

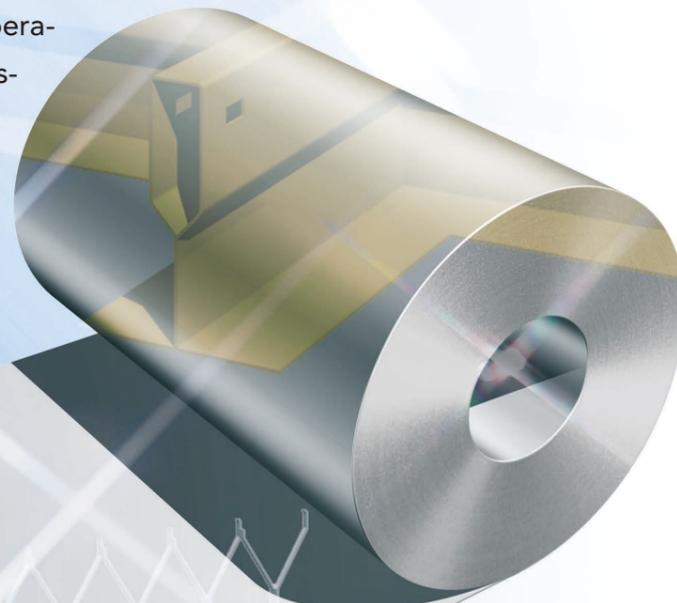
# Tin Mill Black Plate

Steel  
Sheet



## Preface

Our Tin Mill Black Plate (TMBP) was originally developed as a base material for subsequent processing into tin plate and tin free steel. Today, however, TMBP is also used as the base metal for the electrolytic plating of nickel, chrome, brass, copper and zinc, and finds widespread application in the direct printing of containers, household appliances and building materials. We at NIPPON STEEL want to work with you to assure the success of your operation. In addition to further upgrading our product quality and developing an extensive range of products tailored to fit your needs, we offer our full and complete cooperation in helping you deal with such technical problems as raising operational efficiency, enhancing product characteristics, etc.



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## Features

In manufacturing our Tin Mill Black Plate (TMBP), we take full advantage of our superior technology and state-of-the-art equipment and freely draw upon the wealth of experience that our mills have accumulated through the production of tin plate and tin-free steels. Our TMBP has the following features:

### 1 A Wide Assortment of Surface Finishes Ranging from Mirror Bright to Dull

Since tin plate and tin free steels are often used for food containers, heavy emphasis is placed on luster. Based on technology acquired through our production of source coils, we are able to provide a rich assortment of surfaces ranging from a dull matte to a mirror bright for decorative plating.

### 2 Superior Dimensional Accuracy

By using our Automatic Gauge Control System, we can make TMBP with precise longitudinal gauge, and with our other state-of-the-art equipment we can also guarantee superb crown control across the transverse direction and equally precise edge trimming and shearing to length.

### 3 Excellent Shape

Due to the full utilization of integrated processing and our unsurpassed Automatic Shape Control System, NIPPON STEEL TMBP possesses such superior flatness that it has commanded exceptional ratings by our customers.

### 4 Oil Coating Suited to Customer Processing

As standard procedure, our TMBP is oil coated to prevent rusting. But when the customer plans to conduct direct printing or wishes to simplify degreasing operations, we are also able to provide a variety of oil types and coating weights that will match the customer's particular processing needs.

# Applications

## For Plating



Electrolytic Tinning Line



Electrolytic Chromium Coating Line

## Cans

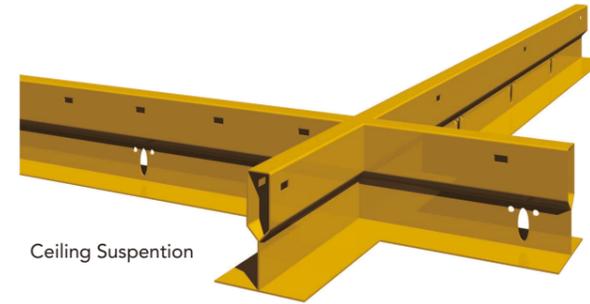


Pail Can



Wastebasket

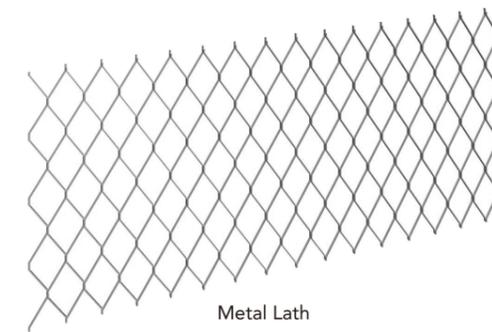
## For Buildings & Appliances



Ceiling Suspension



Office Furniture



Metal Lath



Shed

## Others

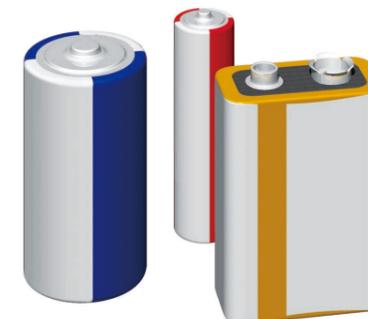


Cable Sheathing



Gasket

Buttons



Dry Cell Batteries

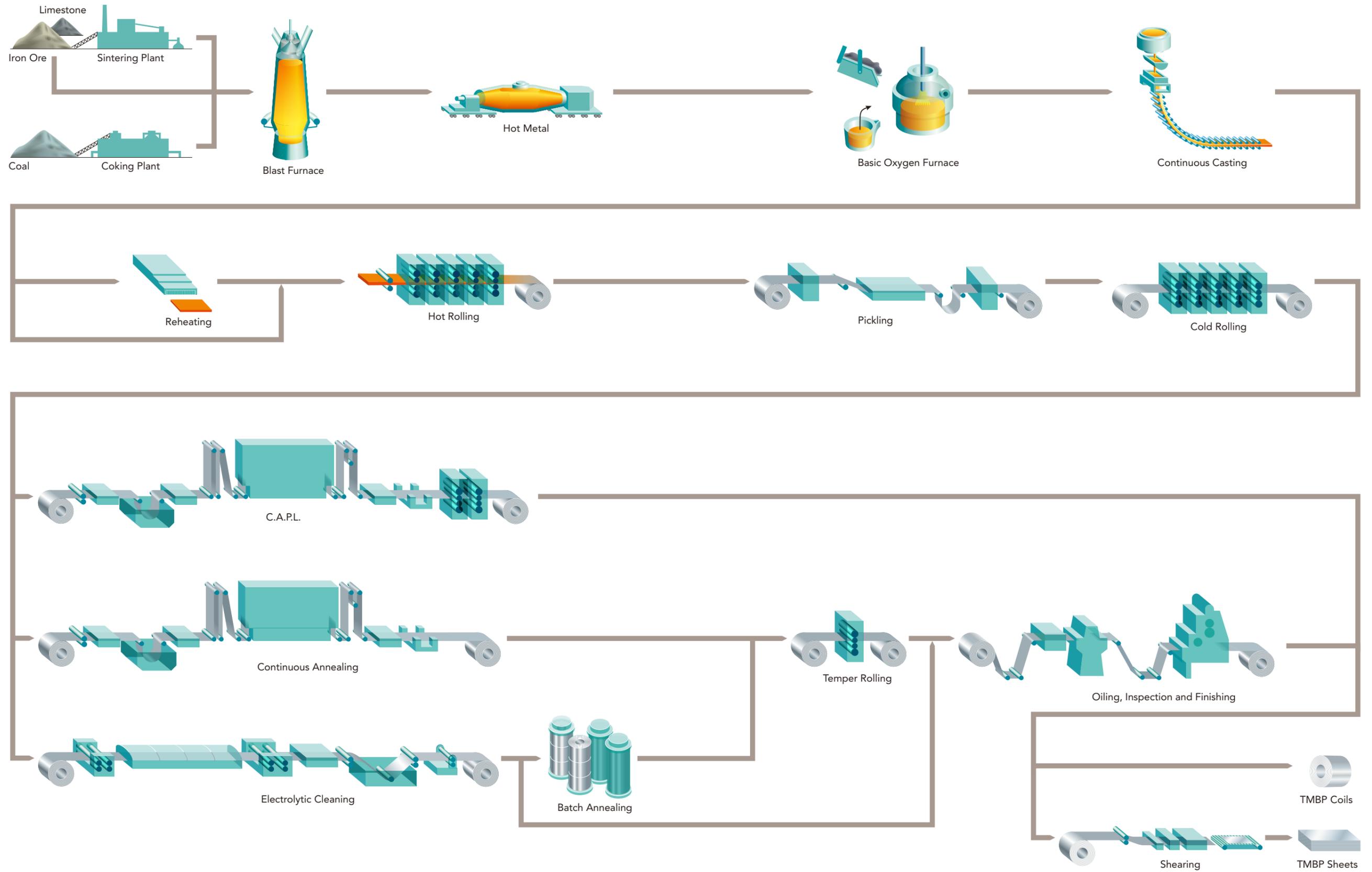


Tray



Barbecue Grill

# Manufacturing Process



## From the Blast Furnace to Hot Rolling

TMBP features excellent surface quality along with exceptional dimensional accuracy and processability, but to impart these features a strict system of quality control is needed, starting from the molten steel stage.

In order to manufacture hot rolled coils with minimal surface and internal defects for subsequent processing into TMBP, we start by exercising precise control over temperature and composition in the steel-making shop. The molten steel is then transported to the continuous caster. With the continuous casting process, which was introduced several years ago and has since come into general use, the conventional steps of ingot casing, stripping and slabbing have been consolidated into a single process which permits the production of products with less segregation and fewer internal and external defects than ever before. At NIPPON STEEL, we have taken the initiative in applying the continuous casting process to the manufacture of TMBP, and now all TMBP is made by this method.

Slabs from the continuous caster pass through a reheating furnace, and are then rolled into coils at the hot strip mill. Temperature and dimensional control is maintained by a large-scale process computer. Furthermore, by using the most advanced equipment, we can ensure accurate width and gauge deviation control to obtain hot rolled coils of consistently high quality.



Basic Oxygen Furnace



Continuous Casting Facility



Hot Rolling Mill

## Pickling

The hot rolled coils are prepared by running them through a continuous pickling line to remove surface scale and obtain a clean surface for subsequent processing.

After the scale is dissolved in the pickling tanks with hydrochloric acid and other chemicals, the coils are fully rinsed and dried, classified by production lot, and sent to the cold rolling mill.



Pickling Line

## Cold Rolling

The pickled coils are rolled into the specified gauges at the cold rolling mill. The important points concerning quality in the cold rolling process are dimensional accuracy and flatness, and with our superior Automatic Gauge Control System, state-of-the-art shape control system and large capacity process computer, we are able to produce TMBP with minimal gauge deviation and excellent shape.



Cold Rolling Mill

## Electrolytic Cleaning

Oil adhering to the surface from cold rolling is removed by the electrolytic cleaning line.



Electrolytic Cleaning Line

## Annealing

Cold rolling elongates the crystal grain structure in the rolling direction and makes the steel hard and brittle. However, in the annealing process, the cold rolled steel is reheated and held at the proper temperature in a reducing atmosphere to form new, undistorted grains that will impart the material properties required for the intended application.

There are two annealing methods – box annealing and continuous annealing. The annealing method is selected according to the product specifications and end use.

At NIPPON STEEL, we employ integrated quality design – beginning with chemical composition and process computer-based, high-precision temperature control – to produce high quality TMBP with little variation in properties.



Box Annealing Furnaces



Continuous Annealing Line

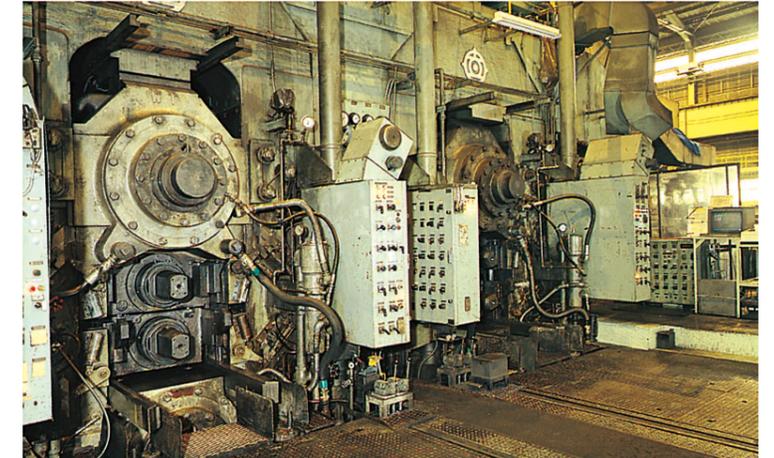


Continuous Annealing and Processing Line

## Temper Rolling

Temper rolling, which is usually the finishing process for TMBP, imparts light hardening to the steel and, together with adding toughness, eliminates yield point elongation. In addition, temper rolling imparts the specified surface finish and improves shape and flatness.

By increasing the reduction ratio, it is possible to produce Double Reduced TMBP. Normally, though, this kind of rolling involves problems with shape correction, but at NIPPON STEEL, we are able to use our accumulated rolling technology, and advanced equipment to produce DR-TMBP with excellent shape characteristics.



Temper Pass Mill

## Final Preparation and Inspection

The temper-rolled coils, when shipped as coils, are run through the coil preparation line where a rust preventative coating is applied before being cut into specified unit weights. When shipped as sheets, the coils are run through the shearing line where they are cut to the specified length and stacked for shipping. In both cases, they are thoroughly inspected for width, gauge and surface defects. Sample specimens for material examination and other testing are collected and sent to the inspection lab, where the decision is made to ship or withhold the product.



Coil Preparation and Inspection Line

# Types and Classifications of Tin Mill Black Plate

TMBP is classified according to specification, steel type, temper designation, annealing method, surface finish, and other characteristics. These classifications are the same as those for tin plate and tin free steels.

## Classification by Standards

Standards	Specification Symbol	Remarks
JIS	SPB	Single & Double reduced, Metric units
ASTM	A625	Single reduced, U.S. units
	A625M	Single reduced, Metric units
	A650	Double reduced, U.S. units
	A650M	Double reduced, Metric units

## Classification of Steel Type

Type of Steel	Remarks
MR	Contains few residual constituents, has good corrosion resistance and is therefore widely used for such applications as containers.
L	Contains very few residual constituents such as Cu, Ni, Cr, or Mo, and is particularly suited for containers requiring improved corrosion resistance.
D	Aluminum-killed steel suited for applications which require deep drawing or other working that is apt to produce Luder's lines.

## Classification by Annealing Method

Annealing Method	Symbol	Features
Batch Annealing	BA	Usually, products with a temper designation of T-1~T-3 are processed using BA method.
Continuous Annealing	CA	Generally used for applications where toughness and strength are important. Usually, products with a temper designation of T-4~DR-10 are processed using CA method.

Please consult with us if it is necessary to select the annealing method based on criteria other than the temper designation. Also, the properties imparted by annealing can vary by process. For example, even when the hardness values are the same, there may be some variation in other mechanical properties. Consequently, when it is necessary to specify a particular annealing method, please indicate so.

## Classification by Temper Designation

	Temper Designation	Nominal Rockwell Hardness HR30T5m	Applications
Single Reduced	T-1	49	Deep drawing where special pliability is necessary
	T-2	53	Drawing where pliability is necessary
	T-2.5	55	Applications requiring a fair amount of pliability
	T-3	57	Applications requiring a fair amount of strength
	T-3.5	59	Applications requiring a fair amount of strength and good toughness
	T-4	61	Applications requiring relatively good toughness
	T-4.5	63	Applications requiring good toughness
	T-5	65	Applications requiring hardness and good denting resistance
Double Reduced	DR-7.5	71	Applications requiring hardness and rigidity
	DR-8	72	Applications requiring hardness and rigidity
	DR-8.5	73	Applications requiring hardness and rigidity
	DR-9	75	Same as above (somewhat harder)
	DR-9M	76	Same as above (still harder)
	DR-10	79	Same as above (very hard)
Full Hard	M	-	Same as above (extremely hard)

## Classification by Surface Finish

Surface Finish	Feature	Comments
Mirror Bright	Mirror luster surface	Suitable as material for decorative plating, etc.
Ultra Bright	Ultra smooth luster	Same as above
Extra Bright	Smooth luster	
Bright	Smooth surface with a fine grindstone-pattern	General use
Stone	Surface with a visible directional grindstone-pattern	Same as above
Super Stone	Surface with a visible directional coarse grindstone-pattern	
Matte	Dull surface	

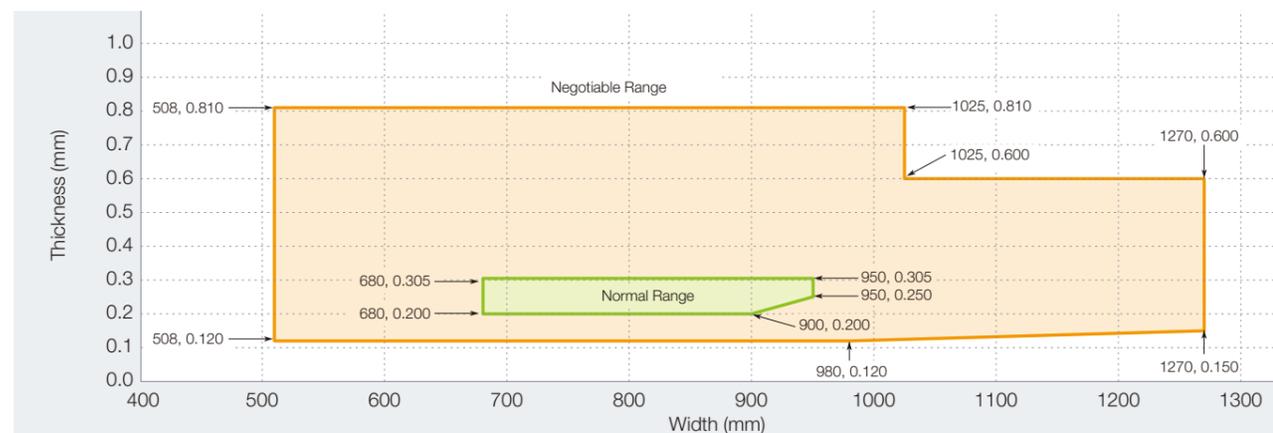
# Possible Manufacturing Range

The range of dimensions to which TMBP can be manufactured is shown in the following graphs. These graphs are not inclusive, and as there are other products that we can supply outside of this range, please feel free to consult with us about your requirements.

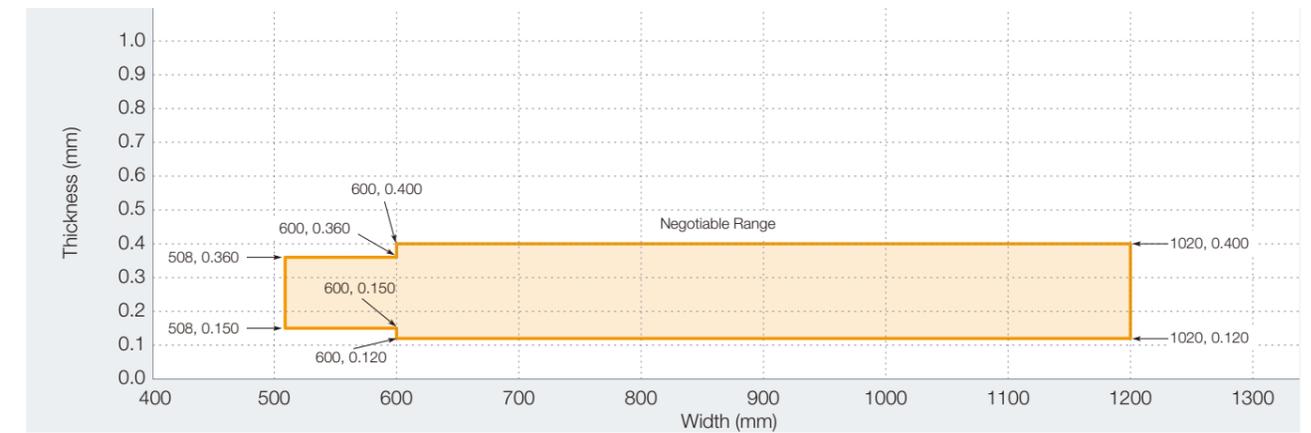
## Single Reduced/Box Annealing



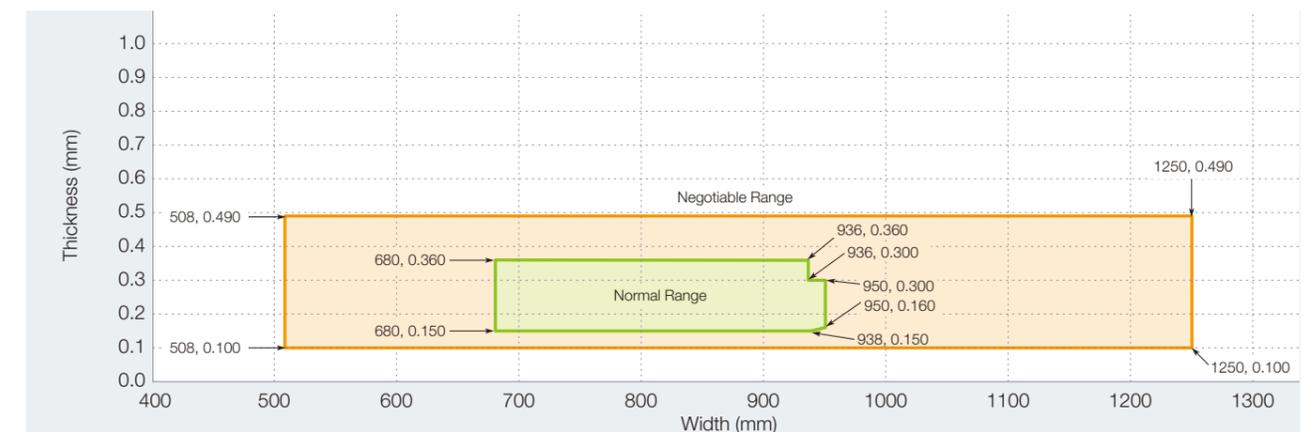
## Single Reduced/Continuous Annealing



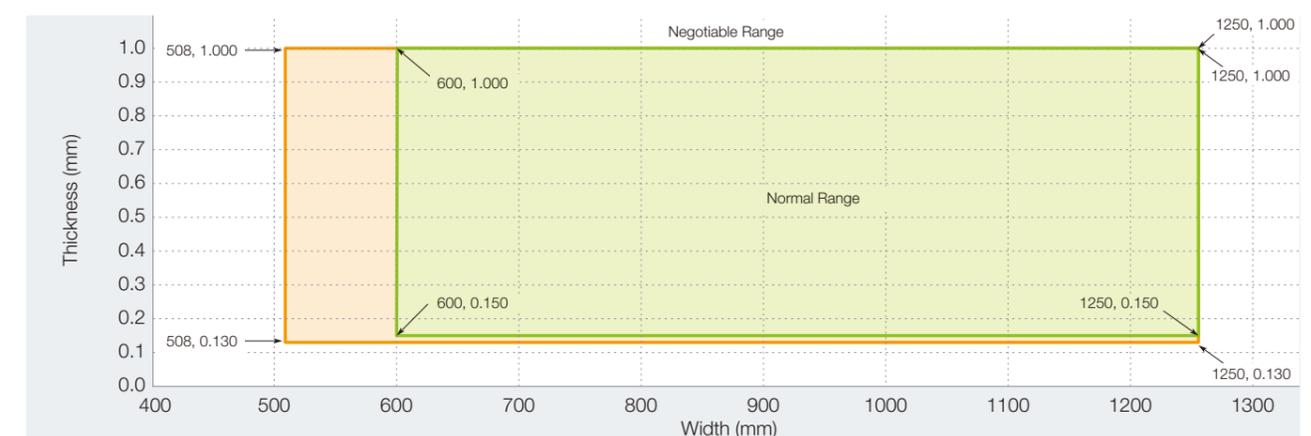
## Double Reduced/Box Annealing



## Double Reduced/Continuous Annealing



## Full Hard



## Packaging and Labeling

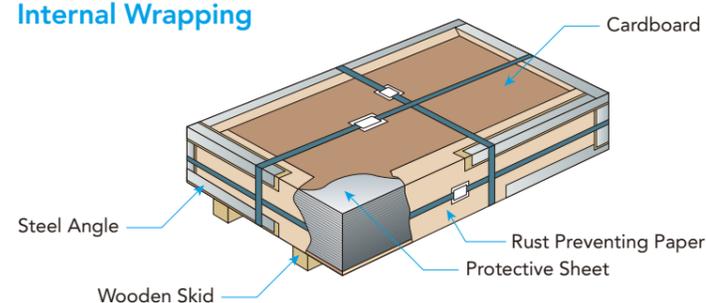
Careful packaging is conducted to prevent any damage from normal handling and storage before processing at the customer's plant.

Also, a package label indicating the product's contents is attached to the outer layer of the packaging and a package card indicating the specific product is attached directly to the material itself to assist in keeping track of the product after acceptance.

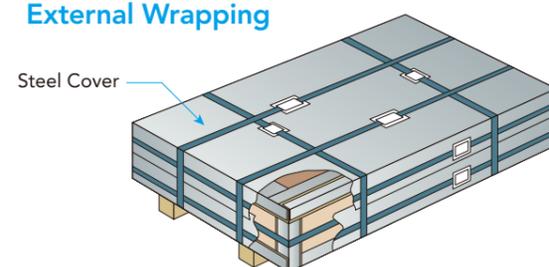
Typical examples of packaging methods are shown below.

### Sheets

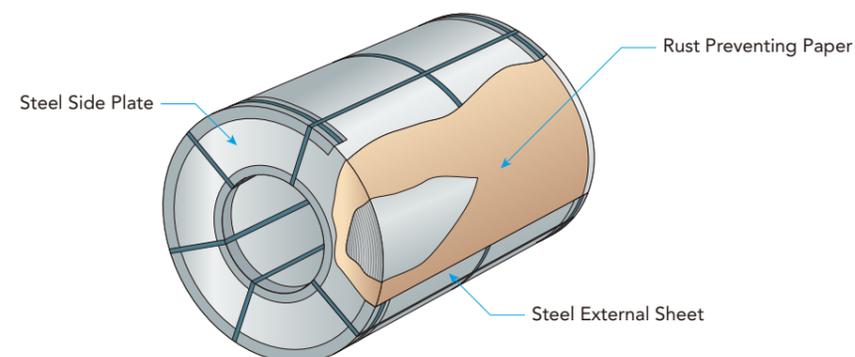
#### Internal Wrapping



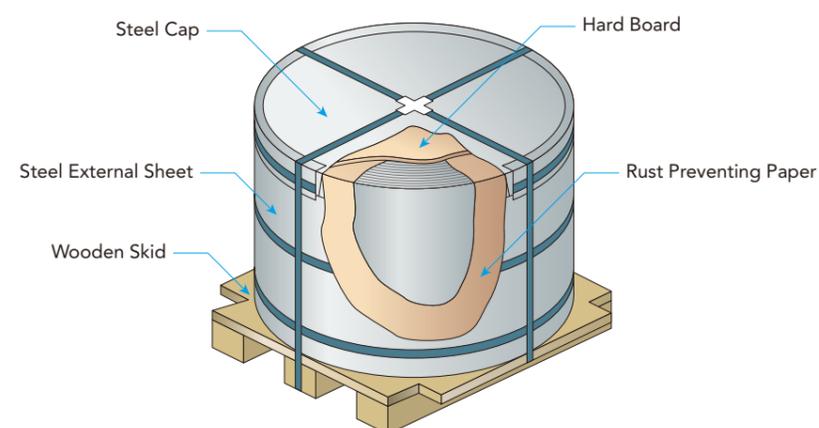
#### External Wrapping



### Coil (Horizontal)



### Coil (Vertical)



## Reference Information on Usage

TMBP comes in many types, each with its own distinct advantages which should be fully utilized in order to economically produce high quality products.

At NIPPON STEEL, we will help you in selecting just the right type of material for your processing needs, and we have set up an organization that specializes in helping you to deal with any processing problems that you may encounter.

### Considerations for Plating

**Degreasing** TMBP is coated with a thin layer of rust preventing oil. In order to obtain an attractive surface appearance and the specified corrosion resistance, this layer of oil should be removed before plating.

There are two general methods of degreasing, i.e. solvent degreasing and alkali electrolytic degreasing. Of these, the latter is usually more economical and simpler to carry out, and is the more widely used of the two.

In the alkali electrolytic process, caustic soda, sodium carbonate and sodium silicate are used. Degreasing conditions are determined mainly by time, temperature, concentration, and the presence or absence of brushing. Also, degreasing efficiency can be raised by the addition of surface active agents.

**Pickling** In order to eliminate surface oxidation or rust, it is necessary to carry out electrolytic pickling. Insufficient pickling will cause poor quality plating.

### Rust Prevention

TMBP is prepared with a thin, uniform layer of low viscosity oil which is superior both in its rust prevention properties and its easy removability during degreasing.

However, since rust may still occur if the coil is allowed to sit for a long time, we ask that it be processed as soon as possible. For those occasions when considerable time will elapse before painting or plating, we ask that attention be paid to the following points.

**Low Humidity** Since humidity exceeding 70 percent usually accelerates the formation of rust, sheets should be stored at less than 60 percent humidity.

**Good Air Circulation** When control over the humidity and temperature of the storage place is impractical, it is recommended that the sheets be stored in a place with good air circulation. In stagnant air, moisture reaches the dew point when the outdoor temperature drops and precipitates as dew on the sheets.

**Clean Air** Airborne hygroscopic substances such as hydrochloric acid gas, ammonium chloride gas, and seawater salt particles accelerate the formation of rust even when the humidity is less than 60 percent and temperatures are above the dew point.

**Protection against Dust** Dust and stains present on the surface tend to break the protective oil film, produce localized galvanic activity with the base metal, and cause rust.

Our packing is designed to protect the products from dust and rain during short periods of outdoor handling, but not during long periods of outdoor storage. Therefore, these products should be stored inside even before unpacking.

### Aging and Stretcher Strain

When running a light pressing operation on aged steel, small ridges and valleys occasionally form on the surface. This is called stretcher strain.

After annealing, if temper rolling is carried out at approximately a 1 percent reduction ratio, stretcher strain will not appear for a while. But, when atmospheric temperature, nitrogen in the steel and the other conditions are especially bad, stretcher strain can occur within a week after rolling. When there is particular concern about stretcher strain, normal procedure is to roller level the strip before use. However, the appearance of stretcher strain after levelling occurs much more quickly than after temper rolling and generally makes it advisable to use the strip within 24 hours of processing.

We can also provide non-aging steel (Type D). Please feel free to inquire when ordering.

### Coil Materials

At NIPPON STEEL, we work hard to eliminate manufacturing defects, but, since coils sometimes receive scratches in areas that cannot be cut out, it is necessary to conduct inspection, sorting and correction operations. Off-gauge sections at the coil head and tail can generally be avoided, but it is possible that there will occasionally be off-gauge sections at and around the welds.

### Material Handling

We take great care in the packaging of TMBP, but rough handling that results in snapped hoops or damaged outer packaging can still seriously affect product quality. Therefore, we ask that care be taken when handling packaged coils.

Also, even though we use a steel sheet for the outer wrapping, damage from excess shock and pressure is still possible. Consequently, in addition to taking care in handling, we ask that sufficient attention also be given to the storage conditions and cleanliness of the storage area.

# Testing Methods

The principle methods for measuring the properties of all TMBP materials are listed below.

## Hardness Testing

The hardness of steel is, to a certain degree, related to such physical properties as strength, abrasion resistance and drawability. Because hardness testing is relatively simple to carry out, it is the most widely used method for estimating these properties.

### •Rockwell Superficial Hardness Testing

A spherical steel indenter is first fitted with a reference load (29.4N (3kgf)) before being pressed into the sample. Next a test load is applied. After the test load is returned to its original position, the difference in depth between the two indentations is automatically measured, and the hardness value is read off the Rockwell 30T or 15T scale.

For the Rockwell superficial 30T hardness test, a 1/16" (1.5875mm) spherical steel indenter is used with a 294N (30kgf) test load. For the Rockwell superficial hardness 15T scale, a 147N (15kgf) test load is used.

The Rockwell superficial 30T hardness scale is accurate for gauges of 0.20mm and above, but the anvil effect interferes with measurements for thinner gauges. In such cases, the hardness is usually estimated using the Rockwell superficial 15T hardness test.

### •Rockwell Hardness Testing

The Rockwell B scale hardness test follows a procedure similar to that for the superficial hardness test, but the reference load is 98N (10kgf) and the test load is 980N (100kgf). The test is reliable for gauges of 0.762mm (0.030") and above, but the anvil effect interferes with measurements for thinner gauges. In such cases, the Rockwell superficial hardness test is used.

### •Vickers Hardness Testing

The Vickers hardness value is defined as the surface area of an indentation in a test surface made by a quadrilateral diamond tipped indenter with opposite angles of 136 degrees. The hardness is calculated from the test load and the distance between opposite angles using the following equation:

$$Hv = 1.8544 F/D^2$$

1) F : test load (9.8 to 490N (1 to 50kgf))  
 2) D : average distance between the two opposite angles of the indentation

Generally, hardness testing for TMBP is performed using the Rockwell superficial hardness method. The hardness value obtained from this test can be converted to other scales by use of the conversion table on the following page.



## Tensile Testing

We sometimes carry out tensile testing when the material characteristics of TMBP cannot be sufficiently determined with the previously mentioned hardness tests.

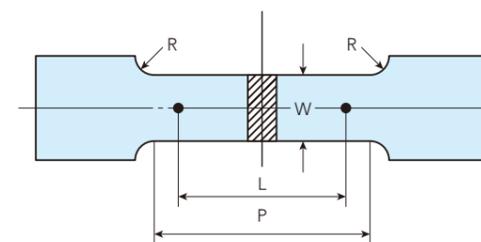
Tensile tests measure the tensile strength and elongation of

the material, and are the fundamental method of determining strength and ductility.

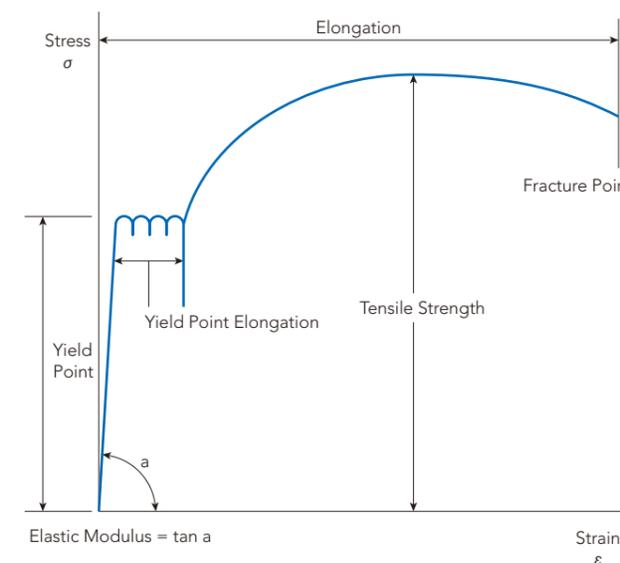
In a typical tensile test, the load is gradually applied to the test piece until fracture.

### •Test Piece

The shape and size of the test piece are determined by JIS or ASTM specifications according to steel type and size. TMBP is usually tested using a JIS Number 5 test piece.



- P : Length of Parallel Section
- L : Length between Marks
- W : Width
- R : Shoulder Radius



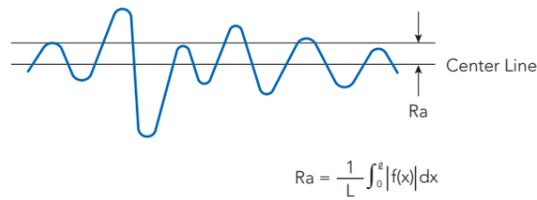
Testing Methods

Measurement of Surface Roughness

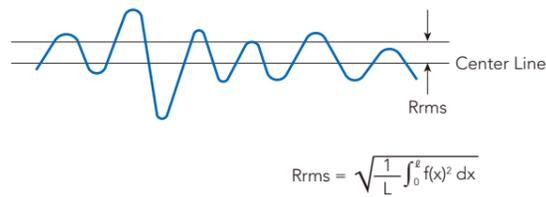
The surface roughness of a steel is a convenient value for evaluating surface appearance.

There are various definitions of surface roughness, but we generally use the following method for TMBP.

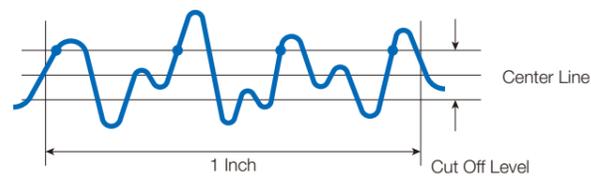
•Center-line Average Roughness (Ra)



•Root Mean Square Roughness (Rrms)



•Peaks Per Inch (PPI)



Defined as the number of peaks greater than the cut off level.  
(In the example, PPI=4)



Ordering Guide

When placing an order, we ask that you please consider the following items.

Specifications

We have a large assortment of products made to JIS or ASTM specifications. Please choose the standard which best meets the end use, degree of processing and processing methods.

Please contact us if you have any questions.

Dimensions

In principle, gauge is indicated in units of 0.01mm for JIS specifications and 5 lbs/BB for ASTM specifications. Width is measured in units of 1mm for JIS specifications and 1/16" for ASTM specifications. Please contact us when specifying anything different.

Unit Packing Weight

Please specify a unit packing weight that will meet your handling and operating conditions.

Sheets — usually specified by the number of sheets, but within a range of 1 to 2.5 tons

Coils — usually 3 to 15 tons is standard  
Please specify the largest (or, if necessary, the smallest) weight that you are able to accept.

Coil Internal Diameter

Standard internal coil diameters are 406mm (16"), 419mm (16.5") and 508mm (20"). Please specify the largest coil diameter that you can accept.

Steel Types

There are three steel types for TMBP (MR: standard, D: processing use, and L: low residual elements). Please select and indicate the most suitable grade for your processing and end use.

Temper Designation

TMBP is also classified by temper designation. After referring to these designations, please select and indicate the one most suited to your needs.

