

# **SPECIALTY STEELS**

**Material's General Catalog**

## **FM ALLOY**

Fusing our hard-earned knowledge with cutting edge technology handles the ever-advancing demands across industries.

1

### Integration of high-grade special steel production technologies

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Proprietary refining technology produces clean high quality materials

2

### Know-how for responding to a wide range of needs

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We produce materials with a full understanding of what is needed because we are also manufacturers of all kinds of machinery

3

### Synergies multiplied to produce near-net products

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We fuse machining, heat treatment, coating, and other technologies to bring products to market

4

### A production system that caters to the demands of wide range, variable volume and short delivery periods

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Flexible production facilities and control systems handle any variety from forging to precision machining

5

### Certified quality assurance

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Quality assurance system fulfills ISO certification and produces TPM award and Deming Prize winning history



Vacuum induction melting furnace

### High quality

Steels are made from highly refined excellent quality materials skillfully produced through a combination of Nachi's proprietary refining methods and the latest production technologies. We also support advances in heat treatment technology and the latest surface processing techniques.



ESR furnace

### Easy to use

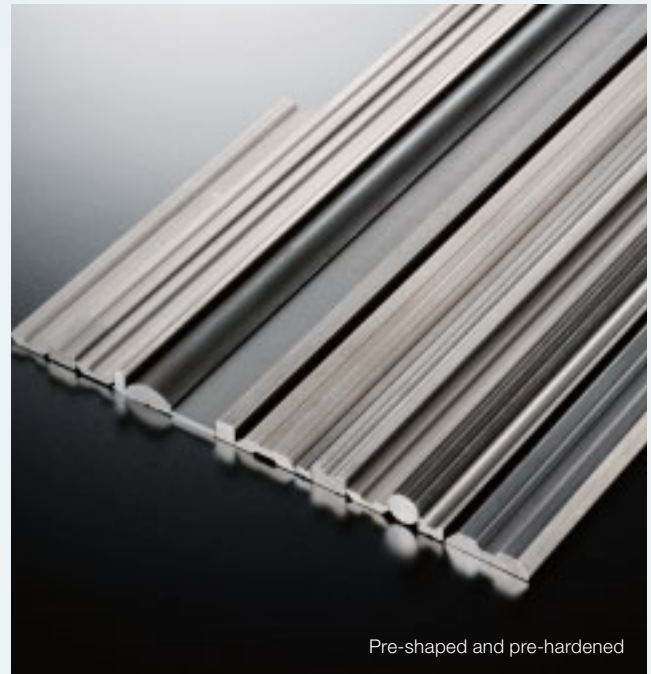
Steels are produced with ever more precise focus on chemical composition and structural control to bring out our high level performance in wear resistance, strength, hardenability, grindability and more. We have a wide range of steels, shapes, and production dimensions in a system to handle requests.



EPMA

### Quality assurance

Steel quality is assured through rigorous inspections of partial and completed products combined with careful process management using a variety of testing equipment.



Pre-shaped and pre-hardened

### Satisfaction

As a multifaceted machinery maker, Nachi-Fujikoshi is maximizing valuable feedback from users with its range of technologies to produce new steel materials that meet demand with unceasing advances in quality.

# 01 High-grade Special Steels

01 High-grade Special Steels

02 High-carbon Chromium Bearing Steels

03 Martensitic Stainless Steel

04 High-performance Alloys

05 Hardness Chart

06 Production Size Ranges

## Steel Grade, Chemical Composition and Properties

### High-speed Tool Steels

Production Category	Category by alloy content	Steel Grade				Chemical Composition (%)						Properties (1 ⇒ 10 better)				
		NACHI Grade	Related Standards			C	W	Mo	Cr	V	Co	Wear Resistance	Hot Hardness	Toughness	Grindability	
			AISI	VDEh	JIS											
Conventional methods (including ESR and VAR)	W · Mo	High V	SKH9	M2	1.3343	SKH51	0.88	6.0	5.0	4.0	2.0	—	5	5	8	5
			SKH9D	—	—	—	0.78	6.0	5.0	4.0	2.0	—	4	4	9	6
		HM4	—	—	—	1.30	6.0	5.0	4.0	4.0	—	9	6	6	2	
	W · Mo · Co	High V	HM35	(M35)	1.3243	SKH55	0.90	6.0	5.5	4.0	2.0	5.0	6	6	6	5
			HS53M	—	—	—	1.05	6.0	6.0	4.0	2.5	5.0	8	7	6	3
		HS97R	—	—	—	1.10	7.5	5.5	3.9	1.8	9.0	8	9	5	4	
		MATRIX2	—	—	—	0.70	1.0	5.0	4.0	1.0	8.0	3	7	7	9	
	Mo	High V	HS93R	(T42)	1.3207	SKH57	1.30	10.0	3.5	4.0	3.5	10.0	10	9	2	2
			HM7	M7	1.3348	SKH58	1.00	1.5	8.5	4.0	2.0	—	5	6	7	7
		HMT12	—	—	—	1.25	3.5	8.0	4.0	2.8	—	8	7	7	4	
		Mo · Co	HM33	M33	—	—	0.95	1.8	9.5	4.0	1.0	8.0	7	8	6	6
		HM42	M42	1.3247	SKH59	1.10	1.5	9.5	4.0	1.0	8.0	8	9	4	5	
		W	SKH2	T1	1.3355	SKH2	0.80	18.0	—	4.0	1.0	—	5	5	7	7
		W · Co	SKH3	T4	1.3255	SKH3	0.80	18.0	—	4.0	1.0	5.0	6	7	5	6
		SKH4	T5	1.3265	SKH4	0.80	18.0	—	4.0	1.0	10.0	7	9	2	5	
	P/M methods	Mo · W	High V	FAX31	—	1.3344	—	1.30	6.0	5.0	4.0	3.0	—	6	6	10
FAX38				—	—	SKH40	1.30	6.0	5.0	4.0	3.0	8.0	7	9	9	9
Mo · W · Co		FAX55	—	—	—	1.55	13.0	—	4.0	5.0	5.0	10	9	7	6	
FAX40		—	—	—	1.30	10.0	3.5	4.0	3.0	10.0	8	9	8	8		
FAXG2		—	—	—	Patented steel						9	10	8	7		

### Alloy Tool Steels

Conventional methods	Alloy Tool Steels	MDS9	—	—	—	1.05	—	1.6	9.3	0.5	—	2	1	8	8
		ICS22	—	—	—	Patented steel						1	1	10	10

# Applications and Heat Treatment

## High-speed Tool Steels

NACHI Grade	Cutting tool										Heat treatment								Hardness							
	Bit	Drill	Reamer	End mill	Milling cutter	Gear cutter	Broach	Saw blade	Screw cutter	Wood-working tool/blade	Industrial blade	Mold/plate	Pin/punch	Rolling tool	Wear resistant machine component	Vane	Mandrel	Dot pin	Formed roll	High-temperature bearing	Austenitizing (°C)	Tempering (°C)	Annealing (HB)	Hardening Tempering (HRC)		
SKH9	○	◎	◎		◎	◎	◎	◎	○	◎	◎	◎	◎	◎	◎	◎	◎	○	◎	○	1150-1220	540-580	<255	58-66		
SKH9D											○	○	◎	◎	○				○		1120-1200	540-600	<209	55-65		
HM4	○		○				○	○												1180-1220	540-580	<277	63-66			
HM35	○	◎	◎	○	◎	◎			○			○	○													64-67
HS53M	○	◎	○		○	◎																				64-68
HS97R		○		◎	◎		○	◎																		65-69
MATRIX2							◎		○															1125-1180	540-560	<235
HS93R	◎		○		○								○								1220-1250	540-580	<285	65-69		
HM7					○			◎													1190-1210		<255	63-66		
HMT12								◎													1180-1200		<285	64-66		
HM33		◎			○	○							◎								1160-1200		<232	63-66		
HM42	◎			◎	○	○	◎		◎				◎								1200-1280		<248	64-68		
SKH2	○								◎	◎				○					○		1200-1290		<285	65-69		
SKH3	◎								◎	◎														62-66		
SKH4	◎								○	○									◎					64-68		
FAX31												◎	◎	○				○			1120-1210		540-600	<285	66-69	
FAX38		◎	○		○	◎		◎				○	○	○					○		1140-1210		540-580	<285	63-69	
FAX55	○			○	○	◎		◎	○				○	○							1200-1240			66-69		
FAX40		◎		○	○	○	○						○	○				○	○		1140-1240			63-69		
FAX62							◎	◎					○								1140-1200			66-69		

## Alloy Tool Steels

MDS9												◎	◎	◎					◎	1000-1050	500-560	Max 210	55-62	
ICS22												◎									900-950	150-300	Max 197	58-64

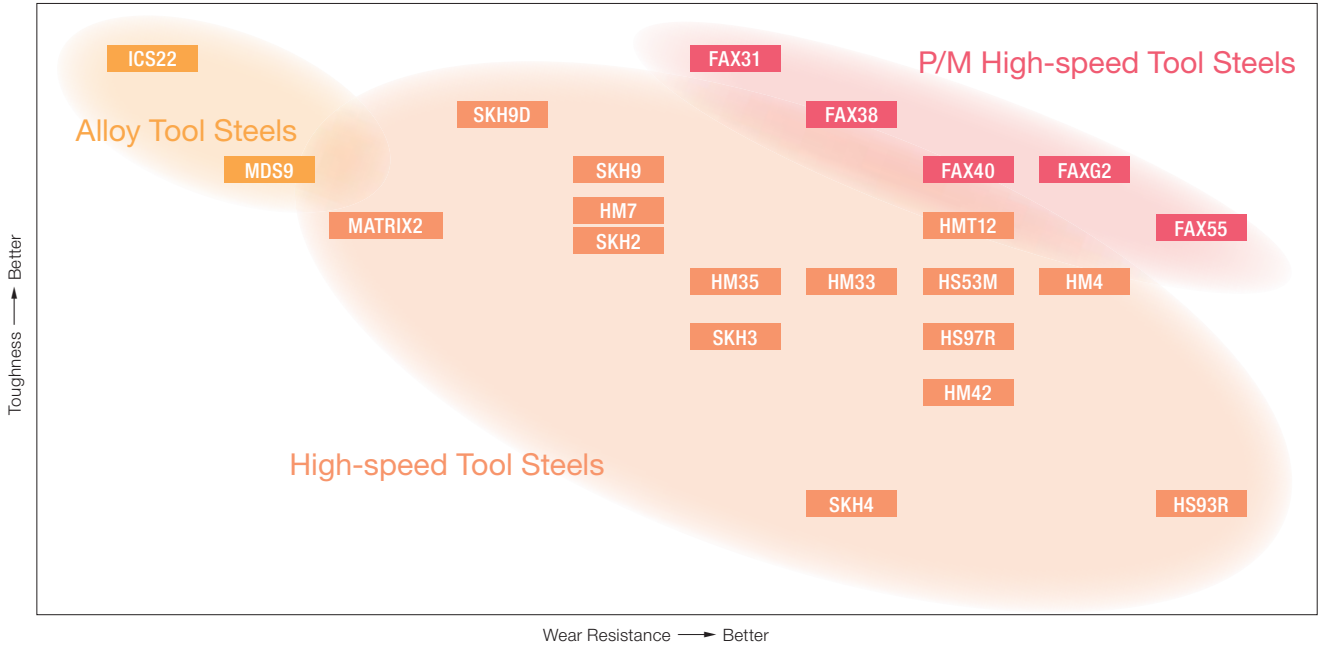
# 01 High-grade Special Steels

01 High-grade Special Steels  
 02 High-carbon Chromium Bearing Steels  
 03 Martensitic Stainless Steel  
 04 High-performance Alloys  
 05 Hardness Chart  
 06 Production Size Ranges

## Properties of high-grade Special Steels

### Ranking of properties

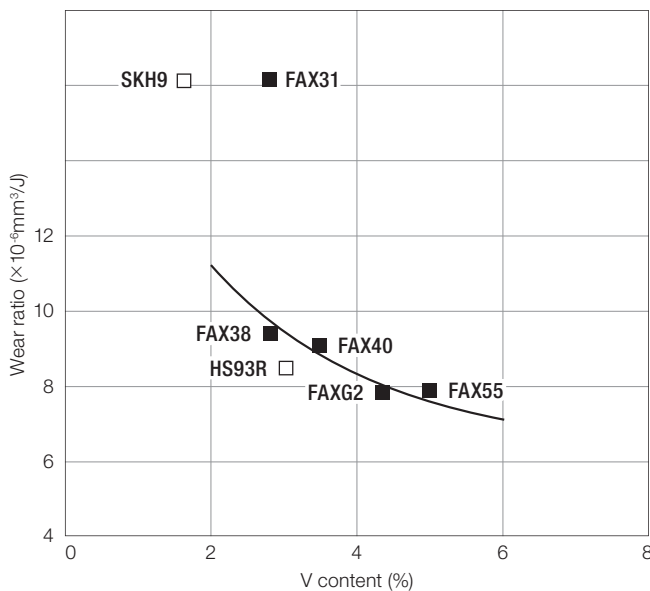
Select the steels developed by NACHI (including original steel grades) to meet your particular requirements.



## Properties of P/M High-speed Tool Steels

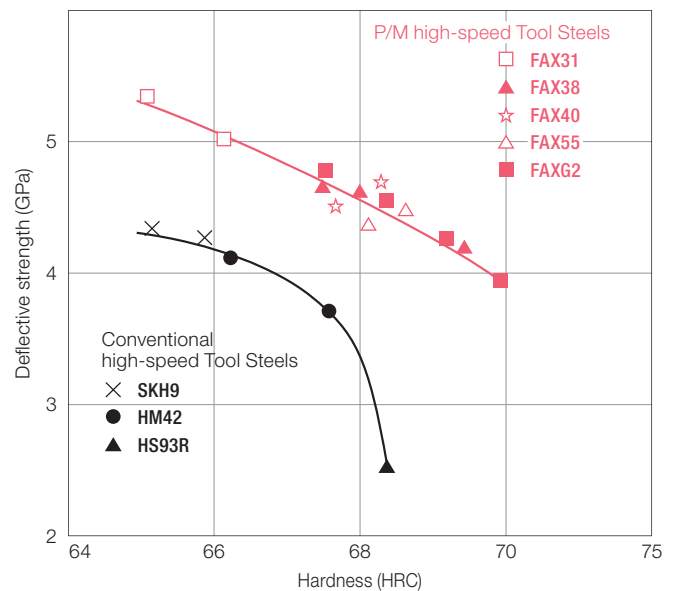
### Wear resistance

Outstanding wear resistance can be obtained.



### Toughness

High toughness can be obtained even at high hardness levels.



# 02 High-carbon Chromium Bearing Steels

SC: Slow cooling      OQ: Oil quenching      AC: Air cooling

Steel Grade			Chemical Composition (%)				Properties	Heat treatment			Hardness		Main application
NACHI Grade	Related Standards		C	Si	Mn	Cr		Annealing (°C)	Austenitizing (°C)	Tempering (°C)	Annealed hardness (HB)	Practical hardness (HRC)	
	AISI SAE	JIS											
SUJ2	E52100	SUJ2	1.00	0.3	—	1.5	750–790 SC	810–850 OQ	150–190 AC	Max 201	62–65	Bearings Gages Rolls	
SUJ3	ASTM A485 Grade 1	SUJ3	1.00	0.6	1.0	1.0		790–830 OQ		Max207		Large bearings	



# 03 Martensitic Stainless Steel

SC: Slow cooling      OQ: Oil quenching      AC: Air cooling

Steel Grade			Chemical Composition (%)				Properties	Heat treatment			Hardness		Main application
NACHI Grade	Related Standards		C	Si	Mn	Cr		Annealing (°C)	Austenitizing (°C)	Tempering (°C)	Annealed hardness (HB)	Practical hardness (HRC)	
	AISI SAE	JIS											
440C	440C	SUS440C	1.05	0.5	—	18.0	800–920 SC	1010–1070 OQ	100–180 AC	Max 269	58–62	High grade blades Bearings	





# 04 High-performance Alloys

01 High-grade Special Steels

02 High-carbon Chromium Bearing Steels

03 Martensitic Stainless Steel

04 High-performance Alloys

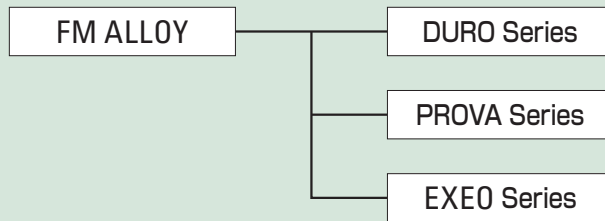
05 Hardness Chart

06 Production Size Ranges

## FM ALLOY

Leveraging the advantages of its specialized proprietary melting and forming technologies, NACHI developed control methods for microstructure that was not possible with conventional special steel production methods. This produces high-performance alloys of high quality with low impurities and homogeneous microscopic structures.

DURO Series, PROVA Series, and EXEO Series are FM Alloys.

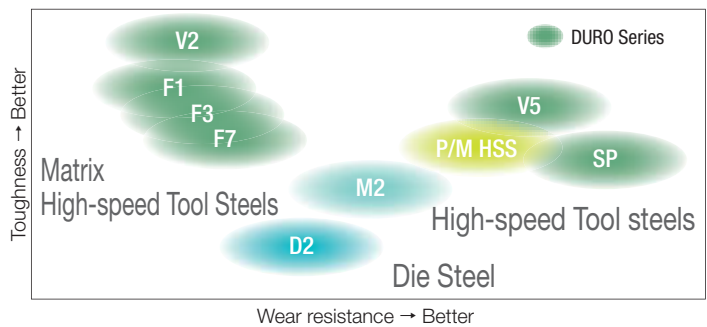


### DURO Series

DURO series steel is for precision die and mold with a superior balance of toughness and wear resistance.



Ranking of steel for cold working

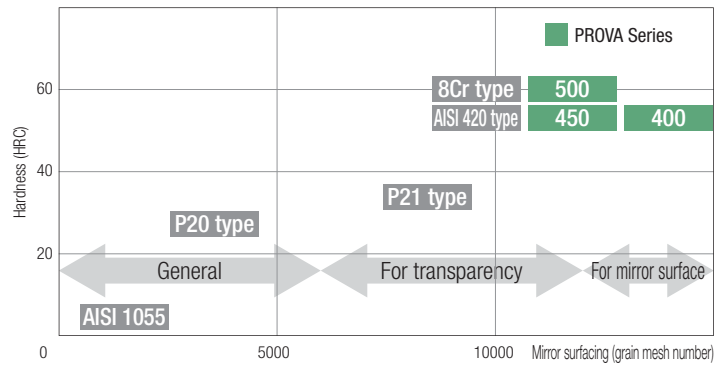


	Steel Grade	Classification	Hardness (HRC)	Features
Hot	<b>DURO-N1</b>	Very tough die steel for hot working	50 – 54	Ultra-tough die steel which has high toughness at the same time as superior high-temperature strength
	<b>DURO-FZ</b>	Very tough matrix HSS	54 – 58	Ultra-tough die steel which has a superior balance of hardness and impact resistance
Cold	<b>DURO-F1</b>	Very tough matrix HSS	54 – 60	Ultra tough die steel which has the highest toughness in all die and mold materials in the 60 HRC class.
	<b>DURO-F3</b>		57 – 62	Well balanced die steel which is a medium grade between F1 and F7, and has good toughness and wear resistance.
	<b>DURO-F7</b>		59 – 65	High wear resistant die steel which has great hardness up to a maximum 65 HRC as well as high toughness
	<b>DURO-V2</b>	Ultra tough matrix HSS	58 – 62	Die steel which has superior fatigue strength and is the toughest in the DURO series
	<b>DURO-V5</b>	High wear resistance and super tough HSS	56 – 62	Die steel which balances wear resistance better than P/M HSS and the toughness of matrix HSS
	<b>DURO-SP</b>	High wear resistance HSS	60 – 67	Super high wear resistance steel which has higher wear resistance than P/M HSS along with good toughness



## PROVA Series

PROVA series steel is for plastic molds with great mirror finishing, corrosion resistance, and wear resistance.



Steel Grade	Classification	Hardness (HRC)	Features
PROVA-400	Corrosion resistant steel for mirror finish molds for plastics	51 – 53	Steel for high-quality molds for aspherical lenses and mobile phones, specifically with mirror finishes
PROVA-450		51 – 53	Corrosion resistant steel with excellent machinability for molds for high-quality clear resins
PROVA-500		58 – 62	Very hard high grade P/M stainless steel for mold which has excellent resistance to deformation under pressure and wear resistance for uses such as optical disc mold

## EXEO Series

EXEO series materials are for functional components requiring such high properties as low expansion, heat resistance, corrosion resistance, and strength.



### Nickel alloys from Nachi

99% Ni EXEO-N201 Corrosion resistance	Fe Co	EXEO-S10	31% Ni Low thermal expansion
	Fe Mo Ti Al	EXEO-M21	18% Ni Strength and toughness
	Cr Fe	EXEO-N600	72% Ni High-temperature corrosion resistance
	Cr Mo Fe Ti Al Nb	EXEO-N718	52% Ni High-temperature strength and corrosion resistance
	Cr Ti Al	EXEO-N80A	75% Ni High-temperature strength

	Material Grade	Classification	Hardness	Features
Fe type	EXEO-NPR Series	For components plasticizing high-grade resin	—	Provides resistance to corrosive wear associated with plasticizing resin For components such as screws of plastic injection machine for forming high-performance resins
	EXEO-SP	Steel for wear resistant parts	—	Excellent for components needing to suppress surface roughness from friction with superior wear resistance
Ni type	EXEO-S10	Low thermal expansion alloy (Super Invar)	75 HRB	Suitable for precision parts with low thermal expansion and cleanness of impurities
	EXEO-M21	Super tough (Maraging Steel)	56 HRC	Excellent for strong and tough parts with superior notch strength, cleanness of impurities
	EXEO-N201	Corrosion resistant material for electronic parts (Nickel 201)	66 HRB	Excellent resistance to alkali (caustic soda etc.). Excellent electro-conductivity, to be used for electronic parts etc.
	EXEO-N600	High-temperature, corrosion resistant, oxidation resistant alloy	87 HRB	Perfect for parts that need high temperature and corrosion resistance, such as core tubes for tube furnaces, molten metal agitator jigs, and heat exchanging equipment
	EXEO-N718	High-temperature strength, corrosion resistant, oxidation resistant alloy	42HRC	Excellent high strength and creep resistance up to 700°C with good corrosion resistance. Suitable for hot extrusion die for copper alloy etc.
	EXEO-N80A	Super heat resistant alloy	105 HRB	Perfect for parts that are strong and exposed to high temperature wear, such as exhaust valves and forging anvils

# 05 Hardness Chart

01 High-grade Special Steels  
02 High-carbon Chromium Bearing Steels

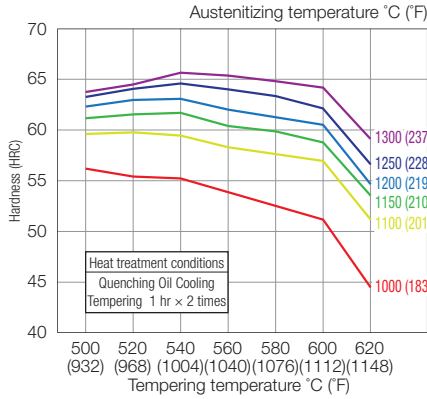
03 Martensitic Stainless Steel

04 High-performance Alloys

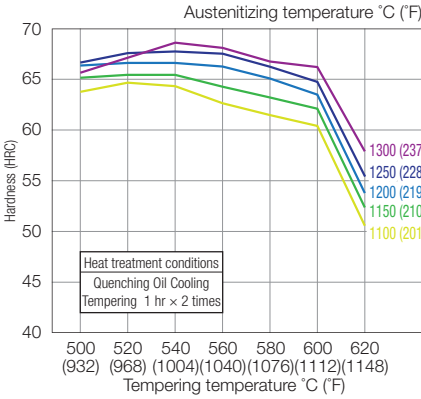
05 Hardness Chart

06 Production Size Ranges

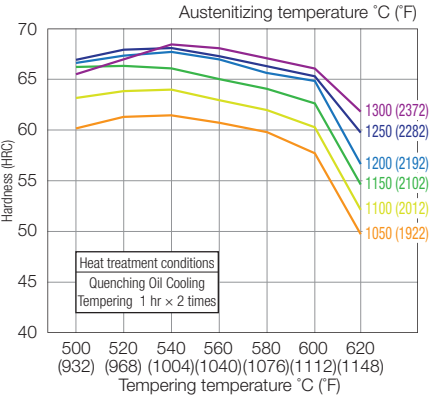
## SKH2



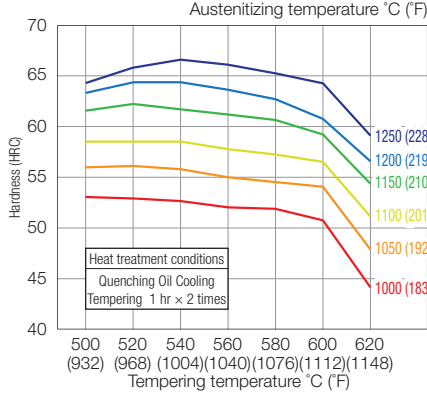
## SKH3



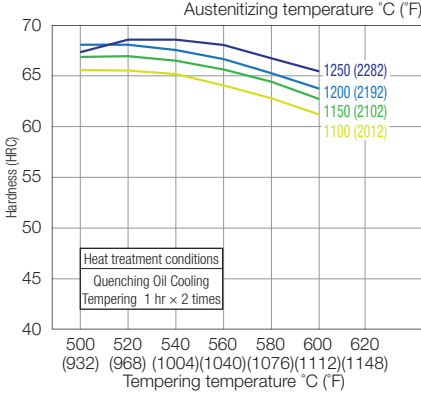
## SKH4



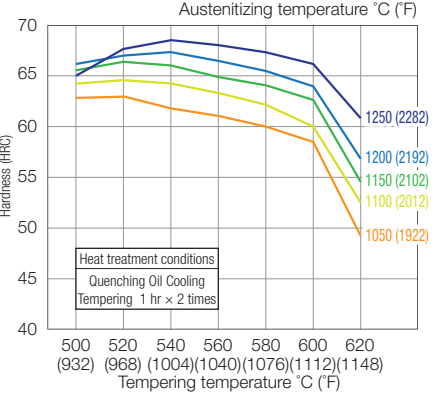
## SKH9 (Equivalent to M2)



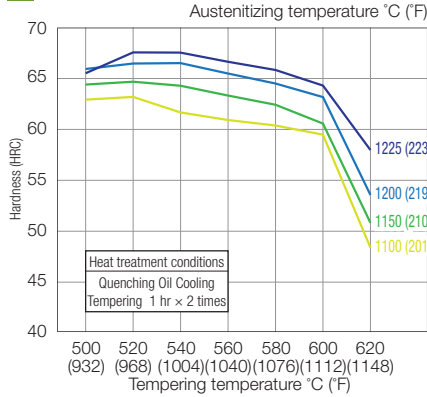
## HS93R



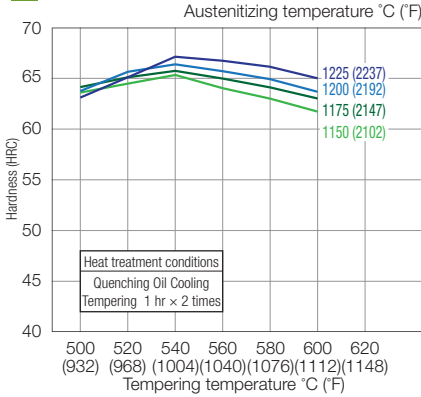
## HS53M



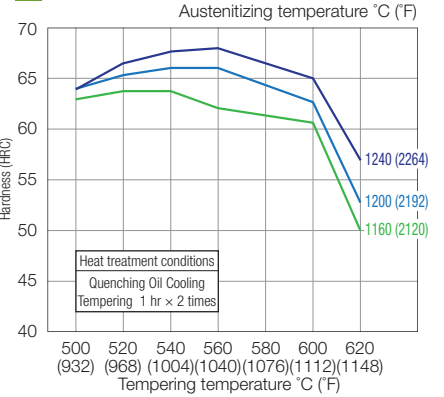
## HM35



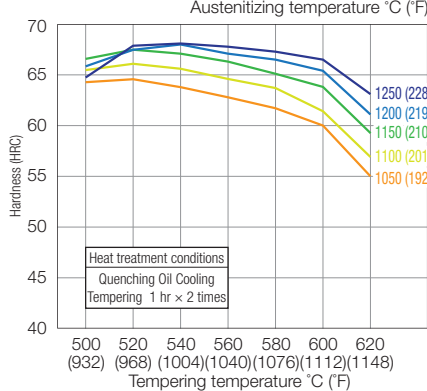
## HMT12



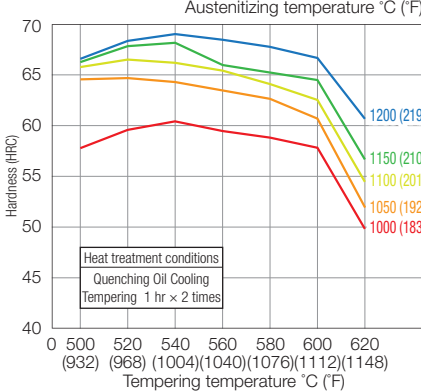
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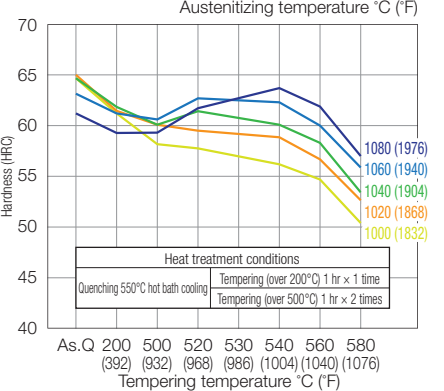
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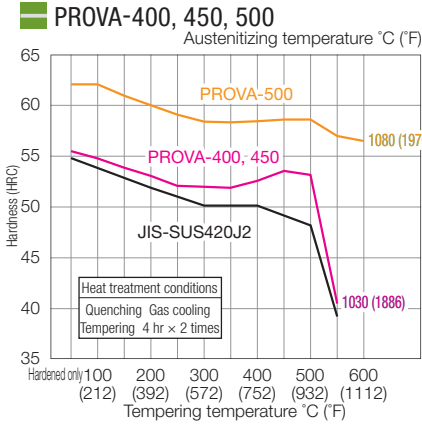
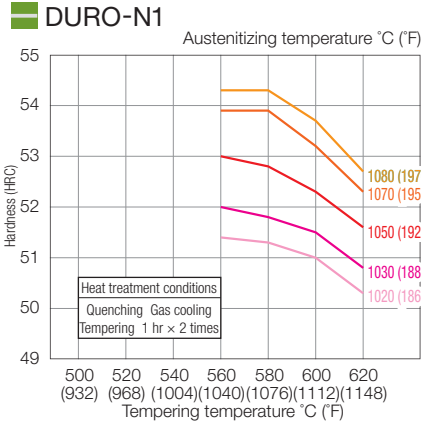
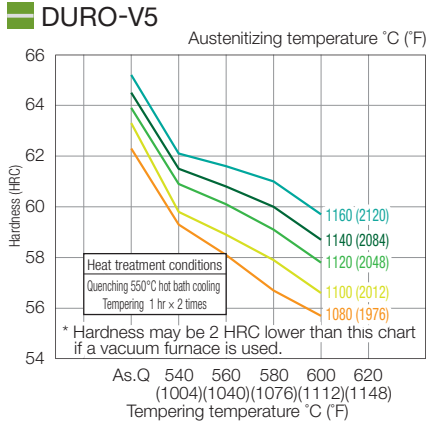
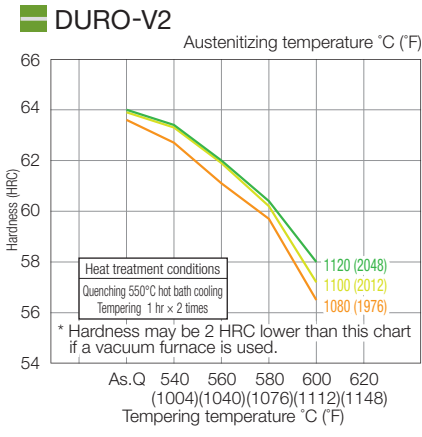
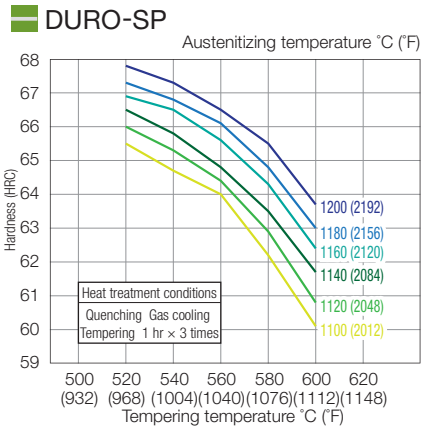
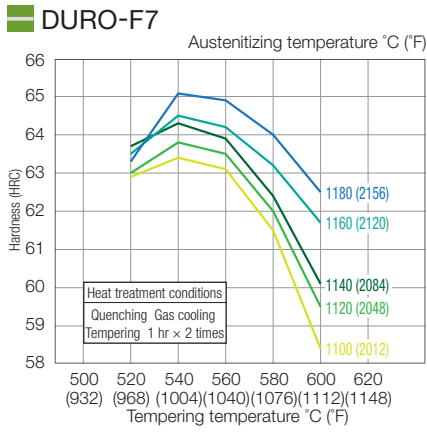
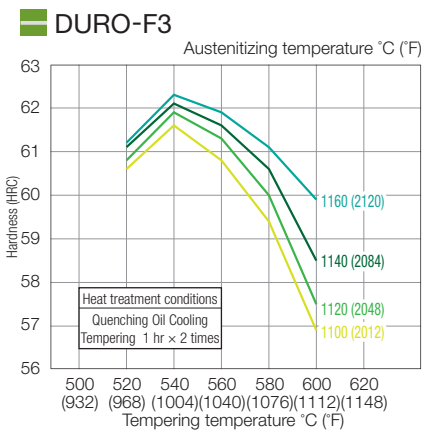
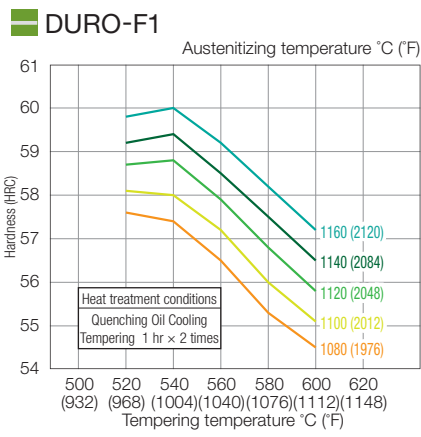
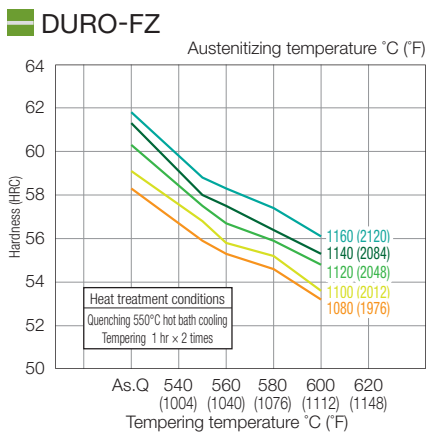
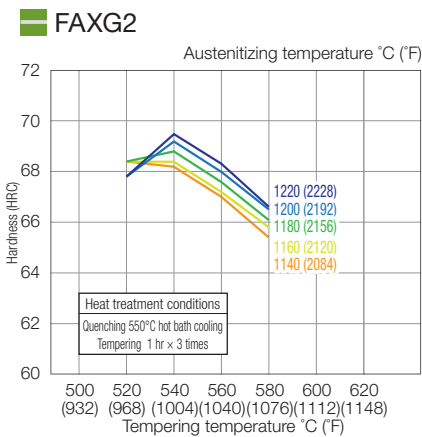
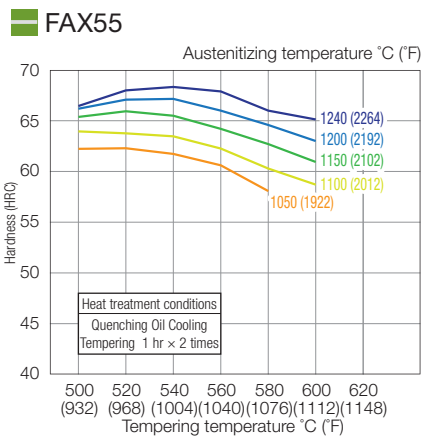
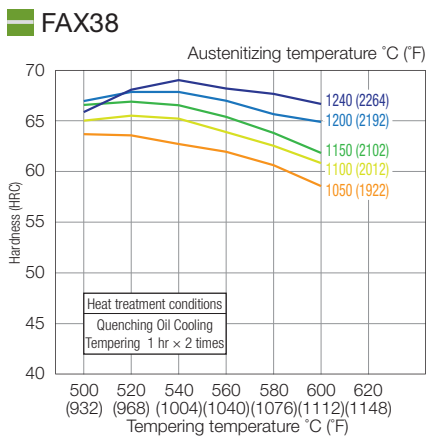


## HM42



## MDS9





# 06 Production Size Ranges

01 High-grade Special Steels

02 High-carbon Chromium Bearing Steels

03 Martensitic Stainless Steel

04 High-performance Alloys

05 Hardness Chart

06 Production Size Ranges

## Regular Steels

### Round Bars

Item	Nominal Dimensions							
	Diameter (mm)							
Hot Rolled Bars	13	14	15	16	17	18	19	20
	21	22	23	24	25	26	27	28
	29	30	31	32	34	36	38	40
	42	44	46	48	50	55	60	65
	70	75	80	85	90	95	100	110
	120	Length 3000 to 5000						

Item	Nominal Dimensions	
	Diameter (mm)	Length (mm)
Rolled and Peeled Bars	13 to 51	2500 to 4500
Rolled and Turned Bars	50 to 115	2000 to 4000
Forged and Turned Bars	90 to 250	2000 to 4000



### Sheets & Plates

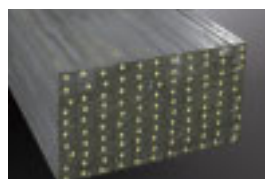
Item	Nominal Dimensions		
	Thickness (mm)	Width (mm)	Length (mm)
Cold Rolled Sheets	0.5 to 2.4	550 to 600	1500 to 2000
	2.5 to 5.9		1500 to 2200
	6.0 to 6.9		1500 to 2000
	7.0 to 7.9	500 to 550	1000 to 1800
	8.0 to 8.9		1000 to 1600
	9.0 to 12.0		1000 to 1500
Hot Rolled Sheets	4.0 to 5.9	550 to 600	1500 to 2000
	6.0 to 6.9		1000 to 2000
	7.0 to 7.9		1000 to 1800
	8.0 to 18.0	500 to 550	1000 to 1500



### Square Bars

Item	Nominal Dimensions				
	Width across flats (mm)				
Hot Rolled Bars	8.5	8.8	9.2	9.5	10.0
	10.3	10.5	11.5	12.5	12.7 <sup>(1/2)</sup>
	13.0	13.5	14.0	15.8	16.0
	17.0	19.0	19.05 <sup>(3/4)</sup>	20.0	21.0
	22.0	23.0	24.0	25.0	25.4 <sup>(1.0)</sup>
	26.0	27.0	28.0	29.0	30.0
	32.0	34.0	35.0	38.0	

\* Dimensions in parentheses ( ) indicate inches.



### Straight Rods

Item	Nominal Dimensions	
	Diameter (mm)	Length (mm)
Cold Drawn	3.1 to 6.0	2000 to 3000
	6.1 to 13.5	3000 to 4000
Ground	3.1 to 6.0	2000 to 3000
	6.1 to 13.0	3000 to 4000
	13.1 to 30.0	2500 to 4000

\* Contact us for diameters less than  $\varnothing 3.0$  mm.

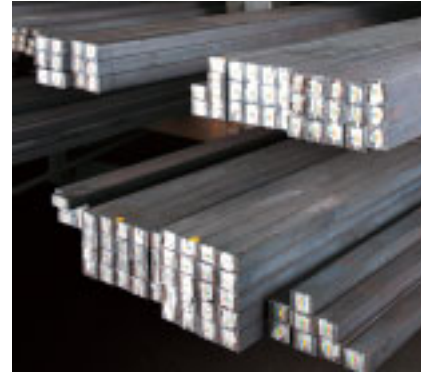
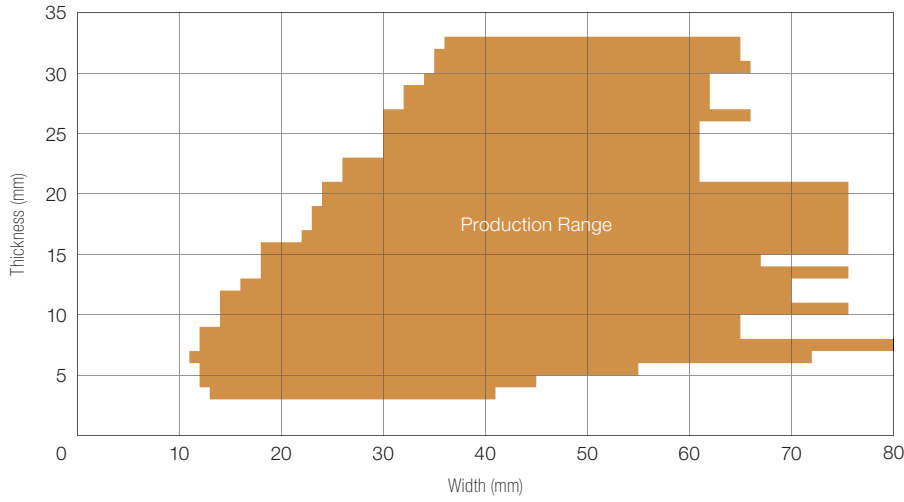


### Coils

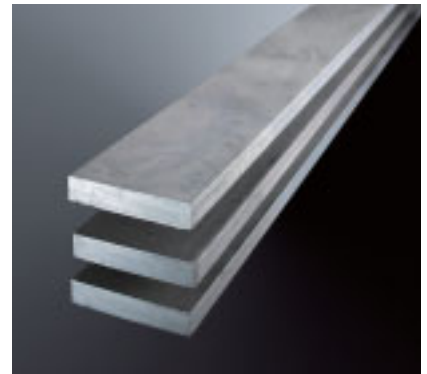
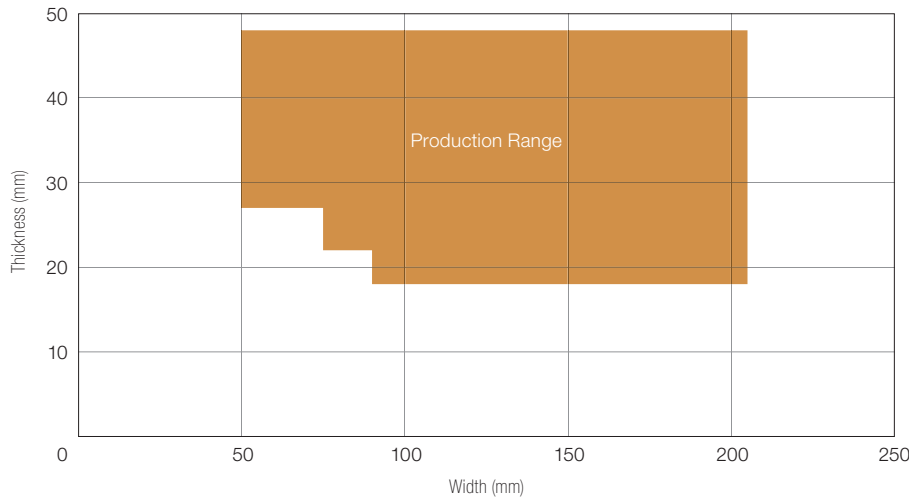
Item	Nominal Dimensions
	Diameter (mm)
Cold drawn	1.3 to 12.0



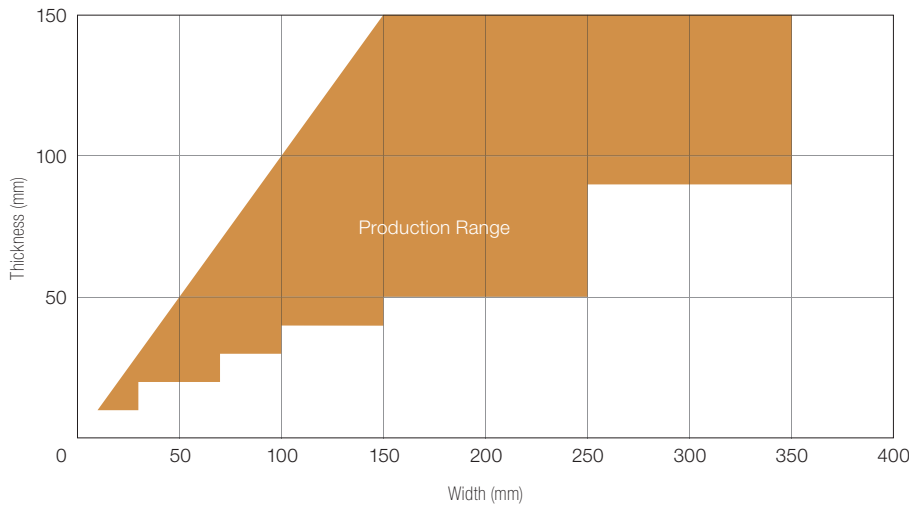
**Small Flat Bars**



**Wide Flat Bars**



**Forged Flat Bars**

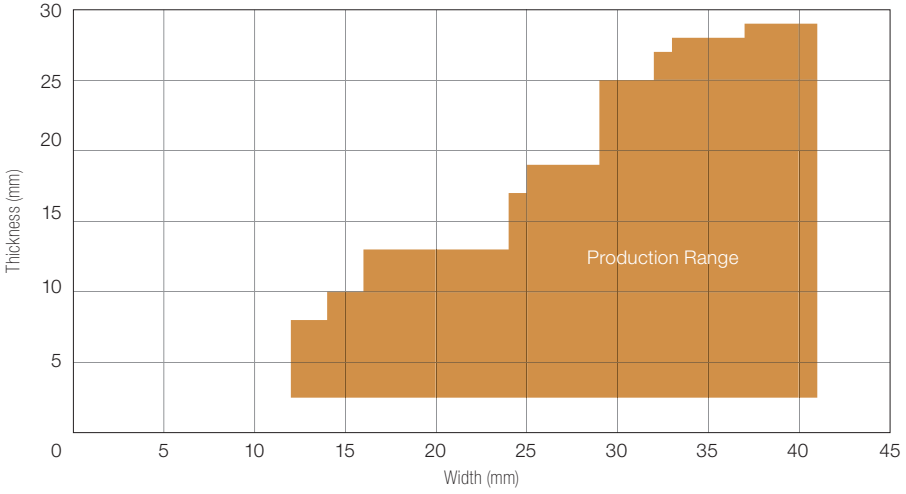


# 06 Production Size Ranges

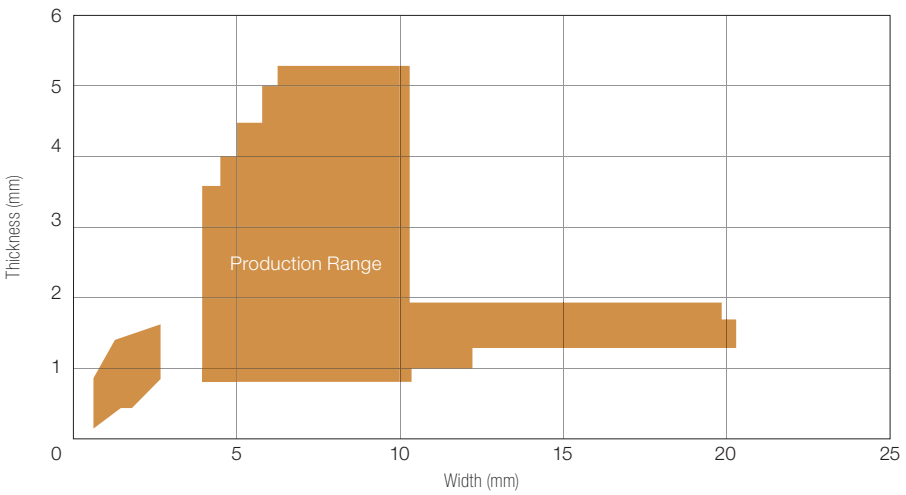
01 High-grade Special Steels  
 02 High-carbon Chromium Bearing Steels  
 03 Martensitic Stainless Steel  
 04 High-performance Alloys  
 05 Hardness Chart  
**06 Production Size Ranges**

## Precision Wrought Products

### Cold Drawn Flat Bars



### Precision Rolled Wires (Turk's head rolling)



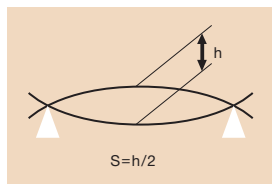
## Hardened Bars

### Production Range

Surface conditions	Diameter (mm)		Standard length (mm)		Cut length (mm)		Surface defect depth (mm)	
	Tolerance	Deviation	Tolerance		Tolerance			
Ground	2.0 to 3.0	+0/ -0.014	<0.005	2000	+10/-0	20 to 500	+0.5/-0 +1.0/-0	0
	3.1 to 6.0	+0/ -0.018	<0.006					
	6.1 to 10.0	+0/ -0.022	<0.007					
	10.1 to 13.0	+0/ -0.027	<0.008					
Precision Drawn	0.3 to 0.9	+0/ -0.012	<0.004	1000	+10/-0	20 to 500	+0.5/-0 +1.0/-0	<0.01
	1.0 to 1.1	+0/ -0.014	<0.005	1500				
	1.1 to 2.5	+0/ -0.020	<0.006	2000				
	2.6 to 3.6	+0/ -0.025	<0.008					
Unground	2.0 to 3.0	+0.04/ -0.02	<0.030	2000	+10/-0	20 to 500	+0.5/-0 +1.0/-0	<0.02
	3.1 to 6.0	+0.06/ -0.02	<0.040					<0.05
	6.1 to 10.0	+0.08/ -0.02	<0.050					<0.12
	10.1 to 13.0	+0.10/ -0.02	<0.060					<0.15

\* Contact us for sizes larger than  $\varnothing 13.0$  mm.

### Straightness



Length (mm)	Straightness(s)
20 to 50	$\leq 0.020$
51 to 75	$\leq 0.045$
76 to 100	$\leq 0.080$
101 to 175	$\leq 0.150$
176 to 200	$\leq 0.200$
201 to 2000	$(L/1000) \times 1.0$

\* L=200 to 2000

### Applicable Steel Type/Heat Treatment Hardness

Steel Grade	NACHI Grade	Related Standards		Hardness (HRC)	
		JIS	AISI	For cutting tools	For metal forming
High-speed Tool Steels	<b>SKH9</b>	SKH51	M2	64 to 66	58 to 61 61 to 64
	<b>HM35</b>	SKH55	M35	65 to 67	60 to 64
	<b>HM33</b>	—	M33		
	<b>HM42</b>	SKH59	M42	66 to 68	60 to 65
P/M high-speed Tool Steel	<b>FAX38</b>	SKH40	—	66 to 68	64 to 68
Martensitic Stainless Steel	<b>440C</b>	SUS440C	440C	53 to 60	53 to 60

\* 440C is only provided as ground. ( $\varnothing 2-10$ )

\* Other grades and hardness are available upon request.





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