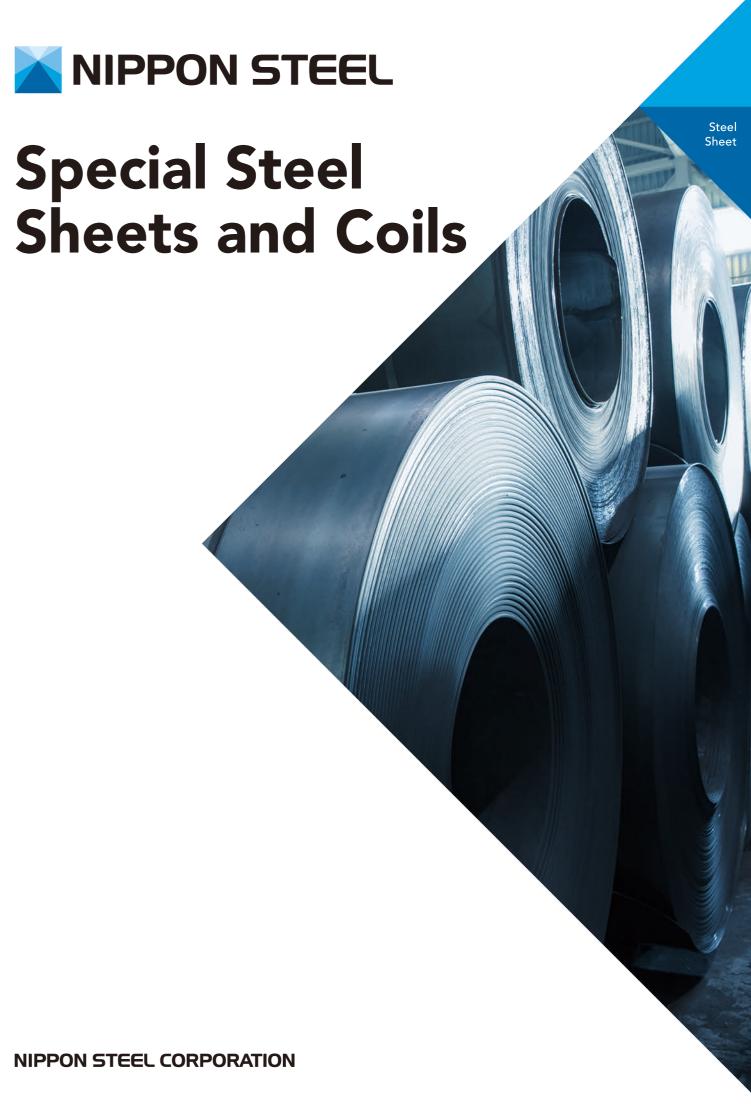


www.nipponsteel.com



# NIPPON STEEL



NIPPON STEEL CORPORATION

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Special Steel Sheets and Coils U006en\_02\_202004f © 2019, 2020 NIPPON STEEL CORPORATION

# Introduction

NIPPON STEEL manufactures various types of Special Steel Sheets and Coils in conformity with Japanese Industrial Standards (JIS), as well as foreign standards, taking advantage of state-of-the-art equipment, a wealth of experience, and various technologies fostered by persistent research and development efforts.

NIPPON STEEL is committed to fulfilling our customers' requirements and offers technical consultations and services regarding applications for our products.

We deeply appreciate your continued support and encouragement.

**Notice:** While every effort has been made to ensure the accuracy of the information contained within this publication, the use of the information is at the reader's risk and no warranty is implied or expressed by NIPPON STEEL CORPORATION with respect to the use of the information contained herein. The information in this publication is subject to change or modification without notice. Please contact the NIPPON STEEL CORPORATION office for the latest information.

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# **Features**

1.

Detailed quality control is employed from the upstream process to the finished products, in accordance with the customer's usage purposes, processing, and heat treatment conditions.



Since our manufacturing facilities use the state-of-the art equipment and management technology, they can manufacture homogeneous products of excellent quality performance.



Our facilities can manufacture a wide variety of high-carbon steel strips such as hot-rolled steel strips and cold-rolled steel strips.



Our facilities manufacture mainly steel grades in conformity with JIS standards, but they also manufacture steel grades developed independently by NIPPON STEEL.



Automotive parts (seat gears)



Automotive parts (clutch plates)



Automotive parts (transmission parts)





Bearing case

• Works



Kyushu Works

Yawata area



Automotive parts (parking pole parts)



Automotive parts (door latches)



# NIPPON STEEL CORPORATION



Kansai Works Wakayama area

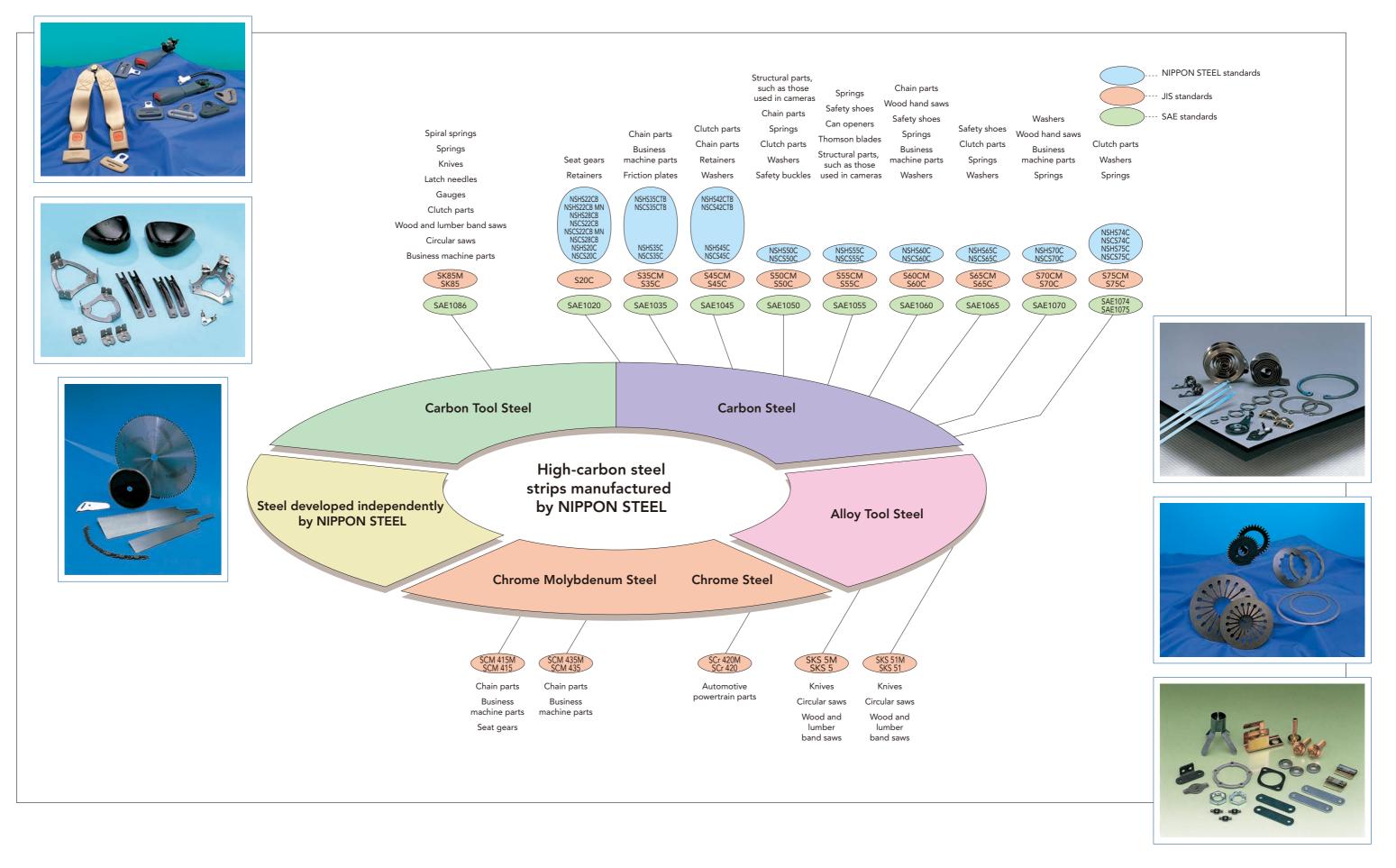


Automotive parts (seatbelt parts)

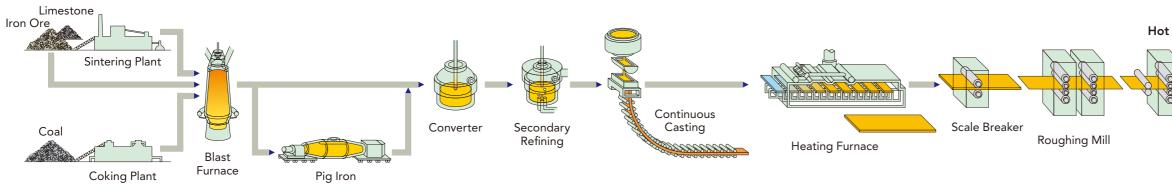


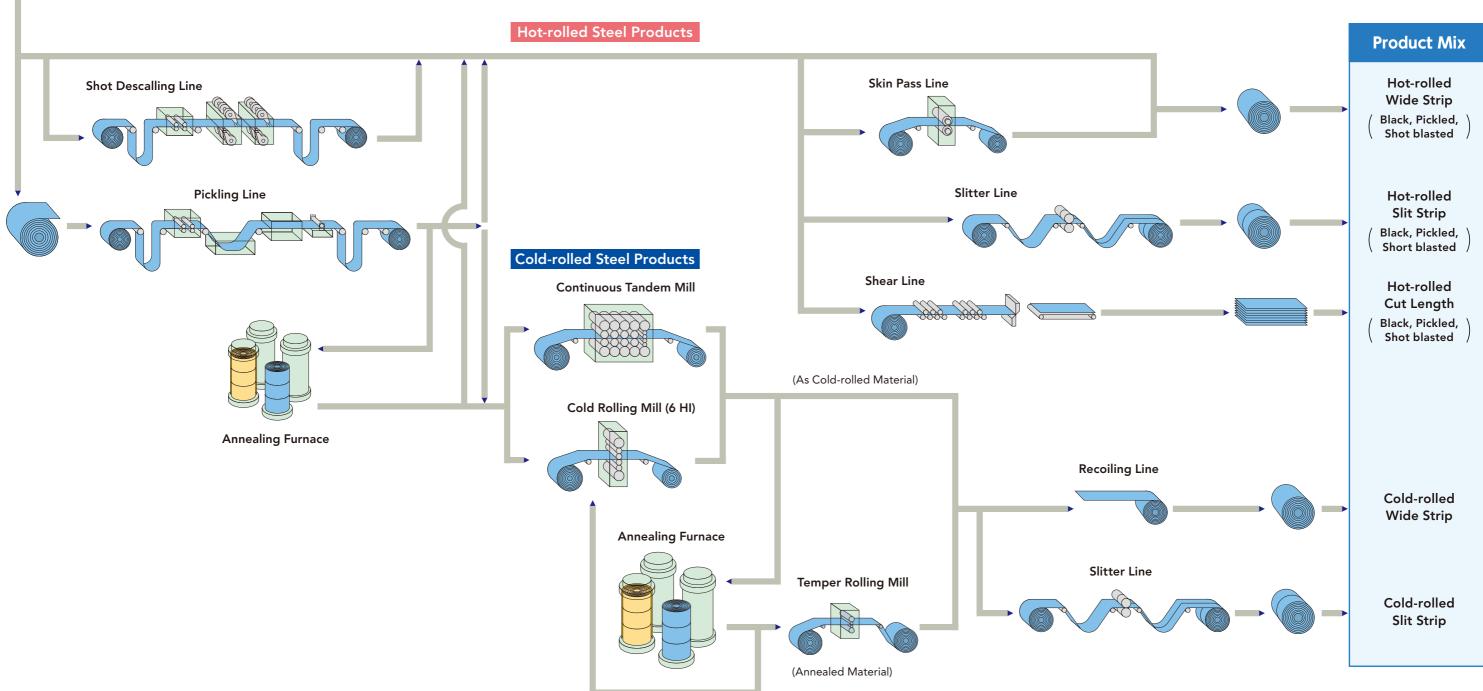
Cutter knives

# **Examples of Use**

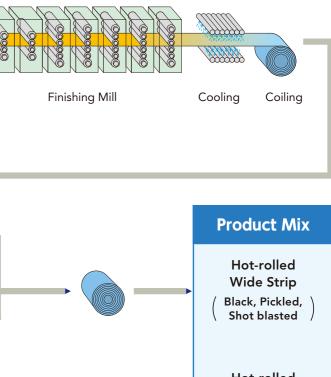


# **Manufacturing Processes**





# Hot Rolling Mill (6 HI, 7 STANDS)



# **Manufacturing Processes**

# From Blast Furnaces to Hot Rolling

At the blast furnace, iron is extracted from the iron ore to produce pig iron, which contains a large amount of elements such as carbon.

During the steelmaking process, ore refining is conducted to remove the impurities contained in the pig iron, and, during the casting process, the steel is baked to produce a half-finished product called "slab." In the hot-rolling process, this slab is hot-rolled to produce a coiled thin steel sheet.



Special steel sheets are used for purposes that require good surface quality, workability, hardenability, and

thickness accuracy. In order to meet

these requirements, rigorous quality

control is needed from the stage of

The chemical composition and

temperature in the steelmaking

process and the temperature, water

quantity, speed, and rolls in the hot-

rolling process are strictly controlled

so that the stock sheets are produced

with less surface or interior defects,

better thickness accuracy, and satisfactory workability after annealing.

Continuous Casting

It is now possible to, using the continuous casting process being currently widely adopted (in which conventional casting, stripping, and blooming are combined), manufacture steel sheets with improved homogeneity, less interior and/or surface defects, or less segregation.



melting.

Pickling

In the pickling process, scales (iron oxide films) on the surface of the hot-rolled coil are removed so that a clean surface texture can be obtained during the subsequent process.

After removing the scales using hydrochloric acid in the pickling tank, the coil is rinsed thoroughly and dried.

Pickling



# Annealing

In the annealing process, the steel sheets (upon the completion of the pickling or cold-rolling process) are heated and maintained in a reducing atmosphere to regulate and grow the grain size, as well as to spheroidize the carbide in order to produce materials best suited to the usage purposes.

During the annealing process, we manufacture high-quality steel sheets with less variation using materials produced under consistent quality design and manufacturing control, including that regarding chemical composition, along with using high-accuracy temperature control technology.

Hot-Rolling Mill

# NIPPON STEEL CORPORATION





# **Cold-Rolling**

Cold-rolled strips are cold-rolled upon the completion of the pickling process or the pickling and annealing process so that they show a specified thickness.

Important in terms of the quality of a cold-rolled strip are thickness accuracy and flatness. We use an excellent automatic plate thickness controller and shape controller to manufacture coldrolled strips exhibiting great shape with less thickness fluctuation.

Cold-Rolling Mill



Annealing Furnace

# **Steel Grades and Chemical Compositions**

The steel grades being manufactured by us and their chemical composition are shown below. We can manufacture other steel grades not mentioned in the tables below, upon request.

# Carbon Steels and Carbon Steels for Machine Structural Use

JIS	SAE	NIPPON STEEL			Cł	nemical comp	osition (%)			
standards	standards	standards	С	Si	Mn	Р	S	Cu	Ni	Cr
S20C			0.18-0.23	0.15-0.35	0.30-0.60	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1020		0.18-0.23	_	0.30-0.60	≦ 0.030	≦ 0.035	—	—	_
		NSHS20C NSCS20C	0.18-0.23	0.15-0.35	0.30-0.60	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S35C			0.32-0.38	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1035		0.32-0.38	—	0.60-0.90	≦ 0.030	≦ 0.035	—	—	_
		NSHS35C NSCS35C	0.32-0.38	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S45C			0.42-0.48	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1045		0.43-0.50	_	0.60-0.90	≦ 0.030	≦ 0.035	—	—	_
		NSHS45C NSCS45C	0.42-0.48	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S50C			0.47-0.53	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1050		0.48-0.55	_	0.60-0.90	≦ 0.030	≦ 0.035	—	—	_
		NSHS50C NSCS50C	0.47-0.53	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S55C			0.52-0.58	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1055		0.50-0.60	—	0.60-0.90	≦ 0.030	≦ 0.035	—	—	—
		NSHS55C NSCS55C	0.52~0.58	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S60C			0.55-0.65	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1060		0.55-0.65	—	0.60-0.90	≦ 0.030	≦ 0.035	—	—	—
		NSHS60C NSCS60C	0.55-0.65	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S65C			0.60-0.70	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1065		0.60-0.70	_	0.60-0.90	≦ 0.030	≦ 0.035	—	—	_
		NSHS65C NSCS65C	0.60-0.70	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S70C			0.65-0.75	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1070		0.65-0.75	_	0.60-0.90	≦ 0.030	≦ 0.035	—	_	_
		NSHS70C NSCS70C	0.65-0.75	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
	SAE1074		0.70-0.80	—	0.50-0.80	≦ 0.030	≦ 0.035	—	—	_
		NSHS74C NSCS74C	0.70-0.80	0.15-0.35	0.50-0.80	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20
S75C			0.70-0.80	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035			≦ 0.20
	SAE1075		0.70-0.80	_	0.40-0.70	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	_
		NSHS75C NSCS75C	0.70-0.80	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20

Ni+Cr $\leq$ 0.35 : JIS standards and NIPPON STEEL standards

# Carbon Tool Steels

JIS standards	SAE standards	Chemical composition (%)										
		С	Si	Mn	Р	S	Cu	Ni	Cr			
SK85 [SK5]		0.80-0.90	0.10-0.35	0.10-0.50	≦ 0.030	≦ 0.030	≦ 0.25	≦ 0.25	≦ 0.30			
	SAE1086	0.80-0.93	—	0.30-0.50	≦ 0.030	≦ 0.035	—	—	—			
SK95 [SK4]		0.90-1.00	0.10-0.35	0.10-0.50	≦ 0.030	≦ 0.030	≦ 0.25	≦ 0.25	≦ 0.30			
	SAE1095	0.90-1.03	—	0.30-0.50	≦ 0.030	≦ 0.035	_	_	—			
SK120 [SK2]		1.15–1.25	0.10-0.35	0.10-0.50	≦ 0.030	≦ 0.030	≦ 0.25	≦ 0.25	≦ 0.30			

The symbols of former JIS steel grades are shown in [  $% \left[ {{\left[ {{R_{{\rm{s}}}} \right]}} \right]$  ].

# Alloy Tool Steels

JIS	Chemical composition (%)											
standards	С	Si	Mn	Р	S	Cu	Ni	Cr				
SKS5	0.75-0.85	≦ 0.35	≦ 0.50	≦ 0.030	≦ 0.030	≦ 0.25	0.70-1.30	0.20-0.50				
SKS51	0.75-0.85	≦ 0.35	≦ 0.50	≦ 0.030	≦ 0.030	≦ 0.25	1.30-2.00	0.20-0.50				
SKS81	1.10-1.30	≦ 0.35	≦ 0.50	≦ 0.030	≦ 0.030	≦ 0.25	≦ 0.25	0.20-0.50				

# Chrome Steels

JIS	Chemical composition (%)											
standards	С	Si	Mn	Р	S	Cu	Ni	Cr				
SCr420	0.18-0.23	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20				
SCr435	0.33-0.38	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20				
SCr440	0.38-0.43	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20				

# Chrome Molybdenum Steels

JIS standards		Chemical composition (%)												
	С	Si	Mn	Р	S	Cu	Ni	Cr	Мо					
SCM415	0.13-0.18	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.25					
SCM420	0.18-0.23	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.25					
SCM430	0.28-0.33	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.30					
SCM435	0.33-0.38	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.30					
SCM440	0.38-0.43	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.30					

# Manganese Steels

JIS standards	SAE standards	Chemical composition (%)										
		С	Si	Mn	Р	S	Cu	Ni	Cr			
	SAE1541	0.36-0.44	_	1.35-1.65	≦ 0.030	≦ 0.035	—	_	_			
SMn443		0.40-0.46	0.15-0.35	1.35–1.65	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	≦ 0.35			

# Boron Steels

NIPPON STEEL	Chemical composition (%)											
standards	С	Si	Mn	Р	S	Cr	В					
NSHS22CB NSCS22CB	0.20-0.25	≦ 0.35	0.50-0.80	≦ 0.030	≦ 0.030	≦ 0.50	0.0010-0.0050					
NSHS22CBMN NSCS22CBMN	0.20-0.25	≦ 0.35	1.10-1.40	≦ 0.030	≦ 0.030	≦ 0.50	0.0010-0.0050					
NSHS28CB NSCS28CB	0.25-0.31	≦ 0.35	0.50-0.80	≦ 0.030	≦ 0.030	≦ 0.50	0.0010-0.0050					
NSHS35CTB NSCS35CTB	0.32-0.39	≦ 0.35	0.30-0.60	≦ 0.030	≦ 0.030	≦ 0.50	0.0010-0.0050					
NSHS42CTB NSCS42CTB	0.40-0.46	≦ 0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.50	0.0010-0.0050					

# **Steel Grades and Chemical Compositions**

#### Cold-rolled Special Steel Strips

	JIS				Chemic	al compositio	on (%)			
	standards	С	Si	Mn	Р	S	Cu	Ni	Cr	Мо
	S35CM	0.32-0.38	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	_
	S45CM	0.42-0.48	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	—
Carbon Steel	S50CM	0.47-0.53	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	—
	S55CM	0.52-0.58	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	_
	S60CM	0.55-0.65	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	_
	S65CM	0.60-0.70	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	_
	S70CM	0.65-0.75	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	_
	S75CM	0.70-0.80	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.035	≦ 0.30	≦ 0.20	≦ 0.20	_
Carbon Tool Steel	SK85M (SK5M)	0.80-0.90	0.10-0.35	0.10-0.50	≦ 0.030	≦ 0.030	≦ 0.25	≦ 0.25	≦ 0.30	_
Alloy Tool	SKS5M	0.75-0.85	≦ 0.35	≦ 0.50	≦ 0.030	≦ 0.030	≦ 0.25	0.70-1.30	0.20-0.50	_
Steel	SKS51M	0.75-0.85	≦ 0.35	≦ 0.50	≦ 0.030	≦ 0.030	≦ 0.25	1.30-2.00	0.20-0.50	_
Chrome Maluk dagung	SCM415M	0.13-0.18	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.25
Molybdenum Steel	SCM435M	0.33-0.38	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	0.15-0.30
Chrome Steel	SCr420M	0.18-0.23	0.15-0.35	0.60-0.90	≦ 0.030	≦ 0.030	≦ 0.30	≦ 0.25	0.90-1.20	—

Ni+Cr $\leq$ 0.35 for S35CM to S75CM

#### Surface Finish

	Classification	Symbol	Application
	Black finish (as Hot-rolled)	х	Steel strips, hot-rolled
Hot-rolled Steel Strips	Pickled finish	Р	Steel strips in which the scales on the surface have been removed by pickling after the hot-rolling process
	Shot blasted finish	S	Steel strips in which the scales on the surface have been removed by shot blasting after the hot-rolling process
	Bright finish	В	Steel strips of a smooth finish using smooth rollers surface roughness: Ra $\leq 0.6 \mu m$ (only for reference)
Cold-rolled Steel Strips	Dull finish	D	Steel strips of matte finish using rollers in which the surfaces are roughened mechanically or chemically surface roughness: $0.2\mu m \leq Ra \leq 1.0\mu m$ (only for reference)

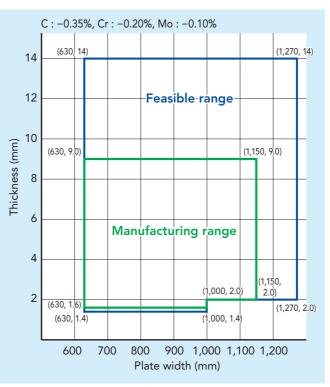
#### Tempering

	Classification	Symbol	Application
Hot-rolled	Annealed	HA	Hot-rolled steel strips that have been annealed
Steel Strips	As Hot-rolled	H1	Steel strips, hot-rolled
Cold-rolled	Annealed and Skinpassed	S	Cold-rolled steel strips that have been annealed
Steel Strips	As Cold-rolled	М	Steel strips, cold-rolled

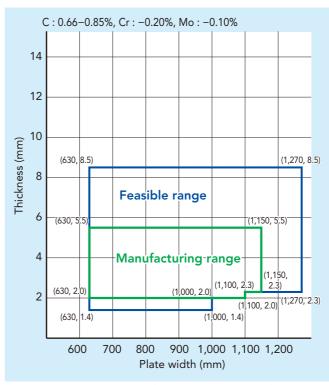
# **Product Size Ranges**

The manufacturing ranges of the hot-rolled and cold-rolled steel strips are shown below. Please note that the manufacturing ranges may vary depending on the standards, usage purposes, etc. We can manufacture other steel grades not mentioned in the tables below, upon request. (We also welcome orders for slit strips.)

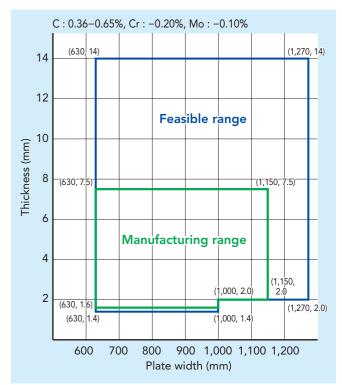
# A. Hot-rolled Steel Strips (except for those to be used for cut plates), Black finish



 $^{\star}$  Please consult with us for products outside our manufacturing range.

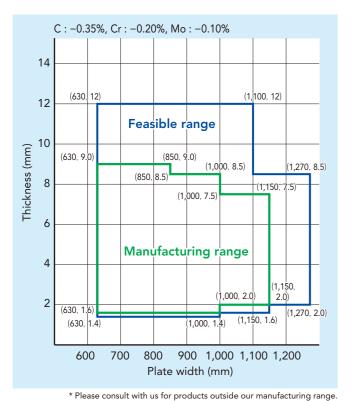


\* Please consult with us for products outside our manufacturing range.

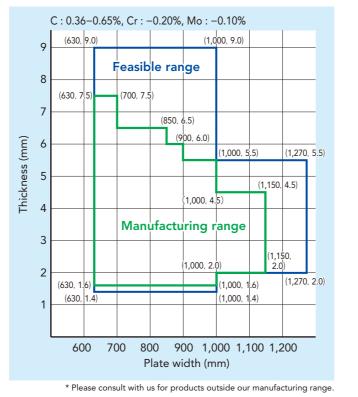


\* Please consult with us for products outside our manufacturing range.

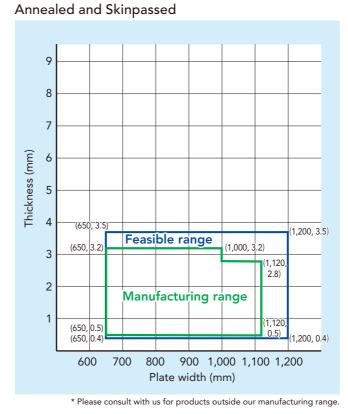
# **Product Size Ranges**



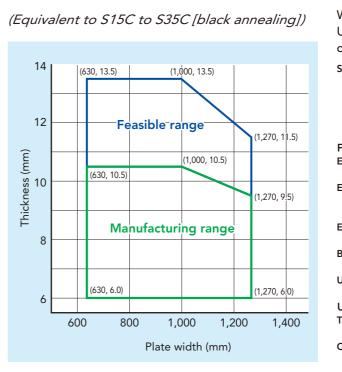
# **Pickled finish**



# **C. Cold-rolled Steel Strips**



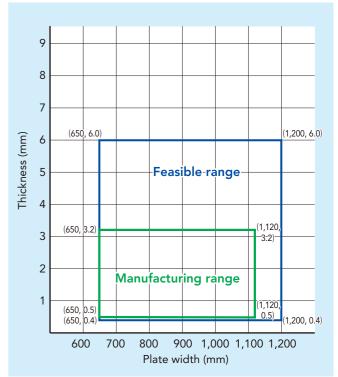
# D. Hot-rolled Steel Strips with Shot Blasting (with a mill edge)



C: 0.66-0.85%, Cr: -0.20%, Mo: -0.10% 9 8 7 (1.000, 6.0 (630, 6 Thickness (mm) (1,000, 5.5) (1,270, 5.5) Feasible range (630, 5 1,000, 4.5) 4.5) 4 Manufacturing range 3 1,150, 2.3) (1,100, 2.3 (630, 2 \_(1,270,-2.3) 2 (1.000, 2.0)(630, 1.4) (1,000, 1.4)700 800 900 1,000 1,100 1,200 600 Plate width (mm)

\* Please consult with us for products outside our manufacturing range.





# As Cold-rolled

\* Please consult with us for products outside our manufacturing range.

We also offer steel sheets descaled by shot blasting. Unlike pickled steel sheets, shot-blasted steel sheets can be descaled exceeding 9 mm.

Shot-blasted steel sheet: Fine steel balls called "shot particles" are blasted at the surface of the hot-rolled coil or pickled coil to remove scales from the surface and to increase the degree of surface roughness—so as to provide various enhanced properties. Features Excellent paint adhesion: Excellent in paint adhesion and therefore suited for a material to be plated Excellent oil retention capacity: Excellent in lubrication oil retention capacity and improves the lubricating effect during processing Excellent adhesion: Suited to be used to stick materials (such as friction materials) to the surface of steel products Beautiful surface appearance: Fine and uniform surface irregularities provide a smooth matte finish. Used as hoop material: Can be used as hoop material since it can be manufactured in a coil Uses Thick automotive parts: Used for thick component materials subject to a fine blanking process or press working

Cold-forged parts: Scaleless steel sheets are suited to thick parts to be cold forged and are widely used for other purposes.

Note: Cold-rolled steel products (cold-rolled steel strips and steel sheets) have been added to JIS G 4051 (Carbon steel for machine structural use), JIS G 4053 (Alloy steel for machine structural use), and JIS G 4401 (Carbon tool steel) (revised in 2008 and 2009).

# **Dimensional Tolerances**

Unless otherwise specified, JIS G 3193 (shapes, dimensions, masses, and tolerances of hot-rolled steel sheets and strips) shall be applicable.\* However, the dimensional tolerance of cold-rolled steel strips shall be in conformity with JIS G 3141 (dimensional tolerance A).

We can manufacture almost any type of steel strip in accordance with your specifications.

Hot-ro	olled Ste	el Strips						(Unit: mm)
	Thickness	$1.60 \le t < 2.00$	$2.00 \le t < 2.50$	$2.50 \le t < 3.15$	$3.15 \le t < 4.00$	$4.00 \leq t < 5.00$	$5.00 \le t < 6.30$	$6.30 \leq t < 9.00$
JIS	G 3193	±0.19	±0.20	±0.22	±0.24	±0.45	±0.50	±0.55
	standard	±0.17	±0.17	±0.19	±0.20	±0.31	±0.34	±0.38
NIPPON STEEL standards	toloropco A	±0.10	±0.10	±0.12	±0.13	±0.13	±0.14	±0.15
standards	narrow tolerance B	±0.09	±0.09	±0.09	±0.10	±0.10	±0.11	_

Remarks: The thickness measurement point shall be any point inside 25 mm or more from the mill edge or any point inside 15 mm or more from the cut edge. Narrow tolerance B is only applied to Boron Steels. Narrow tolerance A, B are applied to cut edge.

# Cold-rolled Steel Strips

Thick	ness	$0.50 \le t < 0.60$	$0.60 \le t < 0.80$	$0.80 \le t < 1.00$	$1.00 \le t < 1.25$	1.25≦t<1.60	$1.60 \le t < 2.00$	$2.00 \le t < 2.50$	2.50≦t<3.15	$3.15 \le t \le 3.20$
JIS G 3141 800 ≦ w < 1,		±0.05	±0.06	±0.06	±0.07	±0.09	±0.11	±0.13	±0.15	±0.17
JIS G 3141 1,000 ≦ w < 1		±0.05	±0.06	±0.07	±0.08	±0.10	±0.12	±0.14	±0.16	±0.19

								(Unit: mm)
	Thickness	$0.50 \le t < 0.60$	$0.60 \leq t < 0.90$	$0.90 \le t < 1.20$	$1.20 \le t < 1.60$	$1.60 \le t < 2.10$	$2.10 \le t < 3.00$	$3.00 \le t \le 3.20$
NIPPON	standard	±0.040	±0.050	±0.060	±0.070	±0.100	±0.110	±0.130
STEEL	narrow tolerance A	±0.030	±0.040	±0.050	±0.060	±0.070	±0.080	±0.090
standards	narrow tolerance B	±0.015	±0.020	±0.025	±0.030	±0.035	±0.040	±0.045

Remarks: The thickness measurement point shall be any point inside 25 mm or more from the mill edge or any point inside 15 mm or more from the cut edge. Narrow tolerance A, B are applied to cut edge.

# Width tolerances of Hot-rolled Steel Strips and Cold-rolled Steel Strips (JIS G 3193)

			Cut edge			
Width	Thickness	Mill edge	An ordinary cutting method is used.			
			+	-		
	t < 3.15	+25	10	0		
$800 \le w < 1,000$	$3.15 \leq t < 6.00$		10	0		
	6.00 ≦ t	0	10	0		
	t < 3.15	1.20	10	0		
$1,000 \le w < 1,250$	$3.15 \le t < 6.00$	+30	10	0		
	$6.00 \leq t$	0	15	0		

**Mechanical Properties** 

Hot-rolled Steel Strips

(Unit: mm)

(Unit: mm)

The standard surface hardness values are shown below.

	Steel grads	Annealed	As Hot-rolled
	S20C, SAE1020, NSHS20C	HRB $\leq$ 80	HRB $\leq$ 90
	S35C, SAE1035, NSHS35C	HRB $\leq$ 88	HRB $\leq$ 95
	S45C, SAE1045, NSHS45C	$HRB \leq 90$	$HRB \leq 100$
	S50C, SAE1050, NSHS50C	HRB $\leq$ 92	(HRB $\leq$ 104) HRC $\leq$ 28
Carbon steels for machine structural use	S55C, SAE1055, NSHS55C	HRB $\leq$ 93	(HRB $\leq$ 107) HRC $\leq$ 32
machine structural use	S60C, SAE1060, NSHS60C	HRB $\leq$ 94	HRC $\leq$ 34
	S65C, SAE1065, NSHS65C	HRB $\leq$ 94	HRC $\leq$ 35
	S70C, SAE1070, NSHS70C	$HRB \leq 96$	HRC $\leq$ 37
	S75C, SAE1074, SAE1075, NSHS74C, NSHS75C	HRB $\leq$ 96	HRC $\leq$ 38
	SK85 [SK5], SAE1086	$HRB \leq 100$	HRC $\leq$ 43
Carbon tool steel	SK95 [SK4], SAE1095	HRC $\leq$ 27	HRC $\leq$ 44
	SK120 [SK2]	HRC $\leq$ 31	_
	SCM415	$HRB \leq 90$	(HRB $\leq$ 105) HRC $\leq$ 29
Chrome molybdenum steel	SCM435	HRB $\leq$ 93	HRC $\leq$ 38
	SCM440	HRB $\leq$ 95	HRC $\leq$ 39
	NSHS22CB	HRB $\leq$ 80	HRB $\leq$ 95
	NSHS22CBMN	HRB $\leq$ 80	HRB $\leq$ 98
Boron Steels	NSHS28CB	HRB $\leq$ 90	HRC $\leq$ 30
	NSHS35CTB	HRB $\leq$ 80	$HRB \leq 100$
	NSHS42CTB	HRB $\leq$ 85	HRB ≦ 100

# Cold-rolled Steel Strips

	Steel grads	Annealed and Skinpassed	As Cold-rolled
	S20C, SAE1020, NSCS20C	≦ HV 170	(HV 200-305)
	S35C, SAE1035, NSCS35C	≦ HV 170	(HV 200-305)
	S45C, SAE1045, NSCS45C	≦ HV 170	(HV 210-335)
	S50C, SAE1050, NSCS50C	≦ HV 180	(HV 220-355)
Carbon steels for machine structural use	S55C, SAE1055, NSCS55C	≦ HV 180	(HV 220-355)
machine structural use	S60C, SAE1060, NSCS60C	≦ HV 190	(Hv 230–370)
	S65C, SAE1065, NSCS65C	≦ HV 190	(HV 230 ≦)
	S70C, SAE1070, NSCS70C	≦ HV 190	(HV 235 ≦)
	S75C, SAE1074, SAE1075, NSCS74C, NSCS75C	≦ HV 200	(HV 240 ≦)
	SK85 [SK5], SAE1086	≦ HV 200	(HV 200–290)
Carbon tool steel	SK95 [SK4], SAE1095	≦ HV 210	(HV 210-300)
	SK120 [SK2]	≦ HV 220	(HV 220-310)
Chrome molybdenum steel	SCM415	≦ HV 170	(HV 170–240)
Chiome molybdendin steel	SCM435	≦ HV 190	(HV 190–270)
	NSCS22CB	(≦ HV 170)	(Please consult with NIPPON STEEL)
	NSCS22CBMN	(≦ HV 180)	(Please consult with NIPPON STEEL)
Boron Steels	NSCS28CB	(≦ HV 180)	(Please consult with NIPPON STEEL)
	NSCS35CTB	(≦ HV 170)	(HV 180–285)
	NSCS42CTB	(≦ HV 180)	(HV 190-315)

Remarks: 1: An annealed material that has been softened can be manufactured. 2. The symbols of former JIS steel grades are shown in [ ].

3.	()	is	ret	ere	nce.	

Remarks: 1. We can also manufacture steel sheets in which the anisotropy has been controlled. 2. We can also manufacture steel sheets excellent in fine blanking and drawability.

3. The symbols of former JIS steel grades are shown in [ ].

4. ( ) is reference.

# **Precautions for Use**

A wide variety of special steel sheets exists, and each type has its own unique characteristics. It is thus necessary to make full use of these characteristics to produce better products more economically. We can recommend the most appropriate type of product best suited to various usage purposes. We have also established a system to cooperate with you regarding any possible problems in your manufacturing processes.

# 1. Rust prevention

Special steel sheets (except for hot-rolled steel strips [black scale]) have been applied uniformly with film using an excellent rust-preventive oil that has low viscosity and that therefore can be removed easily, taking into account rust prevention and degreasing. However, if the strips are left without protection for a long period of time, they may become rusty. When you have unpacked the products, you must use them as soon as possible. Moreover, if they are exposed to water, they may become rusty even though they have been treated with rust-preventive oil. Care must be exercised so that they are not subject to moisture, such as that from dew condensation.

If the wrapping paper is damaged, repair it immediately. You are required to observe the precautions shown below.

- a. Generally, rust tends to develop when humidity is 70% or over, such that you must be careful to keep humidity at 60% or below.
- b. Air pollution may influence rust development. Hygroscopic substances such as hydrochloric acid gas, ammonium chloride gas, or sea salt particles may accelerate rust development at humidity of 60% or below or at a temperature higher than the dew point.
- c. Adhered dust and stains may destroy the oil film and create a local "battery" between the dust and iron substrate, causing rust.

# 2. Springback

The special steel sheets have a higher strength and springback (return action) when compared to general materials. When you remove the band of a coil, there is the risk that the end of the coil may jump up.

# 3. Slit materials and trim materials

Especially, the edge of a thin cold-rolled steel strip is very sharp. When handling it, sufficient safety measures must be taken, such as by wearing gloves.

# 4. Coiled materials

In order to improve material utilization and to achieve continuous and automated operation, it is advantageous, generally speaking, to use coiled materials rather than sheet materials. Coiled materials are those from which the sheet materials are obtained, and they have properties different from sheet materials. If they are put to effective use, productivity would improve.

However, coiled materials contain surface defects such that inspection, sorting, and repair work must be conducted appropriately. Moreover, in principle, the off-gauges at both ends of the coil have been eliminated, but some may get mixed in, thus it is necessary to exercise attention. The same materials are used for coiled materials and sheet materials.

# 5. Boron Steels

Boron-added steel is excellent in hardenability, but not suitable for treatment in a nitrogen atmosphere such as during carbo-nitriding treatment. It is recommended to avoid such treatment. Otherwise, BN is formed ( $B + N \rightarrow BN$ ) on the surface area during the process, and, as a result, B, which is effective in improving hardenability, is consumed. Consequently, the hardenability at the surface area may deteriorate, and the hardness after hardening may drop.

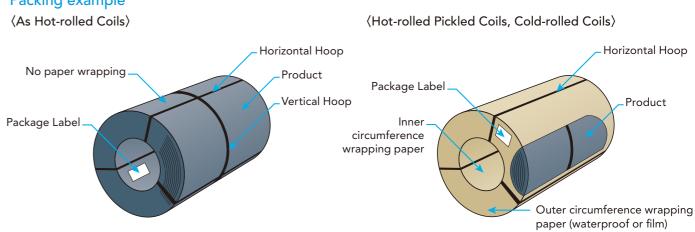
# **Packaging and Labeling**

Our products are shipped bundled and packaged to prevent any possible damages possibly caused by ordinary handling practices or storage conditions prior to actual use. As the products have packaging labels affixed describing the shipped content, please see the affixed label to confirm the product after receipt.

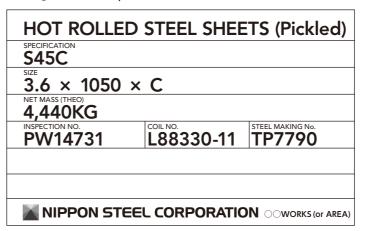
# Package Label Information

ltem	
Product Name	Describes a specified product name.
JIS Certification Mark	JIS is marked on the label of products
Standards Designation	Code of Standards Name, Standards I
Dimensions	The ordered size (thickness width lengt
Net Mass	The actual net or calculated mass is m
Sheets	The actual number of sheets containe
Coils	Marked only if two or more hoops are
Inspection Number	Marked with the unit inspection numb
Coil Number	Marked with the production lot unit c
Steel Making Number	Marked with the production lot unit s
User Name	User's name.
Maker's Name	NIPPON STEEL CORPORAT
Works	(Location Name) WORKS (or AREA)

# Packing example



#### Package Label Sample



# NIPPON STEEL CORPORATION

#### Description

ts authorized to designate the JIS certification mark.

Number, and Standards Code.

gth) is marked. For coil, "C" is marked in place of length.

marked in accordance with contract terms and conditions.

ed.

e bundled.

ber for each shipped product.

coil number.

steel making number.

#### TION

# **Technical Lists and Tables Attached**

#### Effects of various elements on steel

Steel is an alloy of Fe and C, and its various properties are determined by the C content (%). The phase diagram of the equilibrium state of the Fe-C system shows the phase of steel at C content and temperature. What is generally called steel is an Fe-C alloy, which has a C content of less than 2.06%. The alloy is called hypoeutectoid steel when the C content is less than 0.80%, called eutectoid steel when the C

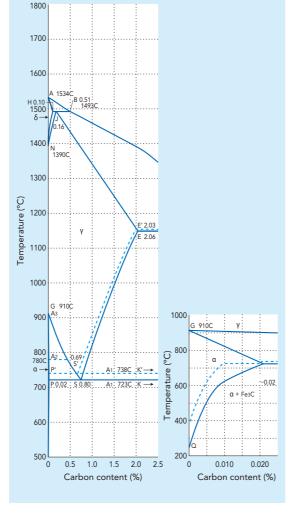
- C toid steel when the C content is less than 0.80%, called eutectoid steel when the C content is 0.80%, and called hypereutectoid steel if C is in the range of 0.80 to 2.06%. The maximum quench hardness is principally governed by the C content. C solid solves into austenite and produces martensite at the time of quenching. With an increase in carbon equivalent, the stress ratio of martensite rises, and quench hardness increases.
- Mn Increases quench hardenability and strength, but with no attendant increase in antitemperability. Effective as a deoxidizing agent, like Si, during refining. Bonds with S, produces sulfide (MnS), preventing red shortness.
- Si Used as a deoxidizing agent during refining. As an element for reinforcing solid solution, raises strength. At temperatures of less than 300°C, increases antitemperability.
- P Generally contained as an impurity element. Segregated along grain boundaries, reducing impact property. Accelerates temper brittleness.

S Generally contained as an impurity element. Forming FeS, produces red shortness, impairing hot workability. On the other hand, helps improve machinability as an Mn sulfide (MnS).

- Cu Liable to induce red shortness. Improves corrosion resistance.
- Ni Drastically reduces A1 transformation and improves hardness, strength, toughness, and hardenability. The effect is enhanced by the compounded addition of a small amount of Cr and Mo. Improves corrosion resistance. Prevents low-temperature
- brittleness. Enhances hardenability and antitemperability. Enhances corrosion resistance. Liable
- Cr Enhances hardenability and antitemperability. Enhances corrosion resistance. Liable to form a stable carbide, accelerates cementation.
- Mo Forming a stable combined carbide with Cr, increases antitemperability. Combined use with Cr produces a markedly improved effect.
- With a C content of less than 0.25%, increases hardenability. By the addition of a small amount, crystal grains become minute. Enhances antitemperability, also improving strength and toughness.
- Nb Very effective in the fining of crystal grains and raises crystal grain-coarsening temperatures. Decreases antitemperability, while somewhat inducing deterioration of hardenability.
- AI Used as a deoxidizing agent during refining. Oxides remain as hard inclusions. When nitrified, bonds with Ni to result in pronounced hardening of the surface. A steel nitride (AIN) is able to bring about the fining of crystal grains.
- N Bonding with Al, V, Ti, Nb, etc., forms a nitride, leading to the fining of crystal grains.
- B The addition of a trace amount (0.001~9.993%) markedly enhances hardenability. Any excessive addition impairs hot workability.

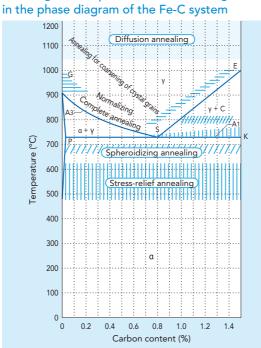
#### Heat treatment of steel

Kind of H	leat Treatment	Purpose	Heating Temperature	Cooling Method	
	Diffusion annealing	Improvement of structure	On the high side, over A3-point	Furnace cooling Air cooling Rapid	
Tomoreira	Complete annealing	Fining of crystal grains	A3 or Acm and over, 40–60°C		
Tempering	Spheroidizing annealing	Spheroidizing of carbides	Just over or just under A1-point		
	Stress-relief annealing	Removal of internal stresses	Under A1-point (500–650°C)		
Nia		Uniformity &	A3-point and over, 40–60°C (hypoeutectic steel)		
INO	rmalizing	structure	A1-point and over, 40–60°C (hypereutectic steel)		
0		Hardening	A3-point and over, 30–50°C (hypoeutectic steel)		
Quenching		nardening	A1-point and over, 30–50°C (hypereutectic steel)	cooling	
Tempering	Low-temperature annealing	Stress relief & prevention of secular change in size	100–200°C	Air cooling or	
	High-temperature annealing	ligh-temperature		rapid cooling	



Phase diagram of the Fe-C system

# The range of temperatures for annealing in the phase diagram of the Ee-C system

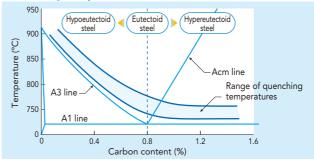


		Ste	el grads	Quench hardness (Oil quench	Estimated	
	JIS	SAE         NIPPON STEEL Standard         Quenching temperature (°C)           SAE1035         NSHS35C, NSCS35C         840–890			Quench hardness (HRC)	hardenability
	S35C	SAE1035	NSHS35C, NSCS35C	840-890	44 ≦	249
	S45C	SAE1045	NSHS45C, NSCS45C	820-870	51 ≦	156
	\$50C	SAE1050	NSHS50C, NSCS50C	810-860	53 ≦	124
	S55C	SAE1055	NSHS55C, NSCS55C	800-850	54 ≦	98
Carbon steels for	\$60C	SAE1060	NSHS60C, NSCS60C	790-850	57 ≦	78
machine structural use	S65C	SAE1065	NSHS65C, NSCS65C	790-850	57 ≦	61
	\$70C	SAE1070	NSHS70C, NSCS70C	790-850	57 ≦	49
	\$75C	SAE1074, SAE1075	NSHS74C, NSCS74C, NSHS75C, NSCS75C	780-840	57 ≦	33
	SK85 [SK5]	SAE1086		750-810	60 ≦	29
Tool Steel	SK95 [SK4]	SAE1095		750-810	60 ≦	18
	SK120 [SK2]			750-810	60 ≦	4
	SKS5			800-850	60 ≦	16
Alloy Tool Steel	SKS51			800-850	60 ≦	11
Chromium Steel	SCr420			850−900 (after holding at 925℃ and carburizing)	—	144
	SCr435			830-880	46 ≦	69
	SCM415			850−900 (after holding at 925℃ and carburizing)	_	132
Chromium	SCM420			850–900 (after holding at 925°C and carburizing)	_	109
Molybdenum Steel	SCM430			830-880	43≦	68
	SCM435			830-880	46≦	52
	SCM440			830-880	49≦	41
Manganese Steel	SAE1541			820-870	50 ≦	47
			NSHS22CB, NSCS22CB	870-920	40 ≦	66
			NSHS22CBMN, NSCS22CBMN	850-900	40 ≦	21
Boron Steel			NSHS28CB, NSCS28CB	860-910	45 ≦	50
			NSHS35CTB, NSCS35CTB	840-890	50 ≦	65
			NSHS42CTB, NSCS42CTB	820-870	54 ≦	27

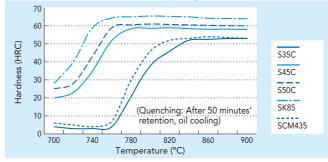
\*: 1. Estimated hardenability is shown as the cooling rate needed to transform the microstructure to 90% martensite (critical cooling rate) in quenching. 2. Symbols in square brackets [] represent those of the former JIS.

3. The table above is reference.

#### Quenching temperatures of carbon steel

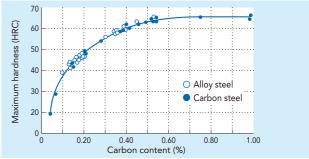


Relations between quenching temperature and hardness

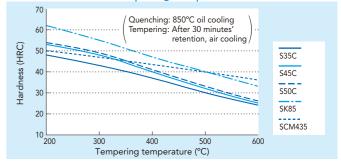


# NIPPON STEEL CORPORATION

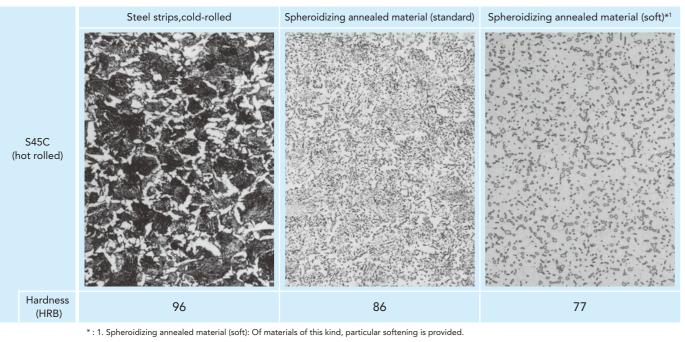
# Relations between carbon content of steel and the maximum quench hardness

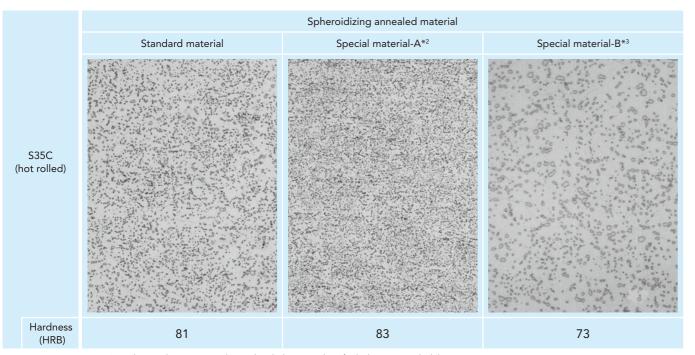


#### Relations between tempering temperature and hardness



#### Microstructures





\*: 2. Special material-A: By structural control, carbides are made to finely disperse. Very high burring property.
3. Special material-B: Like soft materials given spheroidizing annealing, special softening is provided.

# Conversion table of hardness (SAE J417)

Vickers Hardness			Shore Hardness	Tensile Strength	Vickers Hardness	Rockwell	Hardness	Shore Hardness	Tensile Strength	Vickers Hardness	Rockwell	Hardness	Shore	Tensile Strength
(Hv)	B scale (HRB)	C scale (HRC)	(HS)	(N/mm <sup>2</sup> )	(Hv)	B scale (HRB)	C scale (HRC)		(N/mm <sup>2</sup> )	(Hv)	B scale (HRB)	C scale (HRC)	Hardness (HS)	(N/mm <sup>2</sup> )
940	-	68.0	97	_	540	—	51.7	69	1860	280	(103.5)	27.1	40	890
920	_	67.5	96	_	530	_	51.1	_	1825	275	_	26.4	—	875
900	_	67.0	95	_	520	_	50.5	67	1795	270	(102.0)	25.6	38	855
880	_	66.4	93	_	510	—	49.8	_	1750	265	_	24.8	—	840
860	_	65.9	92	_	500	—	49.1	66	1705	260	(101.0)	24.0	37	825
840	_	65.3	91	_	490	_	48.4	_	1660	255	_	23.1	—	805
820	_	64.7	90	_	480	_	47.7	64	1620	250	99.5	22.2	36	795
800	_	64.0	88	_	470	_	46.9	_	1570	245	_	21.3	—	780
780	_	63.3	87	_	460	—	46.1	62	1530	240	98.1	20.3	34	765
760	_	62.5	86	_	450	_	45.3	_	1495	230	96.7	(18.0)	33	730
740	_	61.8	84	_	440	_	44.5	59	1460	220	95.0	(15.7)	32	695
720	_	61.0	83	_	430	_	43.6	_	1410	210	93.4	(13.4)	30	670
700	_	60.1	81	_	420	_	42.7	57	1370	200	91.5	(11.0)	29	635
690	_	59.7	_	_	410	—	41.8	_	1330	190	89.5	(8.5)	28	605
680	_	59.2	80	_	400	_	40.8	55	1290	180	87.1	(6.0)	26	580
670	_	58.8	_	_	390	_	39.8	_	1240	170	85.0	(3.0)	25	545
660	_	58.3	79	_	380	(110.0)	38.8	52	1205	160	81.7	(0.0)	24	515
650	_	57.8	_	_	370	_	37.7	_	1170	150	78.7	_	22	490
640	_	57.3	77	_	360	(109.0)	36.6	50	1130	140	75.0	_	21	455
630	-	56.8	_	_	350	_	35.5	_	1095	130	71.2	_	20	425
620	_	56.3	75	_	340	(108.0)	34.4	47	1070	120	66.7	_	—	390
610	_	55.7	_	_	330	_	33.3	_	1035	110	62.3	_	—	_
600	_	55.2	74	_	320	(107.0)	32.2	45	1005	100	56.2	_		_
590	_	54.7	_	2055	310	_	31.0	_	980	95	52.0	_	—	
580	_	54.1	72	2020	300	(105.5)	29.8	42	950	90	48.0		_	_
570	_	53.6	_	1985	295	_	29.2	_	935	85	41.0	_	_	_
560	_	53.0	71	1950	290	(104.5)	28.5	41	915					
550	_	52.3	_	1905	285	—	27.8	_	905	]				

# **Ordering Information**

When placing an order, please check the following items according to the intended usage.

# 1. Standards

We can manufacture a variety of products in accordance with JIS standards and NIPPON STEEL standards. Please select the "appropriate standard," taking into account the usage purpose, processing degree, and processing method. Please contact us if you have any questions.

# 2. Dimensions

In principle, you can specify the thickness in "0.1-mm units"; however, according to the circumstances, you can specify this using "0.05-mm units." You can also specify the width and length using "1-mm units."

# 3. Annealing

The properties of the products vary widely depending on whether they are annealed or not, thus please clearly specify whether you require "annealing" or "not annealing." A product containing a large amount of carbon may crack during the machining process, thus we recommend that you specify whether the product must be annealed.

# 4. Steel grades and special control points

Steel grade is important because it determines the properties of the product, thus please specify clearly the "steel grade (hot-rolled or cold-rolled)." Also, please specify the special requirements, if any, such as "hardness," "dimensional tolerance," etc.

# 5. Surface finish

Different types of surface finish are applied to hotrolled coils and cold-rolled coils. Please specify either one of the following:

Hot-rolled steel strips: "Black scale (as rolled)," "pickling," "shot blasting"

Cold-rolled steel strips: "Bright finish," "dull finish"

# 6. Roll edge finish

You can specify either "mill edge" or "slit edge" depending on the usage conditions. If the roll edge finish is required because the delivered material will be used as a product as-is or if you need to specify a strict width tolerance, please select "slit edge."

# 7. Oiling

You can specify either "oiled" or "unoiled." Normally, the hot-rolled steel strips (pickling, shot blasting) are "oiled" with rust preventive oil.

# 8. Packing weight

You can specify the packing weight, taking into account cargo-handling capacity and operational characteristics.

Sheet materials: "2 tons or over" is the standard packing weight.

Coiled materials: "5 to 16 tons" is the standard packing weight.

Please specify the maximum weight (and the minimum weight, if necessary).

# 9. Inside and outside diameters of coiled materials

The standard inside diameters of the hot-rolled coils and cold-rolled coils are shown below. Please select either one of them.

Hot-rolled coils: "762 mm (30 inches)" or "610 mm (24 inches)"

Cold-rolled coils: "610 mm (24 inches)" or "508 mm (20 inches)"

Please also specify the maximum outside diameter, if there are restrictions on the acceptable outside diameter.

#### 10. Usage purpose

We carry out thorough quality control in order to manufacture our products so that they fulfill each particular usage purpose. For that reason, we ask that you clarify the intended usage and processing methods, etc.

# 11. Others

Depending on the usage conditions of the product, strict specifications may be required to secure the required assembly accuracy, part accuracy, etc. In such a case, please consult with us in advance and clearly stipulate the specifications.

# MEMO