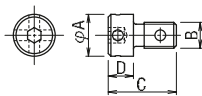
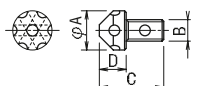


*Tooling by* **DIJET**<sup>®</sup>

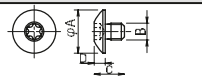
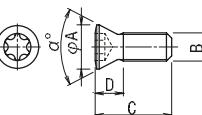
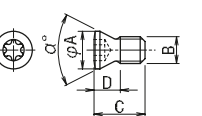
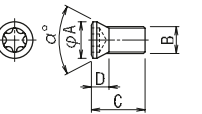
# Technical Information

# Parts

## Adjustable screw

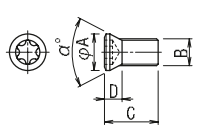
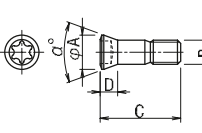
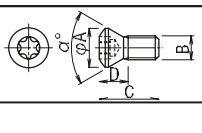
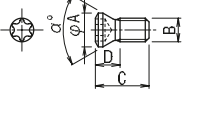
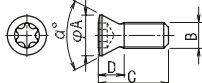
Drawings	Cat. No.	Dimensions (mm)						Wrench
		A	B	C	D	E	$\alpha^\circ$	
	<b>ASW-113</b>	4.8	No.10-32UNF	12.7	4.8	—	—	AD-1845
	<b>ADS-513</b>	7.8	M5×0.5	13.0	5.0	—	—	AD-2080
	<b>ADS-514</b>	5.6	M5×0.5	14.5	6.5	—	—	AD-2080
	<b>ASW-513</b>	9.0	M5×0.5	13.0	5.0	—	—	AD-1845

## Clamp screw

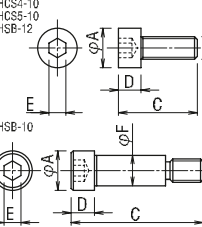
Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	$\alpha^\circ$		
	<b>CB3540</b>	9.0	M3.5×0.6	6.3	2.3	—	—	T-15	2.1
	<b>CSW-1838</b>	2.7	M1.8×0.35	3.7	1.8	—	55	T-6	0.25
	<b>CSW-206</b>	3.5	M2.5×0.45	5.0	2.4	—	55	T-8	0.9
	<b>CSW-2542</b>	3.0	M2.5×0.45	4.2	2.5	—	43	T-7	0.9
	<b>CSW-2547</b>	3.4	M2.5×0.45	4.7	2.5	—	43	T-7	0.9
	<b>CSW-3570</b>	5.5	M3.5×0.6	7.0	3.5	—	55	T-15	2.1
	<b>CSW-3575</b>	5.5	M3.5×0.6	7.5	3.5	—	55	T-15	2.1
	<b>CSW-3595</b>	5.5	M3.5×0.6	9.5	3.5	—	55	T-15	2.1
	<b>CSW-406H</b>	5.0	M4×0.7	6.0	3.6	—	43	T-15	3.6
	<b>CSW-407</b>	5.0	M4×0.7	7.0	3.6	—	43	T-15	3.6
	<b>CSW-408H</b>	5.0	M4×0.7	8.0	3.6	—	43	T-15	3.6
	<b>CSW-4510</b>	6.6	M4.5×0.75	10.0	4.0	—	57	T-20	5.0
	<b>CSW-510</b>	6.4	M5×0.8	11.0	4.5	—	43	T-20	5.5
	<b>CSW-513H</b>	7.0	M5×0.8	13.0	4.4	—	63	T-20	5.5
<b>CSW-515</b>	7.0	M5×0.8	15.0	5.0	—	63	T-20	5.5	
	<b>DSW-1838H</b>	2.5	M1.8×0.35	3.8	2.0	—	55	T-6	0.4
	<b>DSW-2045H</b>	3.0	M2×0.4	4.5	2.3	—	60	T-7	0.5
	<b>DSW-2563H</b>	3.45	M2.5×0.45	6.3	2.6	—	55	T-8	0.9
	<b>DSW-306H</b>	4.3	M3×0.5	6.5	3.2	—	55	T-10	1.8
	<b>DSW-307</b>	4.3	M3×0.5	7.5	2.8	—	55	T-10	1.4
	<b>DSW-307H</b>	4.3	M3×0.5	7.6	3.2	—	55	T-10	1.8
	<b>DSW-309H</b>	4.3	M3×0.5	9.0	3.2	—	55	T-10	1.8
	<b>DSW-4075</b>	5.2	M4×0.7	7.5	3.5	—	55	T-15	3.6
	<b>DSW-408</b>	6.0	M4×0.7	8.5	3.6	—	55	T-15	3.6
	<b>DSW-4085</b>	5.3	M4×0.7	8.5	3.5	—	55	T-15	3.6
	<b>DSW-410H</b>	5.3	M4×0.7	10.0	3.7	—	55	T-15	3.6
	<b>DSW-4510H</b>	6.8	M4.5×0.75	10.0	4.7	—	55	T-20	6.0
	<b>DSW-4512H</b>	6.8	M4.5×0.75	12.5	5.2	—	55	T-20	6.0
	<b>DSW-4515H</b>	6.8	M4.5×0.75	15.5	5.2	—	55	T-20	6.0
	<b>DSW-509</b>	7.0	M5×0.8	9.5	4.9	—	55	T-20	6.1
<b>DSW-511H</b>	7.0	M5×0.8	11.5	4.9	—	55	T-20	6.1	
	<b>ESW-205</b>	3.6	M2.5×0.45	5.5	2.0	—	60	T-8	0.9
	<b>ESW-206</b>	3.6	M2.5×0.45	6.0	2.0	—	60	T-8	0.9
	<b>ESW-304</b>	4.0	M3×0.5	4.5	2.0	—	55	T-8	1.4
	<b>ESW-306</b>	4.0	M3×0.5	6.0	2.0	—	55	T-8	1.4
	<b>ESW-307</b>	4.0	M3×0.5	7.5	2.0	—	55	T-8	1.4
	<b>ESW-405</b>	5.3	M4×0.7	5.9	2.7	—	55	T-15	3.1
	<b>ESW-406</b>	5.3	M4×0.7	6.6	2.7	—	55	T-15	3.1
	<b>ESW-408</b>	5.3	M4×0.7	8.0	2.7	—	55	T-15	3.1

## Parts

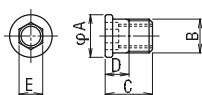
## Clamp screw

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	$\alpha^\circ$		
	<b>ESW-410</b>	5.3	M4×0.7	10.0	2.7	—	55	T-15	3.1
	<b>ESW-412</b>	5.3	M4×0.7	12.0	2.7	—	55	T-15	3.1
	<b>ESW-507</b>	6.8	M5×0.8	7.5	3.4	—	55	T-25	5.5
	<b>ESW-508</b>	6.8	M5×0.8	8.2	3.4	—	55	T-25	5.5
	<b>ESW-510</b>	6.8	M5×0.8	10.0	3.4	—	55	T-25	5.5
	<b>FSW-2005H</b>	2.5	M2×0.25	5.0	1.3	—	40	T-6	0.5
	<b>FSW-2506H</b>	3.0	M2.5×0.35	6.6	1.5	—	40	T-7	0.9
	<b>FSW-3007H</b>	3.8	M3×0.35	8.1	2.0	—	40	T-8	1.2
	<b>FSW-3509H</b>	4.7	M3.5×0.6	9.6	2.3	—	40	T-10	2.0
	<b>FSW-4013H</b>	5.8	M4×0.7	13.5	3.3	—	40	T-15	3.0
	<b>FSW-5016H</b>	6.8	M5×0.8	16.4	3.2	—	40	T-20	4.0
	<b>FSW-6020</b>	8.5	M6×1.0	20.0	4.3	—	40	T-30	5.0
<b>FSW-8025</b>	11.0	M8×1.25	25.0	5.5	—	40	T-40	6.0	
	<b>HSW-614H</b>	10.0	M6×1.0	15.0	7.3	—	60	T-30	7.5
	<b>TSW-2250</b>	3.1	M2.2×0.45	5.0	2.3	—	60	T-7	0.6
	<b>TSW-2556H</b>	3.6	M2.5×0.45	5.6	2.7	—	60	T-8	0.9
	<b>TSW-2567H</b>	3.6	M2.5×0.45	6.7	2.7	—	60	T-8	0.9
	<b>TSW-3510H</b>	5.3	M3.5×0.6	10.0	4.5	—	60	T-15	2.1
	<b>TSW-3512H</b>	5.3	M3.5×0.6	11.5	4.5	—	60	T-15	2.1
	<b>TSW-408</b>	5.5	M4×0.7	8.0	3.3	—	60	T-15	3.1
	<b>TSW-511</b>	7.0	M5×0.8	11.0	5.0	—	60	T-20	5.5
	<b>TSW-612</b>	8.5	M6×1.0	12.0	4.8	—	60	T-25	7.5
<b>TSW-614H</b>	8.5	M6×1.0	14.0	6.2	—	60	T-25	7.5	
	<b>S4513P</b>	6.7	M4.5×0.75	13.0	3.5	—	55	20IP	5.0

## Set bolt

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	<b>HCS4-10</b>	7.0	M4×0.7	14.0	4.0	3.0	—	—	—
	<b>HCS5-10</b>	8.5	M5×0.8	15.0	5.0	4.0	—	—	—
	<b>HSB-10</b>	17.0	M10×1.5	56.0	10.0	8.0	13	—	—
	<b>HSB-12</b>	18.0	M12×1.75	62.0	12.0	10.0	—	—	—

## Shim screw

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	<b>SSW-535</b>	6.3	M5×0.5	7.0	3.1	3.5	—	—	6.5
	<b>SSW-745</b>	8.4	M7×0.5	8.0	2.9	4.5	—	—	8.0

Parts

Wedge screw

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	LS-1	4.6	M6×1.0	22.0	8.5	8.5	3.0	—	6.0
	LS-101	4.6	M6×1.0	16.0	6.5	6.5	3.0	—	6.0
	LS-106	4.6	M6×1.0	14.5	6.5	5.0	3.0	—	6.0
	LS-107	4.6	M6×1.0	13.0	5.0	5.0	3.0	—	6.0
	LS-109	5.5	M7×0.75	19.0	7.5	8.0	—	T-25	7.0
	LS-110	4.8	M6×0.75	22.0	8.0	8.0	—	T-15	6.0
	LS-180	6.0	M8×1.0	19.0	7.0	8.0	—	T-27	8.0

Rest button screw

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	LS-113	3.7	No.10-32UNF	10.2	4.5	4.1	2.4	—	—

Clamp screw

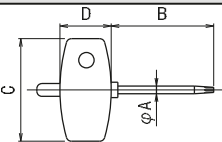
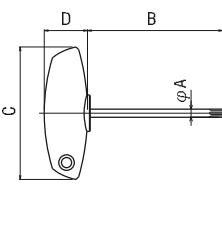


Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	SLS-3	6.0	M8×1.0	20.0	8.0	8.0	4.0	—	8.0

Wrench

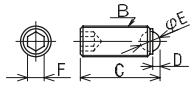
Drawings	Cat. No.	Dimensions (mm)					Wrench size
		A	B	C	D	E	
	LW-015	46.5	14.0	—	—	1.5	—
	LW-020	52.0	15.0	—	—	2.0	—
	LW-025	59.5	18.0	—	—	2.5	—
	LW-030	67.0	20.0	—	—	3.0	—
	LW-035	71.5	22.5	—	—	3.5	—
	LW-040	75.0	25.0	—	—	4.0	—
	LW-045	80.5	27.0	—	—	4.5	—
	LW-050	80.0	28.0	—	—	5.0	—
	LW-120	137.0	45.0	—	—	12.0	—
LW-140	154.0	56.0	—	—	14.0	—	
	A-030	—	60.0	80.0	28.0	3.0	—
	A-07SD	4.0	60.0	80.0	—	—	T-7
	A-08SD	4.0	70.0	80.0	—	—	T-8
	A-10SD	4.0	70.0	95.0	—	—	T-10
	A-20SD	5.0	90.0	105.0	—	—	T-20
	A-25SD	5.0	100.0	105.0	—	—	T-25
	A-06	1.7	34.5	15.0	15.0	—	T-6
	A-07	2.0	34.5	15.0	15.9	—	T-7
	A-08	2.3	39.0	19.0	19.0	—	T-8

## Parts

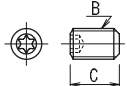
## Wrench

Drawings	Cat. No.	Dimensions (mm)					Wrench size
		A	B	C	D	E	
	<b>A-10</b>	3.0	40.0	40.0	20.0	—	T-10
	<b>A-15</b>	3.5	45.0	40.0	20.0	—	T-15
	<b>A-20W</b>	4.0	45.0	40.0	20.0	—	T-20
	<b>A-15T</b>	4.0	100.0	80.0	26.0	—	T-15
	<b>A-20</b>	4.0	100.0	100.0	32.0	—	T-20
	<b>A-20L</b>	5.5	200.0	100.0	32.0	—	T-20
	<b>A-25</b>	4.5	100.0	100.0	32.0	—	T-25
	<b>A-27</b>	5.5	100.0	100.0	32.0	—	T-27
	<b>A-30</b>	6.0	100.0	100.0	32.0	—	T-30
	<b>A-40</b>	7.0	100.0	100.0	32.0	—	T-40
<b>AP-20</b>	4.0	100.0	100.0	32.0	—	20IP	
	<b>AD-1845</b>	1.8	45.0	—	—	—	—
	<b>AD-2080</b>	2.0	45.0	35.0	—	—	—

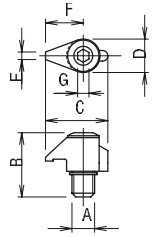
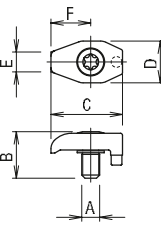
## Wedge lock screw

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	<b>LSM-512</b>	—	M5×1.0	12.6	1.0	3.0	2.5	—	—

## Adjustable screw

Drawings	Cat. No.	Dimensions (mm)						Wrench	Recommended torque (N·m)
		A	B	C	D	E	F		
	<b>RSW-05008</b>	—	M5×0.8	8.0	—	—	—	T-10	—

## Clamp set

Drawings	Cat. No.	Dimensions (mm)							Wrench
		A	B	C	D	E	F	G	
	<b>DCM-1</b>	M5×0.8	13.8	13.8	6.8	2.0	8.5	2.5	—
	<b>DCM-5</b>	M6×1.0	17.0	16.5	8.9	2.0	10.0	3.0	—
	<b>DCM-17</b>	M4.5×0.75	11.7	18.0	10.5	5.0	10.0	—	T-20
	<b>DCM-18</b>	M3.5×0.6	10.0	13.0	7.6	3.0	7.2	—	T-15

## Parts

### Clamp

Drawings	Cat. No.	Dimensions (mm)					
		A	B	C	D	E	F
	<b>DCM-2</b>	M8×1.0	10.0	19.0	11.0	6.0	13.5

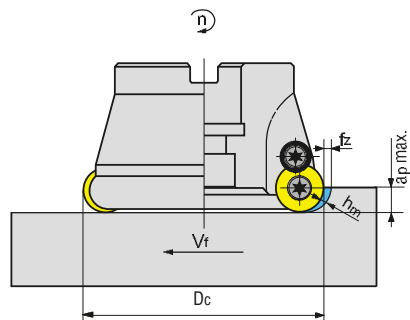
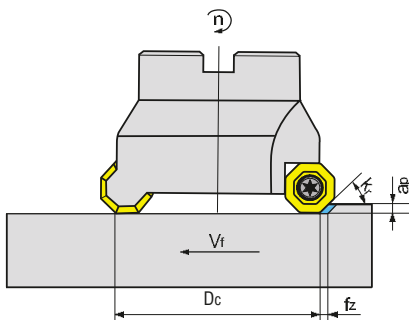
### Clamp washer

Drawings	Cat. No.	Dimensions (mm)					
		A	B	C	D	$\alpha^\circ$	$\beta^\circ$
	<b>CW-11</b>	8.0	5.0	11.0	4.0	55	12

## Terminology and Formulas (for milling)

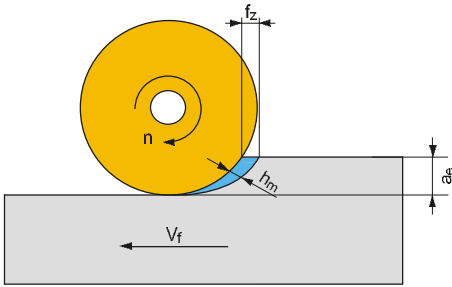
D <sub>c</sub> = Cutting diameter	mm.	Z <sub>c</sub> = Effective number of teeth	
a <sub>e</sub> = Width of cut	mm.	h <sub>ex</sub> = Max chip thickness	mm.
a <sub>p</sub> = Depth of cut	mm.	h <sub>m</sub> = Average chip thickness	mm.
f = Feed rate per revolution	mm/rev.	k <sub>c1</sub> = Specific cutting force (hex = mm)	N/mm <sup>2</sup> .
f <sub>z</sub> = Feed rate per tooth	mm/t.	P <sub>c</sub> = Net cutting power	KW.
D <sub>e</sub> = Effective cutting diameter	mm.	k <sub>r</sub> = Major cutting edge	deg.
V <sub>c</sub> = Cutting speed	m/mm.	V <sub>co</sub> = Constant for cutting speed	
Q = Metal removal rate	cm <sup>3</sup> /min.	C <sub>vc</sub> = Correction factor for cutting speed	min <sup>-1</sup> .
l = Machined length	mm.	n = Spindle speed	KW
V <sub>f</sub> = Feed speed	mm/min.	n <sub>mt</sub> = Efficiency	
D <sub>ap</sub> = Max cutting diameter at specific depth	mm.	m <sub>c</sub> = Rise in specific cutting force (k <sub>c</sub> ) as a function of chip thickness	
Z <sub>n</sub> = Total number of edges in the tool			

General formulas			
Cutting speed	$V_c = \frac{\pi \times D_c \times n}{1000} = \text{m/min.}$	Spindle speed	$n = \frac{V_c \times 1000}{\pi \times D_c} = \text{min.}^{-1}$
Feed speed	$V_f = f_z \times n \times Z_n = \text{mm/min.}$	Feed per tooth	$f_z = \frac{V_f}{n \times Z_n} = \text{mm.}$
Feed per revolution	$f = \frac{V_f}{n} = \text{mm/rev.}$	Metal Removal rate	$Q = \frac{a_p \times a_e \times V_f}{1000} = \text{cm}^3.$
Specific cutting force	$k_c = k_{c1} \times h_{m-mc} = \text{mm/min.}$	Effective cutting diameter	$D_e = 2 \times \sqrt{a_p \times (D_c - a_p)} = \text{mm.}$
Average chip thickness (side & facemilling) when $a_e / D_c \leq 0.1$	$h_m = f_z \sqrt{\frac{a_e}{D_c}} = \text{mm.}$	Net power	$P_c = \frac{a_p \times a_e \times V_f \times k_c}{60 \times 10^6 \times n_{mt}} = \text{kW}$
Average chip thickness when $a_e / D_c \geq 0.1$	$h_m = \frac{\sin k_r \times 180 \times a_e \times f_z}{\pi \times D_c \times \arcsin\left(\frac{a_e}{D_c}\right)} = \text{mm.}$	Cutting time	$T_c = \frac{l}{V_f} = \text{min.}$



# Up Cut and Down Cut

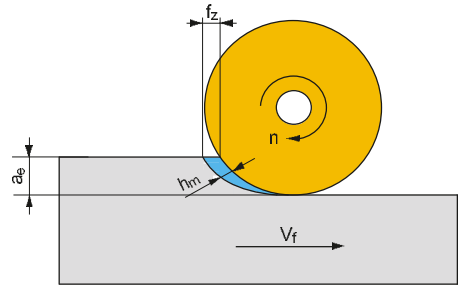
## Down cut milling



- same workpiece direction, feed rate and rotation of milling cutter.
- chip cross-section start on the strongest point.

Generally down milling should be preferred if rigid machine is available.

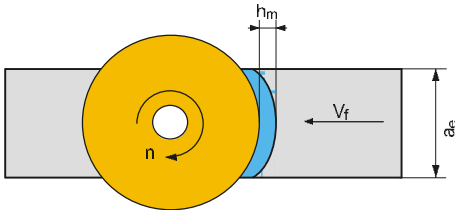
## Up cut milling



- the feed rate of workpiece is counter-clock-wise to the sense of milling cutter rotation.
- chip cross-section start on the weakest point.

Up milling should be applied on instable milling machine and workpiece materials with higher hardness.

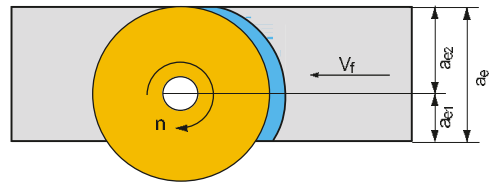
## Tool with central work piece



### Formulas :

$$h_m = \frac{\sin(kr) \times 180 \times a_e \times f_z}{\pi \times d_c \times \arcsin\left(\frac{a_e}{d_c}\right)} \quad f_z = \frac{h_m \times \pi \times \arcsin\left(\frac{a_e}{d_c}\right)}{\sin(kr) \times 180 \times a_e}$$

## Tool with outside center work piece



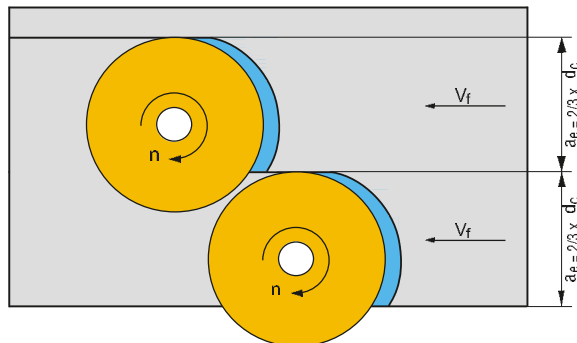
### Formulas :

$$h_m = \frac{\sin(kr) \times 360 \times a_e \times f_z}{\pi \times d_c \times \left[ \arcsin\left(\frac{2xa_{e1}}{d_c}\right) + \arcsin\left(\frac{2xa_{e2}}{d_c}\right) \right]}$$

$$f_z = \frac{h_m \times \pi \times d_c \times \left[ \arcsin\left(\frac{2xa_{e1}}{d_c}\right) + \arcsin\left(\frac{2xa_{e2}}{d_c}\right) \right]}{\sin(kr) \times 360 \times a_e}$$

## Suggested milling operation

*We suggest to work like this when possible or in any case work with tangential tool exit. Up cut and down cut is possible with Ae Max. 2/3 of tool diameter.*

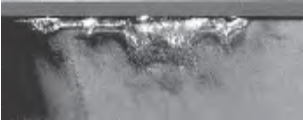







## Troubleshooting

### APPLICATIONS

Milling

PROBLEM	CAUSE	RECOMMENDED ACTION
<b>Chipping</b> 	<ul style="list-style-type: none"> <li>• insert grade</li> <li>• speeds &amp; feeds</li> </ul>	<ul style="list-style-type: none"> <li>• Change to tougher grade</li> <li>• Increase the cutting speed</li> <li>• Reduce the feed/tooth</li> </ul>
<b>Flank Wear</b> 	<ul style="list-style-type: none"> <li>• insert grade</li> <li>• speeds &amp; feeds</li> </ul>	<ul style="list-style-type: none"> <li>• Use a more wear-resistant grade</li> <li>• Reduce the cutting speed</li> <li>• Increase the feed/tooth</li> </ul>
<b>Crater Wear</b> 	<ul style="list-style-type: none"> <li>• insert grade</li> <li>• speeds &amp; feeds</li> </ul>	<ul style="list-style-type: none"> <li>• Use a more crater wear-resistant grade</li> <li>• Reduce the cutting speed</li> <li>• Reduce the feed/tooth</li> </ul>
<b>Broken Nose</b> 	<ul style="list-style-type: none"> <li>• insert grade</li> <li>• speeds &amp; feeds</li> <li>• insert shape</li> </ul>	<ul style="list-style-type: none"> <li>• Use a tougher grade</li> <li>• Adjust the cutting speed</li> <li>• Adjust the feed/tooth</li> <li>• Use a thicker insert</li> </ul>
<b>Poor Surface Finish</b>	<ul style="list-style-type: none"> <li>• insert grade</li> <li>• speeds &amp; feeds</li> <li>• insert shape</li> <li>• tool shape</li> </ul>	<ul style="list-style-type: none"> <li>• Use a more wear-resistant grade</li> <li>• Increase the cutting speed</li> <li>• Use a polished insert</li> <li>• Use a higher rake cutter</li> </ul>
<b>Burrs, Chipping, etc.</b>	<ul style="list-style-type: none"> <li>• insert grade</li> <li>• tool shape</li> </ul>	<ul style="list-style-type: none"> <li>• Increase the cutting speed</li> <li>• Reduce the feed/tooth</li> <li>• Use a higher rake cutter</li> </ul>
<b>Vibration</b>	<ul style="list-style-type: none"> <li>• speeds &amp; feeds</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce the cutting speed</li> <li>• Reduce the feed/tooth</li> </ul>

## Troubleshooting

### APPLICATIONS

Drilling

PROBLEM	CAUSE	RECOMMENDED ACTION
Drill Breakage	<ul style="list-style-type: none"> <li>• speeds &amp; feeds</li> <li>• cutting fluid</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain constant feed rate</li> <li>• Reduce the cutting speed</li> <li>• Reduce the feed rate</li> <li>• Increase coolant flow</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Center Point Breakage	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce drill overhang</li> <li>• Maintain constant feed rate</li> <li>• Reduce the feed rate when starting drill</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Peripheral Cutting Edge Breakage	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce drill overhang</li> <li>• Maintain constant feed rate</li> <li>• Reduce the cutting speed</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Chipping	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> <li>• cutting fluid</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce drill overhang</li> <li>• Maintain constant feed rate</li> <li>• Change the feed rate</li> <li>• Increase coolant flow</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Long Stringy Chips	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> </ul>	<ul style="list-style-type: none"> <li>• Less lead angle</li> <li>• Increase hone</li> <li>• Maintain constant feed rate</li> <li>• Increase the feed rate</li> </ul>
Chip Form Varies	<ul style="list-style-type: none"> <li>• speeds &amp; feeds</li> <li>• cutting fluid</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain constant feed rate</li> <li>• Maintain constant coolant flow</li> <li>• Use a machine with sufficient horsepower</li> </ul>

## Troubleshooting

### APPLICATIONS

Drilling

PROBLEM	CAUSE	RECOMMENDED ACTION
Over Size or Out-of-Round	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce drill overhang</li> <li>• Increase lead angle</li> <li>• Increase the cutting speed</li> <li>• Reduce the feed rate</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Poor Surface Finish	<ul style="list-style-type: none"> <li>• speeds &amp; feeds</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Maintain constant feed rate</li> <li>• Increase the cutting speed</li> <li>• Reduce the feed rate</li> <li>• Use low feed rate when starting drill</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Galling on Drill Body	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce drill overhang</li> <li>• Reduce the cutting speed</li> <li>• Increase the feed rate</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>
Vibration	<ul style="list-style-type: none"> <li>• tool</li> <li>• speeds &amp; feeds</li> <li>• others</li> </ul>	<ul style="list-style-type: none"> <li>• Use light hone</li> <li>• Reduce drill overhang</li> <li>• Maintain constant feed rate</li> <li>• Use a machine with sufficient horsepower</li> <li>• Tighten work piece clamping</li> </ul>

## Material Cross Reference

### Carbon steel

Japan	USA	Germany	
JIS	AISI/SAE	W.-nr	DIN
S10C	1010	1.0301	C10
S15C	1015	1.0401	C15
S20C	1020	1.0402	C22
S25C	1025	1.0406	C25
S30C	1030	1.0528	C30
S35C	1035	1.0501	C35
S40C	1040	1.0511	C40
S45C	1045	1.0503	C45
S50C	1049	1.0540	C50
S55C	1055	1.0535	C55
S58C	1060	1.0601	C58

### Nickel chromium steel

JIS	AISI/SAE	W.-nr	DIN
SNC236	3135	1.5710	36NiCr6
SNC415	3415	1.5732	14NiCr10
SNC631	—	—	—
SNC815	3310	1.5752	14NiCr14
SNC836	—	—	—

### Nickel chromium molybdenum steel

JIS	AISI/SAE	W.-nr	DIN
SNCM220	8620	1.6523	21NiCrMo2
SNCM240	8640	1.6546	40NiCrMo22
SNCM415	—	—	—
SNCM420	4320	—	—
SNCM439	4340	1.6582	35CrNiMo6
SNCM447	—	—	—
SNCM630	—	—	—
SNCM815	—	—	—

### Chromium steel

JIS	AISI/SAE	W.-nr	DIN
SCr415	5015	1.7015	15Cr3
SCr420	5120	1.7020	20Cr4
SCr430	5130	1.7033	34Cr4
SCr435	5132	1.7034	37Cr4
SCr440	5140	1.7045	42Cr4
SCr445	5147	—	—

### Chromium molybdenum steel

JIS	AISI/SAE	W.-nr	DIN
SCM415	—	1.7262	15CrMo5
SCM420	—	—	—
SCM430	4130	1.7218	25CrMo4
SCM435	4137	1.7220	34CrMo4
SCM440	4140	1.7223	41CrMo4
SCM445	4145	—	—

### Manganese steel and Manganese chromium steel

Japan	USA	Germany	
JIS	AISI/SAE	W.-nr	DIN
SMn420	1522	—	—
SMn433	1536	—	—
SMn438	1541	—	—
SMn443	1541	—	—
SMnC420	—	—	—
SMnC443	—	—	—

### Carbon tool steel

JIS	AISI/SAE	W.-nr	DIN
SK1	W1-13	—	—
SK2	W1-11 1/2	—	—
SK3	W1-10	1.1545	C105W1
SK4	W1-9	—	—
SK5	W1-8	1.1525	C80W1
SK6	W1-7	1.1525	C80W1
SK7	—	1.1620	C70W2

### High speed steel

JIS	AISI/SAE	W.-nr	DIN
SKH2	T1	—	—
SKH3	T4	—	—
SKH10	T15	—	—
SKH51	M2	1.3343	S6-5-2
SKH52	M3-1	—	—
SKH53	M3-2	1.3344	S6-5-3
SKH54	M4	—	—
SKH56	M36	—	—

### Alloy tool steel

JIS	AISI/SAE	W.-nr	DI
SKS11	F2	—	—
SKS51	L6	—	—
SKS43	W2-9 1/2	—	—
SKS44	W2-8 1/2	—	—
SKD1	D3	1.2080	X210Cr12
SKD11	D2	1.2379	X100CrMoV5
SKD12	A2	1.2363	X100CrMoV51
SKD2	—	1.2436	X210CrW12
SKD5	H21	1.2581	X30WCrV9
SKD61	H13	1.2344	X40CrMoV5

### Stainless steel (Ferritic)

JIS	AISI/ASTM	W.-nr	DIN
SUS405	AISI 405	1.4724	X6CrAl13
SUS429	AISI 429	—	—
SUS430	AISI 430	1.4742	X6Cr17
SUS430F	AISI 430F	1.4104	X12CrMoS17
SUS434	AISI 434	—	—

## Material Cross Reference

### Stainless steel (Martensitic)

Japan	USA	Germany	
		W.-nr	DIN
JIS	AISI/ASTM		
SUS403	AISI 403	—	—
SUS410	AISI 410	1.4006	X10Cr13
SUS416	AISI 416	—	—
SUS420J1	AISI 420	1.4034	X20Cr13
SUS420F	AISI 420F	—	—
SUS431	AISI 431	1.4057	X20CrNi172
SUS440A	AISI 440A	—	—
SUS440B	AISI 440B	—	—
SUS440C	AISI 440C	—	—

### Stainless steel (Austenitic)

JIS	AISI/ASTM	W.-nr	DIN
SUS202	AISI 202	—	—
SUS301	AISI 301	—	—
SUS302	AISI 302	—	—
SUS302B	AISI 302B	—	—
SUS303	AISI 303	1.4305	X10CrNiS189
SUS303Se	AISI 303Se	—	—
SUS304	AISI 304	1.4301	X5CrNi1810
SUS304L	AISI 304L	1.4306	X2CrNi1911
SUS304NI	AISI 304N	—	—
SUS305	AISI 305	1.4303	X5CrNi1812
SUS308	AISI 308	—	—
SUS309S	AISI 309S	—	—
SUS310S	AISI 310S	—	—
SUS316	AISI 316	1.4401	X5CrNiMo17122
SUS316L	AISI 316L	—	X2CrNiMo17132
SUS316N	AISI 316N	1.4404	—
SUS317	AISI 317	1.4438	X2CrNiMo18164
SUS317L	AISI 317L	1.4438	X2CrNiMo18164
SUS321	AISI 321	—	—
SUS347	AISI 347	1.4550	X6CrNiNb1810
SUS384	AISI 384	—	—

### Heat resistant steel (Austenitic)

JIS	AISI/ASTM	W.-nr	DIN
SUH31	—	—	—
SUH35	—	—	—
SUH36	—	—	—
SUH37	—	—	—
SUH38	—	—	—
SUH309	AISI 309	—	—
SUH310	AISI 310	1.4845	CrNi2520
SUH330	AISI 330	—	—

### Heat resistant steel (Martensitic)

Japan	USA	Germany	
		W.-nr	DIN
JIS	AISI/ASTM		
SUH21	—	—	CrAl1205
SUH409	AISI 409	1.4512	X6CrTi12
SUH446	AISI 446	—	—

### Heat resistant steel (Ferritic)

JIS	AISI/ASTM	W.-nr	DIN
SUH1	—	—	—
SUH3	—	—	—
SUH4	—	—	—
SUH11	—	—	—
SUH600	ASTM 616	—	—

### Grey cast iron

JIS	AISI/SAE	W.-nr	DIN
FC100	20	0.6010	GG 10
FC150	25	0.6015	GG 15
FC200	30	0.6020	GG 20
FC250	35	0.6025	GG 25
FC300	40	0.6030	GG 30
FC350	50	0.6035	GG 35

### Nodular cast iron

JIS	AISI/SAE	W.-nr	DIN
FCD400	60-40-18	0.7040	GGG 40
FCD450	60-40-8	0.7045	GGG 45
FCD500	65-45-12	0.7050	GGG 50
FCD600	80-55-06	0.7060	GGG 60
FCD700	100-70-03	0.7070	GGG 70

# Tool Steel Brand Cross Reference

## Steel for cold molding

Group	JIS	AISI	Aichi Steel	Sanyo Special Steel	Daido Steel	Nippon Koshuha Steel	Hitachi Metals	Nachi Fujikoshi	Udde Holm	Bohler
Carbon tool steel	SK105	W1-10		QK3	YK3					K990
Alloy tool steel	SKS93		SK301	QK3M	YK30	K3M	YCS3			
	SKS3		SKS3	QKS3	GOA	KS3	SGT		ARNE	K460
	SKD1	D3		QC1	DC1	KD1	CRD		SVERKER3	K100, K107
	SKD11	D2	SKD11	QC11	DC11	KD11	SLD	CDS11	SVERKER21	K105, K110
	8% Cr		AUD15 AUD11	QCM7 QCM8	DC53	KD11MAX KD11S, KD21	SLD8	MDS9	SLEIPNER	K340
	Die steel (Matrix type)		SXACE		DCMX	NOGA	ARK1		CALDIE UNIMAX	W360
	SKD12	A2			DC12	KD12			RIGOR	K305
	Pre-harden 40HRC				GO40F	KAP65	HPM-MAGIC		IMPAX HH	
	Flame tempered steel		SX105V	QF3	GO5	KRCX	HMD5		FERMO	
	Low temperature air cooled steel				GO4	KSM	ACD37			
Impact resistant steel			AKS4	QF1	GS5	KTV5	YSM			
Others			AUD11X				SLD10 SLD-MAGIC	ICS22	CALMAX ELMAX VANCRON40 VANADIS4E VANADIS10	K390 K890
High speed tool steel	SKH51	M2		QH51	MH51	H51	YXM1	SKH9		S600
	SKH51 type							SKH9D		
	SKH55 type					HM35	YXM4	HM35 HS53M		S705
	SKH57 type					MV10	XVC5	HS93R DURO-SP		S700
	Matrix type			QHZ	DRM1 DRM2 DRM3 MH85	KMX1 KMX2 KMX3	YXR3 YXR7 YXR33	DURO-F1 DURO-F3 DURO-F7 DURO-V2 DURO-V5		
Sintered high speed tool steel	SKH40				DEX40		HAP40	FAX38	VANADIS30	S590
	Matrix type				DEX-M1 DEX-M3		HAP5R			
	Others			SPM23 SPM30 SPM60 SPMR8	DEX20 DEX60		HAP10 HAP50 HAP72	FAX31 FAX40 FAX55 FAXG2	VANADIS23 VANADIS60	S290 S390 S690 S790

# Tool Steel Brand Cross Reference

## High speed tool steel

Group	JIS	AISI	Aichi Steel	Daido Steel	Nippon Koshuha Steel	Hitachi Metals	Nachi Fujikoshi	Udde Holm	Bohler
Tungsten type	SKH2	T1			H2	YHX2	SKH2		S200
	SKH3	T4			H3		SKH3		S305
	SKH4	T5			H4		SKH4		
	SKH10	T15			HV5				
Molybdenum type	SKH51	M2	QH51	MH51	H51	YXM1	SKH9		S600 S614 S401
	SKH52	M3-1			H52				
	SKH53	M3-2			HV1				S607
	SKH54	M4			HV2		HM4		
	SKH55				HM35	YXM4	HM35		S705
	SKH56	M36			HM36		HM36		
	SKH57				HV10	XVC5	HS93R		S700
	SKH58	M7			HM3		HM7		S400
	SKH59	M42			HM42	YXM42	HM42		S500
	Others				S70	YXM27 YXM60	HS53M HS97R HM1 HMT12 HM33 SKH9D DURO-SP		
Matrix type	Matrix type		QHZ	DRM1 DRM2 DRM3 MH85	KMX1 KMX2 KMX3	YXR3 YXR33 YXR7	DURO-FZ DURO-F1 DURO-F3 DURO-F7 DURO-V2 DURO-V5		
Powdered type	SKH40		SPM30	DEX40		HAP40	FAX38	VANADIS30	S590
	Others		SPM23 SPM60 SPMR8	DEX20 DEX60 DEX-M1 DEX-M3		HAP10 HAP50 HAP72 HAP5R	FAX31 FAX40 FAX55 FAXG2	VANADIS23 VANADIS60	S290 S390 S690 S790

# Tool Steel Brand Cross Reference

## Steel for plastic mold

Group	Hardness (HRC)	JIS	AISI	Aichi Steel	JFE Steel	Kobelco	Sanyo Special Steel	Daido Steel	Nippon Koshuha Steel	Hitachi Metals	Nachi Fujikoshi	Udde Hdm	Bohler	
Pre hardened steel	13	SC type	1055		JFE-MD1	KTSM21 KTSM21M KTSM2A KTSM22	PC55		KPM1 KPMAX					
	28	SCM type	4140		JFE-MD3 JFE-MD5	KTSM31		PDS3						
	33	SCM (Improved)	P20				KTSM3M	PCM30	PX5 PXA30	KPM30	HPM7		IMPAXHH	M200 M201 M238
		SUS type	420						S-STAR D-STAR	GHX 420M	HPM38	PROVA-400 PROVA-450	STAVAX	M303 M310
		SUS type (Free cutting)							G-STAR	U630	HPM77		RoyAlloy	M315
	35	SUS type	S17400				QSH6	NAK101		PSL		CORRAX	N700	
	36	SCM (Improved)	P20						JHX					
	40	SUS type											EDRO400	
		SKD61 (Improved)	H13						DH2F	KAP90F	FDAC			
		Others	P21					PCM40S	NAK80	KAP88	HPM-PRO			M461
P21 (Free cutting)							PCM40	NAK55	KAP65	HPM1			M261	
P21 (Rust resistant)										CENA1				
								HPM-MAGIC			NIMAX			
Quench tempered steel	60	SKD11 (Improved)	D2	AUD11			QCM8	PD613	NOGA	HPM31		RIGOR SLEIPNER CALDIE CALMAX	K105 K110 K340	
	57	SUS type 440C	440C				QPD5 SPC5 (Powdered)	SUS440C		SUS440C	440C PROVA-500 (Powdered)	ELMAX	M340 M390 N685 N690 N695	
	52	SUS type 420						S-STAR D-STAR G-STAR	GHX	HPM38 HPM38S HPM77	PROVA-400 PROVA-450	STAVAX POLMAX MIRRAX	M310 M330	
Age hardened steel	Over 50	Maraging steel						MAS1C	KMS18-20	YAG	EXEO-M21		V720 V721	
		Others										CORRAX		
	40	Non-magnetic steel							NMS1	HPM75				



# Tool Steel Brand Cross Reference

## Steel for hot molding

Group	JIS	AISI	Aichi Steel	Kobelco	Sanyo Special Steel	Daido Steel	Nippon Koshuha Steel	Hitachi Metals	Nachi Fujikoshi	Mitsubishi Steel	Udde Hdm	Bohler
Alloy tool steel	SKD4					DH4	KD4					
	SKD5	H21				DH5	KD5					
	SKD6	H11				DH6	KD6				VIDAR	W300 W400
	SKD61	H13	SKD61		QD61	DHA DHA1	KDA	DAC			ORVAR-2M	W302
	SKD61 (Improved)		AUD61 AUD60A		QDA61 QDN	DHA2 DH21 DHA-WORLD DH31-S DH31-EX	KDA1 KDA1S KDAMAX	DAC3 DAC10 DAC55 DACMAGIC			ORVAR-S DIEVAR	W303 W403
	SKD61 (Free cutting)					DH2F	KAP90F	FDAC				
	SKD62	H12			QD62	DH62	KDB					
	SKD7	H10				DH72	KDH1					W320
	SKD7 (Improved)		AUD72		QDH	DH71 DH73 DH32		DAC40 YEM-K	DURO-N1			
	SKD8	H19				DH41	KDF					
	SKD8 (Improved)					DH42	KDF4	MDC-K				
	SKT4		SKT4A	SKT4	QT41	GFA	KTV	DM			ALVAR14	W500
	SKT4 (Improved)			KTH4	QDT	GF78	TD3					
	Precipitation hardening steel		AUD91 MPH-K			DH76				HD22B		
	Others				QF5	DHA-Thermo					BURE BLADER	
High speed tool steel	Matrix type				QHZ	DRM1 DRM2	KMX1	YXR33	DURO-FZ DURO-F1			

# Hardness Conversion Table

## Approximate conversion value for vickers hardness of steel

Vickers HV	Brinell 10mm ball Load 3,000 kgf		Rockwell			Shore HS	Tensile strength MPa (kgf/2)
	Standard ball	Tungsten carbide ball	A scale Load 60 kgf 120°diamond cone	B scale Load 100 kgf 1/16 inch steel ball	C scale Load 150 kgf 120°diamond cone		
			HRA	HRB	HRC		
1900	-	-	93.1	-	80.5	-	-
1800	-	-	92.6	-	79.2	-	-
1700	-	-	91.9	-	77.9	-	-
1600	-	-	91.3	-	76.6	-	-
1500	-	-	90.5	-	75.3	-	-
1450	-	-	90.1	-	74.6	-	-
1400	-	-	89.6	-	74.0	-	-
1350	-	-	89.1	-	73.4	-	-
1300	-	-	88.7	-	72.7	-	-
1250	-	-	88.3	-	72.1	-	-
1200	-	-	87.9	-	71.5	-	-
1150	-	-	87.5	-	70.9	-	-
1100	-	-	87.1	-	70.3	-	-
1050	-	-	86.6	-	69.6	-	-
1000	-	-	86.2	-	68.9	-	-
940	-	-	85.6	-	68.0	97	-
920	-	-	85.3	-	67.5	96	-
900	-	-	85.0	-	67.0	95	-
880	-	(767)	84.7	-	66.4	93	-
860	-	(757)	84.4	-	65.9	92	-
840	-	(745)	84.1	-	65.3	91	-
820	-	(733)	83.8	-	64.7	90	-
800	-	(722)	83.4	-	64.0	88	-
780	-	(710)	83.0	-	63.3	87	-
760	-	(698)	82.6	-	62.5	86	-
740	-	(684)	82.2	-	61.8	84	-
720	-	(670)	81.8	-	61.0	83	-
700	-	(656)	81.3	-	60.1	81	-
690	-	(647)	81.1	-	59.7	-	-
680	-	(638)	80.8	-	59.2	80	-
670	-	630	80.6	-	58.8	-	-
660	-	620	80.3	-	58.3	79	-
650	-	611	80.0	-	57.8	-	-
640	-	601	79.8	-	57.3	77	-
630	-	591	79.5	-	56.8	-	-
620	-	582	79.2	-	56.3	75	-
610	-	573	78.6	-	55.7	-	-
600	-	564	78.9	-	55.2	74	-
590	-	554	78.4	-	54.7	-	2055(210)
580	-	545	78.0	-	54.1	72	2020(206)
570	-	535	77.8	-	53.6	-	1985(202)
560	-	525	77.4	-	53.0	71	1950(199)
550	(505)	517	77.0	-	52.3	-	1905(194)
540	(496)	507	76.7	-	51.7	69	1860(190)
530	(488)	497	76.4	-	51.1	-	1825(186)
520	(480)	498	76.1	-	-	67	1795(183)
510	(473)	479	75.7	-	50.5	-	1750(179)
500	(465)	471	75.3	-	49.8	66	1750(174)
490	(456)	460	74.9	-	49.1	-	1660(169)
480	448	452	74.5	-	48.4	64	1620(165)
470	441	442	74.1	-	47.7	-	1570(160)
460	433	433	73.6	-	46.9	62	1530(156)
450	425	425	73.3	-	46.1	-	1495(153)
440	415	415	72.8	-	45.3	59	1460(149)
430	405	405	72.3	-	44.5	-	1410(144)
430	405	405	72.3	-	43.6	-	-

Vickers HV	Brinell 10mm ball Load 3,000 kgf		Rockwell			Shore HS	Tensile strength MPa (kgf/2)
	Standard ball	Tungsten carbide ball	A scale Load 60 kgf 120°diamond cone	B scale Load 100 kgf 1/16 inch steel ball	C scale Load 150 kgf 120°diamond cone		
			HRA	HRB	HRC		
420	397	397	71.8	-	42.7	57	1370 (140)
410	388	388	71.4	-	41.8	-	1330 (136)
400	379	379	70.8	-	40.8	55	1290 (131)
390	369	369	70.3	-	39.8	-	1240 (127)
380	360	360	69.8	(110.0)	38.8	52	1205 (123)
370	350	350	69.2	-	37.7	-	1170 (120)
360	341	341	68.7	(119.0)	36.6	50	1130 (115)
350	331	331	68.1	-	35.5	-	1095 (112)
340	322	322	67.6	(108.0)	34.4	47	1070 (109)
330	313	313	67.0	-	33.3	-	1035 (105)
320	303	303	66.4	(107.0)	32.2	45	1005 (103)
310	294	294	65.8	-	31.0	-	980 (100)
300	284	284	65.2	(105.5)	29.8	42	950 (97)
295	280	280	64.8	-	29.2	-	935 (96)
290	275	275	64.5	(104.5)	28.5	41	915 (94)
285	270	270	64.2	-	27.8	-	905 (92)
280	265	265	63.8	(103.5)	27.1	40	890 (91)
275	261	261	63.5	-	26.4	-	875 (89)
270	256	256	63.1	(102.0)	25.6	38	855 (87)
265	252	252	62.7	-	24.8	-	840 (86)
260	247	247	62.4	(101.0)	24.0	37	825 (84)
255	243	243	62.0	-	23.1	-	805 (82)
250	238	238	61.6	99.5	22.2	36	795 (81)
245	233	233	61.2	-	21.3	-	780 (79)
240	228	228	60.7	98.1	20.3	34	765 (78)
230	219	219	-	96.7	(18.0)	33	730 (75)
220	209	209	-	95.0	(15.7)	32	695 (71)
210	200	200	-	93.4	(13.4)	30	670 (68)
200	190	190	-	91.5	(11.0)	29	635 (65)
190	181	181	-	89.5	(8.5)	28	605 (62)
180	171	171	-	87.1	(6.0)	26	580 (59)
170	162	162	-	85.0	(3.0)	25	545 (56)
160	152	152	-	81.7	(0.0)	24	515 (53)
150	143	143	-	78.7	-	22	490 (50)
140	133	133	-	75.0	-	21	455 (46)
130	124	124	-	71.2	-	20	425 (44)
120	114	114	-	66.7	-	-	390 (40)
110	105	105	-	62.3	-	-	-
100	95	95	-	56.2	-	-	-
95	90	90	-	52.0	-	-	-
90	86	86	-	48.0	-	-	-
85	81	81	-	41.0	-	-	-



