014 DOC = .015 - .080
Semi Finishing			F2A	Double Sided Chipbreaker: IPR = .004 - .014 DOC = .015 - .080

Operation	Geometries	Chipbreaker profile	Designation	Description
Finishing			F1	Double Sided Chipbreaker: IPR = .004 - .014 DOC = .007 - .060
Finishing			F3	Single Sided Chipbreaker: IPR = .003 - .015 DOC = .010 - .080
Finishing			F4	Single Sided Chipbreaker: IPR = .003 - .015 DOC = .010 - .080
Finishing			F5	Single Sided Chipbreaker: IPR = .006 - .020 DOC = .025 - .100
Finishing			FA	Double Sided Chipbreaker: IPR = .003 - .015 DOC = .005 - .050