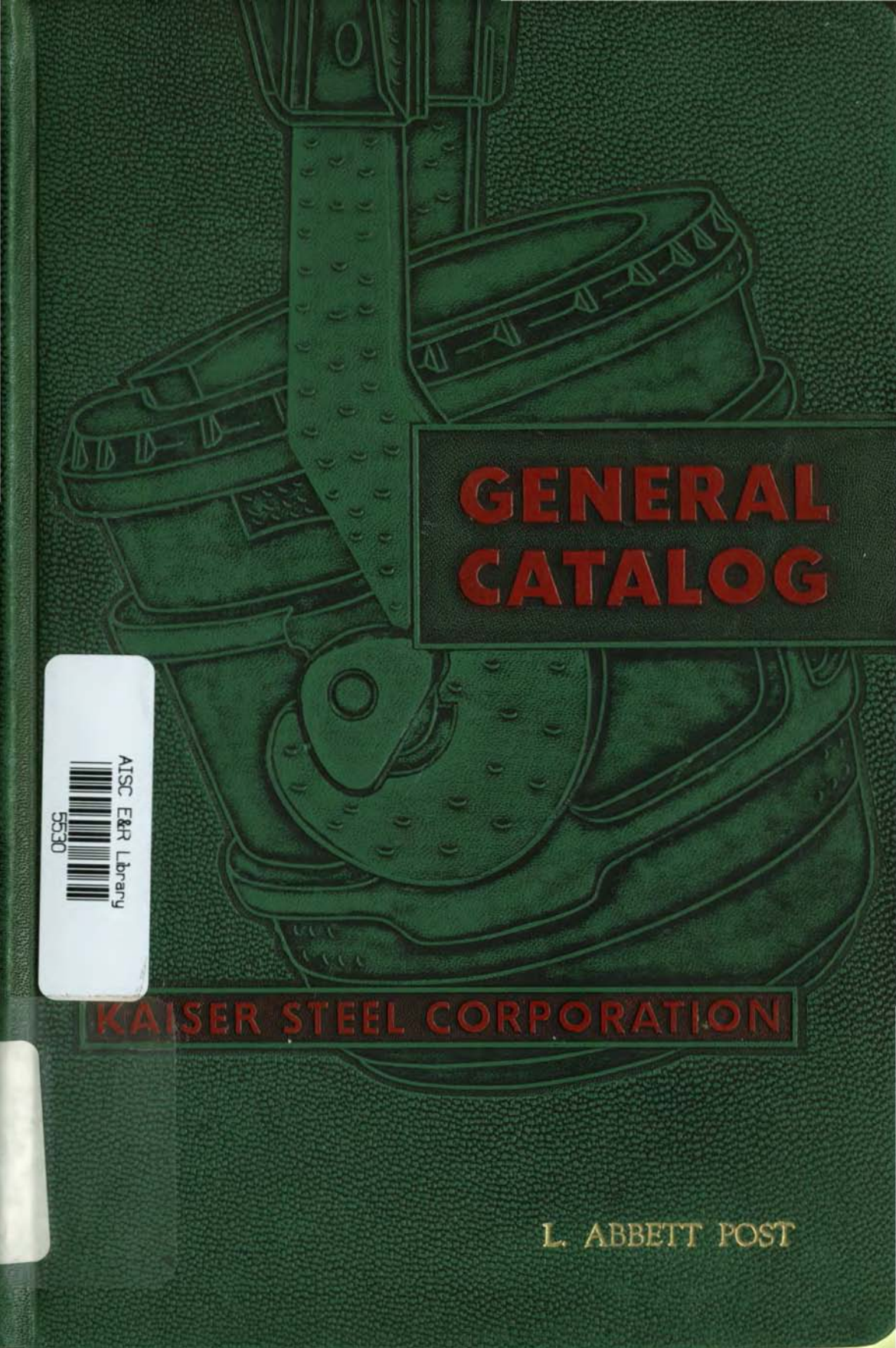

"A point which yesterday was invisible is its goal today and will be its starting post tomorrow."

—*Macaulay*

B241

GENERAL CATALOG

KAISER STEEL CORPORATION

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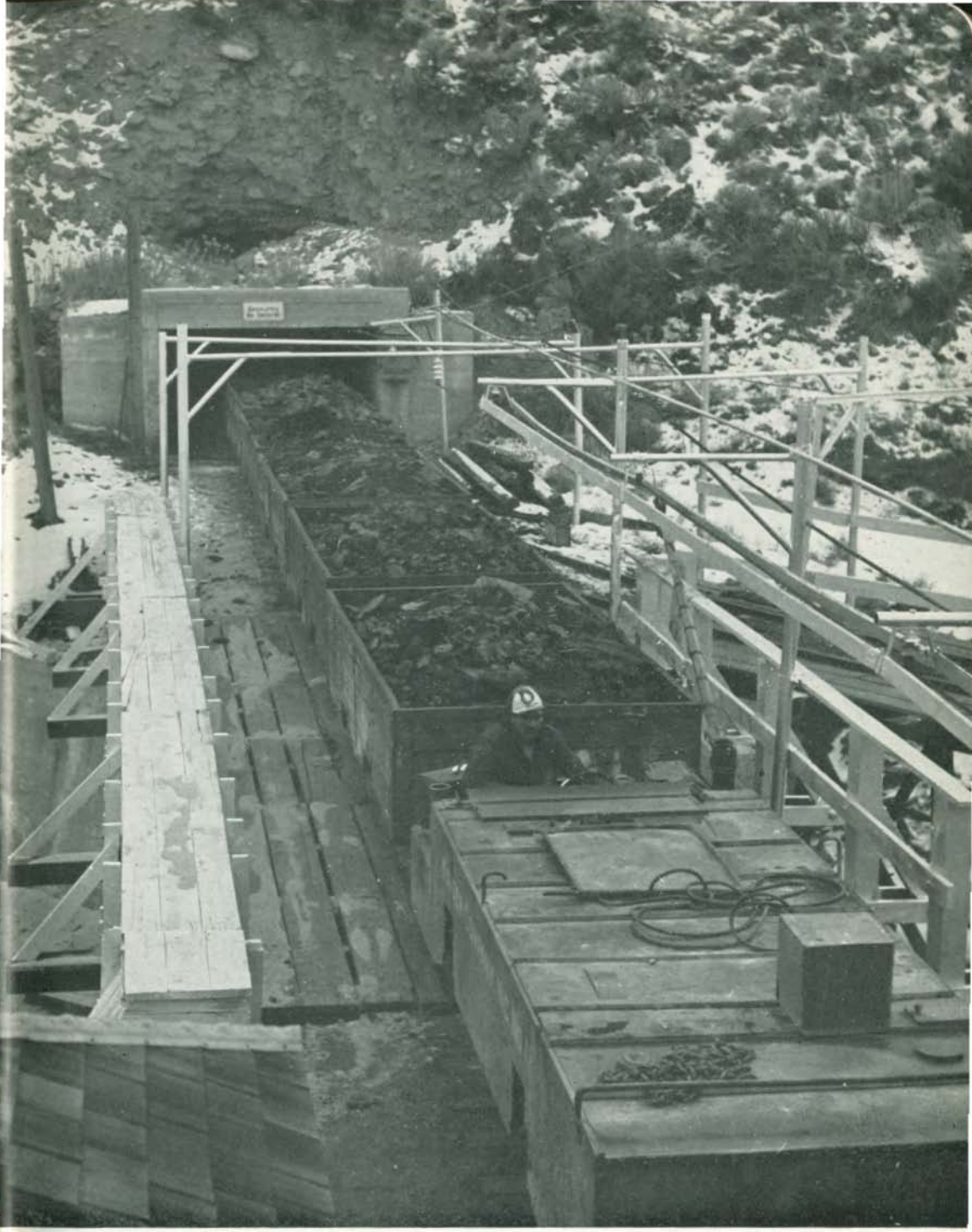
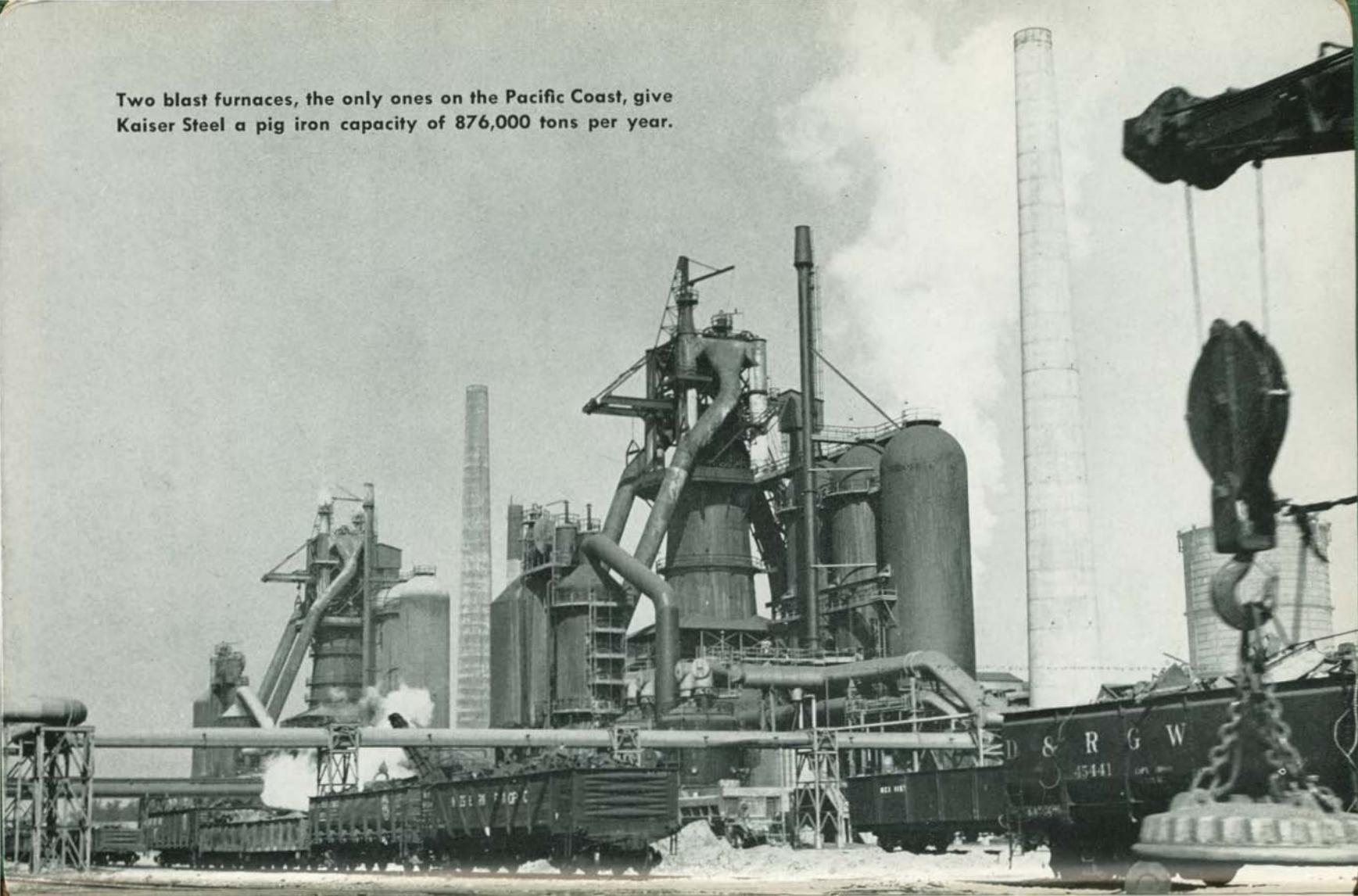
1950

1,500,000 tons of ore, averaging 54 per cent iron content, leave Kaiser's Eagle Mountain open pit mine annually for the short 164 mile rail haul to Fontana.



850,000 tons of volatile-rich coal are mined annually by the Kaiser-owned mines at Sunnyside, Utah.



Two blast furnaces, the only ones on the Pacific Coast, give Kaiser Steel a pig iron capacity of 876,000 tons per year.

KAISER STEEL CORPORATION

sales offices

LOS ANGELES 17, CALIFORNIA
612 S. Flower Street
Madison 6-8211

OAKLAND 12, CALIFORNIA
360 - 17th Street
Twinoaks 3-4600

SEATTLE 4, WASHINGTON
1207 Hoge Building
Seneca 4797

NEW YORK 20, N. Y.
620 Fifth Avenue
Circle 6-4725

PORTLAND 4, OREGON
703 Public Service Bldg.
Atwater 2384

HOUSTON 2, TEXAS
M & M Bldg.
Charter 6222

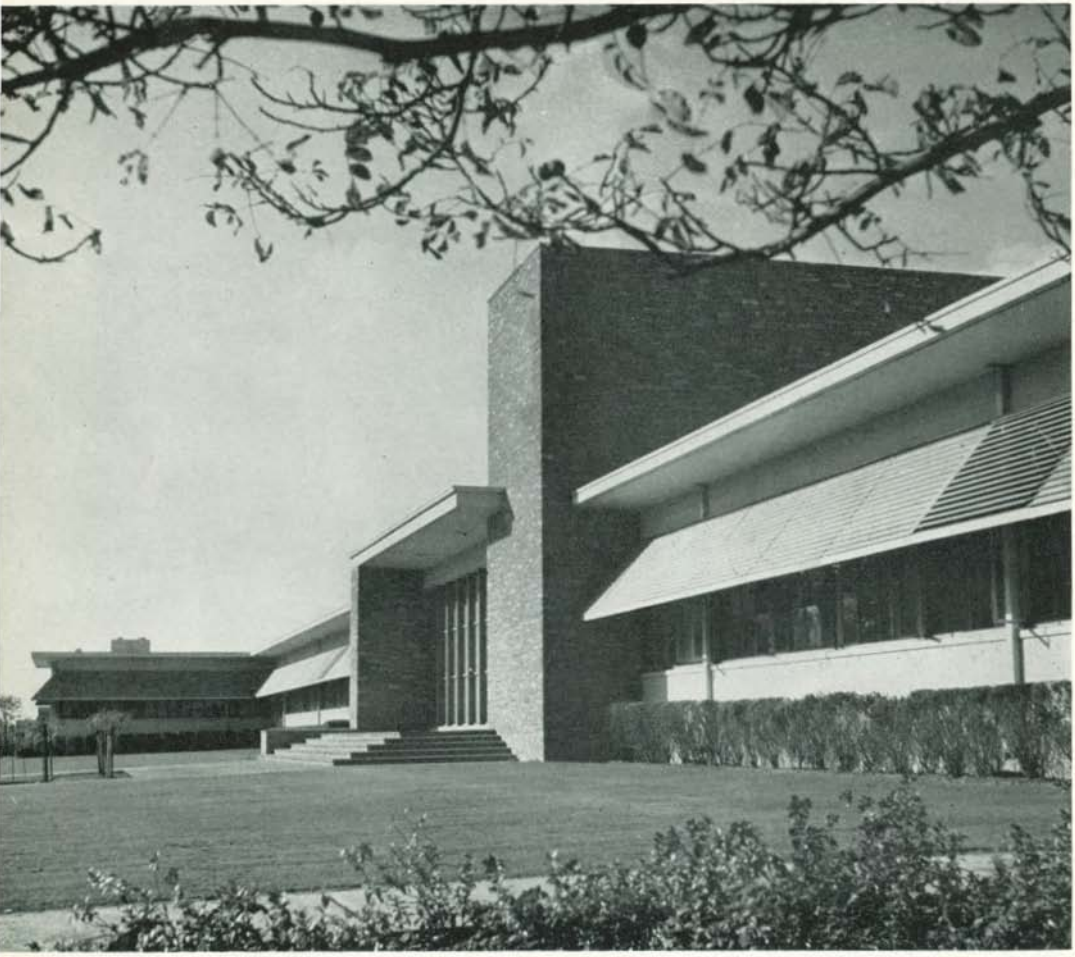
TULSA, OKLAHOMA
619 S. Main Street
Tulsa 54-2871

EXPORT DEPARTMENT
OAKLAND 12, CALIFORNIA
Kaiser Building
Cable Address—Kaisteel

general offices

OAKLAND 12, CALIFORNIA
Kaiser Building
Twinoaks 3-4600

Fertile orchards, vineyards and fields of grain surround the Kaiser Steel plant at Fontana, California. Occupying 1,300 acres, the mill layout permits future expansion without crowding.



Administration Building at the Kaiser Steel plant

FOREWORD

The value of a steel mill to the area it serves is measured by the manner in which it meets the needs of its customers. Ever since its inception KAISER STEEL has pursued a program of diversification that would enable it to produce an ever-widening range of steel products in response to the varied demands of the steel industry in the fastest-growing region in the nation. KAISER STEEL is pleased, therefore, to present this, its first general catalog of its widely-diversified line of products. The products listed herein are those which the company presently has facilities to produce. These facilities are constantly being improved and expanded.

KAISER STEEL operates the only fully-integrated steel plant on the West Coast, occupying a tract of 1,300 acres near Fontana, California. Iron ore is shipped from the company's own mine at Eagle Mountain, near Desert Center, in Riverside County; coking coal is supplied by the Kaiser-owned mines at Sunnyside, Utah. Both raw material sources contain reserves sufficient to supply Fontana for the next half-century or longer.

The steel-making facilities at Fontana are new and of modern design that makes for the utmost in operating efficiency. Skillful blast furnace and open hearth practice, coupled with scientific controls maintained during processing by well equipped metallurgical and laboratory staffs, gives to customers the assurance that specified quality standards will always be met.

KAISER STEEL's facilities include two blast furnaces, the only ones on the West Coast, 135 coke ovens, seven open hearth furnaces, and eight rolling mills producing a wide range of finished and semi-finished steels. Fontana is producing steel at the rate of 1,200,000 ingot tons annually. This mammoth operation, including ore and coal mines, requires a working force of 5,200 men and women, who share an annual payroll of $16,600,000.

Fontana's favorable location in relation to markets gives KAISER STEEL customers a decided advantage. Situated only 45 miles from Los Angeles and on the main lines of the Southern Pacific and Santa Fe railroads, Fontana gives rapid delivery service by rail or truck to all important market centers.

Fontana is a busy place, operating in most departments on a 24-hour basis, but the operators are never too busy to show their bustling steel mill to visitors. So, if you have yet to see the magnitude of this modern steel mill, please consider this an invitation to come and see us at the earliest opportunity. The salesman who calls on you, or anyone else in the KAISER STEEL organization, will arrange a tour for you.

KAISER STEEL CORPORATION

On the casting floor of a Kaiser Steel blast furnace where 250 tons of pig iron are drawn off every five hours. Two furnaces are in operation.

KAISER CUSTOMER SERVICES

The Kaiser Steel Corporation has within its operating and sales organizations several departments which actively assist customers in selecting and securing their steel requirements. To insure that customers receive steel suited to their particular needs, a staff of metallurgists, carefully selected because of their experience and ability to work with customers, is available to provide technical service, make steel recommendations and give helpful suggestions for the economical processing of steel products.

The production planning department works in conjunction with the order service department of each sales office to transmit and answer inquiries, accept and enter orders, plan and schedule rollings and shipments and furnish information requested by the customer.

The quality control division within the operating organization exercises close control of all processing operations to insure the production of highest quality steel. This division includes metallurgical observers of production processes and a corps of mill inspectors who oversee steel rolling operations, make dimensional checks, and take samples for testing during the manufacturing process. The quality control division also includes a staff of metallurgists and chemists who have completely equipped laboratories and facilities for making the chemical and metallurgical investigations, including comprehensive physical tests, necessary to control quality.

Project engineers of the sales department act in liaison with designers, fabricators and contractors in the construction industry. They make the services of Kaiser Steel Corporation available to members of the construction industry by providing designers, fabricators and contractors with necessary technical and product information.

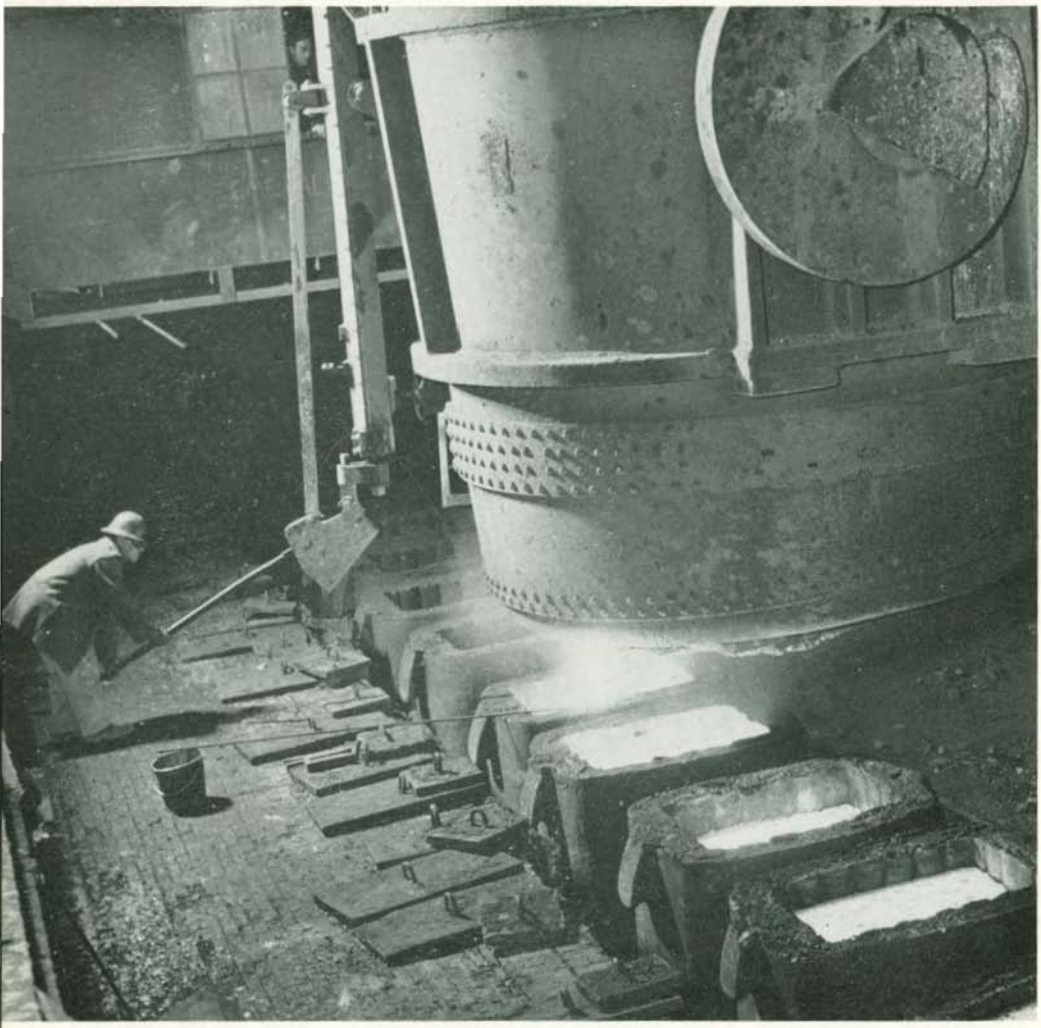
The credit department is available to assist customers in working out the financial details which arise in connection with the purchase of steel.

The traffic department is of valuable assistance to customers in problems incidental to the transportation of steel. This department is constantly engaged in improving transportation service which ultimately reflects economies to all western steel users.

These services have been established as an integral part of the Kaiser Steel program to provide its customers with complete service facilities in conjunction with its steel producing units. It is fully intended that these services be still further extended and improved in keeping pace with the ever expanding steel making operations.

Molten iron from the blast furnaces is poured directly into the open hearths to be refined, along with scrap and other ingredients, into high quality steel.

The seven open hearth furnaces at Fontana average 220 tons of steel at each tapping. The mill now is producing at the rate of 1,200,000 ingot tons per year



A ladleman operates a stopper rod that permits molten steel to flow through a nozzle in the bottom of the ladle into ingot molds. Ingots are poured in many shapes and sizes to meet varying rolling requirements.

STEEL CLASSIFICATIONS

TYPES OF STEELS, CLASSIFIED BY METHOD OF MANUFACTURE

The steel industry, in keeping pace with mounting demands for steel, has demonstrated the economy of the blast furnace process for reducing iron ore to iron, and the open hearth process for making steel from iron and scrap.

The blast furnace reactions are essentially reducing while the controlling reactions of the open hearth process are oxidizing. When steel is being made in the open hearth furnace and the oxidizing reactions have reached the desired stage, the liquid metal contains oxygen. This oxygen reacts with the carbon in the steel to form gas. Unless the oxygen is eliminated or combined with a deoxidizer before the liquid steel is cast into molds, gas evolution will continue during its solidification in the mold. It is the method of deoxidizing or making use of the gases evolved during solidification that determines the type of steel which is made of the liquid metal.

Kaiser Steel Corporation makes four types of steels, namely: Killed, Semi-Killed, Capped and Rimmed. Each type is made for distinct purposes and each has inherent advantages and characteristics which determine its economic use.

KILLED steels are deoxidized steels. They lie quietly in the molds with only slight gas evolution, but a shrinkage cavity, commonly termed "pipe," forms in the top of the ingots during solidification. Provision is always made to discard that part of the ingot containing pipe. Killed steels are characterized by improved internal soundness and more uniform chemical composition. Their structure and hardenability may be controlled to give a desired response to heat treatment. Most higher carbon steels and the alloy steels are produced as killed steels.

SEMI-KILLED steels are partially deoxidized. The degree of deoxidization used in making this type of steel produces ingots having less segregation than rimmed steel and less pipe than killed steel. Kaiser semi-killed rolled steel products have internal soundness and good surface. They are widely used for plates, structurals, bars and other applications and comprise the major portion of the tonnage produced by Kaiser Steel Corporation for structural purposes.

CAPPED steels are those in which the controlled gas evolution is stopped shortly after the ingot is cast by freezing over the top of the ingot. Gas formed after the ingot is capped remains within the ingot and counteracts shrinkage during solidification. Capped steels are somewhat similar to rimmed steels in structure. They are used interchangeably with rimmed steels or with semi-killed steels for selected applications where their characteristics and economic factors make them the logical type of steel for use.

RIMMED steels are not deoxidized. An evolution of gas is allowed to occur while the steel freezes inward to form a rim surrounding the ingot. As a result of the gas evolution, rimmed steel ingots have a rim of higher purity metal while the central part or core contains more carbon, phosphorus and sulphur than the average content of the ingot. Rimmed steels are generally made low in carbon. They form a large part of the nation's steel tonnage and are used for innumerable purposes because of their economy, sound surface and good drawing properties.

TYPES OF STEELS CLASSIFIED BY CHEMISTRY

CARBON STEEL is so classified when no minimum content is specified or required for Aluminum, Boron, Chromium, Cobalt, Columbium, Molybdenum Nickel, Titanium, Tungsten, Vanadium or Zirconium, or any other element added to obtain a desired alloying effect; when the specified minimum content for Copper does not exceed 0.40 per cent; or when the maximum content specified for any of the following elements does not exceed the percentage noted: Manganese 1.65 per cent; Silicon 0.60 per cent; Copper 0.60 per cent.

ALLOY STEEL is so classified when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: Manganese 1.65 per cent; Silicon 0.60 per cent; Copper 0.60 per cent; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized commercial field of alloy steels: Aluminum, Boron, Chromium up to 3.99 per cent, Cobalt, Columbium, Molybdenum, Nickel, Titanium, Tungsten, Vanadium, Zirconium, or any other alloying element added to obtain a desired alloying effect.

Ingots lose some of their heat after they leave the open hearth building so are reheated in soaking pits to a rolling temperature of approximately 2400° F.

ROLLED STEEL PRODUCTS

In the 36-inch blooming mill ingots are reduced to slabs and blooms. Here a slab emerges from the bloomer on its way to the plate mill.

I

Hot rolled semi-finished products

SEMI-FINISHED PRODUCTS

Semi-Finished products are classified as Blooms, Billets, Slabs and Sheet Bars. The terms Blooms and Billets are used interchangeably, the chief distinction being their difference in cross-sectional area.

Semi-Finished products are usually ordered for further conversion by rerolling or forging.

Two general manufacturing methods are employed in the production of Kaiser Semi-Finished products, the method used being determined by the size and quality of material ordered. In one case, the product is rolled on a 36″ blooming mill direct from the ingot. In the second case, the ingot is rolled to an intermediate size on a 36″ blooming mill, conditioned, reheated and rerolled on a 29″ billet or slab mill to ordered size.

BLOOMS AND BILLETS

TABLE 1

KAISER ROLLING LIMITS

Blooms and Billets

Size	Ft. Wt.	Corner Radius
2½ x 2½	21.25	⅜
2¾ x 2¾	25.71	⅜
3 x 3	30.60	7/16
3⅜ x 3⅜	50.32	⅝
4 x 4	54.40	⅝
5 x 5	83.86	¾
6 x 6	120.76	¾

Blooms and Billets are available in lengths from 10′ to 30′.
Sizes shown are regularly produced. Larger sizes may be produced and inquiries are invited.

SLABS

Kaiser Slabs suitable for rerolling, forging and machining are produced in sizes from 2½″ to 3″ in thickness by 4″ to 16½″ in width. Larger sizes may be produced and inquiries are invited. All lengths are subject to inquiry.

SHEET BAR

TABLE 2

KAISER ROLLING LIMITS

Sheet Bar

Minimum Width Inches	Thickness Range Inches	Minimum Weight Lbs. per Ft.
7	⅜ to 1⅛	8.9
8	"	10.2
10	"	12.8
12	"	15.3
14	½ to 1½	23.8
16	"	27.2

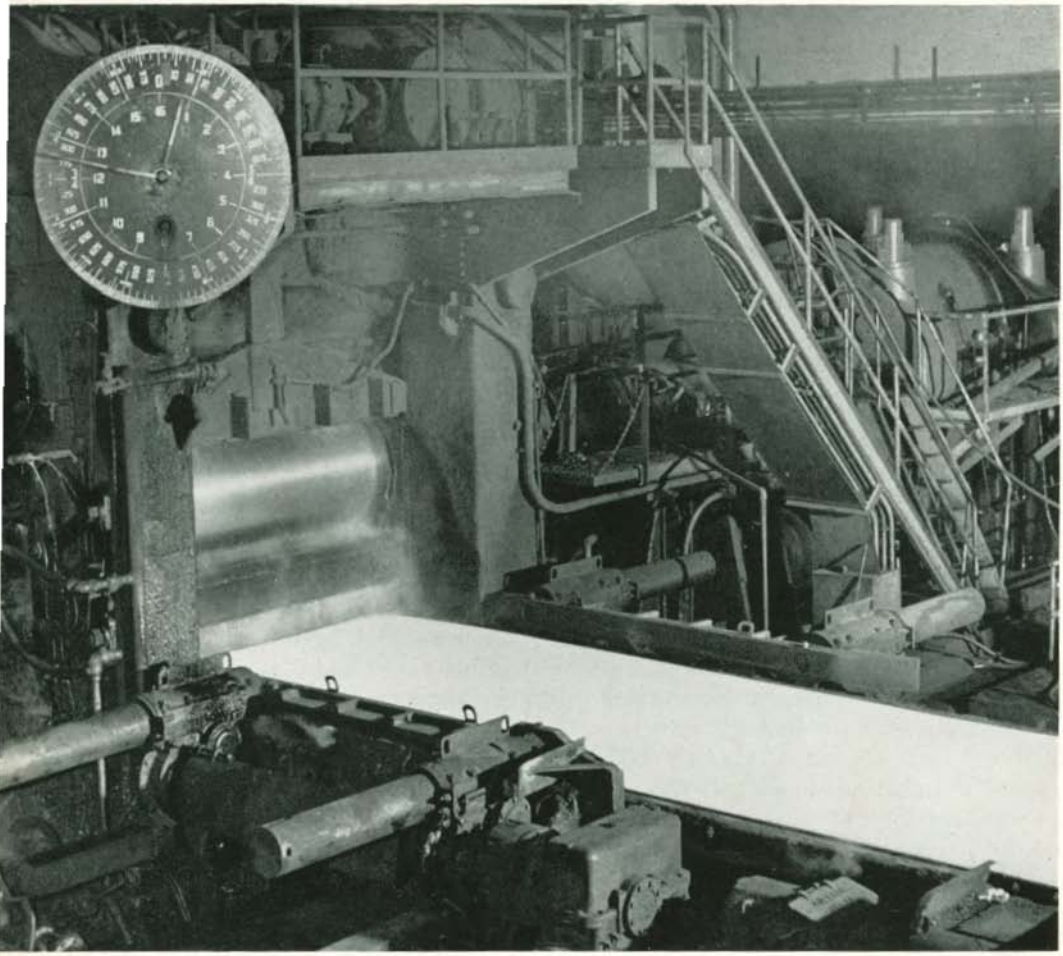
Sheet Bars are available in lengths from 15′ to 30′.

All products listed are available in rerolling quality suitable for conversion to such products as sheets, tin plate, plates, shapes, bars and rods or in forging quality for use in making all types of forgings which, after machining, must be free from injurious defects.

Semi-Finished products are produced to nominal cross section within a weight tolerance of plus or minus 5% for individual pieces and plus or minus 2½% for carload lots. No dimensional tolerances apply.

Semi-Finished products are ordered in tons of 2,000 pounds and are invoiced on mill scale weights. In check weighing by the purchaser, variation from invoiced weights up to one per cent is normal expectancy due to possible scale variations. Over or under shipment of 10% is considered standard within the industry.

On all Kaiser Semi-Finished products, inquiries for sizes not listed are invited for special consideration.



Kaiser Steel plate is finished on this "three-high" mill stand in widths up to 96 inches. The large dial indicates roll setting, permitting accurate control of the plate's thickness.

Hot rolled plate

KAISER HOT ROLLED CARBON STEEL PLATE

Within the steel industry flat rolled steel products over 6″ wide and .2300″ or more in thickness or over 48″ wide and .1800″ or more in thickness are generally classified as plate. Sheared plate has all edges trimmed. Universal Mill or U. M. plate is produced with rolled edges and is sheared to length.

Plates are used in the construction of bridges, buildings, dams, towers and other stationary structures. Large amounts of plate are used in the transportation industry for locomotives, ships, railroad cars and heavy trucks. Steel plates are used extensively in the farm and industrial machinery field, and for pressure vessels in the chemical and oil industry. Additional tonnages of plates are required for tank cars, pipe lines, storage tanks and containers for transport and storage of liquids and gases.

Kaiser Hot Rolled Carbon Steel Plates are rolled to numerous industry specifications. Examples of the more common of these specifications are given on pages 156-161. All plates produced by Kaiser Steel Corporation are rolled from slabs. All slabs are subject to inspection and surface conditioning before rolling. Kaiser Plates ¼″ to ¾″ inclusive in thickness, in widths 48″ and under, down to 36″, are furnished with sheared edges. Plates in these widths over ¾″ thick are furnished with radiographed edges. Plates 7″ to 16″ wide, in thicknesses of ¼″, 5/16″ and ⅜″ are furnished with rolled edges and are sheared to length. Plates 8″ to 14″ wide, in thicknesses of ½″ to 1½″ are furnished with edges which are formed in the rolling of the plate.

Kaiser Steel Corporation's sheared plate mill consists of two units: a two-high reversing, roughing mill and a 110″ three-high finishing mill. The maximum width of plates rolled on this mill is 96″. The rolling facilities include an 86″ continuous mill having four stands of four-high rolls, built in tandem with the plate mill.

METHODS OF DESIGNATING THICKNESS OF PLATE

The thickness of plate may be designated either in inches or in pounds per square foot, except that thickness of plate intended for pressure vessels and plate in excess of 81.6 pounds per square foot, is customarily expressed in inches. Plate weight is calculated on a theoretical weight of 40.8 pounds per square foot per inch of thickness.

When plate thickness is specified in inches, the thickness is measured ⅜″ in from the longitudinal edge, and will not customarily be under the standard tolerance of .010 inches. Variation in weight will generally be over the theoretical weight because: (1) the edge thickness may vary above the required minimum, (2) the plate may be crowned due to rolling conditions and (3) dimensions may vary as a result of shearing. Plate may be ordered to a maximum and minimum thickness in inches but such orders are subject to negotiation. The allowable variations in plates ordered to thickness are shown in Tables 5, 6, and 8 on pages 23 and 24.

When thickness is specified in pounds per square foot, the plate is rolled to average weight and the thickness on the longitudinal edges will be less than the equivalent for the specified weight. Due to rolling conditions, the plate increases in gauge toward the middle. The allowable variation in weight for plate ordered to weight per square foot is shown in Table No. 7 on page 24.

DIMENSIONS OF PLATE

Width and length of plate are ordinarily expressed in inches. If the plates are for resquaring, suitable shearing allowances beyond normal variations should be provided.

Standard variations in width and length allowed for plates, and the restrictive shearing tolerances are given by the Shearing Tables on pages 25 and 26.

GAS CUTTING

The difficulty of shearing plate and the hazard to plate and equipment increases with its thickness and hardness. Heavy plate must, therefore, be gas cut. The allowable variations in width and length for flame cut rectangular plates are shown in Table No. 13 on page 27.

FLATNESS

Because of variables in mill equipment and operating conditions, some deviation from absolute flatness of plates may be expected. The allowable deviations are shown in Table No. 14 on page 27.

CAMBER

Camber in plates is the horizontal edge curvature in the length measured in a flat position. Allowable camber in plates is shown by Table No. 10 on page 26.

SURFACE CONDITIONING

Plates are commonly conditioned by the producer for the removal of surface imperfections or depressions. Rules permitting surface conditioning of plates have been established by the industry. In general they permit grinding, or welding followed by grinding if the repairs are not detrimental to the end use of the plate.

INCIDENTAL ELEMENTS

Limitations of incidental elements involve special selection of scrap, additional manufacturing controls and analytical determinations and necessitate special quality practice. Orders to restrictive chemical limits are subject to negotiation.

SURFACE IMPERFECTIONS DISCLOSED BY PICKLING OR BLAST CLEANING

Plates are sometimes pickled or blast cleaned prior to surface inspection. Plates for such applications necessitate special surface conditioning and closer inspection than customarily employed and are processed as special surface quality plate.

SPECIAL TESTS

Macroetch, impact, segregation and homogeneity tests and magnetic particle inspection can be made before shipment. Special tests, if required, should be requested at the time of the inquiry.

MANUFACTURE—TESTS—INSPECTION

All plate is subject, during manufacture, to mill inspection and tests for control of quality and workmanship. Test specimens for physical and chemical tests prescribed by the specification to which the plate is produced are taken in duplicate from the parent plates as they are laid out for shearing to ordered size. Hundreds of tests are performed each day. Metallurgical test reports are furnished to customers as stipulated by the specification or order. All tests required to assure adherence to the specification are made before the shipment is released. Purchaser's inspection representative will be afforded all reasonable facilities to inspect material during manufacture and prior to shipment.

TABLE 3

KAISER SHEARED PLATE MILL STANDARD SIZE LIMITATIONS

STRUCTURAL GRADES

MAXIMUM LENGTH (INCHES)

Thick	Over 36″ to 42″	To 48″	To 54″	To 60″	To 66″	To 72″	To 78″	To 84″	To 90″	To 96″	Thick
3/16			480	480	400	360					3/16
1/4		480	480	480	480	480	420	400			1/4
5/16	480	480	480	480	480	480	480	480	480	420	5/16
3/8	480	480	480	480	480	480	480	480	480	480	3/8
7/16	480	480	480	480	480	480	480	480	480	480	7/16
1/2	480	480	480	480	480	480	480	480	480	480	1/2
9/16	480	480	480	480	480	480	480	480	480	480	9/16
5/8	480	480	480	480	480	480	480	480	480	480	5/8
11/16	480	480	480	480	480	480	480	480	480	458	11/16
3/4	480	480	480	480	480	480	480	480	448	420	3/4
7/8	480	480	480	480	480	480	443	411	384	360	7/8
1	480	480	480	480	456	420	384	360	336	315	1
1 1/8	480	480	480	451	407	373	344	320	298	273	1 1/8
1 1/4	480	480	448	402	366	336	310	288	263		1 1/4
1 3/8	480	458	407	366	333	305	282	261	244		1 3/8
1 1/2	480	420	373	336	305	280	258	240	224		1 1/2
1 3/4	411	360	320	288	261	240	221	205			1 3/4
2	360	315	280	252	229	210	192	180			2
2 1/4	320	280	248	224	203	186	172	160			2 1/4
2 1/2	288	252	224	201	183	168	155	144			2 1/2
2 3/4	262	229	203	183	166	152	141				2 3/4
3	240	210	186	168	152	140					3
3 1/4	221	193	172	155	141						3 1/4
3 1/2	205	180	160	144	130						3 1/2
3 3/4	192	168	149	134							3 3/4
4	180	157	140	126							4

Sheared plates up to 36″ wide are rolled in multiple widths and sheared to ordered size. Plates shorter than 96″ may be furnished by special arrangement.

Gas cut circles in thicknesses of 3/16″ through 2″, and in diameters within the range of widths shown for the thickness are available by special arrangement.

TABLE 4

KAISER U. M. PLATE

(LENGTH IN INCHES, AND WEIGHT PER FOOT IN LBS.)

Gauge	1/4" (.250)	5/16" (.312)	3/8" (.375)	1/2" (.500)	5/8" (.625)	3/4" (.750)	7/8" (.875)	1" (1.00)	1 1/4" (1.25)	1 1/2" (1.50)
Width in Inches	Max. .85 Carbon			Max. .60 Carbon						
	72" to 126" lengths or 168" to 252" lengths			120" to 480" lengths						
7	5.950	7.438	8.925	11.9	14.88	17.85	20.83	23.8	29.75	35.7
8	6.800	8.500	10.20	13.60	17.00	20.40	23.80	27.20	34.0	40.8
9	7.650	9.563	11.48	15.30	19.13	22.95	26.78	30.60	38.25	45.9
10	8.500	10.63	12.75	17.00	21.25	25.50	29.75	34.00	42.50	51.0
11	9.350	11.69	14.025	18.7	23.38	28.05	32.73	37.4	46.75	56.1
12	10.20	12.75	15.30	20.40	25.50	30.60	35.70	40.80	51.0	61.2
	Max. .25 Carbon			.....	.....	.....	.....	.....	....	....
13	11.05	13.81	16.575	.....	.....	.....	.....	.....	....	....
14	11.90	14.88	17.85	23.80	29.75	35.70	41.65	47.60	59.50	71.40
15	12.75*	15.94*	19.125	.....	.....	.....	.....	.....	.....	.....
16	13.60*	17.00*	20.40	27.20	34.00	40.80	47.60	54.40	68.00	81.60

Specifications of more than .25 Max. Carbon will be accepted in thicknesses over 3/8" upon a special inquiry basis only.

Quotations for intermediate widths and gauges will be furnished upon request.

All lengths for 1/4", 5/16" and 3/8" are to be shown as 72" to 126" or 168" to 252".

*All 1/4", 5/16", 3/8" sizes can be produced in coils except those marked by an asterisk.

QUALITY

Steel quality, as the term relates to plate products, is indicative of many conditions, such as degree of internal soundness, relative uniformity of mechanical property characteristics, chemical composition and relative freedom from injurious defects. Combinations of these conditions determine the quality of the plate.

The list of plate qualities shown on page 22 indicates grades of plate Kaiser Steel Corporation is prepared to furnish. Inquiries are invited for regular and special quality plates made to meet the requirements of any accepted standard specifications. Plates over .35 carbon and .60 manganese are, however, acceptable only as killed steel.

REGULAR QUALITY

Regular quality is commonly specified to chemical composition ranges and limits based on ladle analysis. When specified as stock steel plates, a maximum of 0.33% carbon may be furnished.

Plates furnished to chemistry, as stock plate, as mild steel plate, or other trade designations, are not customarily produced to mechanical property requirements nor are physical test reports covering such mechanical properties furnished.

SPECIAL QUALITY

Special quality plate has been developed for many classes of service. The production of quality plate for a specific service requires special manufacturing practices, additional metallurgical control and inspection procedures.

The following list of special plate qualities and their applications is given for convenient reference.

STRUCTURAL QUALITY plates are intended for application in structures such as bridges, buildings, structural steel for locomotives, railroad cars and other mobile equipment.

HOT PRESSING QUALITY plates are intended for ordinary hot pressing, flanging or bending work. They are not intended for deep drawing or cold forming, nor for pressure vessel construction.

COLD PRESSING QUALITY plates are made of soft steel, which can be bent or formed either longitudinally or transversely at ordinary temperature by good shop practice. Cold bending quality plates are of higher tensile strength and are used where greater design stresses with less severe forming are contemplated.

DRAWING QUALITY plates are produced of low carbon steel suitable for drawing into identified forms.

FORGING QUALITY plates are intended for forging, heat treating or similar purposes in which uniformity of composition and freedom from injurious defects are essential. Plates of this quality are produced by a killed steel practice to chemical ranges and limits.

FLANGE, FIREBOX, LOCOMOTIVE FLANGE, LOCOMOTIVE FIREBOX AND MARINE QUALITIES necessitate rigid controls and close supervision of mill practices, which are based on experience in producing each given grade of special quality plate, together with inspection at all stages in the process of manufacturing. The freedom and scope of application of steel for the several qualities are of necessity progressively limited as the end use becomes more severe.

Flange quality plates are intended for application in pressure vessels and for similar purposes except when exposed to fire or radiant heat.

Firebox quality plates are intended for application in pressure vessels when exposed to fire or radiant heat where they are subject to thermal and mechanical stresses. Firebox quality plates may also be used for unfired pressure vessels in lieu of flange quality and for similar purposes.

Locomotive flange quality plates are used in the construction of locomotive boilers.

Marine quality plates are intended for application in pressure vessels and combustion chambers of marine boilers and are commonly processed to meet the requirements of marine engineering inspection. This quality is made to a killed steel practice and with an additional discard.

TABLE 5

ALLOWABLE VARIATION IN THICKNESS

For Plates Over Two Inches in Thickness

SHEARED MILL AND UNIVERSAL MILL PLATES

Specified Thicknesses, Inches	Variations Over Specified Thickness for Widths Given, Inches			
	To 36 excl.	36 to 60 excl.	60 to 84 excl.	84 to 96 incl.
Over 2 to 3, excl.	1/16	3/32	7/64	1/8
3 to 4, excl.	5/64	3/32	7/64	1/8
4	3/32	1/8	9/64	9/64

Standard variation under specified thickness, 0.01 inches.

TABLE 6

ALLOWABLE VARIATION IN THICKNESS AND WEIGHT WHEN ORDERED TO THICKNESS

Plates Two Inches and Under in Thickness

RECTANGULAR SHEARED MILL AND UNIVERSAL MILL PLATE

Specified Thicknesses, Inches	Excess in Average Weight of Lots* for Widths Given in Inches, Expressed in Percentages of Nominal Weights				
	48 and under	48 excl. to 60 excl.	60 to 72 excl.	72 to 84 excl.	84 to 96 incl.
To 1/4 excl.	7.0	8.0	9.0	10.0	12.0
1/4 to 5/16 excl.	6.0	7.0	8.0	9.0	10.0
5/16 to 3/8 excl.	5.0	6.0	7.0	8.0	9.0
3/8 to 7/16 excl.	4.5	5.0	6.0	7.0	8.0
7/16 to 1/2 excl.	4.0	4.5	5.0	6.0	7.0
1/2 to 5/8 excl.	4.0	4.0	4.5	5.0	6.0
5/8 to 3/4 excl.	4.0	4.0	4.0	4.5	5.0
3/4 to 1 excl.	3.5	4.0	4.0	4.0	4.5
1 to 2 incl.	3.5	3.5	4.0	4.0	4.0

Standard variation under specified thickness, 0.01 inches.

Standard variations in overweight for circular and sketch plates are 25% greater than the amounts given in the above Tables.

Standard variations in overweight for single plates are 1⅓ times the amount indicated above.

The adopted standard density for rolled steel is 0.2833 pound per cubic inch.

*The term lot means all the plates of each tabular width and thickness group represented in each shipment.

TABLE 7

ALLOWABLE VARIATION IN WEIGHT WHEN ORDERED TO WEIGHT

Specified Weights, pounds per square foot	Variation in Average Weight of Lots* for Widths Given in Inches, Expressed in Percentages of the Specified Weights psf.									
	48 and under		48 excl. to 60 excl.		60 to 72 excl.		72 to 84 excl.		84 to 96 incl.	
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
To 10 excl.	4.0	3.0	4.5	3.0	5.0	3.0	5.5	3.0	6.0	3.0
10 to 12.5 excl.	4.0	3.0	4.5	3.0	5.0	3.0	5.5	3.0	6.0	3.0
12.5 to 15.0 excl.	4.0	3.0	4.0	3.0	4.5	3.0	5.0	3.0	5.5	3.0
15 to 17.5 excl.	3.5	3.0	3.5	3.0	4.0	3.0	4.5	3.0	5.0	3.0
17.5 to 20 excl.	3.5	2.5	3.5	2.5	3.5	3.0	4.0	3.0	4.5	3.0
20 to 25 excl.	3.5	2.5	3.5	2.5	3.5	3.0	3.5	3.0	4.0	3.0
25 to 30 excl.	3.0	2.5	3.5	2.5	3.5	2.5	3.5	3.0	3.5	3.0
30 to 40 excl.	3.0	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.5	2.0
40 to 81.6 incl.	2.5	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.5	2.0

Standard variations in overweight for circular and sketch plates are 25% greater than the amounts given in the above Tables.

Standard variations in overweight for single plates are 1⅛ times the amount indicated above.

The adopted standard density for rolled steel is 0.2833 pound per cubic inch.

*The term lot means all the plates of each tabular width and thickness group represented in each shipment.

TABLE 8

RESTRICTIVE THICKNESS TOLERANCES

For Plates Two Inches and Under in Thickness

Sheared Mill and Universal Mill Plates Over and Under

Tolerances in Decimals of an Inch

Specified Thickness, Inches	Variations* Over and Under Specified Thickness for Widths Given, in Inches			
	12 and under	Over 12 to 24 excl.	24 to 36 excl.	36 to 60 excl.
To ⅜ excl.	0.012	0.012	0.014	0.016
⅜ to ½ excl.	0.012	0.014	0.016	0.018
½ to ¾ excl.	0.014	0.016	0.018	0.020
¾ to 1 excl.	0.016	0.018	0.020	0.022
1 to 1½ excl.	0.020	0.022	0.024	0.026
1½ to 2 incl.	0.024	0.026	0.028	0.030

*Variation under of 0.01 inches is sometimes specified, in which case the variation over is equal to the sum of the over and under tolerances minus 0.01 inches.

TABLE 9

WIDTH AND LENGTH TOLERANCES

Sheared Mill Plates One and One-Half Inches and Under in Thickness

Shearing Length Only

Universal Mill Plates Two and One-Half Inches and Under in Thickness

Specified Dimensions, Inches		Variations over Specified Width and Length for Thickness, Inches, and Equivalent Weights Given							
		To 3/8 excl.		3/8 to 5/8 excl.		5/8 to 1 excl.		1 to 2 incl.*	
Widths	Lengths	To 15.3 Lb. per Sq. Ft. excl.		15.3 to 25.5 Lb. per Sq. Ft. excl.		25.5 to 40.8 Lb. per Sq. Ft. excl.		40.8 to 81.6 Lb. per Sq. Ft. incl.	
		Width	Length	Width	Length	Width	Length	Width	Length
To 60 excl.	To	3/8	1/2	7/16	5/8	1/2	3/4	5/8	1
60 to 84 excl.	120	7/16	5/8	1/2	11/16	5/8	7/8	3/4	1
84 to 96 incl.	excl.	1/2	3/4	5/8	7/8	3/4	1	1	1 1/8
To 60 excl.	120	3/8	3/4	1/2	7/8	5/8	1	3/4	1 1/8
60 to 84 excl.	to	1/2	3/4	5/8	7/8	3/4	1	7/8	1 1/4
84 to 96 incl.	240 excl.	9/16	7/8	11/16	15/16	13/16	1 1/8	1	1 3/8
To 60 excl.	240	3/8	1	1/2	1 1/8	5/8	1 1/4	3/4	1 1/2
60 to 84 excl.	to	1/2	1	5/8	1 1/8	3/4	1 1/4	7/8	1 1/2
84 to 96 incl.	360 excl.	9/16	1	11/16	1 1/8	7/8	1 3/8	1	1 1/2
To 60 excl.	360	7/16	1 1/8	1/2	1 1/4	5/8	1 3/8	3/4	1 5/8
60 to 84 excl.	to	1/2	1 1/4	5/8	1 3/8	3/4	1 1/2	7/8	1 5/8
84 to 96 incl.	480 excl.	9/16	1 1/4	3/4	1 3/8	7/8	1 1/2	1	1 7/8
To 60 excl.	480	7/16	1 1/4	1/2	1 1/2	5/8	1 5/8	3/4	1 7/8
60 to 84 excl.	to	1/2	1 3/8	5/8	1 1/2	3/4	1 5/8	7/8	1 7/8
84 to 96 incl.	600 excl.	5/8	1 3/8	3/4	1 1/2	7/8	1 5/8	1	1 7/8
To 60 excl.	600	1/2	1 3/4	5/8	1 7/8	3/4	1 7/8	7/8	2 1/4
60 to 84 excl.	to	5/8	1 3/4	3/4	1 7/8	7/8	1 7/8	1	2 1/4
84 to 96 incl.	720 incl.	5/8	1 3/4	3/4	1 7/8	7/8	1 7/8	1 1/8	2 1/4

Standard variation under specified width and length, 1/4 inch.

*Length tolerances apply also to U. M. plates up to 12 inches in width for thicknesses over 2 to 2 1/2 inches inclusive.

TABLE 10

ALLOWABLE CAMBER
SHEARED MILL AND UNIVERSAL MILL PLATES

Plates Two Inches and Under in Thickness

$$\text{1/8 in.} \times \frac{\text{number of feet of length}}{5}$$

TABLE 11

RESTRICTIVE SHEARING TOLERANCES

Plates One Inch and Under in Thickness

Width and Length of Sheared Plates: Length of Universal Mill Plates

Specified Thickness Inch	Variations Over Specified Width, In.	Variations Over Specified Length, In.	
	When Width is, In.	When Length is, In.	
	To 72, incl.	To 120 incl.	Over 120 to 240 incl.
To 3/8, excl.	1/8	3/16	5/16
3/8 to 3/4, excl.	3/16	1/4	5/16
3/4 to 1, incl.	1/4	5/16	3/8

Standard variation under specified widths and lengths, 1/8 inch.

TABLE 12

ALLOWABLE VARIATION IN ROLLED WIDTH

Plates Two Inches and Under in Thickness

UNIVERSAL MILL PLATES

Specified Dimensions, Inches	Variations Over Specified Width for Thickness, Inches, and Equivalent Weights Given			
	To 3/8 excl.	3/8 to 5/8, excl.	5/8 to 1, excl.	1 to 2, incl.
Width	To 15.3 Lb. per Sq. Ft. excl.	15.3 to 25.5 Lb. per Sq. Ft. excl.	25.5 to 40.8 Lb. per Sq. Ft. excl.	40.8 to 81.6 Lb. per Sq. Ft. excl.
Over 6 to 20, excl.	1/8	1/8	3/16	1/4
20 to 36, excl.	3/16	1/4	5/16	3/8
36 and over	5/16	3/8	7/16	1/2

Standard variation under specified width 1/8 inch.

TABLE 13

ALLOWABLE VARIATION IN WIDTH AND LENGTH

Gas Cut Rectangular Plates

Specified Thicknesses, Inches	Variations Over for All Specified Widths, or Lengths, Inch
To 2, excl.	1/2
2 to 4, excl.	5/8

These variations may be taken all under or divided over and under, if so specified.

Plates with universal rolled edges will be gas cut to length only.

TABLE 14

FLATNESS

Rectangular Sheared Mill, Universal Mill, Circular and Sketch Plates

Specified Thickness, Inches	Specified Weights, Lbs. per Sq. Ft.	Variations from a Flat Surface for Widths, Lengths or Diameters, Given, Inches					
		To 36 excl.	36 to 48 excl.	48 to 60 excl.	60 to 72 excl.	72 to 84 excl.	84 to 96 incl.
To 1/4 excl.	To 10.2 excl.	7/16	5/8	7/8	1	1 1/8	1 1/4
1/4 to 3/8 excl.	10.2 to 15.3 excl.	3/8	9/16	3/4	7/8	1	1 1/8
3/8 to 1/2 excl.	15.3 to 20.4 excl.	5/16	1/2	9/16	11/16	3/4	15/16
1/2 to 3/4 excl.	20.4 to 30.6 excl.	1/4	7/16	1/2	5/8	11/16	3/4
3/4 to 1 excl.	30.6 to 40.8 excl.	1/4	3/8	7/16	1/2	5/8	11/16
1 to 2 excl.	40.8 to 81.6 excl.	1/4	5/16	3/8	7/16	1/2	9/16
2 to 4 incl.	81.6	3/16	1/4	5/16	3/8	7/16	1/2

The shorter dimension specified is considered the width and the variation in flatness across the width should not exceed the tabular amount for that dimension.

The longer dimension specified is considered the length and the variation in flatness along the length should not exceed the tabular amount for that dimension.

When the length exceeds 144 in. the tolerances shown for 144 in. apply for any 12 ft. 0 in. of the specified width or length.

The variations given in above table apply to plates which have a specified maximum tensile strength of not over 72,000 lbs. per sq. in. or equivalent hardness and to Flange, Firebox and Marine Quality plates up to a specified maximum tensile strength of 90,000 lbs. per sq. in. For plates specified to higher tensile strength or hardness, the figures given in the table are customarily doubled.

The above table and notes also cover the variations for flatness of circular and sketch plates, based on the maximum dimensions.

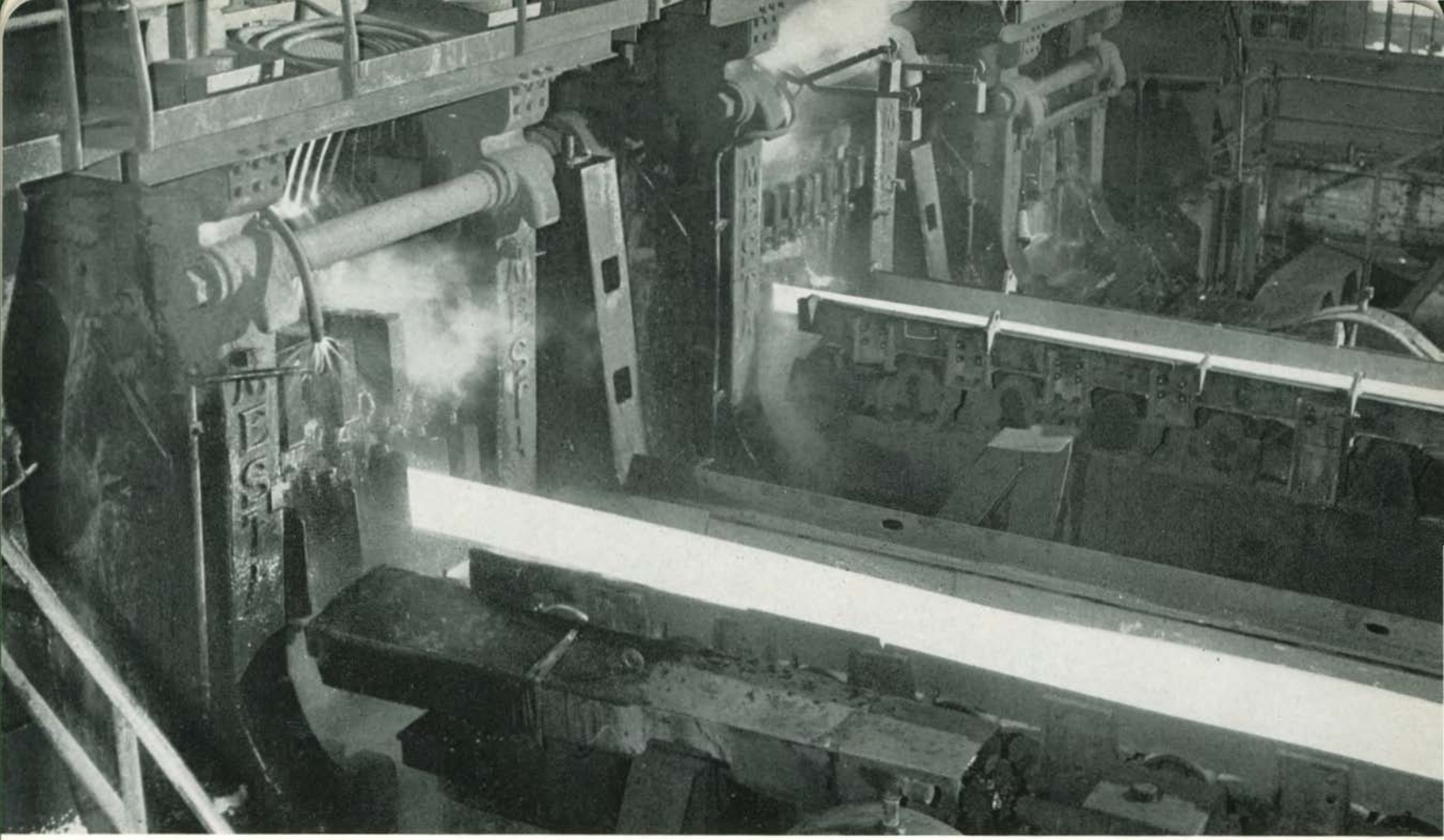
ORDERING PRACTICE FOR KAISER HOT ROLLED CARBON STEEL PLATES

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Plates should specify the following details:

1. Quantity.
2. Size.
3. Specification.
4. End use.
5. Required inspection, if other than mill inspection.
6. Special loading practices if applicable.
7. Shipping destination.
8. Required routing.
9. Requested delivery.
10. Distribution of shipping notices, invoices, and bills of lading.

Plates are invoiced on mill scale weights. In checking weight by the purchaser, one per cent is considered a variation in weight to account for difference in kind, type, location and accuracy of the scales and possible errors of the weighers.

In cases of large quantities of one size and thickness there is the possibility of error in count. For such lots, the count is considered as approximate and weight the more accurate.



The structural mill, shown above, produces a wide range of beams, angles, channels and other structural shapes.

Hot rolled structural shapes

STRUCTURAL SHAPES

Structural shapes is the general term applied to rolled flanged sections used in the construction of bridges, buildings, towers, ships, railroad rolling stock and for numerous other constructional purposes. In general they consist of equal and unequal leg angles, channels, I beams, H beams or column sections, wide flange beams, bulb angles and tee sections.

Kaiser Hot Rolled Structural Shapes are produced in both regular and special sections. Regular sections are those for which there is a popular and constant demand such as standard beams, channels, angles, column sections and wide flange beams. Special sections are those that, due to a fluctuating demand, are rolled at irregular intervals or require special rolls. Included in this group are the miscellaneous carbuilding and shipbuilding channels, bulb angles and tee sections.

Kaiser Structural Shapes are rolled on a 29″ cross country mill composed of a three-high rougher, a three-high intermediate stand and a two-high finishing mill. Structural shapes are rolled from heated blooms which first pass through the rougher taking the form of the pass in that set of rolls. By alternately reversing direction, the steel is progressively formed in following passes until its final shape is accomplished by the finishing rolls, after which the shape is sent to the hot saw for cutting to mill lengths. At this point, samples are taken for laboratory tests. After cooling, the shapes are straightened, inspected, sheared or cold sawed to ordered length and given final inspection before shipment.

Kaiser Wide Flange Beams have been developed as a result of requests made by hundreds of engineers, contractors and fabricators in the western states. They have been especially designed for rolling on the company's 29-inch structural mill, which is equipped with horizontal rolls. Kaiser Wide Flange Beams rolled on this type of mill are made somewhat heavier than other wide flange beams and the inside faces of the flanges are given a slight taper. Two sizes of beams in each group from 8 inches to 16 inches are offered. These beams have substantially the same depth and width as other wide flange beams and therefore are readily interchangeable in any normal steel structure.

The section modulus of the lighter sections about axis x—x and y—x will be found to be approximately 10 per cent and 3 per cent better, respectively, than other wide flange beams due to the increased weight which is in the flanges. The section modulus of the heavier sections in each group is approximately the same as other wide flange beams. These beams, therefore, may be used in the construction of any normal steel structure without sacrifice of efficiency. The 8 x 6½ Kaiser Wide Flange Beam sections will be found to be

useful as columns as well as beams. Their radii of gyration approximate those of similar sections and their area is 10 per cent greater.

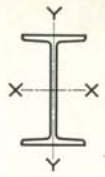
This range of Kaiser Wide Flange Beams, together with the H column sections and standard shapes offered by the company, makes available to engineers, contractors and fabricators a group of popular structural sections which can be used in the complete design and construction of many buildings, bridges and other steel structures.

In offering this wide range of structural shapes it is the aim of Kaiser Steel Corporation to render western industry an increased service and by frequent rollings provide a western source which has not before been available.

On the following pages are listed complete data on properties for designing and dimensions for detailing on all sizes of structural shapes produced by Kaiser Steel Corporation. Structural shapes of all sizes are purchased on the basis of the theoretical weight per foot. The weights of rolled steel shapes in the following tables are computed on the basis of one cubic foot of steel weighing 489.6 lbs. The weight per linear foot of the section is 3.4 times the sectional area in square inches.

TABLE 15

KAISER WF SHAPES
PROPERTIES FOR DESIGNING

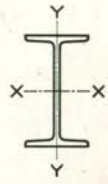


Nominal Size	Wt. per Foot	Area	Depth	FLANGE		Web Thickness	AXIS X-X			AXIS Y-Y		
				Width	Thickness		I	S	r	I	S	r
Inches	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
16 x 7	45.1	13.26	15.875	7.110	.487	.417	530.1	66.8	6.32	24.2	6.8	1.35
	38.7	11.39	15.875	6.992	.487	.299	490.8	61.9	6.56	22.9	6.5	1.42
14 x 6¾	38.1	11.18	13.875	6.852	.440	.389	346.7	49.9	5.57	19.2	5.6	1.31
	32.4	9.53	13.875	6.733	.440	.270	320.2	46.1	5.79	18.1	5.4	1.38
12 x 6½	32.5	9.54	12.000	6.570	.456	.310	238.1	39.7	5.00	17.8	5.4	1.37
	29.6	8.70	12.000	6.500	.456	.240	228.0	38.0	5.12	17.1	5.3	1.40
10 x 5¾	29.1	8.55	9.875	5.935	.389	.425	131.5	26.6	3.92	11.2	3.7	1.14
	22.9	6.73	9.875	5.750	.389	.240	116.6	23.6	4.16	19.9	3.5	1.22
8 x 6½	30.8	9.06	7.875	6.675	.454	.420	95.7	24.3	3.25	18.6	5.6	1.43
	26.1	7.68	7.875	6.500	.454	.245	88.6	22.5	3.40	17.1	5.2	1.49
8 x 5¼	22.5	6.61	8.000	5.395	.352	.375	68.3	17.1	3.23	7.5	2.8	1.08
	18.5	5.44	8.000	5.250	.352	.230	62.1	15.5	3.38	6.9	2.6	1.13

All Flanges have 6° taper and flange thickness is an average thickness.

TABLE 17

LIGHT COLUMNS OR H BEAMS
PROPERTIES FOR DESIGNING



Nominal Size	Wt. per Foot	Area of Sect.	Depth of Sect.	Width of Flange	Web Thickness	AXIS X-X			AXIS Y-Y		
						I	S	r	I	S	r
Inches	Lb.	In.^{2}	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
8 x 8	34.3	10.09	8.00	8.000	.375	115.5	28.9	3.40	35.1	8.8	1.87
	32.6	9.59	8.00	7.938	.313	112.8	28.2	3.45	34.2	8.6	1.90
6 x 6	22.5	6.62	6.00	6.063	.375	41.0	13.7	2.49	12.2	4.0	1.36
	20.0	5.88	6.00	5.938	.250	38.8	12.9	2.57	11.4	3.8	1.39
5 x 5	18.9	5.56	5.00	5.000	.313	23.8	9.5	2.08	7.8	3.1	1.20
4 x 4	13.8	3.99	4.00	4.000	.313	10.7	5.3	1.64	3.6	1.8	.95

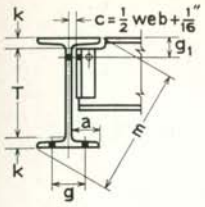


TABLE 16

KAISER WF SHAPES
DIMENSIONS FOR DETAILING

I

Nominal Size	Weight per Foot	Depth	FLANGE		WEB		DISTANCE						Usual Gauge g
			Width	Thick-ness	Thick-ness	Half Thick-ness	a	T	k	m	g1	c	
Inches	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
16 x 7	45.0	15 7/8	7 1/8	1/2	7/16	3/16	3 3/8	13 7/8	1	17 3/8	2 1/4	1/4	3 1/2
	38.6	15 7/8	7	1/2	5/16	1/8	3 3/8	13 7/8	1	17 3/8	2 1/4	3/16	3 1/2
14 x 6 3/4	38.0	13 7/8	6 7/8	7/16	3/8	3/16	3 1/4	12	15/16	15 1/2	2 1/4	1/4	3 1/2
	32.4	13 7/8	6 3/4	7/16	1/4	1/8	3 1/4	12	15/16	15 3/8	2 1/4	3/16	3 1/2
12 x 6 1/2	32.4	12	6 9/16	7/16	5/16	1/8	3 1/8	10 1/8	15/16	13 5/8	2 1/4	3/16	3 1/2
	29.5	12	6 1/2	7/16	1/4	1/8	3 1/8	10 1/8	15/16	13 5/8	2 1/4	3/16	3 1/2
10 x 5 3/4	29.1	9 7/8	5 15/16	3/8	7/16	3/16	2 3/4	8 1/4	13/16	11 1/2	2 1/4	1/4	2 3/4
	22.9	9 7/8	5 3/4	3/8	1/4	1/8	2 3/4	8 1/4	13/16	11 3/8	2 1/4	3/16	2 3/4
8 x 6 1/2	30.8	8	6 11/16	3/8	7/16	3/16	3 1/8	6 1/8	7/8	10 3/8	2 1/4	1/4	3 1/2
	26.1	8	6 1/2	3/8	1/4	1/8	3 1/8	6 1/8	7/8	10 1/4	2 1/4	3/16	3 1/2
8 x 5 1/4	22.4	8	5 3/8	3/8	3/8	3/16	2 1/2	6 1/2	3/4	9 5/8	2 1/4	1/4	2 3/4
	18.5	8	5 1/4	3/8	1/4	1/8	2 1/2	6 1/2	3/4	9 5/8	2 1/4	3/16	2 3/4

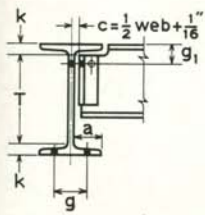


TABLE 18

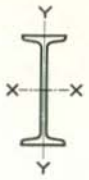
LIGHT COLUMNS OR H BEAMS
DIMENSIONS FOR DETAILING

I

Nominal Size	Weight per Foot	Depth	FLANGE		WEB		DISTANCE					Max. Flg. Rivet	Usual Gauge g
			Width	Thick-ness	Thick-ness	Half Thick-ness	a	T	k	g1	c		
Inches	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
8 x 8	34.3	8	8	7/16	3/8	3/16	3 7/8	6 1/4	7/8	2 1/2	1/4	7/8	5 1/2
	32.6	8	8	7/16	5/16	3/16	3 7/8	6 1/4	7/8	2 1/2	1/4	7/8	5 1/2
6 x 6	22.5	6	6 1/8	3/8	3/8	3/16	2 7/8	4 3/8	13/16	2 1/4	1/4	7/8	3 1/2
	20	6	6	3/8	1/4	1/8	2 7/8	4 3/8	13/16	2 1/4	3/16	7/8	3 1/2
5 x 5	18.9	5	5	7/16	5/16	3/16	2 3/8	3 3/8	13/16	2 1/4	1/4	3/4	2 3/4
4 x 4	13.8	4	4	3/8	5/16	3/16	1 7/8	2 1/2	3/4	2	1/4	5/8	2 1/4

I

TABLE 19
AMERICAN STANDARD BEAMS
PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	FLANGE		Web Thick-ness	AXIS X-X			AXIS Y-Y		
				Width	Thick-ness		I	S	r	I	S	r
Inches	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.
20 x 6¼	75.0	21.90	20.00	6.391	.789	.641	1263.5	126.3	7.60	30.1	9.4	1.17
	65.4	19.08	20.00	6.250	.789	.500	1169.5	116.9	7.83	27.9	8.9	1.21
18 x 6	70.0	20.46	18.00	6.251	.691	.711	917.5	101.9	6.70	24.5	7.8	1.09
	54.7	15.94	18.00	6.000	.691	.460	795.5	88.4	7.07	21.2	7.1	1.15
15 x 5½	50.0	14.59	15.00	5.640	.622	.550	481.1	64.2	5.74	16.0	5.7	1.05
	42.9	12.49	15.00	5.500	.622	.410	441.8	58.9	5.95	14.6	5.3	1.08
12 x 5	35.0	10.20	12.00	5.078	.544	.428	227.0	37.8	4.72	10.0	3.9	.99
	31.8	9.26	12.00	5.000	.544	.350	215.8	36.0	4.83	9.5	3.8	1.01
10 x 4⅝	35.0	10.22	10.00	4.944	.491	.594	145.8	29.2	3.78	8.5	3.4	.91
	25.4	7.38	10.00	4.660	.491	.310	122.1	24.4	4.07	6.9	3.0	.97
8 x 4	23.0	6.71	8.00	4.171	.425	.441	64.2	16.0	3.09	4.4	2.1	.81
	18.4	5.34	8.00	4.000	.425	.270	56.9	14.2	3.26	3.8	1.9	.84
6 x 3⅜	17.25	5.02	6.00	3.565	.359	.465	26.0	8.7	2.28	2.3	1.3	.68
	12.5	3.61	6.00	3.330	.359	.230	21.8	7.3	2.46	1.8	1.1	.72
5 x 3	14.75	4.29	5.00	3.284	.326	.494	15.0	6.0	1.87	1.7	1.0	.63
	10.0	2.87	5.00	3.000	.326	.210	12.1	4.8	2.05	1.2	.82	.65
4 x 2⅝	9.5	2.76	4.00	2.796	.293	.326	6.7	3.3	1.56	.91	.65	.58
	7.7	2.21	4.00	2.660	.293	.190	6.0	3.0	1.64	.77	.58	.59

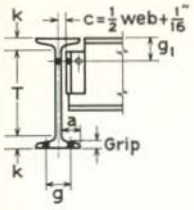


TABLE 20

AMERICAN STANDARD BEAMS

DIMENSIONS FOR DETAILING

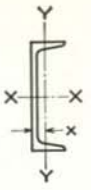
I

Depth of Section	Weight per Foot	FLANGE		WEB		DISTANCE					Grip	Max. Fl. Rivet	Usual Gauge g
		Width	Mean Thickness	Thickness	Half Thickness	a	T	k	g_1	c			
Inches	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
20	75.0	6 3/8	13/16	5/8	5/16	2 7/8	16 7/8	1 9/16	3	3/8	13/16	7/8	3 1/2
	65.4	6 1/4	13/16	1/2	1/4	2 7/8	16 7/8	1 9/16	3	5/16	3/4	7/8	3 1/2
18	70.0	6 1/4	11/16	3/4	3/8	2 3/4	15 1/4	1 3/8	2 3/4	7/16	11/16	7/8	3 1/2
	54.7	6	11/16	1/2	1/4	2 3/4	15 1/4	1 3/8	2 3/4	5/16	11/16	7/8	3 1/2
15	50.0	5 5/8	5/8	9/16	5/16	2 1/2	12 1/2	1 1/4	2 3/4	3/8	9/16	3/4	3 1/2
	42.9	5 1/2	5/8	7/16	1/4	2 1/2	12 1/2	1 1/4	2 3/4	5/16	9/16	3/4	3 1/2
12	35.0	5 1/8	9/16	7/16	1/4	2 3/8	9 3/4	1 1/8	2 1/2	5/16	1/2	3/4	3
	31.8	5	9/16	3/8	3/16	2 3/8	9 3/4	1 1/8	2 1/2	1/4	1/2	3/4	3
10	35.0	5	1/2	5/8	5/16	2 1/8	8	1	2 1/2	3/8	1/2	3/4	2 3/4
	25.4	4 5/8	1/2	5/16	3/16	2 1/8	8	1	2 1/2	1/4	1/2	3/4	2 3/4
8	23.0	4 1/8	7/16	7/16	1/4	1 7/8	6 1/4	7/8	2 1/4	5/16	7/16	3/4	2 1/4
	18.4	4	7/16	5/16	1/8	1 7/8	6 1/4	7/8	2 1/4	3/16	7/16	3/4	2 1/4
6	17.25	3 5/8	3/8	1/2	1/4	1 1/2	4 1/2	3/4	2	5/16	3/8	5/8	2
	12.5	3 3/8	3/8	1/4	1/8	1 1/2	4 1/2	3/4	2	3/16	5/16		
5	14.75	3 1/4	5/16	1/2	1/4	1 3/8	3 5/8	11/16	2	5/16	5/16	1/2	1 3/4
	10.0	3	5/16	1/4	1/8	1 3/8	3 5/8	11/16	2	3/16	5/16	1/2	1 3/4
4	9.5	2 3/4	5/16	5/16	3/16	1 1/4	2 3/4	5/8	2	1/4	5/16	1/2	1 1/2
	7.7	2 5/8	5/16	3/16	1/8	1 1/4	2 3/4	5/8	2	3/16	5/16		

TABLE 21

AMERICAN STANDARD CHANNELS

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	FLANGE		Web Thickness	AXIS X-X			AXIS Y-Y			
				Width	Aver. Thickness		I	S	r	I	S	r	x
Inches	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
15 x 3⅜	50.0	14.64	15.00	3.716	.650	.716	401.4	53.6	5.24	11.2	3.8	.87	.80
	40.0	11.70	15.00	3.520	.650	.520	346.3	46.2	5.44	9.3	3.4	.89	.78
	33.9	9.90	15.00	3.400	.650	.400	312.6	41.7	5.62	8.2	3.2	.91	.79
12 x 3	30.0	8.79	12.00	3.170	.501	.510	161.2	26.9	4.28	5.2	2.1	.77	.68
	25.0	7.32	12.00	3.047	.501	.387	143.5	23.9	4.43	4.5	1.9	.79	.68
	20.7	6.03	12.00	2.940	.501	.280	128.1	21.4	4.61	3.9	1.7	.81	.70
10 x 2⅝	25.0	7.33	10.00	2.886	.436	.526	90.7	18.1	3.52	3.4	1.5	.68	.62
	20.0	5.86	10.00	2.739	.436	.379	78.5	15.7	3.66	2.8	1.3	.70	.61
	15.3	4.47	10.00	2.600	.436	.240	66.9	13.4	3.87	2.3	1.2	.72	.64
8 x 2¼	18.75	5.49	8.00	2.527	.390	.487	43.7	10.9	2.82	2.0	1.0	.60	.57
	13.75	4.02	8.00	2.343	.390	.303	35.8	9.0	2.99	1.5	.86	.62	.56
	11.5	3.36	8.00	2.260	.390	.220	32.3	8.1	3.10	1.3	.79	.63	.58
7 x 2⅛	14.75	4.32	7.00	2.299	.366	.419	27.1	7.7	2.51	1.4	.79	.57	.53
	12.25	3.58	7.00	2.194	.366	.314	24.1	6.9	2.59	1.2	.71	.58	.53
	9.8	2.85	7.00	2.090	.366	.210	21.1	6.0	2.72	.98	.63	.59	.55
6 x 2	13.0	3.81	6.00	2.157	.343	.437	17.3	5.8	2.13	1.1	.65	.53	.52
	10.5	3.07	6.00	2.034	.343	.314	15.1	5.0	2.22	.87	.57	.53	.50
	8.2	2.39	6.00	1.920	.343	.200	13.0	4.3	2.34	.70	.50	.54	.52
5 x 1¾	9.0	2.63	5.00	1.885	.320	.325	8.8	3.5	1.83	.64	.45	.49	.48
	6.7	1.95	5.00	1.750	.320	.190	7.4	3.0	1.95	.48	.38	.50	.49
4 x 1⅝	7.25	2.12	4.00	1.720	.296	.320	4.5	2.3	1.47	.44	.35	.46	.46
	5.4	1.56	4.00	1.580	.296	.180	3.8	1.9	1.56	.32	.29	.45	.46
3 x 1½	5.0	1.46	3.00	1.498	.273	.258	1.8	1.2	1.12	.25	.24	.41	.44
	4.1	1.19	3.00	1.410	.273	.170	1.6	1.1	1.17	.20	.21	.41	.44

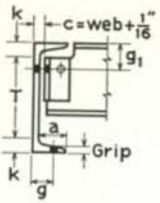


TABLE 22

AMERICAN STANDARD CHANNELS

DIMENSIONS FOR DETAILING

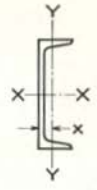
Depth of Section	Weight per Foot	FLANGE		WEB		DISTANCE					Grip	Max. Flange Rivet	Usual Gauge g
		Width	Mean Thickness	Thickness	Half Thickness	a	T	k	g_1	c			
Inches	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
15	50.0	3 3/4	5/8	3/4	3/8	3	12 3/8	1 5/16	2 3/4	13/16	5/8	1	2 1/4
	40.0	3 1/2	5/8	9/16	1/4	3	12 3/8	1 5/16	2 3/4	5/8	5/8	1	2
	33.9	3 3/8	5/8	7/16	3/16	3	12 3/8	1 5/16	2 3/4	1/2	5/8	1	2
12	30.0	3 1/8	1/2	1/2	1/4	2 5/8	9 7/8	1 1/16	2 1/2	9/16	1/2	7/8	1 3/4
	25.0	3	1/2	3/8	3/16	2 5/8	9 7/8	1 1/16	2 1/2	7/16	1/2	7/8	1 3/4
	20.7	3	1/2	5/16	1/8	2 5/8	9 7/8	1 1/16	2 1/2	3/8	1/2	7/8	1 3/4
10	25.0	2 7/8	7/16	9/16	1/4	2 3/8	8 1/8	15/16	2 1/2	5/8	7/16	3/4	1 3/4
	20.0	2 3/4	7/16	3/8	3/16	2 3/8	8 1/8	15/16	2 1/2	7/16	7/16	3/4	1 1/2
	15.3	2 5/8	7/16	1/4	1/8	2 3/8	8 1/8	15/16	2 1/2	5/16	7/16	3/4	1 1/2
8	18.75	2 1/2	3/8	1/2	1/4	2	6 3/8	13/16	2 1/4	9/16	3/8	3/4	1 1/2
	13.75	2 3/8	3/8	5/16	3/16	2	6 3/8	13/16	2 1/4	3/8	3/8	3/4	1 3/8
	11.5	2 1/4	3/8	1/4	1/8	2	6 3/8	13/16	2 1/4	5/16	3/8	3/4	1 3/8
7	14.75	2 1/4	3/8	7/16	1/4	1 7/8	5 3/8	13/16	2	1/2	3/8	5/8	1 1/4
	12.25	2 1/4	3/8	5/16	3/16	1 7/8	5 3/8	13/16	2	3/8	3/8	5/8	1 1/4
	9.8	2 1/8	3/8	1/4	1/8	1 7/8	5 3/8	13/16	2	5/16	3/8	5/8	1 1/4
6	13.0	2 1/8	3/8	7/16	1/4	1 3/4	4 1/2	3/4	2	1/2	5/16	5/8	1 3/8
	10.5	2	3/8	5/16	3/16	1 3/4	4 1/2	3/4	2	3/8	3/8	5/8	1 1/8
	8.2	1 7/8	3/8	3/16	1/8	1 3/4	4 1/2	3/4	2	1/4	5/16	5/8	1 1/8
5	9.0	1 7/8	5/16	5/16	3/16	1 1/2	3 5/8	1 1/16	2	3/8	5/16	1/2	1 1/8
	6.7	1 3/4	5/16	3/16	1/8	1 1/2	3 5/8	1 1/16	2	1/4	5/16	1/2	1 1/8
4	7.25	1 3/4	5/16	5/16	3/16	1 3/8	2 3/4	5/8	2	3/8	5/16	1/2	1
	5.4	1 5/8	5/16	3/16	1/8	1 3/8	2 3/4	5/8	2	1/4	1/4	1/2	1
3	5.0	1 1/2	1/4	1/4	1/8	1 1/4	1 3/4	5/8		5/16	1/4	1/2	7/8
	4.1	1 3/8	1/4	3/16	1/8	1 1/4	1 3/4	5/8		1/4	1/4		

TABLE 23

CHANNELS

CARBUILDING AND SHIPBUILDING

PROPERTIES FOR DESIGNING



Nominal Size	Weight per Foot	Area	Depth	FLANGE		Web Thickness	AXIS X-X			AXIS Y-Y			
				Width	Aver. Thickness		I	S	r	I	S	r	x
Inches	Lb.	In.^{2}	In.	In.	In.	In.	In.^{4}	In.^{3}	In.	In.^{4}	In.^{3}	In.	In.
18 x 4	58.0	16.98	18.00	4.200	.625	.700	670.7	74.5	6.29	18.5	5.6	1.04	.88
	51.9	15.18	18.00	4.100	.625	.600	622.1	69.1	6.40	17.1	5.3	1.06	.87
	45.8	13.38	18.00	4.000	.625	.500	573.5	63.7	6.55	15.8	5.1	1.09	.89
	42.7	12.48	18.00	3.950	.625	.450	549.2	61.0	6.64	15.0	4.9	1.10	.90
13 x 4	50.0	14.66	13.00	4.412	.610	.787	312.9	48.1	4.62	16.7	4.9	1.07	.98
	40.0	11.71	13.00	4.185	.610	.560	271.4	41.7	4.82	13.9	4.3	1.09	.97
	35.0	10.24	13.00	4.072	.610	.447	250.7	38.6	4.95	12.5	4.0	1.10	.99
	31.8	9.30	13.00	4.000	.610	.375	237.5	36.5	5.05	11.6	3.9	1.11	1.01
12 x 4	45.0	13.24	12.00	4.000	.700	.700	248.4	41.4	4.37	16.0	5.4	1.11	1.05
	40.0	11.70	12.00	3.890	.700	.590	232.6	38.8	4.46	14.5	5.1	1.11	1.05
	35.0	10.22	12.00	3.767	.700	.467	214.9	35.8	4.58	12.9	4.8	1.12	1.07
12 x 3½	37.0	10.80	12.00	3.600	.600	.600	203.4	33.9	4.34	10.3	3.8	.98	.89
	32.9	9.60	12.00	3.500	.600	.500	189.0	31.5	4.44	9.4	3.6	.99	.89
	30.9	9.00	12.00	3.450	.600	.450	181.8	30.3	4.50	8.9	3.5	.99	.90
10 x 4	33.6	9.80	10.00	4.100	.575	.575	138.0	27.6	3.75	13.7	4.6	1.18	1.11
	28.5	8.30	10.00	3.950	.575	.425	125.5	25.1	3.89	11.8	4.2	1.19	1.15

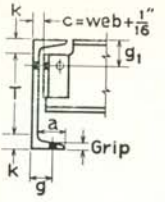


TABLE 24

CHANNELS

CARBUILDING AND SHIPBUILDING

DIMENSIONS FOR DETAILING

[

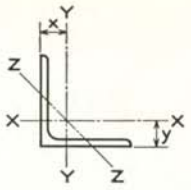
Depth of Section	Weight per Foot	FLANGE		WEB		DISTANCE					Grip	Max. Flange Rivet	Usual Gauge g
		Width	Mean Thickness	Thickness	Half Thickness	a	T	k	g_1	c			
Inches	Lb.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
18	58.0	4 1/4	5/8	11/16	3/8	3 1/2	15 3/8	1 5/16	2 3/4	3/4	5/8	1	2 1/2
	51.9	4 1/8	5/8	5/8	5/16	3 1/2	15 3/8	1 5/16	2 3/4	11/16	5/8	1	2 1/2
	45.8	4	5/8	1/2	1/4	3 1/2	15 3/8	1 5/16	2 3/4	9/16	5/8	1	2 1/2
	42.7	4	5/8	7/16	1/4	3 1/2	15 3/8	1 5/16	2 3/4	1/2	5/8	1	2 1/2
13	50.0	4 3/4	5/8	13/16	7/16	3 5/8	10 3/8	1 5/16	2 3/4	7/8	5/8	1	2 1/2
	40.0	4 1/2	5/8	9/16	5/16	3 5/8	10 3/8	1 5/16	2 3/4	5/8	5/8	1	2 1/2
	35.0	4 1/8	5/8	7/16	1/4	3 5/8	10 3/8	1 5/16	2 3/4	1/2	9/16	1	2 1/2
	31.8	4	5/8	3/8	3/16	3 5/8	10 3/8	1 5/16	2 3/4	7/16	9/16	1	2 1/2
12	45.0	4	11/16	11/16	3/8	3 3/8	9 1/2	1 1/4	2 1/2	3/4	11/16	1	2 1/2
	40.0	3 7/8	11/16	5/8	5/16	3 3/8	9 1/2	1 1/4	2 1/2	11/16	11/16	1	2 1/2
	35.0	3 3/4	11/16	1/2	1/4	3 3/8	9 1/2	1 1/4	2 1/2	9/16	11/16	1	2 1/2
12	37.0	3 5/8	5/8	5/8	5/16	3	9 1/2	1 1/4	2 1/2	11/16	5/8	7/8	2 1/4
	32.9	3 1/2	5/8	1/2	1/4	3	9 1/2	1 1/4	2 1/2	9/16	9/16	7/8	2 1/4
	30.9	3 1/2	5/8	7/16	1/4	3	9 1/2	1 1/4	2 1/2	1/2	9/16	7/8	2 1/4
10	33.6	4 1/8	9/16	9/16	5/16	3 1/2	7 5/8	1 3/16	2 1/2	5/8	9/16	7/8	2
	28.5	4	9/16	7/16	1/4	3 1/2	7 5/8	1 3/16	2 1/2	1/2	9/16	7/8	2

TABLE 25

ANGLES

EQUAL LEGS

PROPERTIES FOR DESIGNING



Size	Thick-ness	Weight per Ft.	Area	AXIS X-X AND AXIS Y-Y				AXIS Z-Z
				I	S	r	x or y	r
In.	In.	Lb.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.
8 x 8	1⅛	56.9	16.73	98.0	17.5	2.42	2.41	1.56
	1	51.0	15.00	89.0	15.8	2.44	2.37	1.56
	⅞	45.0	13.23	79.6	14.0	2.45	2.32	1.57
	¾	38.9	11.44	69.7	12.2	2.47	2.28	1.57
	⅝	32.7	9.61	59.4	10.3	2.49	2.23	1.58
	½	26.4	7.75	48.6	8.4	2.50	2.19	1.59
6 x 6	1	37.4	11.00	35.5	8.6	1.80	1.86	1.17
	⅞	33.1	9.73	31.9	7.6	1.81	1.82	1.17
	¾	28.7	8.44	28.2	6.7	1.83	1.78	1.17
	⅝	24.2	7.11	24.2	5.7	1.84	1.73	1.18
	½	19.6	5.75	19.9	4.6	1.86	1.68	1.18
	⅜	14.9	4.36	15.4	3.5	1.88	1.64	1.19
5 x 5	¾	23.6	6.94	15.7	4.5	1.51	1.52	.97
	⅝	20.0	5.86	13.6	3.9	1.52	1.48	.98
	½	16.2	4.75	11.3	3.2	1.54	1.43	.98
	⅜	12.3	3.61	8.7	2.4	1.56	1.39	.99
4 x 4	¾	18.5	5.44	7.7	2.8	1.19	1.27	.78
	⅝	15.7	4.61	6.7	2.4	1.20	1.23	.78
	½	12.8	3.75	5.6	2.0	1.22	1.18	.78
	⅜	9.8	2.86	4.4	1.5	1.23	1.14	.79
	5/16	8.2	2.40	3.7	1.3	1.24	1.12	.79
	¼	6.6	1.94	3.0	1.1	1.25	1.09	.80
3½ x 3½	½	11.1	3.25	3.6	1.5	1.06	1.06	.68
	⅜	8.5	2.48	2.9	1.2	1.07	1.01	.69
	5/16	7.2	2.09	2.5	.98	1.08	.99	.69
	¼	5.8	1.69	2.0	.79	1.09	.97	.69
3 x 3	½	9.4	2.75	2.2	1.1	.90	.93	.58
	⅜	7.2	2.11	1.8	.83	.91	.89	.58
	5/16	6.1	1.78	1.5	.71	.92	.87	.59
	¼	4.9	1.44	1.2	.58	.93	.84	.59
	3/16	3.71	1.09	.96	.44	.94	.82	.59
2½ x 2½	½	7.7	2.25	1.2	.72	.74	.81	.49
	⅜	5.9	1.73	.98	.57	.75	.76	.49
	5/16	5.0	1.47	.85	.48	.76	.74	.49
	¼	4.1	1.19	.70	.39	.77	.72	.49
	3/16	3.07	.90	.55	.30	.78	.69	.49
2 x 2	⅜	4.7	1.36	.48	.35	.59	.64	.39
	5/16	3.92	1.15	.42	.30	.60	.61	.39
	¼	3.19	.94	.35	.25	.61	.59	.39
	3/16	2.44	.71	.27	.19	.62	.57	.39

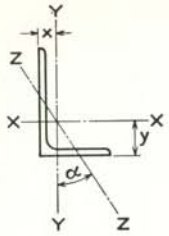


TABLE 26

ANGLES

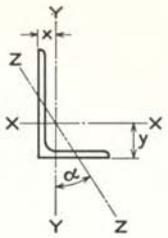
UNEQUAL LEGS

PROPERTIES FOR DESIGNING

Size	Thick-ness	Wt. per Ft.	Area	AXIS X-X				AXIS Y-Y				AXIS Z-Z	
				I	S	r	y	I	S	r	x	r	Tan α
Inches	In.	Lb.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.	
9 x 4	5/8	26.3	7.73	64.9	11.5	2.90	3.36	8.3	2.6	1.04	.86	.85	.216
	9/16	23.8	7.00	59.1	10.4	2.91	3.33	7.6	2.4	1.04	.83	.85	.218
	1/2	21.3	6.25	53.2	9.3	2.92	3.31	6.9	2.2	1.05	.81	.85	.220
8 x 6	1	44.2	13.00	80.8	15.1	2.49	2.65	38.8	8.9	1.73	1.65	1.28	.543
	7/8	39.1	11.48	72.3	13.4	2.51	2.61	34.9	7.9	1.74	1.61	1.28	.547
	3/4	33.8	9.94	63.4	11.7	2.53	2.56	30.7	6.9	1.76	1.56	1.29	.551
	5/8	28.5	8.36	54.1	9.9	2.54	2.52	26.3	5.9	1.77	1.52	1.29	.554
	1/2	23.0	6.75	44.3	8.0	2.56	2.47	21.7	4.8	1.79	1.47	1.30	.558
	7/16	20.2	5.93	39.2	7.1	2.57	2.45	19.3	4.2	1.80	1.45	1.31	.560
8 x 4	1	37.4	11.00	69.6	14.1	2.52	3.05	11.6	3.9	1.03	1.05	.85	.247
	7/8	33.1	9.73	62.5	12.5	2.53	3.00	10.5	3.5	1.04	1.00	.85	.253
	3/4	28.7	8.44	54.9	10.9	2.55	2.95	9.4	3.1	1.05	.95	.85	.258
	5/8	24.2	7.11	46.9	9.2	2.57	2.91	8.1	2.6	1.07	.91	.86	.262
	1/2	19.6	5.75	38.5	7.5	2.59	2.86	6.7	2.2	1.08	.86	.86	.267
	7/16	17.2	5.06	34.1	6.6	2.60	2.83	6.0	1.9	1.09	.83	.87	.269
7 x 4	3/4	26.2	7.69	37.8	8.4	2.22	2.51	9.1	3.0	1.09	1.01	.86	.324
	5/8	22.1	6.48	32.4	7.1	2.24	2.46	7.8	2.6	1.10	.96	.86	.329
	1/2	17.9	5.25	26.7	5.8	2.25	2.42	6.5	2.1	1.11	.92	.87	.335
	3/8	13.6	3.98	20.6	4.4	2.27	2.37	5.1	1.6	1.13	.87	.88	.339
6 x 4	7/8	27.2	7.98	27.7	7.2	1.86	2.12	9.8	3.4	1.11	1.12	.86	.421
	3/4	23.6	6.94	24.5	6.3	1.88	2.08	8.7	3.0	1.12	1.08	.86	.428
	5/8	20.0	5.86	21.1	5.3	1.90	2.03	7.5	2.5	1.13	1.03	.86	.435
	1/2	16.2	4.75	17.4	4.3	1.91	1.99	6.3	2.1	1.15	.99	.87	.440
	3/8	12.3	3.61	13.5	3.3	1.93	1.94	4.9	1.6	1.17	.94	.88	.446
5 x 3 1/2	3/4	19.8	5.81	13.9	4.3	1.55	1.75	5.6	2.2	.98	1.00	.75	.464
	5/8	16.8	4.92	12.0	3.7	1.56	1.70	4.8	1.9	.99	.95	.75	.472
	1/2	13.6	4.00	10.0	3.0	1.58	1.66	4.1	1.6	1.01	.91	.75	.479
	3/8	10.4	3.05	7.8	2.3	1.60	1.61	3.2	1.2	1.02	.86	.76	.486
	5/16	8.7	2.56	6.6	1.9	1.61	1.59	2.7	1.0	1.03	.84	.76	.489
5 x 3	5/8	15.7	4.61	11.4	3.5	1.57	1.80	3.1	1.4	.81	.80	.64	.350
	1/2	12.8	3.75	9.5	2.9	1.59	1.75	2.6	1.1	.83	.75	.65	.357
	3/8	9.8	2.86	7.4	2.2	1.61	1.70	2.0	.89	.84	.70	.65	.364
	5/16	8.2	2.40	6.3	1.9	1.61	1.68	1.8	.75	.85	.68	.66	.368

TABLE 26—(Continued)

ANGLES
UNEQUAL LEGS
PROPERTIES FOR DESIGNING



Size	Thick-ness	Weight per Ft.	Area	AXIS X-X				AXIS Y-Y				AXIS Z-Z	
				I	S	r	y	I	S	r	x	r	Tan α
Inches	In.	Lb.	In.^{2}	In.^{4}	In.^{3}	In.	In.	In.^{4}	In.^{3}	In.	In.	In.	
4x3	1/2	11.1	3.25	5.1	1.9	1.25	1.33	2.4	1.1	.86	.83	.64	.543
	3/8	8.5	2.48	4.0	1.5	1.26	1.28	1.9	.87	.88	.78	.64	.551
	5/16	7.2	2.09	3.4	1.2	1.27	1.26	1.7	.73	.89	.76	.65	.554
	1/4	5.8	1.69	2.8	1.0	1.28	1.24	1.4	.60	.90	.74	.65	.558
3 1/2x3	1/2	10.2	3.00	3.5	1.5	1.07	1.13	2.3	1.1	.88	.88	.62	.714
	3/8	7.9	2.30	2.7	1.1	1.09	1.08	1.9	.85	.90	.83	.62	.721
	5/16	6.6	1.93	2.3	.95	1.10	1.06	1.6	.72	.90	.81	.63	.724
	1/4	5.4	1.56	1.9	.78	1.11	1.04	1.3	.59	.91	.79	.63	.727
3 1/2x2 1/2	1/2	9.4	2.75	3.2	1.4	1.09	1.20	1.4	.76	.70	.70	.53	.486
	3/8	7.2	2.11	2.6	1.1	1.10	1.16	1.1	.59	.72	.66	.54	.496
	5/16	6.1	1.78	2.2	.93	1.11	1.14	.94	.50	.73	.64	.54	.501
	1/4	4.9	1.44	1.8	.75	1.12	1.11	.78	.41	.74	.61	.54	.506
3x2 1/2	1/2	8.5	2.50	2.1	1.0	.91	1.00	1.3	.74	.72	.75	.52	.667
	3/8	6.6	1.92	1.7	.81	.93	.96	1.0	.58	.74	.71	.52	.676
	5/16	5.6	1.62	1.4	.69	.94	.93	.90	.49	.74	.68	.53	.680
	1/4	4.5	1.31	1.2	.56	.95	.91	.74	.40	.75	.66	.53	.684
3x2	1/2	7.7	2.25	1.9	1.0	.92	1.08	.67	.47	.55	.58	.43	.414
	3/8	5.9	1.73	1.5	.78	.94	1.04	.54	.37	.56	.54	.43	.428
	5/16	5.0	1.47	1.3	.66	.95	1.02	.47	.32	.57	.52	.43	.435
	1/4	4.1	1.19	1.1	.54	.95	.99	.39	.26	.57	.49	.43	.440
	3/16	3.07	.90	.84	.41	.97	.97	.31	.20	.58	.47	.44	.446
2 1/2x2	3/8	5.3	1.55	.91	.55	.77	.83	.51	.36	.58	.58	.42	.614
	5/16	4.5	1.31	.79	.47	.78	.81	.45	.31	.58	.56	.42	.620
	1/4	3.62	1.06	.65	.38	.78	.79	.37	.25	.59	.54	.42	.626
	3/16	2.75	.81	.51	.29	.79	.76	.29	.20	.60	.51	.43	.631
2 1/2x1 1/2	5/16	3.92	1.15	.71	.44	.79	.90	.19	.17	.41	.40	.32	.349
	1/4	3.19	.94	.59	.36	.79	.88	.16	.14	.41	.38	.32	.357
	3/16	2.44	.72	.46	.28	.80	.85	.13	.11	.42	.35	.33	.364
2x1 1/2	3/8	3.99	1.17	.43	.34	.61	.71	.21	.20	.42	.46	.32	.527
	5/16	3.39	1.00	.38	.29	.62	.69	.18	.17	.42	.44	.32	.535
	1/4	2.77	.81	.32	.24	.62	.66	.15	.14	.43	.41	.32	.543
	3/16	2.12	.62	.25	.18	.63	.64	.12	.11	.44	.39	.32	.551

ROLLING PRACTICE—STRUCTURAL SHAPES

Kaiser shapes are rolled to conform to the requirements of standard structural specifications for bridges and buildings, for ships, for locomotives and cars, for structural silicon steel or high strength low alloy structural steel (Kaisaloy). Material conforming to other specifications may be furnished by special arrangement.

The dimensions and weights of shapes published in this catalog are theoretical and are subject to the usual industry variations.

All Kaiser shapes are normally produced in lengths up to 65 feet. Longer lengths are subject to special arrangement.

Fig. 1

Fig. 3

Fig. 2

Fig. 4

Figures 1 to 4 illustrate the method of increasing the areas and weights of Kaiser Wide Flange Shapes, Column Sections, Standard Beams, and Channels. The thickness of the web may be changed with a corresponding change in the flange width.

Fig. 5

In the case of Angles, as shown in Figure 5, equal increments are added to the thickness of each leg, which also slightly increases the length of each leg.

ROLLING AND CUTTING TOLERANCES

Due to a small but unavoidable amount of roll wear which occurs during the production of rolled structural shapes, the finished pieces may vary slightly from published or theoretical dimensions. Steel producers have recognized these variations and have set up standard rolling tolerances. Kaiser structural shapes are rolled to these standards.

The variation from the calculated or specified weight is customarily plus or minus 2.5 per cent. Other tolerances may be agreed upon by special negotiation.

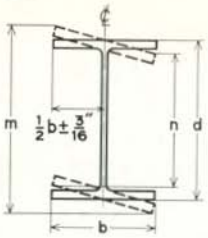
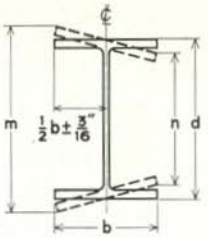


TABLE 27

ROLLING AND CUTTING TOLERANCES

KAISER WIDE FLANGE SHAPES

ROLLING TOLERANCES



Size—Depth	d Depth		b Width of Fl.		m minus n	m	
	Over	Under	Over	Under	Out of Square or Parallel	Maximum Depth at any point	Web Off Center
Up to and including 12"...	1/8"	1/8"	1/4"	3/16"	Not more than 3/16"	Not more than 1/4" over theo.	Not more than 3/16"
Over 12".....	1/8"	1/8"	1/4"	3/16"	Not more than 1/4"	Not more than 1/4" over theo.	Not more than 3/16"

Shapes may have an allowable variation in weight of 2½% either way from the nominal weight. Beam depth (d) is measured at center line of web.

CUTTING TOLERANCES

Size—Depth	Up to 30′ inc.		Over 30′	
	Over	Under	Over	Under
Beams to 24" incl.	3/8"	3/8"	3/8" plus 1/16" for each 5′ or fraction thereof above 30′.....	3/8"
Columns—all Sizes	1/2"	1/2"	1/2" plus 1/16" for each 5′ or fraction thereof above 30′.....	1/2"

Ends Out of Square:
1/64" per inch of depth or flange width if greater than depth.

Allowance for Milling:
For material which is to be milled customer should state on orders whether one or both ends are to be milled, what allowance has been made and whether we are to cut to standard or special tolerances as given above.

We recommend for material to be milled that ordered lengths be made as follows:

For milling one end only: Finished length plus 5/8".

For milling both ends: Finished length plus 7/8".

Straightness:

Tolerances for beams: $\frac{1}{8}'' \times \frac{\text{total length in feet}}{10'}$

Where sections are specified on orders as columns, the following tolerances will apply:

Lengths up to 45′0″: $\frac{1}{8}'' \times \frac{\text{total length in feet}}{10'}$ but not over 3/8" maximum.

Lengths over 45′0″: $\frac{3}{8}'' + \frac{1}{8}'' \times \frac{\text{total length} - 45'}{10'}$

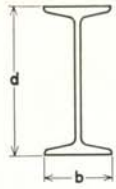


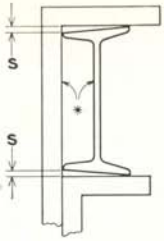
TABLE 28

ROLLING AND CUTTING TOLERANCES

AMERICAN STANDARD BEAMS

STRUCTURAL SIZES

ROLLING TOLERANCES



Size—Depth	d Depth		b Width of Flanges		s + s Out of Square or Parallel	Weight	
	Over	Under	Over	Under		Over	Under
3″ to 7″ inc.	3/32″	1/16″	1/8″	1/8″	1/32″	2½%	2½%
Over 7″ to 14″ inc.	1/8″	3/32″	5/32″	5/32″	per inch of	2½%	2½%
Over 14″ to 24″ inc.	3/16″	1/8″	3/16″	3/16″	flange	2½%	2½%

Beam depth d is measured at center line of web.

CUTTING TOLERANCES

Size—Depth	Up to 30′ inc.		Over 30′ to 40′ inc.		Over 40′ to 50′ inc.		Over 50′	
	Over	Under	Over	Under	Over	Under	Over	Under
Structural Beams	3/8″	3/8″	5/8″	3/8″	7/8″	3/8″	1″	3/8″

Ends out of square—1/64″ per inch of depth.

$$\text{Camber tolerance} = 1/8'' \times \frac{\text{total length in feet}}{5'}$$

Weight tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per linear foot.

*Back of square and web to be parallel when measuring for "out of square."

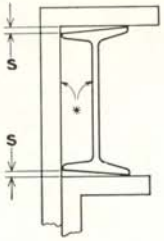


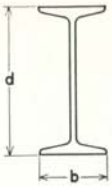
TABLE 29

ROLLING AND CUTTING TOLERANCES

COLUMN SECTIONS

STRUCTURAL SIZES

ROLLING TOLERANCES



Size—Depth	d Depth		b Width of Flanges		s + s Out of Square or Parallel	Weight	
	Over	Under	Over	Under		Over	Under
4.....	3/32"	1/16"	1/8"	1/8"	1/32" per Inch of flange	2½%	2½%
5.....	3/32"	1/16"	5/32"	5/32"		2½%	2½%
6.....	1/8"	3/32"	3/16"	3/16"		2½%	2½%
8.....	1/8"	3/32"	3/16"	3/16"		2½%	2½%

Beam depth d is measured at center line of web.

CUTTING TOLERANCES

Size—Depth	Up to 30′ Inc.		Over 30′ to 40′ Inc.		Over 40′ to 50′ Inc.		Over 50′	
	Over	Under	Over	Under	Over	Under	Over	Under
All H Beams...	3/8"	3/8"	5/8"	3/8"	7/8"	3/8"	1"	3/8"

Ends out of square—1/64" per inch of depth or flange width.

$$\text{Camber tolerance} = \frac{1}{8}'' \times \frac{\text{total length in feet}}{5'}$$

Weight tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per linear foot.

*Back of square and web to be parallel when measuring for "out of square."

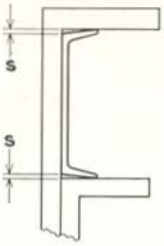
TABLE 30

ROLLING AND CUTTING TOLERANCES

STANDARD, CAR AND SHIP CHANNELS

STRUCTURAL SIZES

ROLLING TOLERANCES



Size—Depth	d Depth		b Width of Flanges		s + s Out of Square or Parallel	Weight	
	Over	Under	Over	Under		Over	Under
3″ to 7″ inc.	3/32″	1/16″	1/8″	1/8″	1/32″	2½%	2½%
Over 7″ to 14″ inc.	1/8″	3/32″	1/8″	5/32″	per inch of flange	2½%	2½%
Over 14″ to 18″ inc.	3/16″	1/8″	1/8″	3/16″		2½%	2½%

Channel depth d is measured at back of web.

CUTTING TOLERANCES

Size—Depth	Up to 30′ inc.		Over 30′ to 40′ inc.		Over 40′ to 50′ inc.		Over 50′	
	Over	Under	Over	Under	Over	Under	Over	Under
Structural	3/8″	3/8″	5/8″	3/8″	7/8″	3/8″	1″	3/8″

Ends out of square—1/64″ per inch of depth.

$$\text{Camber tolerance} = 1/8'' \times \frac{\text{total length in feet}}{5'}$$

Weight tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per linear foot.

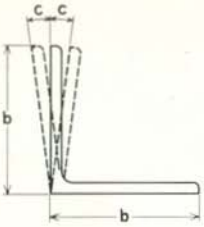


TABLE 31

ROLLING AND CUTTING TOLERANCES

STANDARD ANGLES

STRUCTURAL SIZES

ROLLING TOLERANCES

Size—Length of Leg	Gauges	b Length of Leg		c Out of Square	Weight	
		Over	Under		Over	Under
3″ to 4″ incl.	All	1/8″	3/32″	1½° or	2½%	2½%
Over 4″ to 6″ inc.	All	1/8″	1/8″	3/128″ per inch of leg length	2½%	2½%
Over 6″	All	3/16″	1/8″		2½%	2½%

CUTTING TOLERANCES

Size—Length of Leg	Gauges	Up to 30′ inc.		Over 30′ to 40′ inc.		Over 40′	
		Over	Under	Over	Under	Over	Under
Structural	All	3/4″	0″	1″	0″	1¼″	0″

Ends out of square—For Angles, 1½ degrees or 3/128″ per inch of leg length.

$$\text{Camber tolerance} = \tfrac{1}{8}'' \times \frac{\text{total length in feet}}{5'}$$

Weight tolerances are based on each shipment consisting of carload lots or fraction thereof of the same figured or ordered weight per linear foot.

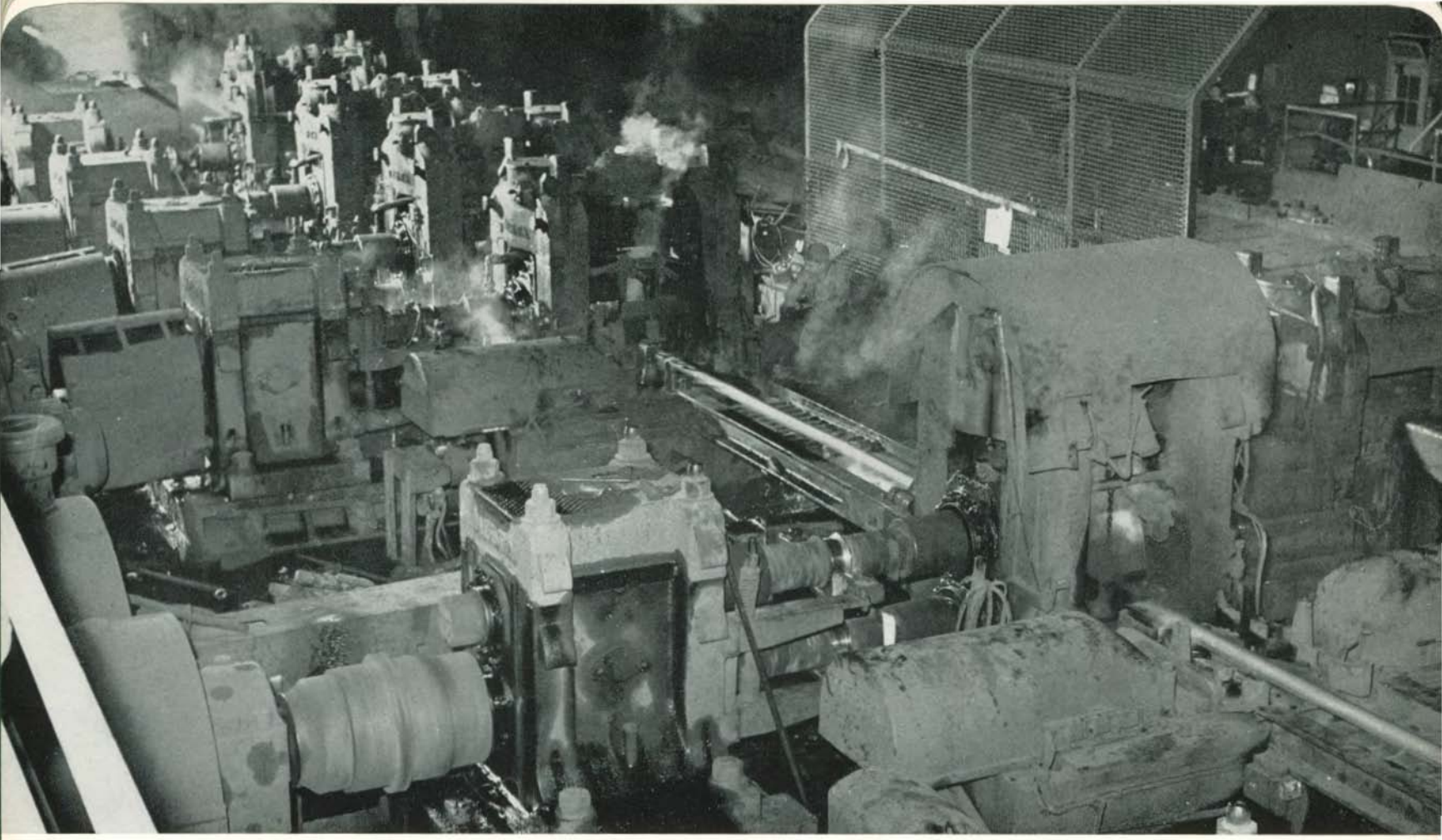
Longer leg of unequal leg angle determines size for tolerance.

ORDERING PRACTICE FOR KAISER STRUCTURAL STEEL SHAPES

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Structural Shapes should specify the following details:

1. Quantity.
2. Size, including foot weight and length.
3. Specification.
4. End use.
5. Required inspection, if other than mill inspection.
6. Special loading practices if applicable.
7. Shipping destination.
8. Required routing.
9. Requested delivery.
10. Distribution of shipping notices, invoices, and bills of lading.

Structural sections of all types are estimated and invoiced on the basis of calculated weights per lineal foot as shown in the preceding tables.



Square edge flats and other bar sections are rolled in the Merchant Mill.

4

Hot rolled bars and bar size shapes

KAISER HOT ROLLED CARBON STEEL BARS AND BAR SIZE SHAPES

Hot rolled products commonly classified as bars include the following:

Rounds	1/4" to 8 1/4" inclusive.
Squares	1/4" to 5 1/2" inclusive.
Round Cornered Squares	3/8" to 8" inclusive.
Hexagons	1/4" to 4 1/16" inclusive.
Flats	13/64" and over in thickness and up to 6" in width.

Bar Size Shapes, angles, channels, tees and zees when their greatest sectional dimension is less than 3".

All sections and all sizes, however, are not rolled by all producers. Bars and bar size shapes rolled by Kaiser Steel Corporation are shown on pages 55 to 59.

Hot rolled carbon steel bars are the raw material for many forgings and are the product from which most cold drawn steel bar products are made. They are used for numerous applications in machinery, structures, transportation equipment and in general construction.

Kaiser hot rolled carbon steel bars are produced from double converted and conditioned billets in rounds, squares, square edge flats, round edge flats and bar size equal and unequal angles. They are rolled on a 21"-18"-14" merchant mill consisting of an 8-stand continuous roughing mill and four 2-high finishing stands. Production may be to specified chemical limits or in accordance with the physical properties and chemical limits of standard specifications, as required by the customer. Merchant Bar Quality and Special Bar Quality are rolled in all steel grades and in the range of sizes and shapes shown on the following pages.

TABLE 32

KAISER STANDARD ROUNDS

Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.	Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.
1/2	.67	.20	1 15/16	10.02	2.95
5/8	1.04	.31	2	10.68	3.14
11/16	1.26	.37	2 1/16	11.36	3.34
3/4	1.50	.44	2 1/8	12.06	3.55
13/16	1.76	.52	2 3/16	12.78	3.76
7/8	2.04	.60	2 1/4	13.52	3.98
15/16	2.35	.69	2 5/16	14.28	4.20
1	2.67	.79	2 3/8	15.06	4.43
1 1/16	3.02	.89	2 7/16	15.87	4.67
1 1/8	3.38	.99	2 1/2	16.69	4.91
1 3/16	3.77	1.11	2 9/16	17.53	5.16
1 1/4	4.17	1.23	2 5/8	18.40	5.41
1 5/16	4.60	1.35	2 11/16	19.29	5.67
1 3/8	5.05	1.48	2 3/4	20.20	5.94
1 7/16	5.52	1.62	2 13/16	21.12	6.21
1 1/2	6.01	1.77	2 7/8	22.07	6.49
1 9/16	6.52	1.92	2 15/16	23.04	6.78
1 5/8	7.05	2.07	3	24.03	7.07
1 11/16	7.60	2.24	3 1/16	25.05	7.37
1 3/4	8.18	2.41	3 1/8	26.08	7.67
1 13/16	8.77	2.58	3 3/16	27.13	7.98
1 7/8	9.39	2.76	3 1/4	28.21	8.30

Kaiser standard rounds from 1/2" to 1" inclusive may be supplied either in cut lengths up to 65 feet or in coils weighing an average of 1,250 lbs. each.

Two coil dimensions may be furnished: 56" O. D. × 46" I. D. or 39" O. D. × 34" I. D

TABLE 33

KAISER STANDARD SQUARES

Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.	Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.
½	.85	.25	1½	7.65	2.25
⅝	1.33	.39	1⅝	8.98	2.64
¾	1.91	.56	1¾	10.41	3.06
⅞	2.60	.77	1⅞	11.95	3.52
1	3.40	1.00	2	13.60	4.00
1⅛	4.30	1.27	2¼	17.21	5.06
1¼	5.31	1.56	2½	21.25	6.25
1⅜	6.43	1.89	2¾	25.71	7.56

THE FOLLOWING NOTES APPLY TO BOTH KAISER STANDARD ROUNDS AND SQUARES:

1. Merchant Bar Quality is acceptable in all sizes.

2. Special Bar Quality is acceptable in all steel grades on round sizes from ¾" to 3¼" inclusive.

3. Special Bar Quality is acceptable in all steel grades on square sizes from ⅝" to 2¼" inclusive.

4. Special Bar Quality is acceptable in grades C-1035 and higher on squares over 2¼"

5. Rounds and Squares are produced in maximum lengths of 65 feet.

6. Machine straightened rounds are limited to 2½" round maximum.

TABLE 34

KAISER ROUND CORNERED SQUARES

Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.	Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.
1½	7.55	2.22	2¼	16.98	4.99
1⅝	8.86	2.61	2½	20.97	6.17
1¾	10.27	3.02	2¾	25.37	7.46
1⅞	11.79	3.46	3	30.60	9.00
2	13.42	3.95			

Merchant Bar Quality is acceptable in all sizes.
Special Bar Quality is acceptable in all steel grades to 2¼" inclusive.
Over 2¼" Special Bar Quality is acceptable in grades C-1035 and higher.
The above sizes are produced in maximum lengths of 65 feet.

TABLE 35

KAISER BAR SIZE SHAPES

ANGLES (Equal)			ANGLES (Unequal)		
Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.	Size in Inches	Wt. Per Ft., Lbs.	Area Sq. In.
2 x 2 x 3/16	2.44	.71	2 x 1½ x 3/16	2.12	.62
1/4	3.19	.94	1/4	2.77	.81
5/16	3.92	1.15	5/16	3.39	1.00
3/8	4.7	1.36	3/8	3.99	1.17
2½ x 2½ x 3/16	3.07	.90	2½ x 1½ x 3/16	2.44	.72
1/4	4.1	1.19	1/4	3.19	.94
5/16	5.0	1.47	5/16	3.92	1.15
3/8	5.9	1.73			
1/2	7.7	2.25	2½ x 2 x 3/16	2.75	.81
			1/4	3.62	1.06
			5/16	4.5	1.31
			3/8	5.3	1.55

Bar size shapes are produced in maximum lengths of 65 feet. Quotation for sizes not shown will be furnished on request.

TABLE 36

KAISER SQUARE EDGE FLATS

(Weight per foot in lbs.)

Thick-ness	1/4"	5/16"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"	1 1/2"
Width	.250	.3125	.375	.500	.625	.750	.875	1.00	1.25	1.50
1 1/2"	.....	.....	1.913	2.550	3.188	3.825	.....	.....	.....	.....
1 3/4"	.....	.....	2.231	2.975	3.719	4.463	.....	.....	.....	.....
2"	1.700	2.125	2.550	3.400	4.250	5.100	5.950	6.800	.....	.....
2 1/2"	2.125	2.656	3.188	4.250	5.313	6.375	7.438	8.500	.....	.....
3"	2.550	3.188	3.825	5.100	6.375	7.650	8.925	10.200	12.750	15.30
3 1/2"	2.975	3.719	4.463	5.950	7.438	8.925	10.41	11.900	14.875	17.85
4"	3.400	4.250	5.100	6.800	8.500	10.200	11.90	13.600	17.000	20.40
5"	4.250	5.313	6.375	8.500	10.625	12.750	14.88	17.000	21.250	25.50
6"	5.100	6.375	7.650	10.200	12.750	15.300	17.85	20.400	25.500	30.60

1. All widths are produced to 780 inches maximum length.

2. Between 2" and 6" in width, intermediate widths not listed are available on a special inquiry basis.

3. Special Bar Quality is acceptable in all steel grades in thicknesses up to 1" inclusive; and in grades C-1035 and higher in 1 1/4" and 1 1/2" thicknesses.

TABLE 37

KAISER SPRING FLATS (ROUND EDGE)

(Weight per foot in lbs.)

Thickness	3/16"	15/64"	1/4"	9/32"	5/16"	3/8"	1/2"	5/8"	3/4"	7/8"	1"
Width	.1875	.234	.250	.28125	.3125	.375	.500	.625	.750	.875	1.00
1¾"	1.116	1.395	1.488	1.673	1.859	2.231	2.975	3.719	.....	.....	.....
2"	1.275	1.594	1.700	1.913	2.125	2.550	3.400	4.250	.....	.....	.....
2¼"	1.434	1.793	1.913	2.152	2.391	2.869	3.825	4.781	.....	.....	.....
2½"	1.594	1.992	2.125	2.391	2.656	3.188	4.250	5.313	.....	.....	.....
2¾"	1.753	2.192	2.338	2.630	2.922	3.506	4.675	5.844	.....	.....	.....
3"	.....	2.391	2.550	2.869	3.188	3.825	5.100	6.375	.....	.....	.....
3½"	.....	2.789	2.975	3.348	3.719	4.463	5.950	7.438	8.925	.....	.....
4"	.....	3.188	3.400	3.815	4.250	5.100	6.800	8.500	10.200	11.900	13.600
4½"	.....	.....	.....	4.303	4.781	5.738	7.650	9.554	11.475	13.388	15.300
5"	.....	.....	.....	4.781	5.313	6.375	8.500	10.625	12.750	14.875	17.000
6"	.....	.....	.....	5.737	6.375	7.650	10.200	.....	.....	.....	.....

1. For thicknesses 3/16" and 15/64" the maximum length is 240".

2. For thicknesses 1/4" and over the maximum length is 780".

3. Lengths shown, in inches, are maximum. Quotations for intermediate widths and gauges will be furnished on request.

4. 15/64" and 9/32" gauges are subject to inquiry.

MERCHANT BAR QUALITY

Merchant quality and special quality are the two fundamental qualities of carbon steel bars. Merchant quality carbon steel bars are specified for a wide range of structural uses involving mild cold bending, mild hot forming, punching, and welding as used in the production of non-critical parts of bridges, buildings, ships, agricultural implements, road building and railway equipment, machinery and other uses. The type of steel in which merchant bar quality is produced is customarily left to the producer's discretion. Bars of merchant quality should be free of visible pipe. They may, however, contain pronounced segregation. Seams or other surface irregularities may be expected.

SPECIAL BAR QUALITY

Special quality hot rolled carbon steel bars are produced for applications involving forging, heat treating, cold drawing, machining, and the like. These bars are furnished in standard or restricted chemical grades or to mechanical property specifications. Special quality bars are produced in the type of steel determined by producer's facilities and the end use requirements.

Visible pipe is eliminated and bars are subject to standard variations in check analysis. Blooms and billets for special quality bars are conditioned before rolling to eliminate surface imperfections, but surface defects may be present to some degree after final rolling. If defects in special quality bars are removed by chipping or grinding, the extent of the conditioning must be consistent with the end use of the bars.

Special quality carbon steel bars are sometimes specified with requirements for chemical composition, workmanship or finish more restrictive than special quality as previously described and additional handling, processing, testing or inspection procedures are required. Bars for forging and/or heat treating should be ordered as killed steel.

SPECIAL BAR QUALITY INVOLVING OTHER RESTRICTIVE REQUIREMENTS

Special quality bars involving other restrictive requirements are cold heading quality, special surface quality, or those in which special heat treating requirements must be met. They also include those bars requiring restricted ladle or check analysis, restricted decarburization or specified maximum incidental elements.

STANDARD PRACTICE TABLES

Variations for Dimensions and Workmanship

The accuracy of dimensions of rolled steel products is influenced by many factors such as mill design, heating practices, roll pass design, reduction between passes, roll wear and grade of steel. The cumulative effect of these, as well as other factors, precludes hot rolling to exact ordered size and requires that provisions be made for variations.

The accompanying tables indicate the expectancy of dimensional variations.

TABLE 38

ROUNDS AND SQUARES AND ROUND CORNERED SQUARES

SIZE

Specified Sizes	Variations from Size		Out of Round or Out of Square Section
	Over	Under	
To 5/16 incl.	0.005	0.005	0.008
Over 5/16 to 7/16 incl.	0.006	0.006	0.009
Over 7/16 to 5/8 incl.	0.007	0.007	0.010
Over 5/8 to 7/8 incl.	0.008	0.008	0.012
Over 7/8 to 1 incl.	0.009	0.009	0.013
Over 1 to 1 1/8 incl.	0.010	0.010	0.015
Over 1 1/8 to 1 1/4 incl.	0.011	0.011	0.016
Over 1 1/4 to 1 3/8 incl.	0.012	0.012	0.018
Over 1 3/8 to 1 1/2 incl.	0.014	0.014	0.021
Over 1 1/2 to 2 incl.	1/64	1/64	0.023
Over 2 to 2 1/2 incl.	1/32	0	0.023
Over 2 1/2 to 3 incl.	3/64	0	0.035

NOTE: Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section. Out-of-square section is the difference in the two dimensions at the same cross section of a square bar between opposite faces.

TABLE 39

SQUARE-EDGE AND ROUND-EDGE FLATS

Thickness and Width

Specified Widths	Variations from Thickness, for Thicknesses Given, Over & Under					Variations from Width	
	Under 1/4	1/4 to 1/2 incl.	Over 1/2 to 1, incl.	Over 1 to 2 incl.	Over 2	Over	Under
To 1 incl.	0.007	0.008	0.010	.....	.....	1/64	1/64
Over 1 to 2 incl.	0.007	0.012	0.015	1/32	.....	1/32	1/32
Over 2 to 4 incl.	0.008	0.015	0.020	1/32	3/64	1/16	1/32
Over 4 to 6 incl.	0.009	0.015	0.020	1/32	1/16	3/32	1/16

TABLE 40

STANDARD STRAIGHTNESS

ALL BARS AND BAR SIZE SECTIONS

¼ inch in any 5 ft. or ¼ inch × number of ft. of length divided by 5.

Because of warpage, straightness tolerances do not apply to bars if any subsequent heating operation has been performed.

TABLE 41

AUTOMOTIVE LEAF SPRING FLATS

Thickness, Width and Concavity
In Inches

Variations in Width		Variations in Thickness,[1] Over and Under			Variations towards Concavity[2]			Maximum Difference in Thickness[3]		
		For Thickness			For Thickness			For Thickness		
Specified Widths	Variation Over No. Var. Under	0.375 and Under	Over 0.375 to 0.875 incl.	Over 0.875 to 1.500 incl.	0.375 and Under	Over 0.375 to 0.875 incl.	Over 0.875 to 1.500 incl.	0.375 and Under	Over 0.375 to 0.875 incl.	Over 0.875 to 1.500 incl.
To 2½ incl.....	1/32	0.005	0.006	.....	0.005	0.006	.....	0.002	0.002	.....
Over 2½ to 4 incl..	3/64	0.006	0.008	0.012	0.006	0.008	0.012	0.003	0.004	0.006
Over 4 to 5 incl....	1/16	0.007	0.010	0.016	0.007	0.010	0.016	0.004	0.005	0.008
Over 5 to 6 incl....	3/32	.....	0.012	0.020	.....	0.012	0.020	.....	0.006	0.010

[1]Thickness measurements are taken at the edges of the bar where the flat surfaces intersect the rounded edges.

[2]Concavity is the difference between the thickness at the center of the bar and the thickness at the edges.

[3]Maximum difference in thickness between the two edges of each bar.

TABLE 42

BAR SIZE ANGLES

Dimensions

Specified Length of Leg	Variations from Thickness for Thicknesses Given, Over and Under			Variations From Length of Leg, Over and Under
	To 3/16 Incl.	Over 3/16 to 3/8, Incl.	Over 3/8	
To 1, incl.	0.008	0.010	....	1/32
Over 1 to 2, incl.	0.010	0.010	0.012	3/64
Over 2 to 3, incl.	0.012	0.015	0.015	1/16

The longer leg of an unequal angle determines the size for variations.

The out-of-square tolerance in either direction is 1½ degrees.

TABLE 43

ROUNDS, SQUARES AND FLATS

Length

Hot Shearing

Rounds and Squares	Flats		Variations Over Specified Length No Variation Under				
	Thickness	Width	5-10 ft. excl.	10-20 ft. excl.	20-30 ft. excl.	30-40 ft. excl.	40-60 ft. incl.
To 1, incl.	To 1, incl.	To 3, incl.	1/2	5/8	3/4	1¼	1¾
Over 1 to 2, incl.	Over 1	To 3, incl.	5/8	3/4	1	1½	2
Over 1 to 2, incl.	To 1, incl.	Over 3 to 6, incl.	5/8	3/4	1	1½	2
Over 2	Over 1	Over 3 to 6, incl.	1	1¼	1½	1¾	2¼
Other sections			5/8	3/4	1	1½	2

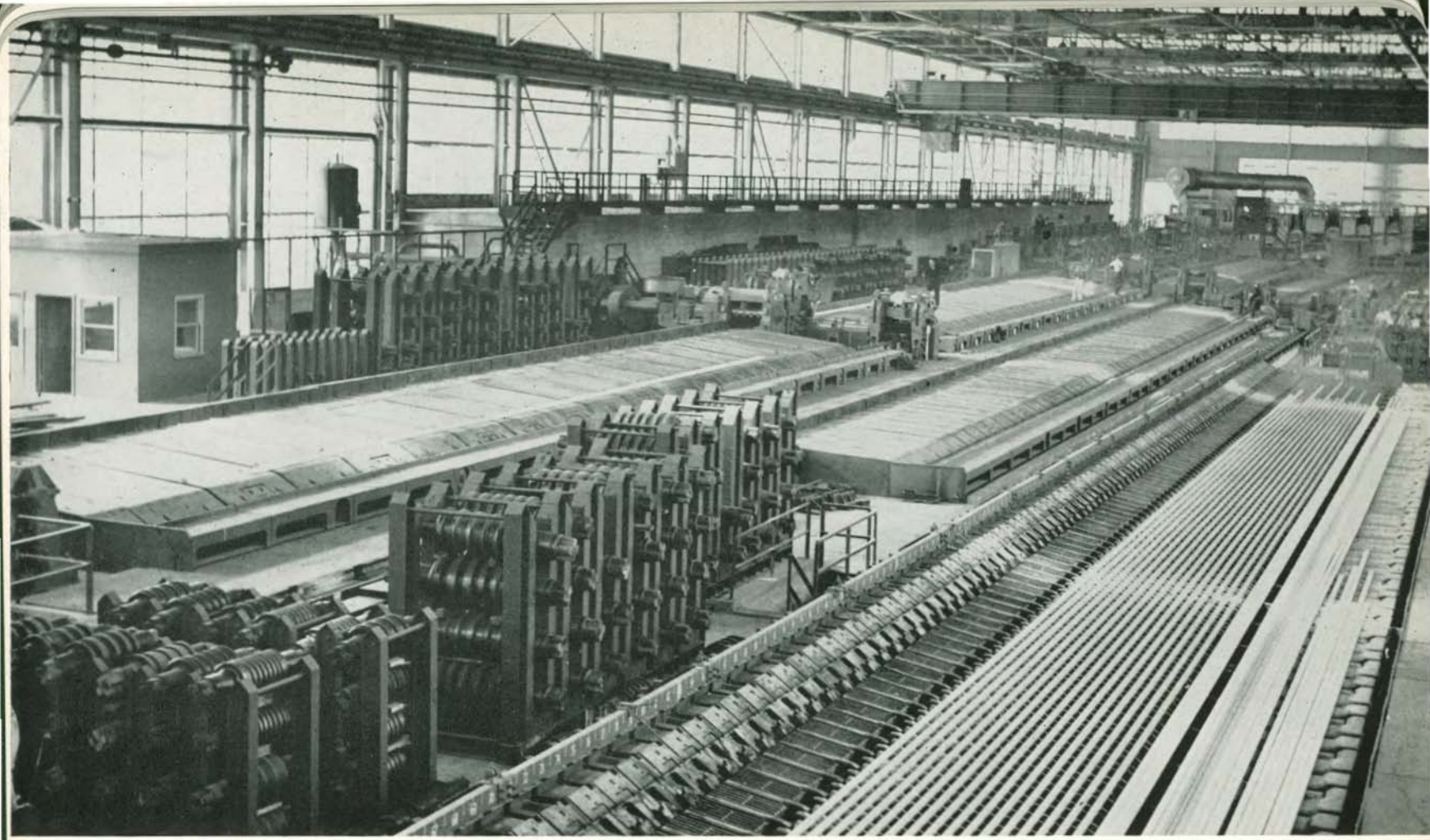
ORDERING PRACTICE FOR KAISER CARBON STEEL BARS AND BAR SIZE SHAPES

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Bars and Bar Sized Shapes, should specify the following details:

1. Quantity.
2. Size.
3. Specification.
4. Quality (either merchant bar quality or special bar quality).
5. End use.
6. Required inspection, if other than mill inspection.
7. Special loading practices if applicable.
8. Shipping destination.
9. Required routing.
10. Requested delivery.
11. Distribution of shipping notices, invoices, and bills of lading.

When ordering round bars that are to be machined, experience has shown that it is advisable for the purchaser to make adequate allowances for finishing. These allowances should not be less than $\frac{1}{16}$" from the surface for rounds $1\frac{1}{2}$" to 3" in diameter and $\frac{1}{8}$" for rounds over 3" in diameter. All sections of cut bars may be ordered to specific or random lengths. The maximum length is 65 feet.

Bars are invoiced on mill scale weights. In check-weighing by the purchaser, variation from invoiced weights up to 1% may be expected due to differences in kind, type, location and accuracy of the scales. When the number of pieces in a lift is required to be shown on the shipping papers, the count is considered as approximate and weight the more accurate.



Portion of the rod and bar section of the Merchant Mill where Kaiser Hi-Bond reinforcing bar is produced.

5

Hot rolled concrete reinforcing bars

KAISER CONCRETE REINFORCING BARS

Concrete reinforcing bars are steel bars used to resist tension, compression or shear stresses in concrete. Deformed bars with surface patterns meeting certain minimum industry standards for deformation are most generally used. Plain bars, however, are used in many special cases. It has become a practice in the trade to use the word "nominal" in referring to the size of deformed bars and to designate them by number. The nominal size of a deformed bar is equivalent to the diameter of a plain round bar or the side of a square bar having the same weight per foot as the deformed bar. The number of the bar indicates its nominal size in $\frac{1}{8}$ inches.

Kaiser concrete reinforcing bars are extensively used in the construction of concrete dams, bridges, buildings, pipe lines, aqueducts, foundations and the like.

Kaiser concrete reinforcing steel bars are produced from new open hearth steel billets in grades to conform to latest industry specifications in either deformed bars (Kaiser Hi-Bond Bars) in sizes from $\frac{1}{2}$" to $1\frac{1}{4}$" inclusive, or in plain round bars, in sizes from $\frac{1}{2}$" to 1" inclusive.

TABLE 44

KAISER CONCRETE REINFORCING BARS

Bar No.	4	5	6	7	8	9	10	11
Size inches.. (rounds)	½	⅝	¾	⅞	1	1.128 (1 sq.)	1.270 (1⅛ sq.)	1.410 (1¼ sq.)
Area ..... (sq. in.)	0.20	0.31	0.44	0.60	0.79	1.00	1.27	1.56
Weight.... (lbs. per lin. ft.)	0.668	1.043	1.502	2.044	2.670	3.400	4.303	5.313

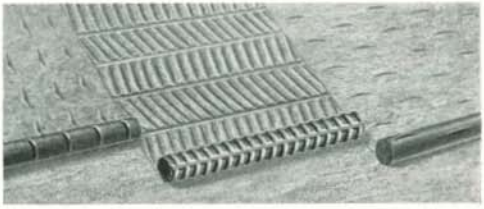
Orders for $\frac{1}{2}$" bars are accepted only by special arrangement. For those sizes designated as numbers 9, 10 and 11, Kaiser Hi-Bond Bars of round section are furnished to the equivalent sectional area of square bars. For those sizes designated as numbers 4, 5, 6, 7 and 8, both plain round bars and Kaiser Hi-Bond bars are furnished. Plain round bars in cut lengths only, also may be furnished in sizes $1\frac{1}{8}$", $1\frac{1}{4}$" and $1\frac{1}{2}$" in diameter in lengths not exceeding 60 feet.

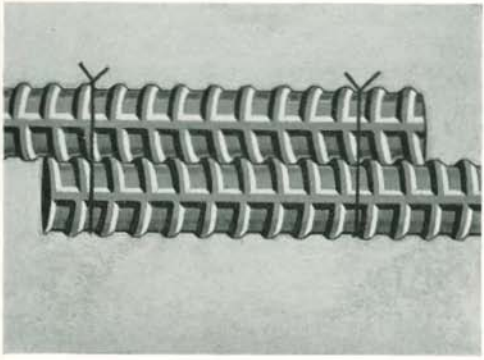
KAISER HI-BOND CONCRETE REINFORCING BARS

Kaiser Hi-Bond Concrete Reinforcing Bar increases the effectiveness of reinforcing steel in concrete through greatly improved load transfer between the two materials. This is accomplished by means of reversed double helical ribs of proper height which extend between diametrically opposed longitudinal ribs. The helical ribs are spaced at close intervals and so dimensioned as to provide potential bearing and shearing areas which in addition to having the proper relationship to each other, are properly proportioned to the effective strength of the bars. The bearing area is more than double that of most types of reinforcing bars.

These reversed double-helical ribs in Kaiser Hi-Bond reinforcing bars provide the most effective mechanical grip with concrete ever developed—regardless of the position in which the bars are cast or the direction in which they are pulled.

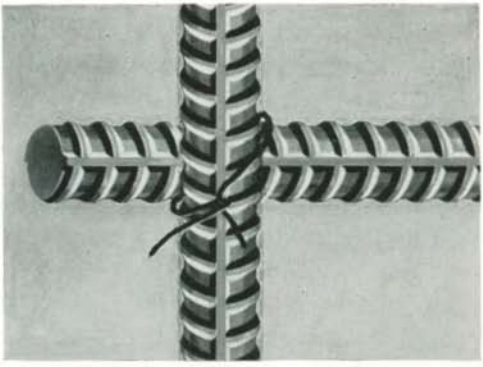
Patterns in wet concrete prove no ordinary bar can anchor itself as firmly as a Kaiser Hi-Bond bar.





High tensile strength at splices—with shorter overlap—comes from dovetailed helical ribs.

Kaiser Hi-Bond bars have gear-like contact when crossed and wired. The result is that they hold firmly with a simple tie.



The angle at which the ribs are inclined is so fixed that the area for any section normal to the longitudinal axis of the bar is a constant. The large fillets where the helical ribs join the body of the bar induce better contact between the concrete and the steel.

This design results in a bar which bends exceptionally well and is easy to handle and fabricate due to the close and even rib arrangement.

All engineering tests which have been conducted support the following conclusions:

Kaiser Hi-Bond Bars have the highest possible bond value as compared with other reinforcing bars.

Kaiser Hi-Bond Bars provide a more effective mechanical grip with the concrete regardless of the position in which they are cast, or the direction in which they are pulled.

Kaiser Hi-Bond Bars provide a more efficient transfer of stress at splices and reduce the need for hook anchorage.

Kaiser Hi-Bond Bars reduce the width of cracks, thereby reducing the possibility of corrosion of the steel at the cracks.

Kaiser Hi-Bond Bars, through superior resistance to slip, reduce deflections of beams and deformations of columns.

Kaiser Hi-Bond Bars contribute to the effective use of high yield strength reinforcing steel and the development of pre-stressed construction.

Kaiser Hi-Bond Bars in reinforced concrete result in more efficient structures and lower construction costs through the conservation of materials and labor.

Kaiser Hi-Bond Bars are rolled in sizes from ½″ to 1¼″ inclusive and are furnished in cut lengths from 20′ to 60′ inclusive. Shorter or longer lengths may be furnished by special arrangement. In sizes from ½″ to 1″ inclusive, these bars may be furnished in coils averaging in weight 1,000 lbs. per coil, to standard industry specifications.

Two sizes of coils are supplied:

56″ O.D. x 46″ I.D.

39″ O.D. x 34″ I.D.

KAISER PLAIN ROUND CONCRETE REINFORCING BARS

Kaiser plain round concrete reinforcing bars are rolled in sizes from ½″ to 1″ inclusive and may be furnished in cut lengths from 20′ to 60′ inclusive. Shorter or longer lengths may be supplied by special arrangement. Plain round bars may also be furnished in coils averaging 1,000 lbs. per coil. Two sizes of coils are furnished to standard industry specifications.

56″ O.D. x 46″ I.D.

39″ O.D. x 34″ I.D.

TOLERANCES

The length of concrete reinforcing bars is customarily specified in feet and inches and all lengths are commonly subject to variations from ordered lengths as follows:

Up to 40′ inclusive.....2″ over and 1″ under

Over 40′.....3″ over and 1″ under

Concrete reinforcing bars, by industry practice, are furnished to weight tolerances and are not customarily furnished to dimensional tolerances other than for length. The theoretical weights of Kaiser plain and deformed reinforcing bars of the same nominal size are considered to be the same, i.e., the metal in the deformation is included in the theoretical weight and is not additional to it. Actual weights should not differ from theoretical weights more than the variations shown below.

TABLE 45

KAISER CONCRETE REINFORCING BARS

Standard Variation from Theoretical Weights

Size in Inches	Variation, Per Cent	
	Over	Under
½″ to 1¼″ inclusive in any lot	3½	3½
½″ to 1¼″ inclusive individual bars.....	—	6

NOTE: The term "lot" means all the bars of the same nominal size in a carload.

ORDERING PRACTICE FOR KAISER CONCRETE REINFORCING BARS

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Concrete Reinforcing Bars, should specify the following details:

1. Quantity.
2. Size (on sizes 1", 1⅛" and 1¼" clarify as to whether rounds or square equivalents are required).
3. Specification.
4. Grade (intermediate grade or structural grade).
5. Required inspection, if other than mill inspection.
6. Special loading practices if applicable.
7. Shipping destination.
8. Required routing.
9. Requested delivery.
10. Distribution of shipping notices, invoices and bills of lading.

Concrete reinforcing bars are invoiced on the basis of the theoretical weight per foot of the bar.

Careful loading practice insures delivery of hot rolled rods in good condition.

Hot rolled rods

KAISER HOT ROLLED CARBON STEEL COILED RODS

Kaiser coiled rods are rolled from Billets to an approximate round cross section. They are produced in coils of one continuous length. Rods are not comparable to hot rolled bars in accuracy of cross section nor surface finish. Rods are a semi-finished product.

Kaiser coiled rods are rolled for use where continuous length material is essential or where economies may be effected by the use of coiled rods. They are produced from double converted billets on a combination mill. The manufacture of the larger sizes of rods involves additional precautions in steel making and in the preparation of billets to assure a quality more readily obtainable in the smaller sizes of rods.

RANGE OF SIZES

$\frac{1}{2}$" to $\frac{47}{64}$" in $\frac{1}{16}$" increments

Coil Diameters—56" O.D. x 46" I.D. or 39" O.D. x 34" I. D.

Coil Weights—1250 lbs. average.

Kaiser coiled rods are available in standard grades and conform to the specified quality requirements of the end use or commodity designated. They are rolled to conform to standard size tolerances.

Size Tolerances for Kaiser Hot Rolled Rods

Variation from specified diameter: Plus or Minus $\frac{1}{64}$" (0.0156")

Out of round variation: 0.025 maximum

Out of round means the difference between the maximum and minimum diameters measured at the same cross section.

Tolerances closer than the above standards necessitate a manufacturing procedure such as is used to produce bars.

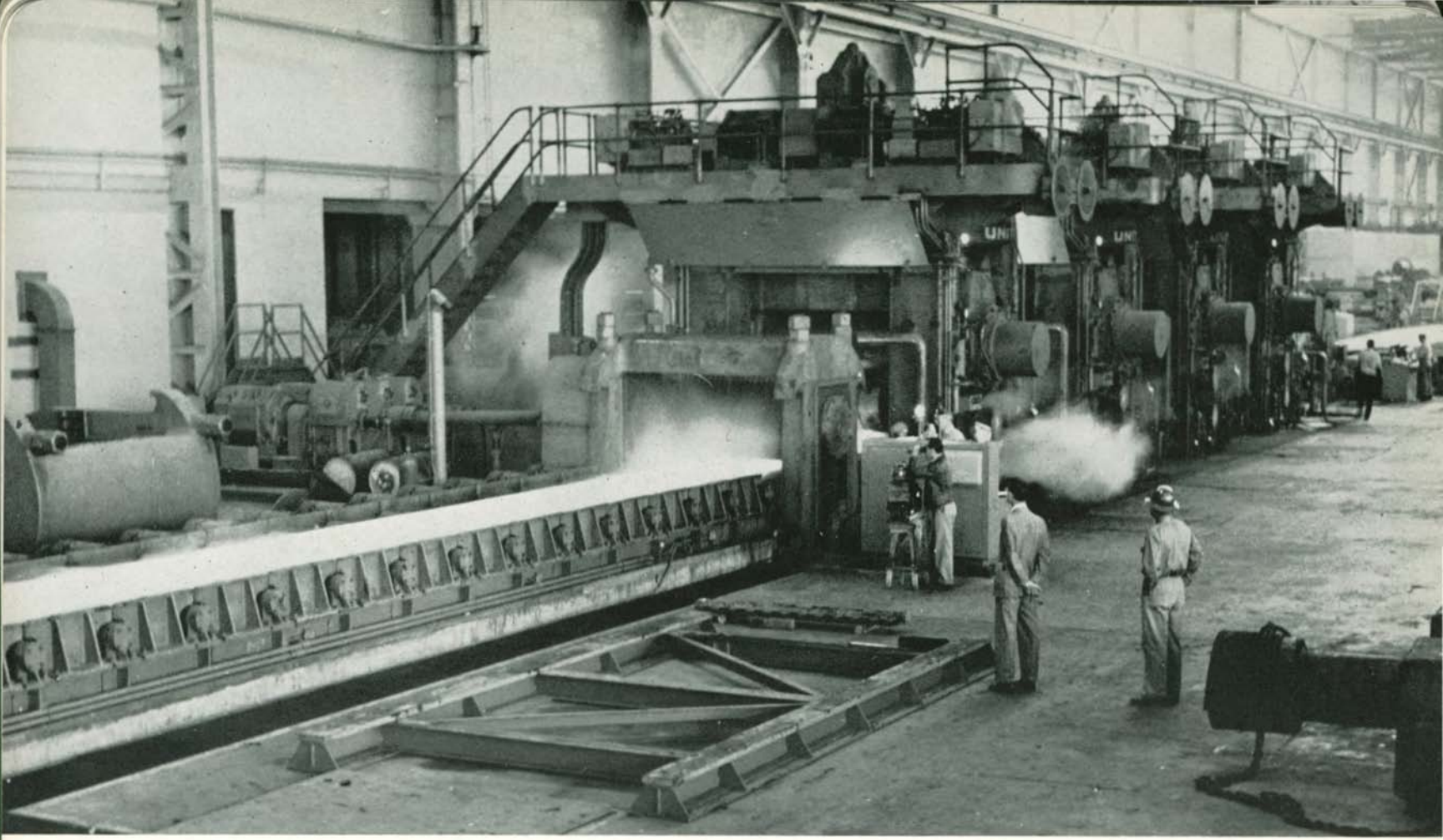
ORDERING PRACTICE FOR KAISER COILED RODS

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Coiled Rods should specify the following details:

1. Quantity.
2. Size.
3. Specification.
4. Quality (that is, merchant quality, cold rolling quality, cold forging quality, etc.).
5. End use.
6. Required inspection, if other than mill inspection.
7. Special loading practices if applicable.
8. Shipping destination.
9. Required routing.
10. Requested delivery.
11. Distribution of shipping notices, invoices and bills of lading.

Coiled rods are invoiced on the basis of mill scale weights.

In check weighing by the purchaser, variation from invoiced weights up to one per cent may be expected due to differences in kind, type, location and accuracy of the scales.



Kaiser Steel's hot strip mill produces hot rolled sheets in coils or cut lengths, in widths from 24 to 72 inches.

Hot rolled sheets

KAISER HOT ROLLED CARBON STEEL SHEETS

The table of flat rolled products on page 164 is the classification of sizes and gauges of hot rolled carbon steel sheets having widest industry acceptance and is given herein for convenient reference.

Kaiser hot rolled carbon steel sheets are used in large tonnages for drawn, cold formed and structural parts in the manufacturing and fabricating industries. They are used in automobile parts, machinery, furniture, pipe, general appliances and many other fields of manufacture.

Kaiser hot rolled sheets are made in the full range of plain carbon steel grades used in industry. Sheets 24″ to 72″ in width are rolled on a combination mill consisting of a 110″ reversing roughing mill and a 110″ three-high semi-finishing mill, and are finished on four stands of 86″ four-high continuous finishing mills. Sheets over 12″ to 16¾″ in width are rolled on a ten-stand, tandem continuous mill. Sheets from 12″ to 72″ in width may be cut to length or coiled after rolling. Coils over 12″ wide to 16¾″ wide may be furnished as hot rolled or pickled and oiled sheets.

TABLE 46

ROLLING LIMITS

KAISER HOT ROLLED CARBON STEEL SHEETS

Width (Inches)	Minimum Thickness	Maximum Thickness
Over 12 to 14¾	.104	.2299
Over 14¾ to 16¾	.125	.2299
Over 24 to 36	.078	.2299
Over 24 to 42	.093	.2299
Over 42 to 48	.093	.2299
Over 48 to 54	.105	.1799
Over 54 to 60	.110	.1799
Over 60 to 66	.123	.1799
Over 66 to 72	.134	.1799

The above table is based on low carbon quality. Other quality specifications may be furnished. Inquiries are invited.

Sheets over 12″ to 16¾″ wide are available in lengths from 72″ to 126″ and from 168″ to 252″. Coils in this width range will average 220 lbs. per inch of width and are furnished with mill edge only.

Sheets 24″ to 72″ wide are produced with sheared edges only. Coils or cut lengths from 96″ to 240″ are available.

Kaiser Hot Rolled Carbon Sheet Qualities

Commercial Quality hot rolled sheets are suitable for many purposes where the presence of oxide is not objectionable and surface is of secondary importance. They are not commonly used for exposed parts where finish is the prime requirement. When a carbon content is not specified, it is assumed that commercial quality sheets, not exceeding 0.15 per cent carbon on ladle analysis, are desired. When required, commercial quality sheets may be specified to standard chemical ranges and limits.

For any carbon range specified or required, the maximum of which does not exceed 0.15 per cent, a test specimen should withstand being bent flat on itself in any direction at room temperature.

For any carbon range specified or required, the maximum of which is over 0.15 per cent and not over 0.25 per cent, a test specimen should withstand being bent, at room temperature, through 180 degrees in any direction around a thickness equal to that of the specimen.

Bend tests are not customarily required for commercial quality sheets with carbon over 0.25 per cent maximum.

If mechanical properties or uniformity of temper are required, physical quality should be specified.

If greater ductility than that indicated by the foregoing bend test is required, drawing quality should be specified.

Drawing Quality sheets are customarily produced for use in fabricating identified parts where the surface before and after drawing is of secondary importance. Proper identification of parts may include visual examination, prints or description, or combination of these. These sheets are not recommended for exposed parts. They should produce parts too difficult for the fabricating properties of commercial quality sheets, within the breakage allowance as commonly negotiated between purchaser and producer. This quality of sheets is not commonly specified to chemical composition.

Physical Quality sheets are produced when mechanical properties are specified or required other than the bend tests of commercial quality or when uniformity of temper is required. Such properties or values include those determined by tensile tests, hardness tests, or other commonly accepted mechanical tests. It is customary to specify only one kind of a test requirement on any one item.

Requirements of sheets to meet both mechanical tests and drawing qualities are commonly negotiated between purchaser and producer.

Physical quality sheets are sometimes specified to structural specifications or to standard tensile ranges. The composition of steel is related to the required tensile properties; hence, a range for carbon is not commonly specified.

When surface finish is of prime importance, special surface should be specified.

TABLE 47

STANDARD TOLERANCES FOR HOT ROLLED SHEETS

(For carbon steel sheets of 0.25% maximum carbon content)

Hot Rolled Sheets

Variations in Weight

(All of one gauge and size)

Specified Weights, Lbs. per Sq. Ft.	Variation from Specified Weight, Percent Over or Under			
	20 Tons and Over	Under 20 Tons to 3 Tons, incl.	Under 3 Tons to 1 Ton, incl.	Under 1 Ton
1.875 (18 gauge) and Heavier....	3.5	5	7.5	10
1.874 (19 gauge) and Lighter.....	2.5	3	5	10

For sheets 72" and over in width, add 2 to percentage shown in the table.

TABLE 48

HOT ROLLED SHEETS

Variations from Specified Thickness

(Coils and Cut Lengths)

Specified Widths, Inches	Variation from Specified Thickness for Widths and Thicknesses Given—Over or Under, Inches						
	.2299 .1875	.1874 .1800	.1799 .1420	.1419 .0972	.0971 .0822	.0821 .0710	.0709 .0568
Over 12 to 15 incl.....	.008	.007	.007	.007	.006	.006	.006
Over 15 to 20 incl.....	.008	.008	.008	.008	.007	.007	.006
Over 20 to 32 incl.....	.009	.009	.009	.008	.007	.007	.006
Over 32 to 40 incl.....	.009	.009	.009	.009	.008	.007	.006
Over 40 to 48 incl.....	.010	.010	.010	.010	.008	.007	.006
Over 48 to 60 incl.....	....	....	.010	.010	.008	.007	.007
Over 60 to 70 incl.....	....	....	.011	.011	.009	.008	.007
Over 70 to 80 incl.....	....	....	.012	.012	.009	.008	....

Thickness is measured at any point on the sheet not less than 3/8" in from an edge.

TABLE 49

HOT ROLLED SHEETS

Variations in Width

(Sheets Not Resquared)

(Coils and Cut Lengths)

Specified Widths, Inches	Variation Over Specified Widths, Inches No Variation Under
	Sheared or Slit Edge
To 15 incl.	1/8
Over 15 to 20 incl.	1/8
Over 20 to 30 incl.	3/16
Over 30 to 50 incl.	1/4
Over 50 to 80 incl.	5/16

TABLE 50

HOT ROLLED SHEETS

Variations in Length

(Sheets Not Resquared, including Pickled Sheets)

Specified Lengths, Inches	Variation Over Specified Length, Inches No Variation Under
To 15 incl.	1/8
Over 15 to 30 incl.	1/4
Over 30 to 60 incl.	1/2
Over 60 to 96 incl.	3/4
Over 96 to 120 incl.	1
Over 120 to 156 incl.	1 1/4
Over 156 to 192 incl.	1 1/2
Over 192 to 240 incl.	1 3/4
Over 240	2

CAMBER

Camber is the greatest deviation of a side edge from a straight line; and measurement is taken on the concave side with a straight edge. The camber for sheets in cut lengths, not resquared, is shown below:

TABLE 51

HOT ROLLED SHEETS

CAMBER

(Includes Pickled Sheets)

Sheet Length, Feet	Camber, Inches
To 4 incl.	1/8
Over 4 to 6 incl.	3/16
Over 6 to 8 incl.	1/4
Over 8 to 10 incl.	5/16
Over 10 to 12 incl.	3/8
Over 12 to 14 incl.	1/2
Over 14 to 16 incl.	5/8
Over 16 to 18 incl.	3/4
Over 18 to 20 incl.	7/8
Over 20 to 30 incl.	1 1/4
Over 30 to 40 incl.	1 1/2

For sheets in coils, camber does not commonly exceed one inch in any 20′ of length.

HOT ROLLED SHEETS

Out-of-Square

(Not Resquared, including Pickled and Oiled Sheets)

Out-of-square is the greatest deviation of an end edge from a straight line at right-angles to a side and touching one corner. The variation for sheets of all gauges and all sizes is 1/16 inch per 6 inches, or fraction thereof, of width.

HOT ROLLED SHEETS

Resquared Sheets—Variations

(Includes Pickled and Oiled Sheets)

When sheets are specified resquared, the width and length are customarily not less than the dimensions specified. The variation for over-width, over-length, camber and out-of-square customarily does not exceed 1/16 inch for sheets up to and including 48 inches in width and up to and including 120 inches in length; nor 1/8 inch for wider or longer sheets.

TABLE 52

HOT ROLLED SHEETS

Variations from a Horizontal Flat Surface

(Sheets Not Specified to Stretcher Leveled Standard of Flatness, including Pickled and Oiled Sheets)

Specified Weight Lb. per Sq. Ft.	Specified Thickness, Inch	Specified Width, Inches	Variation from Flat, Inch
2.375 (16 Ga.) and heavier	0.0568 and thicker	To 60 incl. Over 60 to 72 incl. Over 72	½ ¾ 1

The flatness standards in Table 52 above are not applicable to coils.

ORDERING PRACTICE FOR KAISER HOT ROLLED STEEL SHEETS

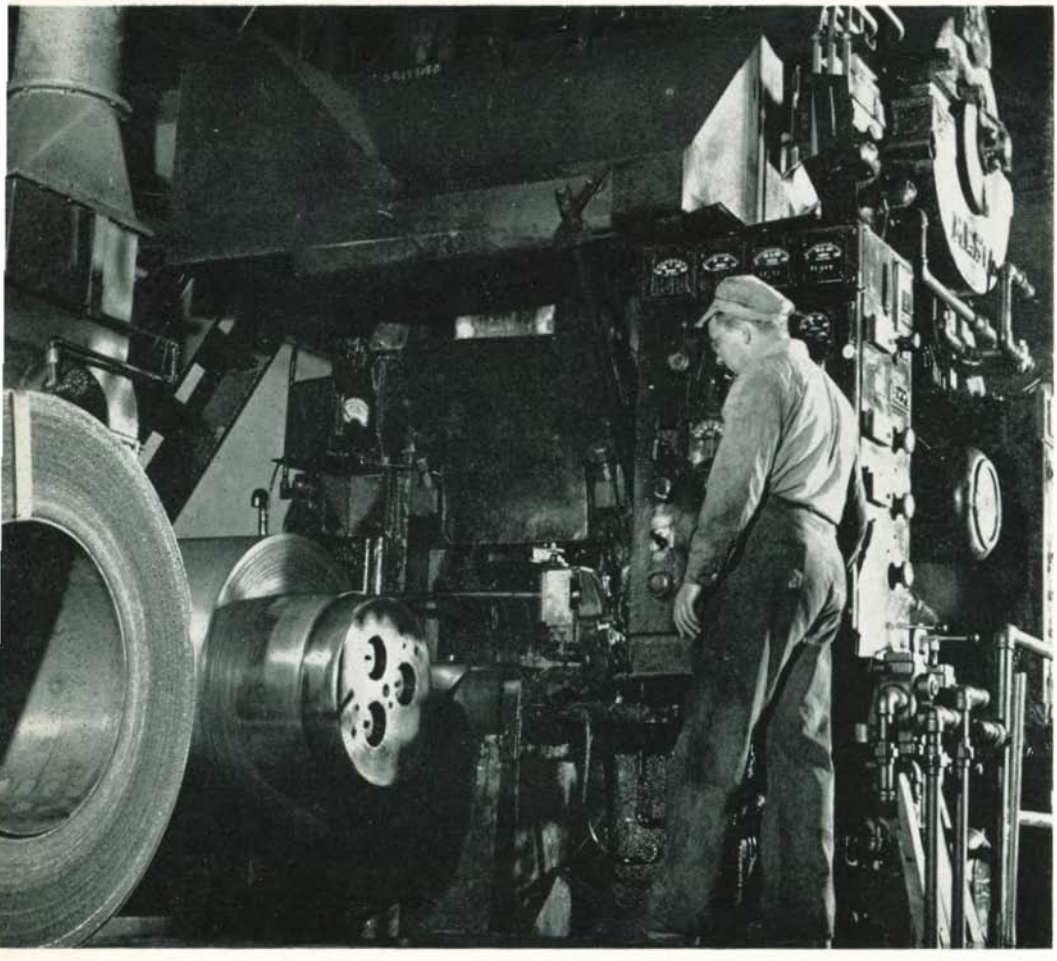
In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Hot Rolled Sheets, should specify the following details:

1. Quantity.
2. Size.
3. Specification.
4. Quality (that is, commercial quality, drawing quality, special killed steel, or physical quality, etc.).
5. End use.
6. Required inspection, if other than mill inspection.
7. Special loading practices if applicable.
8. Shipping destination.
9. Required routing.
10. Requested delivery.
11. Distribution of shipping notices, invoices, and bills of lading.

Sheets are invoiced on mill scale weights.

In check-weighing by the purchaser a variation from invoiced weights up to one per cent may be expected due to differences in kind, type, location and accuracy of the scales.

In cases of large quantities of one size and thickness, there is the possibility of error in count. For such lots, the weight is considered more accurate than the count as the basis for settlement of the invoices.



Superior surface finish and forming qualities are inherent in Kaiser Steel's cold rolled sheets due to equipment of the latest design. The cold-roll mill is a "four-high" reversing stand.

Cold rolled sheets

KAISER COLD ROLLED CARBON STEEL SHEETS

Kaiser cold rolled steel sheets are produced to the highest standards of quality and are extensively used for articles requiring a superior surface and excellent forming properties. Cold rolled sheets are used extensively for automobile parts, conduit, electrical fixtures, household appliances, machine parts, hardware and in many other applications. It is important that Kaiser metallurgists be given complete information on the manufacturing process and the end product so that the mill can be set up to produce sheets with properties suitable for the ordered use.

Kaiser cold rolled sheets are rolled to gauge from hot rolled, coiled, pickled sheets on a four-high reversing cold rolling mill and are bright annealed in controlled zone furnaces. After annealing they are carefully skin rolled on a two-high mill to produce the right stiffness and ductility required for the part to be formed. Sheets may be shipped in coils or cut lengths as ordered and will be furnished with sheared edges unless natural mill edge is specified. The maximum coil weight is approximately 220 pounds per inch of width. The inside coil diameter is 16". Surface finish more lustrous than normal bright finish or two side inspection may be specified but such restrictions are subject to negotiation. Kaiser cold rolled sheets are produced from 15 gauge to 28 gauge and from 12⅛ inches to 16 inches in width.

GRADES OF COLD ROLLED SHEETS

Cold rolled sheets are graded according to surface conditions as cold rolled primes or cold rolled sheets, and can be so specified.

Cold Rolled Sheets may contain surface inperfections of such a character that the sheets can be used for identified parts with a reasonable amount of metal finishing by the purchaser. They are supplied in coils or cut lengths.

Cold Rolled Primes are sheets inspected to meet specific surface requirements without metal finishing by the purchaser to remove surface imperfections other than those caused by the purchaser's handling and fabrication. They are supplied in cut lengths only. Inquiries for this grade are subject to negotiation.

QUALITIES OF COLD ROLLED SHEETS

Cold rolled sheets are commonly produced in three principal qualities: commercial quality, drawing quality and physical quality.

Commercial Quality sheets are ordinarily produced in a low carbon grade of steel, and are suitable for exposed parts requiring a good surface. Commercial quality sheets are not guaranteed to be suitable for electroplating where surface uniformity in the finished product is essential. Commercial quality can be specified to standard chemical ranges. Where no chemical composition is specified, commercial quality sheets should ordinarily not exceed a hardness equivalent of Rockwell B60. Hardness values, however, are not reported. Commercial quality sheets are processed so as to be free from sur-

face disturbances known as stretcher straining during fabrication, provided the sheets are properly roller leveled immediately before using.

DRAWING QUALITY sheets are customarily produced for fabricating identified parts where the surface before and after drawing is of prime importance. Proper identification of parts may include visual examination, prints or description, or combination of these. Drawing quality sheets are not suitable for electroplating where surface uniformity in the finished product is essential. Drawing quality sheets should produce identified parts too difficult for the drawing properties of sheets of any other quality, within the breakage allowances as commonly negotiated between purchaser and producer. When sheets of this quality are required to be essentially free from surface disturbances such as stretcher strains without roller leveling immediately prior to use, or when the sheets are to be essentially free from significant changes in mechanical properties over a period of time, Special Killed Steel should be specified.

PHYSICAL QUALITY sheets are produced when mechanical properties are specified or required, other than those described under other qualities of cold rolled sheets. Such properties or values include those determined by tension tests, hardness tests, or other commonly accepted mechanical tests. It is customary to specify only one kind of a test requirement. Cold rolled sheets of this quality are subject to negotiation.

Cold rolled sheets with luster finish may be supplied in any quality. Inquiries for this finish are subject to negotiation. Such sheets are produced on specially prepared rolls.

Tables covering the dimensional tolerances allowed in the production of Kaiser cold rolled sheets are given on the following pages. These tolerances are recognized as standard by the steel industry.

TABLE 53

COLD ROLLED SHEETS

Variations in Weight

(All of One Gauge and Size)

Specified Weights, Lbs. per Sq. Ft.	Variation from Specified Weight, Per Cent Over or Under			
	20 Tons and Over	Under 20 Tons to 3 Tons, incl.	Under 3 Tons to 1 Ton, incl.	Under 1 Ton
1.875 (18 gauge) and Heavier....	3.5	5	7.5	10
1.874 (19 gauge) and Lighter.....	2.5	3	5	10

TABLE 54

COLD ROLLED SHEETS

Variations from Specified Thickness

(Coils and Cut Lengths)

Specified Widths, Inches	For Widths and Thicknesses Given—Over or Under, In.						
	.1875 and Thicker	.1874 .1420	.1419 .0972	.0971 .0822	.0821 .0710	.0709 .0568	.0567 .0509
Up to 15 incl....	.007	.006	.006	.006	.005	.005	.005
Over 15 to 20 incl...	.007	.007	.007	.006	.005	.005	.005
Over 20 to 24 incl...	.007	.007	.007	.006	.005	.005	.005

Specified Widths, Inches	For Widths and Thicknesses Given—Over or Under, In.						
	.0508 .0389	.0388 .0314	.0313 .0255	.0254 .0195	.0194 .0142	.0141 .0113	.0112 and Thinner
Up to 15 incl....	.004	.003	.003	.003	.002	....	....
Over 15 to 20 incl...	.004	.003	.003	.003	.002	....	....
Over 20 to 24 incl...	.004	.003	.003	.003	.002	....	....

The thickness is measured at any point on the sheet not less than 3/8" in from an edge.

TABLE 55

COLD ROLLED SHEETS

Variations in Width

(Sheets not Resquared)

(Coils and Cut Lengths)

Specified Widths, Inches	Variation Over Specified Width, Inches No Variation Under
Up to 20 incl.	1/8
Over 20 to 32 incl.	3/16

TABLE 56

COLD ROLLED SHEETS

Variations in Length

(Sheets Not Resquared)

Specified Lengths, Inches	Variation Over Specified Length, Inches No Variation Under
To 15 incl.	1/8
Over 15 to 30 incl.	1/4
Over 30 to 60 incl.	1/2
Over 60 to 96 incl.	3/4
Over 96 to 120 incl.	1
Over 120 to 156 incl.	1 1/4
Over 156 to 192 incl.	1 1/2
Over 192 to 240 incl.	1 3/4
Over 240	2

TABLE 57

COLD ROLLED SHEETS

CAMBER

Camber is the greatest deviation of a side edge from a straight line; and measurement is taken on the concave side with a straight edge.

The camber for sheets in cut lengths, not resquared, is as follows.

Sheet Length, Feet	Camber, Inch
To 4 incl.	1/8
Over 4 to 6 incl.	3/16
Over 6 to 8 incl.	1/4
Over 8 to 10 incl.	5/16
Over 10 to 12 incl.	3/8
Over 12 to 14 incl.	1/2
Over 14 to 16 incl.	5/8
Over 16 to 18 incl.	3/4
Over 18 to 20 incl.	7/8
Over 20 to 30 incl.	1 1/4
Over 30 to 40 incl.	1 1/2

For sheets in coils, camber does not commonly exceed 1 inch in any 20 feet of length.

TABLE 58

COLD ROLLED SHEETS

Variations from a Horizontal Flat Surface

(Sheets Not Specified to Stretcher Leveled Standard or Flatness)

Specified Weight, Lbs. per Sq. Ft.	Specified Thickness, Inch	Specified Width, Inches	Variation from Flat, Inch
2.375 (16 Ga.) and Heavier	0.0568 and Thicker	To 60 incl.	1/2
2.374 (17 Ga.) and Lighter	0.0569 and Thinner	To 36 incl.	1/2

The flatness standards in Table 58 are not applicable to coils.

COLD ROLLED SHEETS

Out-of-Square
(Not Resquared)

Out-of-square is the greatest deviation of an end edge from a straight line at right angle to a side and touching one corner. The variation for sheets of all gauges and all sizes is 1/16 inch per 6 inches, or fraction thereof, of width.

COLD ROLLED SHEETS

Variations
Resquared Sheets

When sheets are specified resquared, the width and length are customarily not less than the dimensions specified. The variation for over-width, over-length, camber and out-of-square customarily does not exceed 1/16 inch for sheets up to and including 48 inches in width and up to and including 120 inches in length; nor 1/8 inch for wider or longer sheets.

ORDERING PRACTICE

Cold rolled sheets may be specified to chemical composition, may be produced to mechanical requirement specifications or may be ordered to hardness ranges. Hardness of Rockwell B-60 maximum is commonly recognized as a standard for commercial quality sheets. When cold rolled sheets are specified to a hardness range, no special finish beyond recognized sheet standards should be designated nor should the sheet be required to meet definite forming requirements. Standard variations from a horizontal flat surface do not commonly apply when sheets are produced to hardness ranges.

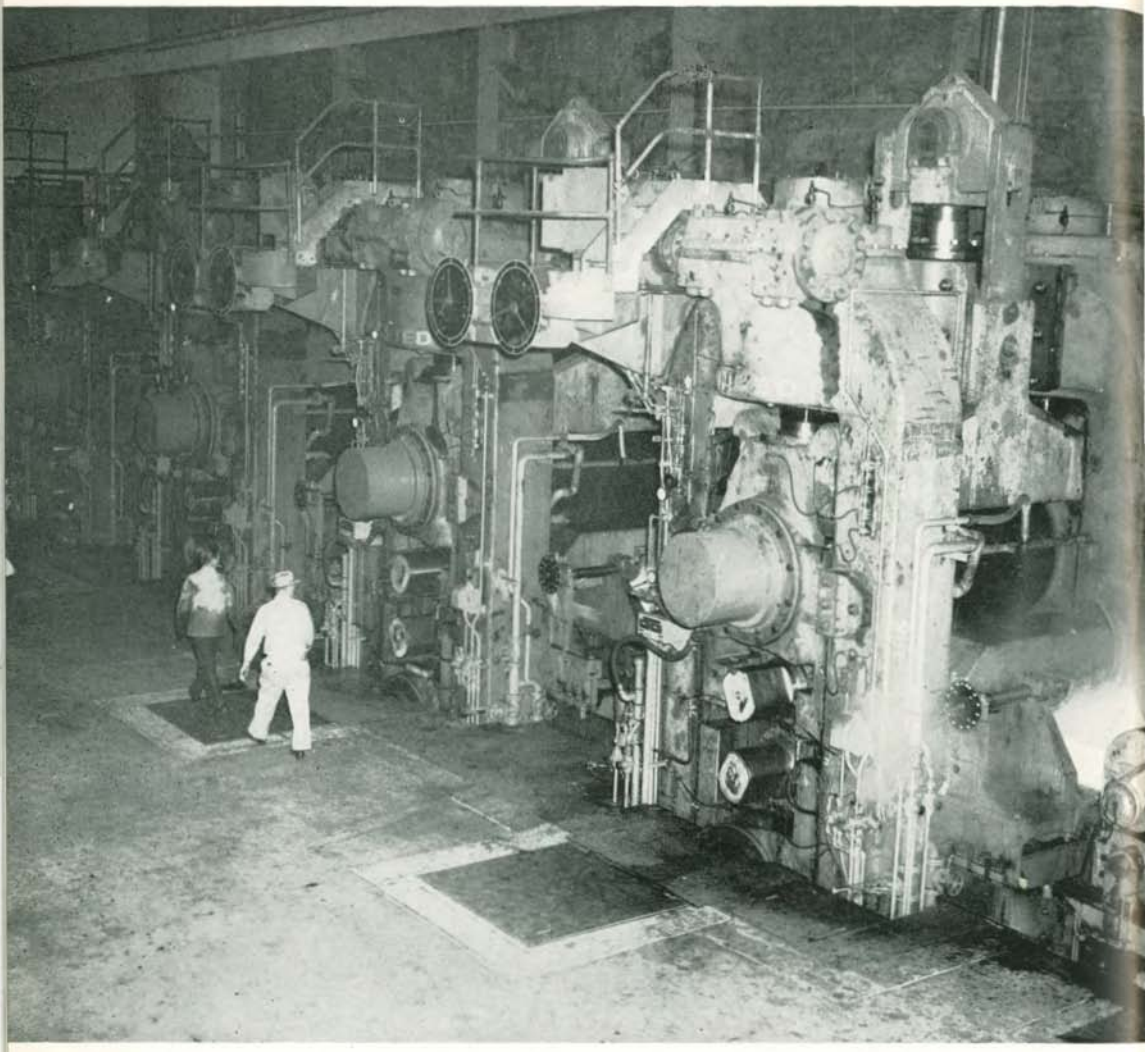
ORDERING PRACTICE FOR KAISER COLD ROLLED STEEL SHEETS

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Cold Rolled Sheets should specify the following details:

1. Quantity.
2. Size.
3. Quality (that is, commercial quality, drawing quality or physical quality).
4. Special and restrictive requirements (include in specification where applicable, special killed steel, special finish quality, primes only, and any specification restrictions closer than standard tolerances.).
5. End use.
6. Required inspection, if other than mill inspection.
7. Special loading practices if applicable.
8. Shipping destination.
9. Required routing.
10. Requested delivery.
11. Distribution of shipping notices, invoices, and bills of lading.

Sheets are invoiced on mill scale weights. In check-weighing by the purchaser a variation from invoiced weights up to one per cent may be expected due to differences in kind, type, location and accuracy of the scales.

In cases of large quantities of one size and thickness, there is the possibility of error in count. For such lots, the weight is considered more accurate than the count as the basis for settlement of the invoices.



Four "four-high" stands comprise the principal unit of the hot strip mill, handling slabs weighing from three to four tons. The end product meets high standards of quality.

HOT ROLLED STRIP

KAISER HOT ROLLED CARBON STEEL STRIP

Kaiser Hot Rolled Carbon Steel Strip is 12 inches or less in width and under .2300 inches in thickness. It is produced to qualities and dimensional limits as described later in this section. In general, hot rolled strip is used when a specific width within the strip range is needed or a mill edge is required. It is used in the automotive, building, industrial and mechanical fields.

Kaiser Hot Rolled Carbon Steel Strip is rolled on a continuous mill consisting of a series of vertical and horizontal rolls arranged in tandem so that strip rolled on the mill passes continuously through successive stands until it is reduced to the desired thickness. The vertical rolls control the width of the strip and loosen the oxide scale which is then removed by suitable hydraulic sprays. The strip may be coiled or cut in lengths as it leaves the mill. All cut length strip is accurately sheared and leveled before shipment.

The high standard of workmanship and quality maintained in Kaiser hot rolled strip is a principal reason for its wide use in industry.

The table below shows the chemical ranges and rolling limits of hot rolled strip rolled by Kaiser Steel Corporation.

TABLE 59

KAISER HOT ROLLED CARBON STEEL STRIP

ROLLING LIMITS

MAXIMUM .25 CARBON		MAXIMUM C-1085	
Width	Gauge	Width	Gauge
2″ to 4½″ incl.....	.125 to .203	6″.....	.1875 to .203
5⅛″ to 6″ incl.....	.104 to .203	6⅛″ to 12″ incl.....	.1875 to .2299
6⅛″ to 12″ incl.....	.104 to .2299		

Widths: 2″ to 4½″ acceptable in ½″ increments.
5⅛″ to 12″ acceptable in ⅛″ increments.

All above sizes 5⅛″ and wider are available in coils or cut lengths.

Sizes 2″ to 4½″ are available in cut lengths only.

QUALITIES

Kaiser Hot Rolled Strip is furnished in commercial quality, drawing quality and physical quality.

COMMERCIAL QUALITY strip is ordinarily produced in a low carbon grade of steel, and is suitable for many purposes where the presence of oxide and normal surface defects are not objectionable. Commercial quality is commonly specified to chemical ranges and limits. When a carbon content is not specified, it is assumed that hot rolled commercial quality strip, not exceeding 0.15 per cent carbon by ladle analysis, is desired. For any carbon range specified or required, the maximum of which does not exceed 0.15 per cent, a test specimen should withstand being bent flat on itself in any direction at room temperature. If mechanical properties or uniformity of temper are required, physical quality is commonly specified. If greater ductility than that indicated by the foregoing bend test is required drawing quality is commonly specified.

DRAWING QUALITY strip is customarily produced for use in fabricating identified parts where the surface before and after drawing is of secondary importance. Proper identification of parts may include visual examination, prints or description, or a combination of these. This quality of strip is not recommended for exposed parts. This quality should produce parts too difficult for the fabricating properties of commercial quality strip, within the breakage allowance as commonly negotiated between purchaser and producer. Because of excessive die scoring, the oxide on hot rolled strip should be removed by pickling prior to drawing.

PHYSICAL QUALITY strip is produced when mechanical properties are specified or required other than the bend tests of commercial quality or when uniformity of temper is required. Such properties or values include those determined by tensile tests, hardness tests, or other commonly accepted mechanical tests. It is customary to specify only one kind of a test requirement on any one item.

The tensile characteristics of hot rolled strip are influenced chiefly by (1) chemical composition, (2) thickness of section, (3) variables in mill design and practice. The carbon content is the dominant factor, and is employed by each mill in meeting required tensile properties in accordance with individual experience. Consequently, if the ultimate use or method of fabrication should require either a maximum or a minimum carbon limit along with tensile limits, the specified carbon should not have the effect of restricting the normal application for the given thickness and tensile requirements.

Strip of this quality is customarily identified as Physical Quality, or PQ, by showing this designation or symbol on each shipping unit.

SPECIAL SURFACE strip is produced for applications requiring a better surface than commonly obtained in the previously described types of hot rolled strip. This surface is commonly specified when strip having one smooth, clean surface and adherent oxide is required.

Hot rolled special surface, together with the proper strip quality, is commonly specified when the strip after pickling or blast cleaning by the purchaser is required to have a surface equivalent to that of the pickled commercial quality.

All Kaiser Hot Rolled Strip is furnished with a natural mill edge.

CAMBER

Camber is the greatest deviation of a side edge from a straight line; and measurement is taken by placing an eight-foot straight edge on the concave side and measuring the distance between the strip edge and the straight edge in the center of the arc.

The camber for hot rolled strip is shown in the table below.

TABLE 60

ALLOWABLE CAMBER

For strip wider than 1½ inches.....	¼ inch in any 8 feet
For strip 1½ inches and narrower.....	½ inch in any 8 feet

KAISER HOT ROLLED STRIP MANUFACTURING TOLERANCES

TABLE 61

THICKNESS

Coils and Cut Lengths

Specified Widths, Inches	Variations from Specified Thickness for Widths Given—Over or Under, Inches					
	0.2299 to 0.2031 incl.	0.2030 to 0.1875 incl.	0.1874 to 0.1180 incl.	0.1179 to 0.0568 incl.	0.0567 to 0.0344 incl.	0.0343 to 0.0255 incl.
Up to 3½ incl....	....	0.006	0.005	0.004	0.003	0.003
Over 3½ to 6 incl.	....	0.006	0.005	0.005	0.003	....
Over 6 to 12 incl.	0.006	0.006	0.005	0.005	....	....

Thickness measurements for Table 60 are taken $\frac{3}{8}$" in from edge of strip on 1 inch or wider; and at any place on the strip when narrower than 1 inch.

The given variations do not include crown.

TABLE 62

CROWN

Tolerance for Thickness at Center of Strip is that of the Edge Measurement Plus the Following:

Specified Widths, Inches	Variations from Specified Width for Thicknesses Given, Inches					
	0.2299 to 0.2031 incl.	0.2030 to 0.1875 incl.	0.1874 to 0.1180 incl.	0.1179 to 0.0568 incl.	0.0567 to 0.0344 incl.	0.0343 to 0.0255 incl.
Over 1 to 3½, incl.	....	0.001	0.002	0.002	0.002	0.002
Over 3½ to 6, incl.	....	0.002	0.002	0.003	0.003	....
Over 6 to 12, incl.	0.002	0.003	0.003	0.004	....	....

TABLE 63

WIDTH

Specified Widths, Inches	Variations from Specified Width for Thicknesses Given, Over or Under, Inches		
	Mill Edge and Square Edge All Thicknesses	Slit Edge	
		To 0.109 incl.	Over 0.109
To 2, incl.	1/32	0.008	0.016
Over 2 to 5, incl.	3/64	0.008	0.016
Over 5 to 10, incl.	1/16	0.010	0.016
Over 10 to 12, incl.	3/32	0.016	0.016

TABLE 64

LENGTH

Specified Widths, Inches	Variation over Specified Length in Feet for Widths Given, Inches					
	To 5′ incl.	Over 5′ to 10′ incl.	Over 10′ to 20′ incl.	Over 20′ to 30′ incl.	Over 30′ to 40′ incl.	Over 40′
To 3, incl.	¼	⅜	½	¾	1	1½
Over 3 to 6, incl.	⅜	½	⅝	¾	1	1½
Over 6 to 12, incl.	½	¾	1	1¼	1½	1¾

No variation under.

ORDERING PRACTICE FOR KAISER HOT ROLLED STEEL STRIP

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Hot Rolled Strip, should specify the following details:

1. Quantity.
2. Size.
3. Specification.
4. Quality (that is, commercial quality, drawing quality, special killed steel or physical quality, etc.).
5. End use.
6. Required inspection, if other than mill inspection.
7. Special loading practices if applicable.
8. Shipping destination.
9. Required routing.
10. Requested delivery.
11. Distribution of shipping notices, invoices, and bills of lading.

Hot rolled strip is invoiced on mill scale weights. In check-weighing by the purchaser, a variation in invoiced weights up to one per cent may be expected due to differences in kind, type, location, and accuracy of the scales.

Kaiser cold rolled strip steel is produced in many widths, gauges and tempers.

COLD ROLLED STRIP

KAISER COLD ROLLED CARBON STEEL STRIP

Kaiser Cold Rolled Strip is produced to specified temper, edge, and finish. The processing of steel in pickling, rolling, annealing, temper rolling and slitting to meet the requirements for temper, edge and finish that are demanded by cold rolled strip necessitates such close control of all operations that cold rolled strip is literally a tailor-made product.

Among its many applications, Kaiser Cold Rolled Strip is used in the manufacture of moldings, furniture tubing, household and general hardware, tools and instruments, calculators, automobile and aircraft parts and plumbing and heating equipment.

In the Kaiser practice, mill scale is removed from the coils of hot rolled steel in modern, continuous pickling equipment to prepare it for cold rolling. The action of a combination of mechanical and chemical processes, which takes place as the steel moves through the pickling unit, produces a remarkably clean and stain free surface. Continuous inspection of the pickled surface insures the selection of hot rolled strip with sound surface for cold rolling.

The pickled strip is cold rolled to the desired thickness by successive passes in alternate directions through a four-high reversing mill. The Kaiser practice of large percentage reduction from the hot roll to the cold roll thickness insures excellent recrystallization in the cold rolled strip and superior drawing properties in the final product. An electric gauge, mounted on the rolling mill, continuously measures the thickness of the strip during rolling, enabling the operator to maintain uniformly accurate thickness throughout the coil.

After cold rolling to thickness the steel is hard, stiff and has very little ductility. Annealing in modern, bell type, zone controlled furnaces softens the strip. The original brightness of the strip is retained during annealing by a protective atmosphere. The annealed strip is dead soft but it is characteristic of annealed steel that when it is stressed beyond its elastic limit, initial elongation does not occur uniformly but commences in isolated areas which become visible as objectionable depressions in the surface. These depressions are commonly termed "stretcher strains." Stretcher strains can be prevented by lightly rolling annealed strip. To eliminate stretcher straining and develop desired physical characteristics, annealed strip is temper rolled to the degree of ductility or stiffness needed for the end product. The effect of skin rolling, however, is not permanent, and stretcher strains may reappear in the softer temper strip unless it is used shortly after temper rolling. If freedom from stretcher strains is imperative, special aluminum killed steel should be specified.

The following data shows the width and thickness ranges and the tempers and edges of Kaiser Cold Rolled Strip.

Widths: Over ½″ to 12″ inclusive
Over 12″ to 16″ inclusive (When a particular temper or a special edge, or special finish is specified).

Thickness: .0149 to .0747 inches

Lengths: This material is available in coils or cut lengths 48″ to 120″.
Standard weight per inch of coil width is 200 pounds.
Standard coil dimensions: I.D. 16″ O.D. 42″

TEMPERS

Kaiser Cold Rolled Strip is temper rolled to degrees of ductility commonly designated by temper numbers. Temper numbers indicate ranges of hardness associated with the ability of the steel to withstand deformation. The close control given the temper rolling of Kaiser strip largely contributes to its successful performance.

The following is a full description of cold rolled strip tempers, currently accepted as standard practice.

No. 1 (Hard Temper) is a very stiff, springy, cold rolled strip intended for flat work not requiring ability to withstand cold forming. This temper is commonly produced in chemical compositions of less than 0.25 per cent carbon (ladle analysis) and Rockwell B-84 minimum for thicknesses 0.070 inches and greater, or Rockwell B-90 minimum for thicknesses less than 0.070 inches.

No. 2 (Half Hard Temper) is a moderately stiff cold rolled strip suitable for limited bending. Strip of this temper can be bent 90 degrees across the direction of rolling around a radius equal to the thickness. This temper is commonly produced in chemical compositions of less than 0.25 per cent carbon (ladle analysis) Rockwell B-70 minimum and approximately Rockwell B-85 maximum.

No. 3 (Quarter Hard Temper) is a medium soft cold rolled strip suitable for limited bending and forming and drawing. Strip of this temper can be bent 180 degrees across the direction of rolling and 90 degrees in the direction of rolling around a radius equal to the thickness. This temper is commonly produced in chemical compositions of less than 0.25 per cent carbon (ladle analysis) Rockwell B-60 minimum and approximately Rockwell B-75 maximum.

No. 4 (Skin Rolled Temper) is a soft, ductile, cold rolled strip, suitable for fairly deep drawing where surface disturbances such as stretcher strains are objectionable. It is capable of being bent flat upon itself in any direction. Skin-rolled, planish rolled, and pinch passed are equivalent terms with respect to temper. This temper is commonly produced in chemical compositions of less than 0.15 per cent carbon (ladle analysis) and approximately Rockwell B-65 maximum.

No. 5 (Dead Soft Temper) is a soft, ductile, cold rolled strip produced without definite control of stretcher straining and fluting. It is suitable for difficult drawing applications where such surface disturbances are not objectionable. It is suitable for bending flat upon itself in any direction. This temper is commonly produced in chemical compositions of less than 0.15 per cent carbon (ladle analysis) and approximately Rockwell B-55 maximum.

Although the maximum ductility is obtained in strip steel in its dead soft or annealed condition, it is unsuited to many forming operations due to its tendency to stretcher strain. A small amount of cold rolling will prevent this, but the effect is only temporary due to the phenomenon called aging. Usually the higher the storage temperature, and the less the amount of skin rolling after final annealing, the shorter the elapsed time necessary for stretcher strain to recur. The phenomenon of aging is accompanied by a loss of ductility with an increase in hardness, yield point, and tensile strength. For those uses in which stretcher straining or breakage due to aging of the steel are likely to occur, the material should be fabricated as promptly as possible after temper rolling.

No. 1 temper strip is rolled direct to gauge on the four-high reversing mill and is not annealed. Strip of Nos. 2, 3 and 4 tempers are rolled slightly heavier than the final thickness on the four-high reversing mill and after annealing are temper rolled on the two-high mill to the final thickness and desired temper. No. 5 temper strip is rolled to gauge on the four-high reversing mill and no further rolling is done after annealing. The strip is shipped in the dead soft annealed condition. After slitting to width and final inspection and testing, coils are bundled or cut into specified lengths for shipment.

COLD ROLLED STRIP FINISHES

No. 2 (Regular bright finish). This luster surface is produced by finishing on bright rolls and is the finish regularly supplied.

No. 3 (Best bright finish). This high luster surface is produced by special practice and by finishing on especially bright rolls. It is guaranteed for electroplating. A limited amount of No. 3 finish is accepted for processing, and inquiries for this finish are subject to negotiation.

EDGES

Kaiser Cold Rolled Strip may be furnished with mill or slit edges.

The edge desired should be specified on the order.

No. 2 Edge—Natural mill edge. Suitable for blanking.

No. 3 Edge—Natural slit edge. Approximately square.

TABLE 65

DEFINITION AND CLASSIFICATION

COLD ROLLED CARBON STEEL STRIP

It is Produced in Coils or Cut Lengths with a Maximum Width of 23 15/16" from Hot Rolled Steel which has been Pickled to Remove Scale.

Widths, Inches	Thicknesses, Inches		
	0.2500 and Thicker	0.2499 to 0.0142	0.0141 and Thinner
To 12 incl.	Bar	Strip (3)	Strip (3)
Over 12 to 24 incl.	Strip (1)	Strip (1)	Strip (1)
Over 12 to 24 incl.	Sheet (2)	Sheet (2)	

(1) When a particular temper, special edge, or special finish is specified.

(2) When no special temper, edge or finish is specified.

(3) When the width is greater than the thickness with a maximum of ½ inch and a cross-sectional area not exceeding 0.05 Sq. In., and the material has rolled or prepared edges, it is classified as flat wire.

TOLERANCES FOR COLD ROLLED CARBON STEEL STRIP

TABLE 66

CROWN

Tolerance for Thickness at Center of Strip is that of the Edge Measurement Plus the Following:

Thickness, Inches	Width, Inches		
	1 to 5 incl.	Over 5 to 12 incl.	Over 12 to 23 15/16 incl.
	Additional Thickness at Center, Inches		
0.005 to 0.010 incl.	0.00075	0.001	0.0015
Over 0.010 to 0.025 incl.	0.001	0.0015	0.002
Over 0.025 to 0.065 incl.	0.0015	0.002	0.0025
Over 0.065 to 0.187 incl.	0.002	0.0025	0.003
Over 0.187 to 0.2499 incl.	0.002	0.0025	0.003

TOLERANCES FOR COLD ROLLED CARBON STEEL STRIP

TABLE 67

THICKNESS

Measured 3/8 Inch in from Edge on 1 Inch or Wider; and on Narrower than 1 Inch at Any Place on the Strip

Specified Thickness, Inches		Variation from Specified Thickness, Plus or Minus, Inches							
		Widths, Inches							
Over	To and incl.	Over ½ less than 1	1 and less than 3	3 to 6 incl.	Over 6 to 9 incl.	Over 9 to 12 incl.	Over 12 to 16 incl.	Over 16 to 20 incl.	Over 20 to 23 15/16 incl.
.160	.2499	.002	.003	.0035	.0035	.0035	.0045	.005	.005
.099	.160	.002	.002	.003	.003	.003	.0035	.0045	.005
.068	.099	.002	.002	.0025	.003	.003	.0035	.0035	.0035
.049	.068	.002	.002	.0025	.0025	.0025	.003	.0035	.0035
.039	.049	.002	.002	.0025	.0025	.0025	.003	.003	.003
.034	.039	.002	.002	.002	.002	.002	.002	.002	.002
.031	.034	.0015	.0015	.002	.002	.002	.002	.002	.002
.028	.031	.0015	.0015	.0015	.002	.002	.002	.002	.002
.025	.028	.001	.0015	.0015	.002	.002	.002	.002	.002
.019	.025	.001	.001	.0015	.0015	.0015	.002	.002	.002
.012	.019	.001	.001	.001	.0015	.0015	.0015	.0015	.0015
.011	.012	.001	.001	.001	.001	.0015	.0015	.0015	.0015
.009	.011	.001	.001	.001	.001	.001	.001	.001	.001
.005	.009	.00075	.00075	.00075	.001	.001	.001	.001	.001
...	.005	.0005	.0005	.0005	....	....	....	....	....

TABLE 68

WIDTH FOR No. 2 EDGE (MILL EDGE)

Specified Width, Inches		Variation from Specified Width, Plus or Minus, Inches
Over	Up to and Including	
½	2	1/32
2	5	3/64
5	10	5/64
10	15	3/32
15	20	1/8
20	23 15/16	5/32

TOLERANCES FOR COLD ROLLED CARBON STEEL STRIP

TABLE 69

WIDTH FOR No. 3 EDGE (SLIT EDGE)

Specified Thickness, Inches		Width, Inches				
Over	To and incl.	Over ½ to 6 incl.	Over 6 to 9 incl.	Over 9 to 12 incl.	Over 12 to 20 incl.	Over 20 to 23 15/16 incl.
		Variations from Specified Width, Plus or Minus, Inches				
.160	.2499	.016	.020	.020	.031	.031
.099	.160	.010	.016	.016	.020	.020
.068	.099	.008	.010	.010	.016	.020
.016	.068	.005	.005	.010	.016	.020
Up to	.016	.005	.005	.010	.016	.020

TABLE 70

VARIATIONS FROM SPECIFIED LENGTHS

Variation in Inches Over the Specified Length

Specified Width, Inches	24 to 60 inches incl.	Over 60 to 120 inches incl.	Over 120 to 240 inches incl.
Over ½ to 12, incl.	¼	½	¾
Over 12 to 23 15/16, incl. . . .	½	¾	1

TABLE 71

CAMBER

Camber is the deviation of a side edge from a straight line, and measurement is taken by placing an eight-foot straight edge on the concave side and measuring the distance between the strip edge and the straight edge.

The camber for cold rolled carbon steel strip is shown below.

For strip wider than 1½" . . . . . ¼" in any 8 feet

For strip 1½" or narrower . . . . . ½" in any 8 feet

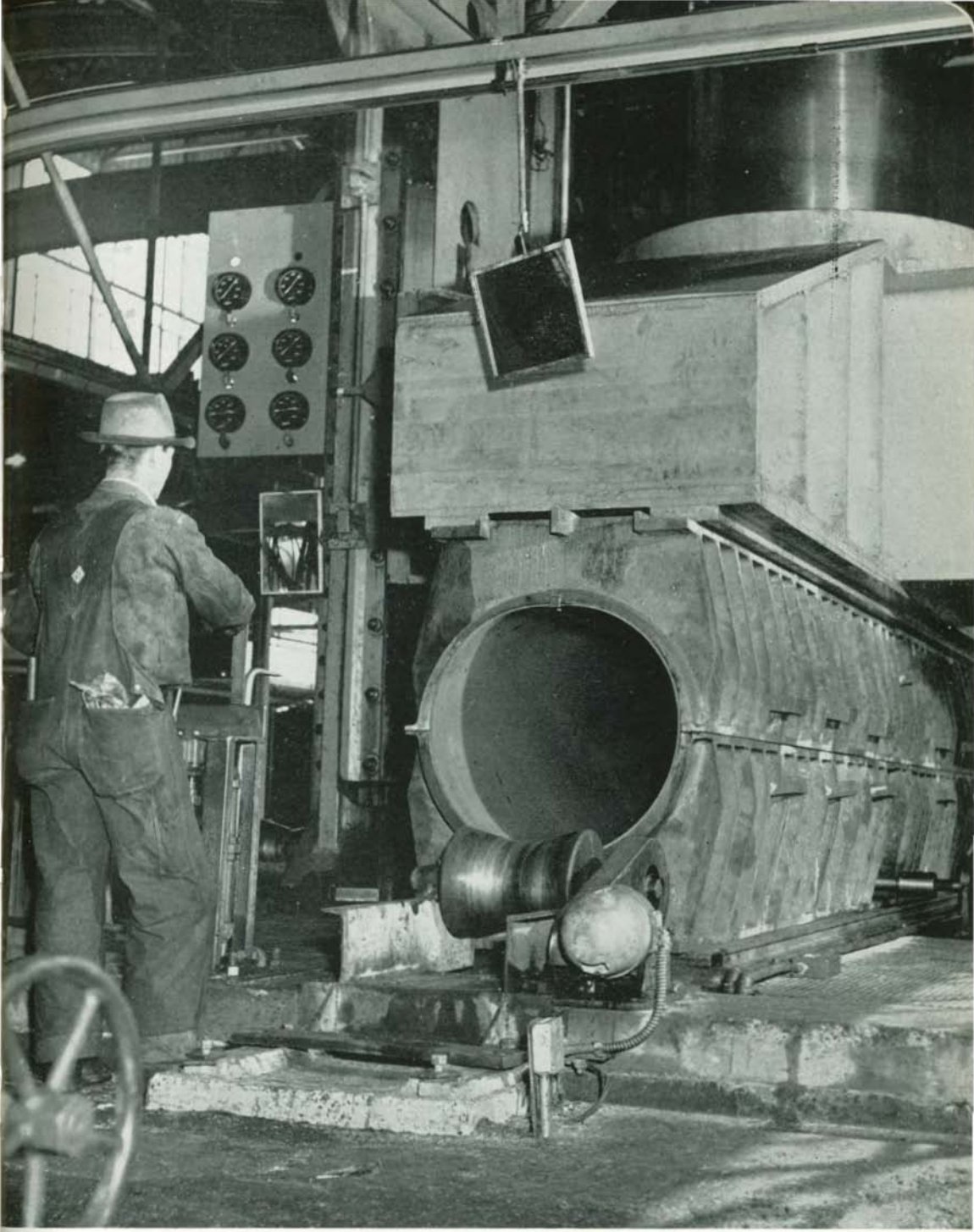
When the camber shown above is not suitable for a particular purpose, cold rolled carbon steel strip is sometimes machine straightened to specified camber. This requirement is commonly negotiated between purchaser and producer.

ORDERING PRACTICE FOR KAISER COLD ROLLED STEEL STRIP

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Cold Rolled Strip, should specify the following details:

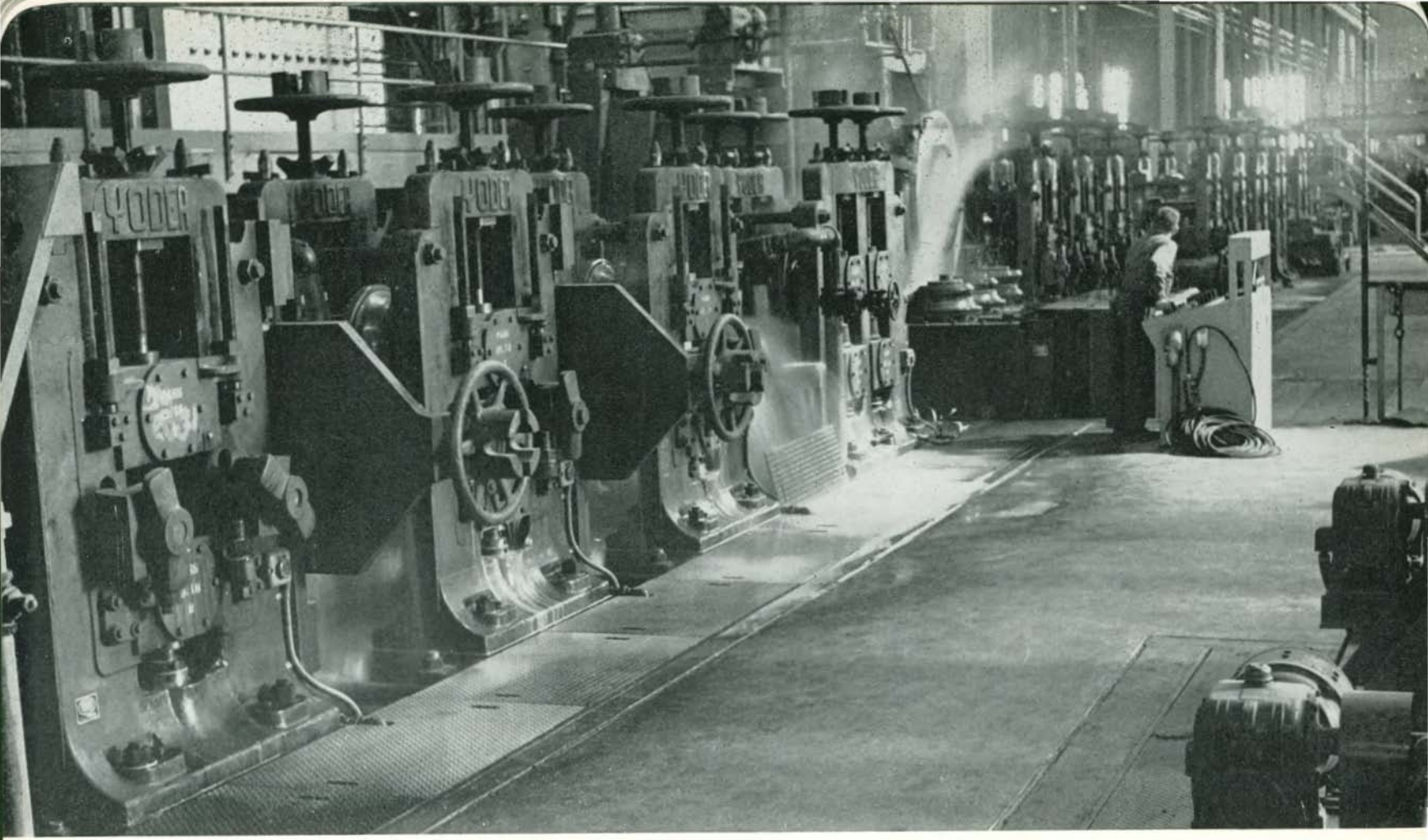
1. Quantity.
2. Size (Cold rolled strip should be ordered to decimal thickness).
3. Temper, edge, finish.
4. Any special requirements such as special tolerances or special killed steel.
5. End use.
6. Required inspection, if other than mill inspection.
7. Special loading practices if applicable.
8. Shipping destination.
9. Required routing.
10. Requested delivery.
11. Distribution of shipping notices, invoices, and bills of lading.

Cold rolled strip is invoiced on mill scale weights. In check-weighing by the purchaser, a variation in invoiced weights up to one per cent may be expected due to differences in kind, type, location, and accuracy of the scales.



Basalt-Kaiser line pipe up to 30" O.D. is formed in this giant press. Final sizing is by cold reduction or hydraulic expansion, effecting a cold working of the metal for improved physical qualities.

Standard pipe, either galvanized or black, is produced at Fontana in diameters from ½" to 4", by the continuous-weld process which insures high quality pipe of uniform wall thickness.



Steel pipe from 5⁹⁄₁₆" to 14" O.D. is formed and resistance welded in this Yoder welding unit in lengths up to 55 feet. Perfect welds and uniform wall thicknesses are characteristics of Kaiser pipe.

TUBULAR PRODUCTS

KAISER TUBULAR PRODUCTS

Steel tubular products are those cylindrical forms designated as pipe or tubing which are generally used for conveying gases or liquids and for a diversity of mechanical and structural purposes. Kaiser Tubular Products are used throughout the West for plumbing, heating and ventilating systems in homes, schools, hotels, apartments and factories. They are extensively used in the petroleum industry and by public utilities for the transportation of oil, gas, water and other liquids. Kaiser Tubular Products are also used for many structural purposes such as stanchions, columns and trusses in buildings. The general terms pipe, tubes and tubing are not sharply defined within the industry and are therefore used interchangeably.

At Fontana, California, Kaiser Steel Corporation is engaged in a fully integrated pipe production program involving both continuous welded steel pipe and electric resistance welded steel pipe. The skelp used for these pipe mills is rolled to the desired sizes and standards on the Company's own mills.

Continuous welded steel pipe is rolled in nominal sizes from ½" to 4" inclusive on a modern continuous weld type mill. It is supplied in 21-foot uniform lengths and in random lengths, either plain end or threaded and coupled and either black or galvanized. Both standard and extra strong weights are produced.

Electric resistance welded pipe is rolled in sizes from 5$\frac{9}{16}$" O.D. to 14" O.D. inclusive on a Yoder type welding unit of latest design. This pipe can be produced in wall thicknesses from .188" to .400" inclusive, depending on the outside diameter. The maximum lengths produced are 55 feet.

In conjunction with the Steel Division of the Basalt Rock Company at Napa, California, Kaiser Steel Corporation is in a position to offer fusion welded pipe in sizes from 8$\frac{5}{8}$" to 30" O.D. inclusive, in lengths approximately 40 feet long. Wall thicknesses range from .250" to .500". The pipe in sizes 14" to 22" O.D. inclusive is manufactured by the press forming method with one longitudinal weld which is made with a welding pass first on the inside and then on the outside. This large diameter pipe is hydraulically expanded to size, thereby increasing the yield strength to desired specification limits.

All the above described pipe will meet the latest applicable industry specifications. A more detailed description of the manufacturing process involved will be found on succeeding pages.

KAISER CONTINUOUS WELD STEEL PIPE

Kaiser Continuous Weld Steel Pipe is made in both Standard and Extra Strong weights. Nominal sizes range from ½" to 4" inclusive. The skelp used in making continuous weld pipe comes from the rolling department of the steel mill in coils with a specified width and thickness, according to the size of pipe to be made. The edges of the skelp are slightly beveled so that the surface of the skelp which is to become the inside of the pipe is not quite as wide as that which forms the outside; thus, when the edges are brought together, they meet squarely, as indicated in the adjacent figure.

In order to produce pipe by the continuous weld process, the steel is rolled in coils containing 185 to 550 feet of skelp weighing from 600 to 1800 pounds depending on the size of the pipe being made. As these coils are paid out one at a time, the skelp passes through a roller leveler which flattens it. When the tail of one coil reaches the flash welding machine, the starting end of the next coil is electric resistance welded to it, thereby forming a continuous ribbon. Following a trimming process where the excess welding metal is removed, the skelp is drawn through the gas fired reheating furnace which raises it to a welding temperature in a minimum of 30 seconds. The edges of the steel approach a softening point in order to insure proper welding. As it leaves the furnace, jets of air impinge on the edges of the skelp, increasing the temperature 100 to 200 degrees or up to the mean welding temperature. The skelp then passes through a forming roll. Welding and sizing is completed by ten pairs of grooved rolls arranged in five sets, each set consisting of a pair of vertical and a pair of horizontal rolls.

After the pipe is rolled into shape, it is cut to lengths of approximately 21 feet by means of a flying hot saw, and after partial cooling is re-cut to more uniform 21 foot lengths. The pipe is then fed into three pairs of rolls, where the final sizing is done and scale is loosened and removed both internally and externally. After final cooling, the pipe goes into the finishing department where it is straightened and the ends finished, followed by hydrostatic testing to specification. It may then either be pickled and galvanized or finished black. Threading is done on modern high-speed threading machines. Black pipe is furnished either coated or uncoated, as required by the purchaser.

All sizes are supplied either black or galvanized for use in the transmission of air, gas, steam, water, oil and other fluids and for miscellaneous purposes. Standard pipe intended for ordinary uses such as low-pressure steam, water, air or gas lines is tested hydrostatically in accordance with latest industry specifications. When intended for special purposes such as bending or coiling, Kaiser Steel Pipe is subject to bending, flattening and tensile tests as well as hydrostatic tests. Black continuous weld pipe is also manufactured for line pipe and is available either with plain ends or threaded and coupled.

Kaiser Continuous Weld Standard Pipe is furnished as may be desired, with threaded ends and couplings, threaded ends without couplings, plain ends, or ends beveled for welding. It is furnished in either 21 foot uniform lengths or in random lengths up to 44 feet long. Threaded and coupled pipe is furnished with one coupling screwed on one end and the length of each pipe is measured over all, including the coupling.

KAISER CONTINUOUS WELD STEEL PIPE

TABLE 72

Black and Galvanized

Dimensions, Weights and Test Pressures

STANDARD WEIGHT

Nom. Size	Wt. per Foot		Pipe			Threads per Inch	Couplings			Test Pressure Psi
	T & C	Plain Ends	Thickness	Diameters			Length	Ext. Diameter	Wt.	
				Ext.	Int.					
In.	Lb.	Lb.	In.	In.	In.		In.	In.	Lb.	Lb.
½	.85	.85	.109	.840	.622	14	1 9/16	1.063	.17	700
¾	1.13	1.13	.113	1.050	.824	14	1 5/8	1.313	.26	700
1	1.68	1.68	.133	1.315	1.049	11½	2	1.576	.40	700
1¼	2.28	2.27	.140	1.660	1.380	11½	2 1/16	1.900	.48	800
1½	2.73	2.72	.145	1.900	1.610	11½	2 1/16	2.200	.67	800
2	3.68	3.65	.154	2.375	2.067	11½	2⅛	2.750	1.05	800
2½	5.82	5.79	.203	2.875	2.469	8	3⅛	3.250	2.09	800
3	7.62	7.58	.216	3.500	3.068	8	3¼	4.000	3.35	800
*3½	9.20	9.11	.226	4.000	3.548	8	3⅜	4.625	4.82	1200
4	10.89	10.79	.237	4.500	4.026	8	3½	5.000	4.61	1200

TABLE 73

EXTRA STRONG WEIGHT

Nominal Size	Weight, per Foot, Plain Ends	Thickness	Diameters		Test Pressure Psi
			External	Internal	
In.	Lb.	In.	In.	In.	Lb.
½	1.09	.147	.840	.546	850
¾	1.47	.154	1.050	.742	850
1	2.17	.179	1.315	.957	850
1¼	3.00	.191	1.660	1.278	1100
1½	3.63	.200	1.900	1.500	1100
2	5.02	.218	2.375	1.939	1100
2½	7.66	.276	2.875	2.323	1100
3	10.25	.300	3.500	2.900	1100
*3½	12.51	.318	4.000	3.364	1700
4	14.98	.337	4.500	3.826	1700

*This size is not regularly produced. Orders for same are subject to negotiation.

TABLE 74

KAISER BLACK LINE PIPE

Dimensions, Weights and Test Pressures

Nom. Size	Wt. per Foot		Pipe			Threads per Inch	Couplings			Test Pressure Psi
	T & C	Plain Ends	Thickness	Diameters Ext.	Diameters Int.		Length	Ext. Diameter	Wt.	
In.	Lb.	Lb.	In.	In.	In.		In.	In.	Lb.	Lb.
½	.86	.85	.109	.840	.622	14	2⅛	1.063	.24	700
¾	1.14	1.13	.113	1.050	.824	14	2⅛	1.313	.34	700
1	1.70	1.68	.133	1.315	1.049	11½	2⅝	1.516	.54	700
1¼	2.30	2.27	.140	1.660	1.380	11½	2¾	2.054	1.03	800
1½	2.75	2.72	.145	1.900	1.610	11½	2¾	2.200	.90	800
2	3.75	3.65	.154	2.375	2.067	11½	3¼	2.875	2.13	800
2½	5.90	5.79	.203	2.875	2.469	8	4⅛	3.375	3.27	800
3	7.70	7.58	.216	3.500	3.068	8	4¼	4.000	4.07	800
3½	9.25	9.11	.226	4.000	3.548	8	4⅜	4.625	5.92	1200
4	11.00	10.79	.237	4.500	4.026	8	4½	5.200	7.59	1200

Kaiser Black T & C Line Pipe is manufactured by the continuous weld process for use under conditions where increased pressure or stress requires pipe with the heavier, recessed line pipe coupling. The dimensions and data on this pipe are shown in the table above.

Terms relating to diameters, wall thicknesses, or foot-weights, and the terms *actual* and *nominal* in reference to sizes always carry the qualifying conditions imposed by manufacturing tolerances. The term *nominal* as used herein refers to a named or given dimension as distinguished from the actual or real dimension. There are some wide differences between actual and nominal dimensions, and published tables should be consulted. For example, ½ in. standard weight pipe has an actual outside diameter of 0.840 in. and an inside diameter of 0.622 in.

PIPE MILL PRACTICES

The weights of steel tubular products are calculated on the basis of 0.2833 lb. per cu. in. and are commonly expressed as weights per foot.

The outside diameter of a given size of pipe is the same regardless of weight per foot. Variations in weight or wall thickness affect the inside diameter only. The standard weight per foot of pipe with threads and couplings is based on a length of twenty feet over all when the coupling is pulled tight.

All pipe in sizes 2″ and larger is shipped loose. Double length pipe is shipped loose but single length pipe in sizes 1½″ and under are bundled as per the following table.

TABLE 75

BUNDLING TABLE

21′ Uniform Lengths

Nominal Size Inches	Footage Per Ton (Nearest Foot)		Pieces Per Bundle	Footage Per Bundle (Nearest Foot)	Weight Per Bundle (Pounds)
	T. and C.	Plain End			
½	2353	2353	12	252	214
¾	1770	1770	7	147	166
1	1190	1190	5	105	176
1¼	877	881	3	63	144
1½	733	735	3	63	172
2	543	548	Pipe 2″ and over is not bundled		
2½	344	345			
3	262	264			
4	184	185			

Pipe is furnished reasonably straight as common practice. When specific straightness is desired, the mill should be so advised on the order.

On plain end pipe ordered beveled for welding, it is standard to bevel to an angle of 30° from vertical on the outside with an average flat width at the end of the pipe of 1/16″.

KAISER ELECTRIC WELD STEEL PIPE

Regular Weight—Plain End

Kaiser Electric Resistance Welded Pipe is produced from cold, flat skelp. Since the pipe forming operations do not alter the thickness of the plate, the wall thickness of the finished pipe is uniform, and the inside and outside surfaces are concentric.

The skelp is first passed through a roller leveler to achieve a smooth, flat surface. From the leveler operation, the skelp undergoes an edge cleaning which prepares the metal for good contact with the welding electrodes and insures free passage of the welding current. A thorough cleaning is accomplished by a steel shot blasting process under high pressure.

A perfectly straight welding surface is essential and a uniform width must be maintained throughout the full length of the skelp. To insure this, the skelp is passed through rotary shears which trim both edges to close tolerances immediately before the forming and welding operations. During this process the skelp is carefully inspected for surface defects. In effect, this means close inspection of both surfaces of the finished pipe.

The skelp is passed from the edge trimmer directly into a series of forming rolls which progressively form it, without undue strain, into an open tube. The tube is moved into the welding unit where revolving circular electrodes contact the steel close to each edge and transmit the current which generates the welding heat. By careful control of current, speed and pressure, the edges are bonded to produce a weld of the same strength and properties of the parent metal, extruding just enough metal both inside and outside of the tube to insure a complete weld. The extruded weld metal is immediately removed by stationary cutters, leaving a perfectly smooth wall of the same gauge throughout.

The welded pipe is passed through several stands of rolls which slightly reduce the diameter and insure correct size and straightness. Final roll straightening is done prior to a thorough visual inspection of each length of pipe for surface imperfections. The pipe is then magnetically inspected for weld quality. Throughout the production process, Kaiser Electric Weld Pipe is carefully tested and controlled so that final properties will conform in all respects to applicable industrial specifications. Following inspection and crush testing, the pipe ends are beveled, grooved or left plain, as required by the buyer. If threading is desired, this operation is performed before the final hydrostatic tests are run. While under pressure, the pipe is struck with pneumatic hammers near the ends of the pipe and again checked for possible defects. After final inspection to insure conformance to specification, each length is measured and marked in preparation for shipment to the customer. It is standard mill practice to coat each length of pipe unless otherwise specified.

The following table lists the dimensions, weights and test pressures pertaining to Kaiser Plain End Electric Weld Line Pipe available for sale and shipment from our Fontana Mill.

TABLE 76

KAISER ELECTRIC WELD PIPE

Regular Weight Plain End Line Pipe

Dimensions, Weights and Test Pressures

Size O. D.	Size I. D.	Wall Thickness	Weight per Foot	Grade A	Grade B
In.	In.	In.	Lb.	Psi	Psi
5 9/16	5.187	0.188	10.76	1200	1400
5 9/16	5.125	0.219	12.49	1400	1700
5 9/16	5.047	0.258	14.62-s	1700	1900
5 9/16	5.001	0.281	15.87	1800	2100
5 9/16	4.939	0.312	17.52	2000	2400
5 9/16	4.875	0.344	19.16	2200	2500
5 9/16	4.813	0.375	20.78-x	2400	2500
6 5/8	6.249	0.188	12.89	1000	1200
6 5/8	6.187	0.219	14.97	1200	1400
6 5/8	6.125	0.250	17.02	1400	1600
6 5/8	6.065	0.280	18.97-s	1500	1800
6 5/8	6.001	0.312	21.07	1700	2000
6 5/8	5.937	0.344	23.06	1900	2200
6 5/8	5.875	0.375	25.03	2000	2400
8 5/8	8.249	0.188	16.90	800	900
8 5/8	8.187	0.219	19.64	900	1100
8 5/8	8.125	0.250	22.36	1000	1200
8 5/8	8.071	0.277	24.70-s	1200	1300
8 5/8	8.001	0.312	27.74	1300	1500
8 5/8	7.981	0.322	28.55-s	1300	1600
8 5/8	7.937	0.344	30.40	1400	1700
8 5/8	7.875	0.375	33.04	1600	1800
10 3/4	10.374	0.188	21.15-*	650	750
10 3/4	10.312	0.219	24.60	750	850
10 3/4	10.250	0.250	28.04	850	1000
10 3/4	10.192	0.279	31.20-s	1000	1200
10 3/4	10.136	0.307	34.24-s	1000	1200
10 3/4	10.062	0.344	38.20	1100	1300
10 3/4	10.020	0.365	40.48-s	1200	1400
12 3/4	12.312	0.219	29.28-*	600	700
12 3/4	12.250	0.250	33.38	700	800
12 3/4	12.188	0.281	37.45	800	950
12 3/4	12.126	0.312	41.51	900	1000
12 3/4	12.090	0.330	43.77-s	1000	1200
12 3/4	12.062	0.344	45.55	1000	1200
12 3/4	12.000	0.375	49.56-s	1100	1200
14	13.500	0.250	36.71-*	650	750
14	13.438	0.281	41.21-*	700	850
14	13.376	0.312	45.68	800	950
14	13.312	0.344	50.14	900	1000
14	13.250	0.375	54.57-s	950	1100

I.D. is a theoretical dimension only. s = Standard Wt. x = Extra Strong Wt.* = Special Wt.

BASALT-KAISER STEEL LINE PIPE

Basalt-Kaiser Steel Line Pipe is produced and marketed under a joint manufacturing and sales agreement between the steel division of the Basalt Rock Company, Napa, California, and the Kaiser Steel Corporation. This large diameter welded steel pipe is offered in sizes ranging from 8⅝″ to 30″ outside diameter and in lengths up to 40 feet. All sizes meet applicable industry specifications.

The plate is first cut to the exact width desired and edges are trimmed so as to insure a good weld. It is then descaled and cleansed in a pickling bath, dried and inspected. The sized and pickled plate is automatically conveyed through the first machine, the edge pre-former, where a series of alloy rollers shape the edges of the plate to prepare it for the forming presses. The material then continues through the "U"-ing press which shapes it into an approximate "U" in a single operation. Both these machines were specially designed to provide exceptional precision and to maintain highest quality through an automatic conveying system.

Before the final step in forming a pipe, the "U"-ed shape is automatically sprayed with oil to assist easy forming in the 40-foot dies of the main press. This machine is actually two separate presses aligned and synchronized. Its hydraulic rams press the "U" shaped plate into a round shape in a single operation with edges aligned for welding. Before welding the formed pipe is conveyed through a degreasing bath, then into one of two types of welding machines, depending upon the specification.

LINE PIPE 8⅝″–22″

Fusion welded pipe in sizes from 8⅝″ to 22″ outside diameter is produced by a single pass submerged arc weld with 100 per cent penetration. The same sizes through 20″ may also be produced on an electric resistance welding unit. This welding equipment heats the two edges of the formed plate to the proper welding temperature, and the welding operation is completed by pressure rolls. The combination of heat and pressure makes a sound, continuous weld the entire length of the pipe. "Flash" is removed both inside and outside the pipe by a cutting tool which leaves smooth, flush surfaces.

After careful inspection of the weld the pipe moves to the sizing and straightening machine. In this operation the pipe is passed through a series of transverse rolls which size, straighten and cold reduce the pipe to finished dimensions. The ends are then squared or beveled for welding.

Before the pipe reaches the hydrostatic tester all laboratory checks for physical properties have been completed. These include crush, bend and tensile strength tests which are run continuously on each order. In final testing operations, each pipe section is subjected to a predetermined internal hydraulic pressure and carefully checked after heavy hammer blows along the entire length of the weld to detect any flaws.

Final inspection includes checking every dimension of each length of pipe for compliance with specifications. Each pipe is stenciled with the markings required by the order. After final inspection and marking, the finished pipe is given a protective coating or left bare, according to specifications. Shipping preparations include carefully planned loading practice to insure safe delivery at destination.

TABLE 77

BASALT-KAISER ELECTRIC WELD

Black Plain End Steel Line Pipe

Dimensions, Weights and Test Pressures

Size O. D.	Size I. D.	Wall Thickness	Weight per Foot	Grade A	Grade B	Grade X-42
In.	In.	In.	Lb.	Psi	Psi	Psi
8⅝	7.749	0.438	38.26	1800	2100	3000
8⅝	7.625	0.500	43.39	2100	2400	3000
10¾	9.874	0.438	48.19	1500	1700	2910
10¾	9.750	0.500	54.74	1700	2000	3000
12¾	11.874	0.438	57.53	1200	1400	2460
12¾	11.750	0.500	65.42	1400	1600	2810
14	13.500	0.250	*36.71	650	750	1280
14	13.438	0.281	*41.21	700	850	1440
14	13.376	0.312	45.68	800	950	1600
14	13.312	0.344	50.14	900	1000	1760
14	13.250	0.375	54.57	950	1100	1920
14	13.124	0.438	63.37	1100	1300	2240
14	13.000	0.500	72.09	1300	1500	2550
16	15.500	0.250	*42.05	550	650	1120
16	15.438	0.281	*47.22	650	750	1260
16	15.376	0.312	52.36	700	800	1400
16	15.312	0.344	57.48	750	900	1540
16	15.250	0.375	62.58	850	1000	1680
16	15.124	0.438	72.72	1000	1100	1960
16	15.000	0.500	82.77	1100	1300	2240
18	17.500	0.250	*47.39	500	600	1000
18	17.438	0.281	*53.22	550	650	1120
18	17.376	0.312	59.03	600	750	1240
18	17.312	0.344	64.82	700	800	1370
18	17.250	0.375	70.59	750	900	1490
18	17.124	0.438	82.06	900	1000	1740
18	17.000	0.500	93.45	1000	1200	1990
20	19.500	0.250	*52.73	450	500	900
20	19.438	0.281	*59.23	500	600	1010
20	19.376	0.312	65.71	550	650	1120
20	19.312	0.344	72.16	600	700	1230
20	19.250	0.375	78.60	700	800	1340
20	19.124	0.438	91.41	800	900	1570
20	19.000	0.500	104.13	900	1000	1790
22	21.500	0.250	*58.07	400	500	820
22	21.438	0.281	*65.24	450	550	920
22	21.376	0.312	72.38	500	600	1020
22	21.312	0.344	79.51	550	650	1120
22	21.250	0.375	86.61	600	700	1220
22	21.124	0.438	100.75	700	850	1430
22	21.000	0.500	114.81	800	950	1630

I.D. is a theoretical dimension only. * Special weight.

BASALT-KAISER EXPANDED STEEL LINE PIPE

(Sizes 24″-30″)

Pipe in sizes from 24″ to 30″ O.D. inclusive is fusion welded and hydraulically expanded to size.

Plate for this pipe, in 40 foot lengths, is cut to size, pickled, edge conditioned, press formed to cylindrical shape and cleaned of oil and grease as previously described. Tabs are attached to the seam ends to facilitate longitudinal welding.

The first weld pass is made on the inside of the pipe. In this operation the pipe is fixed in position while the welding head, mounted on a boom, movably positioned with positive accuracy over the longitudinal seam, traverses the length of pipe and completes the inside weld. The outside weld is made as the pipe is drawn through a stationary welding fixture in which the electrodes are mounted. Very accurate positioning of the outside weld is maintained in this operation by reason of the unhampered visual observation afforded the weld operator for making radial adjustment of the seam under the electrodes.

When welding is completed, the tabs are removed and the pipe is placed in the expander. This is double purpose equipment in which the extreme ends of the pipe are first expanded mechanically and the body of the pipe is expanded hydraulically, within restraining dies, to a very accurate diameter, concentricity and straightness. Cold working of the metal during expansion increases its strength and produces pipe whose physical properties meet the requirements of the high yield strength specifications.

After expansion to size, the pressure is dropped to the hydrostatic test pressure, the dies are opened and the pipe while under test pressure is struck hammer blows of measured impact along the seam to further test the soundness of the weld. The ends of the pipe are then milled and beveled to prepare them for girth welding. The pipe receives a final careful visual inspection, dimensional checks are made, and test coupons are taken and tests made as prescribed by the specifications.

TABLE 78

BASALT-KAISER EXPANDED PIPE

Dimensions, Weights and Test Pressures

Size O. D.	Size I. D.	Wall Thickness	Weight per Foot	42,000 Psi Min. Yield
Inches	Inches	Inches	Pounds	
24.....	23.500	0.250	*63.41	750
24.....	23.438	0.281	*71.25	840
24.....	23.376	0.312	79.06	930
24.....	23.312	0.344	86.85	1030
24.....	23.250	0.375	94.62	1120
24.....	23.188	0.406	102.37	1210
24.....	23.124	0.438	110.10	1310
24.....	23.000	0.500	125.49	1490
26.....	25.500	0.250	*68.75	690
26.....	25.438	0.281	*77.25	780
26.....	25.376	0.312	85.73	860
26.....	25.312	0.344	94.19	950
26.....	25.250	0.375	102.63	1030
26.....	25.188	0.406	111.05	1120
26.....	25.124	0.438	119.44	1210
26.....	25.000	0.500	136.17	1380
				52,000 Psi Min. Yield
30.....	29.500	0.250	79.44	740
30.....	29.438	0.281	89.19	830
30.....	29.376	0.312	98.93	920
30.....	29.312	0.344	108.95	1010
30.....	29.250	0.375	118.66	1100
30.....	29.188	0.406	128.32	1200
30.....	29.124	0.438	138.28	1290
30.....	29.000	0.500	157.53	1470

I.D. is a theoretical dimension only. * Special weight.

ORDERING PRACTICE FOR KAISER TUBULAR PRODUCTS

In order to more clearly describe the material desired and to avoid misunderstanding, purchasers' inquiries and orders for Kaiser Tubular Products should specify the following details:

1. Quantity (in linear feet, number of pieces or bundles, or weight).
2. Size. (O. D. or nominal).
3. Foot-weight or wall thickness.
4. Method of manufacture (continuous welded, electric welded, etc.).
5. Class of material (standard pipe, line pipe, etc.).
6. End finish (threaded and coupled, plain end, threaded only, etc.).
7. If plain end, method of joining to be used.
8. Grade of steel, where specifications provide this option.
9. Length (single random, double random, average, definite cut, or uniform).
10. Type of coating or lining, if any.
11. Applicable specifications.
12. Purpose for which material is intended (flanging, bending, high temperature service, etc.).
13. Delivery date desired.
14. Type of Inspection Required (Mill Inspection, Outside Inspection, Agency, etc.).

Tubular products are invoiced on the basis of the quoted price per one hundred feet.

WEIGHT ESTIMATING TABLES

KAISER STANDARD WEIGHT PIPE

TABLE 79

Plain End, 21 ft. Uniform lengths

Nom. Size In.		1 Bdl.	2 Bdl.	3 Bdl.	4 Bdl.	5 Bdl.	6 Bdl.	7 Bdl.	8 Bdl.	9 Bdl.	15 Bdl.	25 Bdl.	35 Bdl.	45 Bdl.
½	Ft.	252	504	756	1008	1260	1512	1764	2016	2268	3780	6300	8820	11340
	Lb.	214	428	643	857	1071	1285	1499	1714	1928	3213	5355	7497	9639
¾	Ft.	147	294	441	588	735	882	1029	1176	1323	2205	3675	5145	6615
	Lb.	166	332	498	664	831	997	1163	1329	1495	2492	4153	5814	7475
1	Ft.	105	210	315	420	525	630	735	840	945	1575	2625	3675	4725
	Lb.	176	353	529	706	882	1058	1235	1411	1588	2646	4410	6174	7938
1¼	Ft.	63	126	189	252	315	378	441	504	567	945	1575	2205	2835
	Lb.	143	286	429	572	715	858	1001	1144	1287	2145	3575	5005	6435
1½	Ft.	63	126	189	252	315	378	441	504	567	945	1575	2205	2835
	Lb.	171	343	514	685	857	1028	1200	1371	1542	2568	4279	5990	7700

TABLE 80

Nom. Size In.		1 Pc.	2 Pcs.	3 Pcs.	4 Pcs.	5 Pcs.	6 Pcs.	7 Pcs.	8 Pcs.	9 Pcs.	15 Pcs.	25 Pcs.	35 Pcs.	45 Pcs.
2	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	77	153	230	307	383	460	537	613	690	1150	1916	2683	3449
2½	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	122	243	365	486	608	730	851	973	1094	1824	3040	4256	5472
3	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	159	318	478	637	796	955	1114	1273	1433	2388	3980	5571	7163
4	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	227	453	680	906	1133	1360	1586	1813	2039	3399	5665	7931	10197

WEIGHT ESTIMATING TABLES

KAISER STANDARD WEIGHT PIPE

TABLE 81

Threaded and Coupled, 21 ft. Uniform Lengths

Nom. Size In.		1 Bdl.	2 Bdl.	3 Bdl.	4 Bdl.	5 Bdl.	6 Bdl.	7 Bdl.	8 Bdl.	9 Bdl.	15 Bdl.	25 Bdl.	35 Bdl.	45 Bdl.
½	Ft.	252	504	756	1008	1260	1512	1764	2016	2268	3780	6300	8820	11340
	Lb.	214	428	643	857	1071	1285	1499	1714	1928	3213	5355	7497	9639
¾	Ft.	147	294	441	588	735	882	1029	1176	1323	2205	3675	5145	6615
	Lb.	166	332	498	664	831	997	1163	1329	1495	2492	4153	5814	7475
1	Ft.	105	210	315	420	525	630	735	840	945	1575	2625	3675	4725
	Lb.	176	353	529	706	882	1058	1235	1411	1588	2646	4410	6174	7938
1¼	Ft.	63	126	189	252	315	378	441	504	567	945	1575	2205	2835
	Lb.	144	287	431	575	718	862	1005	1149	1293	2155	3591	5027	6464
1½	Ft.	63	126	189	252	315	378	441	504	567	945	1575	2205	2835
	Lb.	172	344	516	688	860	1032	1204	1376	1548	2580	4300	6020	7740

TABLE 82

Nom. Size In.		1 Pc.	2 Pcs.	3 Pcs.	4 Pcs.	5 Pcs.	6 Pcs.	7 Pcs.	8 Pcs.	9 Pcs.	15 Pcs.	25 Pcs.	35 Pcs.	45 Pcs.
2	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	77	155	232	309	386	464	541	618	696	1159	1932	2705	3478
2½	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	122	244	367	489	611	733	856	978	1100	1833	3056	4278	5500
3	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	160	320	480	640	800	960	1120	1280	1440	2400	4001	5601	7201
4	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	229	457	646	915	1143	1372	1601	1830	2058	3430	5717	8004	10291

WEIGHT ESTIMATING TABLES

KAISER EXTRA–HEAVY WEIGHT PIPE

TABLE 83

Plain End, 21 ft. Uniform Lengths

Nom. Size In.		1 Bdl.	2 Bdl.	3 Bdl.	4 Bdl.	5 Bdl.	6 Bdl.	7 Bdl.	8 Bdl.	9 Bdl.	15 Bdl.	25 Bdl.	35 Bdl.	45 Bdl.
½	Ft.	252	504	756	1008	1260	1512	1764	2016	2268	3780	6300	8820	11340
	Lb.	275	549	824	1099	1373	1648	1923	2197	2472	4120	6867	9614	12361
¾	Ft.	147	294	441	588	735	882	1029	1176	1323	2205	3675	5145	6615
	Lb.	216	432	648	864	1080	1297	1513	1729	1945	3241	5402	7563	9724
1	Ft.	105	210	315	420	525	630	735	840	945	1575	2625	3675	4725
	Lb.	228	456	684	911	1139	1367	1595	1823	2051	3418	5696	7975	10253
1¼	Ft.	63	126	189	252	315	378	441	504	567	945	1575	2205	2835
	Lb.	189	378	567	756	945	1134	1323	1512	1701	2835	4725	6615	8505
1½	Ft.	63	126	189	252	315	378	441	504	567	945	1575	2205	2835
	Lb.	229	457	686	915	1143	1372	1601	1830	2058	3430	5717	8004	10291

TABLE 84

Nom. Size In.		1 Pc.	2 Pcs.	3 Pcs.	4 Pcs.	5 Pcs.	6 Pcs.	7 Pcs.	8 Pcs.	9 Pcs.	15 Pcs.	25 Pcs.	35 Pcs.	45 Pcs.
2	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	105	211	316	422	572	633	738	843	949	1581	2636	3690	4744
2½	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	161	322	483	643	804	965	1126	1287	1448	2413	4022	5630	7239
3	Ft.	21	42	63	84	105	126	147	168	189	315	525	735	945
	Wt.	215	431	646	861	1076	1292	1507	1722	1937	3229	5381	7534	9686

TABLE 85

STRUCTURAL PROPERTIES OF KAISER STEEL PIPE

Outside Dia.	Thickness	Weight per Foot	Moment of Inertia	Section Modulus	Area of Metal	Bore Area	Radius of Gyration
In.	In.	Lb.	In. 4	In. 3	In. 2	In. 2	In.
.840	.109	.850	.01709	.04069	.2503	.3039	.2613
.840	.147	1.087	.02008	.04780	.3200	.2342	.2505
1.050	.113	1.130	.03704	.07055	.3326	.5333	.3337
1.050	.154	1.473	.04479	.08531	.4335	.4324	.3214
1.315	.133	1.678	.08734	.1328	.4939	.8642	.4205
1.315	.179	2.171	.1056	.1606	.6388	.7193	.4066
1.660	.140	2.272	.1947	.2346	.6685	1.4957	.5397
1.660	.191	2.996	.2418	.2913	.8815	1.2327	.5237
1.900	.145	2.717	.3099	.3262	.7995	2.0358	.6226
1.900	.200	3.631	.3912	.4118	1.068	1.767	.6052
2.375	.154	3.652	.6657	.5606	1.075	3.355	.7871
2.375	.218	5.022	.8679	.7309	1.477	2.953	.7665
2.875	.203	5.793	1.539	1.064	1.704	4.788	.9474
2.875	.276	7.661	1.924	1.339	2.254	4.238	.9241
3.500	.216	7.575	3.017	1.724	2.228	7.393	1.164
3.500	.300	10.252	3.894	2.225	3.016	6.605	1.136
4.000	.226	9.109	4.788	2.394	2.680	9.886	1.337
4.000	.318	12.505	6.280	3.140	3.678	8.888	1.307
4.500	.237	10.790	7.233	3.214	3.174	12.730	1.520
4.500	.337	14.983	9.610	4.271	4.407	11.497	1.477
5.563	.1875	10.764	11.45	4.117	3.166	21.140	1.902
5.563	.219	12.490	13.15	4.727	3.686	20.629	1.890
5.563	.250	14.185	14.76	5.305	4.173	20.133	1.881
5.563	.258	14.617	15.16	5.451	4.300	20.006	1.878
5.563	.281	15.870	16.31	5.864	4.665	19.650	1.870
5.563	.3125	17.523	17.83	6.409	5.155	19.151	1.860
5.563	.344	19.160	19.31	6.942	5.642	18.673	1.849
5.563	.375	20.778	20.67	7.431	6.112	18.194	1.839
6.625	.1875	12.891	19.66	5.935	3.792	30.680	2.277
6.625	.21875	14.966	22.61	6.826	4.403	30.069	2.266
6.625	.250	17.021	25.47	7.690	5.007	29.465	2.256
6.625	.280	18.974	28.14	8.496	5.581	28.891	2.245
6.625	.3125	21.068	30.94	9.342	6.197	28.275	2.235
6.625	.344	23.076	33.57	10.14	6.788	27.684	2.224
6.625	.375	25.030	36.09	10.90	7.367	27.119	2.214

TABLE 85 (Continued)

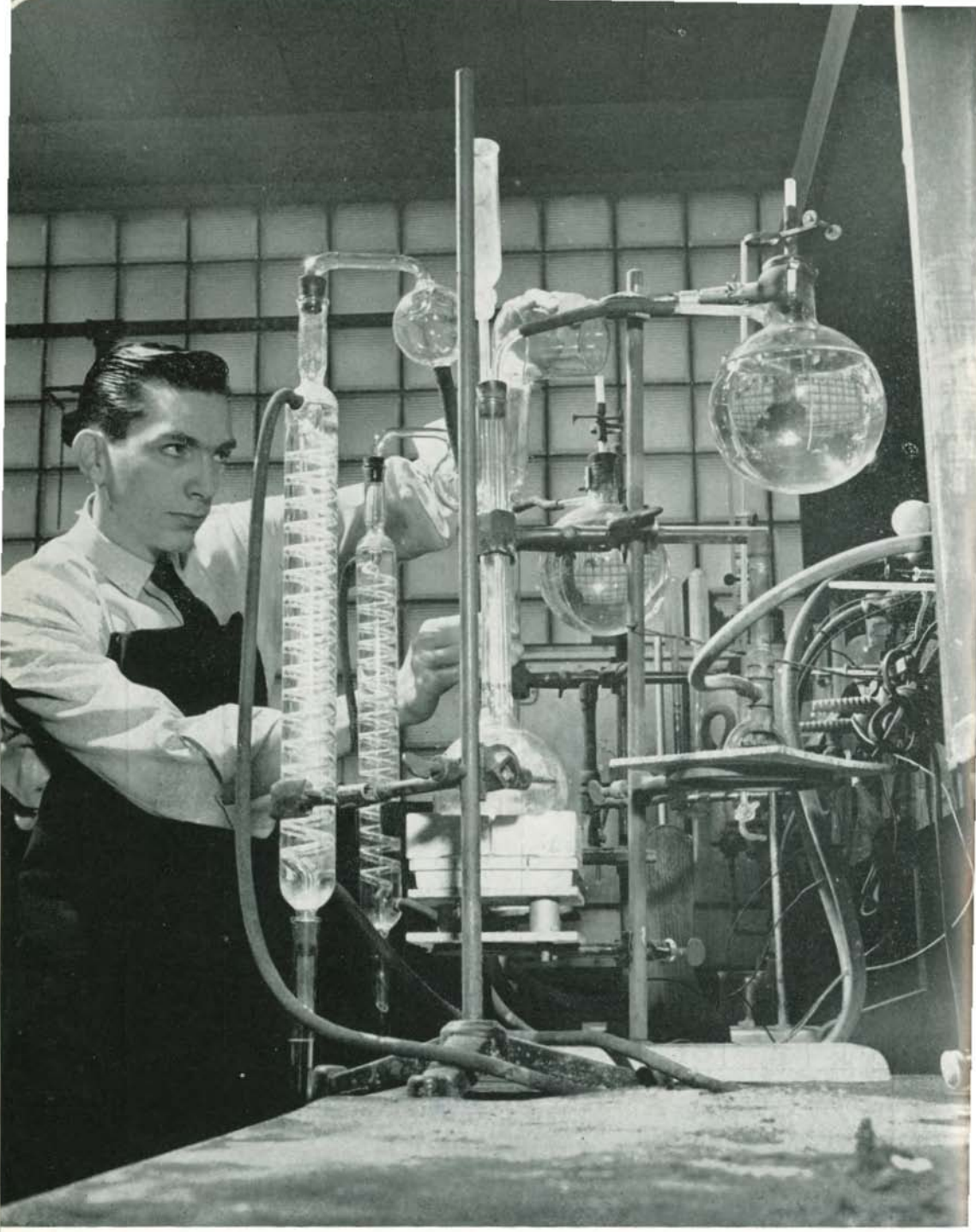
STRUCTURAL PROPERTIES OF KAISER STEEL PIPE

Outside Dia.	Thickness	Weight per Foot	Moment of Inertia	Section Modulus	Area of Metal	Bore Area	Radius of Gyration
In.	In.	Lb.	In. 4	In. 3	In. 2	In. 2	In.
8.625	.188	16.940	44.36	10.29	4.983	53.443	2.984
8.625	.21875	19.639	51.06	11.84	5.777	52.649	2.973
8.625	.250	22.361	57.72	13.38	6.578	51.848	2.962
8.625	.277	24.696	63.35	14.69	7.265	51.161	2.953
8.625	.3125	27.743	70.59	16.37	8.161	50.265	2.941
8.625	.322	28.554	72.49	16.81	8.399	50.027	2.938
8.625	.34375	30.402	76.80	17.81	8.943	49.483	2.930
8.625	.375	33.041	82.86	19.21	9.719	48.707	2.920
8.625	.438	38.256	94.56	21.93	11.25	47.18	2.899
8.625	.500	43.388	105.7	24.51	12.76	45.67	2.878
10.750	.21875	24.604	100.4	18.67	7.237	83.526	3.724
10.750	.188	21.15	87.0	16.18	6.238	84.527	3.735
10.750	.250	28.035	113.7	21.16	8.247	82.516	3.713
10.750	.279	31.201	125.9	23.42	9.178	81.585	3.702
10.750	.307	34.240	137.4	25.57	10.07	80.69	3.694
10.750	.344	38.200	150.4	27.98	11.25	79.55	3.683
10.750	.348	38.661	154.0	28.65	11.37	79.39	3.680
10.750	.365	40.483	160.7	29.90	11.91	78.85	3.674
10.750	.438	48.19	189.0	35.16	14.19	76.58	3.649
10.750	.500	54.74	212.0	39.43	16.10	74.66	3.628
12.750	.21875	29.276	169.1	26.52	8.612	119.065	4.431
12.750	.250	33.375	191.8	30.09	9.817	117.860	4.420
12.750	.28125	37.453	214.2	33.60	11.02	116.66	4.409
12.750	.3125	41.510	236.3	37.06	12.21	115.47	4.399
12.750	.330	43.773	248.5	38.97	12.88	114.80	4.393
12.750	.34375	45.547	258.0	40.46	13.40	114.28	4.388
12.750	.375	49.562	279.3	43.82	14.58	113.10	4.377
12.750	.438	57.53	321.5	50.43	16.94	110.74	4.330
12.750	.500	65.415	361.5	56.71	19.24	108.44	4.335
14.000	.250	36.424	253.4	36.20	10.71	143.23	4.862
14.000	.281	41.208	285.3	40.75	12.12	141.82	4.851
14.000	.3125	45.682	314.9	44.98	13.44	140.50	4.841
14.000	.314	50.140	316.4	45.20	13.50	140.44	4.837
14.000	.34375	50.136	344.0	49.14	14.75	139.19	4.830
14.000	.375	54.568	372.8	53.25	16.05	137.89	4.819

TABLE 85 (Continued)

STRUCTURAL PROPERTIES OF KAISER STEEL PIPE

Outside Dia.	Thickness	Weight per Foot	Moment of Inertia	Section Modulus	Area of Metal	Bore Area	Radius of Gyration
In.	In.	Lb.	In. 4	In. 3	In. 2	In. 2	In.
14.000	.438	63.441	429.5	61.36	18.66	135.28	4.797
14.000	.500	72.091	483.8	69.11	21.21	132.73	4.776
16.000	.250	42.053	383.7	47.96	12.37	188.69	5.569
16.000	.28125	47.215	429.1	53.64	13.89	187.17	5.558
16.000	.3125	52.357	474.0	59.25	15.40	185.66	5.547
16.000	.34375	57.478	518.3	64.79	16.91	184.15	5.537
16.000	.375	62.579	562.1	70.26	18.41	182.65	5.526
16.000	.4375	72.716	648.1	81.01	21.39	179.67	5.504
16.000	.500	82.771	731.9	91.49	24.35	176.71	5.483
18.000	.250	47.393	549.1	61.02	13.94	240.53	6.276
18.000	.28125	53.223	614.6	68.28	15.66	238.81	6.265
18.000	.3125	59.032	679.3	75.47	17.36	237.11	6.254
18.000	.34375	64.821	743.3	82.59	19.07	235.40	6.244
18.000	.375	70.589	806.6	89.63	20.76	233.71	6.233
18.000	.4375	82.061	931.3	103.5	24.14	230.33	6.211
18.000	.500	93.451	1053.0	117.0	27.49	226.98	6.190
20.000	.250	52.73	756.6	75.66	15.52	298.76	6.983
20.000	.28125	59.231	847.0	84.70	17.42	296.74	6.972
20.000	.3125	65.708	936.7	93.67	19.33	294.83	6.961
20.000	.34375	72.164	1026.0	102.6	21.23	292.93	6.951
20.000	.375	78.599	1113.0	111.3	23.12	291.04	6.940
20.000	.4375	91.407	1287.0	128.7	26.89	287.27	6.918
20.000	.500	104.131	1457.0	145.7	30.63	283.53	6.897



Metallurgical and chemical laboratory staffs check each step in the production of Kaiser Steel. Numerous analyses, tests and inspections are conducted to insure compliance with specifications.

ALLOY AND SPECIAL STEELS

KAISER HOT ROLLED ALLOY STEELS

Steels in which alloys are present beyond defined maximum amounts (see Page 9) are considered alloy steels. The alloy content of a large number of standard and special alloy steels has been established by the industry. Tables of standard alloy steels are published by the American Iron & Steel Institute. Kaiser Steel Corporation rolls alloy steels into blooms, billets, plates, structurals and bars including spring steel flats and precision rounds.

Kaiser Hot Rolled Alloy Steels have many applications in industry. In the construction of railway and automotive equipment, farm implements, construction, rock, gravel and material handling fields and in mechanical applications, Kaiser alloy steel products have wide and increasing uses.

The special properties imparted by alloys to steel, while in themselves beneficial to the steel, increase the hazards to the steel and equipment during processing. Kaiser alloy steels, therefore, receive special care and many precautions are taken during production to insure satisfactory hot rolled products. They are rolled from double converted, semi-finished products, carefully inspected and conditioned so that the finished products are sound and exceptionally free of surface imperfections.

Kaiser Hot Rolled Alloy Blooms, Billets, Plates, Structurals and Bars are available in many analyses and are furnished in most of the sizes in which the corresponding carbon steel products are rolled. They are produced subject to the allowable variation in chemical analysis and to standard practice variations for dimensions and workmanship. They are normally supplied in the as-rolled condition without heat treatment except that flats may be packed annealed during cooling after rolling.

Alloy steels are specified for individual applications for which the type of service or experience in use determines the necessity for specific quality or properties. It is always helpful and often essential for the steel mill to have complete information regarding fabrication, heat treatment and service of the final steel part, to plan the processing of the steel to produce the desired end product. Inquiries for alloy steels which include information regarding the processing of the end product and its heat treatment will more promptly develop specific replies regarding their production and delivery.

KAISALOY

High Strength Steel

KAISALOY is a high yield strength, low alloy steel of excellent fabricating and welding characteristics. KAISALOY is designed for use where greater yield strength is needed and less weight is wanted. It is recommended for constructional purposes where steel of superior physical properties is required and where cold forming, welding, and ease of fabrication are essential.

KAISALOY conforms to the requirements of ASTM Specification A-242, the standard specification for low alloy structural steel, and is generally sold to meet a minimum yield strength of 50,000 psi and a minimum tensile strength of 70,000 psi, but its physical properties may be adjusted to meet specific requirements. The superior properties of KAISALOY are inherent in the steel as rolled. Heat treatment is not required to develop them.

KAISALOY, in its design, utilizes the metallurgical principle that optimum strengthening of steel is effected by adding small amounts of a number of scientifically selected alloying elements. The maximum beneficial characteristics of a high yield strength, low alloy steel have been developed in KAISALOY without undesirable features of large alloy additions.

TABLE 86

LIMITING CHEMICAL RANGE

C Max.	Mn Max.	P Max.	S Max.	Si Max.	Cu Max.	Ni Max.	Cr Max.	Mo Max.	Va Min.	Ti Min.
.18	1.50	.04	.05	.35	.35	.30	.20	.10	.02	.005

TABLE 87

TYPICAL CHEMICAL ANALYSIS

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Va	Ti
.15	.93	.020	.031	.19	.25	.18	.12	.04	.05	.015

TABLE 88

TYPICAL PHYSICAL PROPERTIES OF KAISALOY

Section	Tested	Yield Strength Psi	Tensile Strength Psi	Elong. 8″	Elong. 2″	Red. Area
6 x 6 x ⅝″ Angle....	As Rolled	55260	74950	26%	.....	.....
6 x 4 x ½″ Angle....	As Rolled	56460	76030	27%	.....	.....
½″ Plate.....	As Rolled	54805	78920	21%	32%	.....
⅜″ Plate.....	As Rolled	56850	79360	22%	35%	.....
¼″ Plate.....	As Rolled	62290	80480	21%	32%	.....
½″ Plate.....	Normalized	53530	73770	23%	36%	.....
⅜″ Plate.....	Normalized	51190	72080	28%	49%	.....
¼″ Plate.....	Normalized	54900	72990	25%	44%	.....
3/16″ x 1″ Flat	Normalized	58360	75240	26%	.....	.....
½″ x 1″ Flat.....	Normalized	60930	78440	34%	.....	.....
1″ Square.....	Normalized	65540	81600	27%	.....	69.4%
1½″ Square.....	Normalized	55140	75290	31%	.....	68.6%
2″ Square.....	Normalized	49320	73880	26%	.....	67.5%

PHYSICAL PROPERTIES OF KAISALOY IN HEAVIER SECTIONS

KAISALOY maintains its high yield strength and tensile strength when rolled into heavier sections.

TABLE 89

TYPICAL CHEMICAL ANALYSIS

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti
.15	1.11	.023	.026	.22	.22	.27	.11	.025	.05	.011

TABLE 90

TYPICAL PHYSICAL PROPERTIES

96″ Wide Plate

	Yield Strength Psi	Tensile Strength Psi	Elong. 8″	Bend
½″ Plate—As Rolled Longitudinal.....	55680	74490	23.5	OK
¾″ Plate—As Rolled Longitudinal.....	53690	74230	25.0	OK
¾″ Plate—As Rolled Transverse.....	55990	76120	20.5	OK

PHYSICAL PROPERTIES OF STRESS-RELIEVED KAISALOY

Articles fabricated from KAISALOY have increased yield strength when stresses are relieved.

TABLE 91

TYPICAL CHEMICAL ANALYSIS

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti
.16	1.25	.029	.025	.22	.25	.20	.13	.024	.055	.010

TABLE 92

TYPICAL PHYSICAL PROPERTIES

96″ Wide Plate

	Yield Strength Psi	Tensile Strength Psi	Elong. 8″
¾″ Plate—As Rolled			
Longitudinal	56010	84610	24.0
Transverse	60550	83980	22.5
¾″ Plate—Stress Relieved 2 Hours at 850° F.			
Longitudinal	61700	73070	23.0
Transverse	62370	81710	24.0

TABLE 93

IMPACT VALUES OF KAISALOY

(0.5″ Thick Plate)
(Key-Hole Charpy Specimen)

Temperature °F.	As Rolled Foot Pounds	Normalized 1700° F. Foot Pounds
100°	49	60
70°	43	60
30°	40	60
15°	40	58
0°	39	54
—10°	35	53
—25°	33	50
—35°	32	46
—50°	32	47
—60°	31	43
—70°	24	41

GENERAL CHARACTERISTICS

KAISALOY is essentially a high yield strength, low alloy structural steel having a combination of superior properties. Its balanced composition and its method of production result in a uniformly fine-grained steel of outstanding workability. It can be sheared, punched, bent, flame-cut, hot-formed, riveted and welded with the same methods and with but few precautions beyond those required in the fabrication of ordinary steel.

WORKABILITY

KAISALOY can be satisfactorily formed in press brakes and other cold-forming equipment. It is generally found, however, that consistent with its higher strength, greater force is required for bending and increased radius of bends will prove an advantage. KAISALOY may be easily hot-formed and its physical properties are not materially altered by heating for forming.

GAS CUTTING

No problems are presented by the gas cutting of KAISALOY since it does not flame-harden in normal gas cutting operations. Speeds and torch adjustments, when gas cutting KAISALOY, are much the same as used in cutting ordinary steels of comparable thickness.

WELDING

KAISALOY does not require special handling or procedure for welding. It may be welded, by any of the methods used in welding ordinary structural steels. For metal arc welding, covered electrodes of the E-60 group will give ductile welds of adequate strength. If higher strength welds are desired, covered electrodes of the E-70 group will provide satisfactory welds. KAISALOY is readily joined by submerged arc welding. The rod ordinarily used for structural steels has generally provided entirely satisfactory welds.

ENDURANCE STRENGTH AND NOTCH SENSITIVITY

KAISALOY will be found to have a higher endurance strength and increased resistance to notch sensitivity when compared with ordinary structural steels. Improvement in these properties reflects the inherent superior physical characteristics of KAISALOY resulting from its composition and controlled manufacture.

CORROSION RESISTANCE

Since varying conditions of service and exposure to corrosion have a marked bearing on the service life of steel, the production of a high yield strength, low alloy steel having improved resistance to corrosion was an impelling objective in the development of KAISALOY. The substantial improvement in resistance to corrosion incorporated in this steel is an important factor in influencing its selection for use over ordinary steels.

ABRASION RESISTANCE

While mechanical conditions of wear are necessarily the controlling factors in abrasion, it will be found that KAISALOY, due to its higher strength, its

structure, and composition, will provide appreciably increased life under abrasive conditions.

ROLLED PRODUCTS

KAISALOY is available in most rolled products. It is rolled into plates, structurals, bars, sheets and strip. It may also be purchased as cold rolled sheets and strip of drawing quality.

KAISER ABRASION RESISTING STEEL

The advantage of abrasion resisting steel in cutting costs of handling abrasive materials is well established. It is indispensable for many applications, such as dredge pipe, digging and stacking ladders for dredges, road machinery, and farm machinery; sand and gravel, coal and concrete aggregate handling equipment, conveyors, chutes, liners for ore bins and dust collecting systems.

The ability of abrasion resisting steels to keep equipment operating for longer periods, to lessen shut down time and to decrease maintenance costs gives it new economic importance in view of present day increasing costs.

Kaiser Abrasion Resisting Steel is furnished in the following chemical analysis range:

Carbon	Manganese	Phosphorus	Sulphur	Silicon
35/50	1.20/1.70	.05 maximum	.05 maximum	.20 aim

Kaiser Abrasion Resisting Steel of the above analysis may be expected to have a Brinell hardness of 200 to 250.

KAISER HARD ROLLED SHEETS FOR WATER WELL CASING

By variation of its composition or method of production, physical properties and characteristics may be developed in sheet steel which make it particularly adaptable to certain uses. Kaiser Hard Rolled Sheets are produced for water well casing. They are supplied in medium carbon grade for cold shaping and fusion welding into tubular form. Kaiser Hard Rolled Sheets roll form without loose scale and they are produced to meet the demands of the trade for water well casing for welding, driving and perforating. They are rolled as 12 gauge, 10 gauge and 8 gauge sheets in widths from 24″ to 48″.

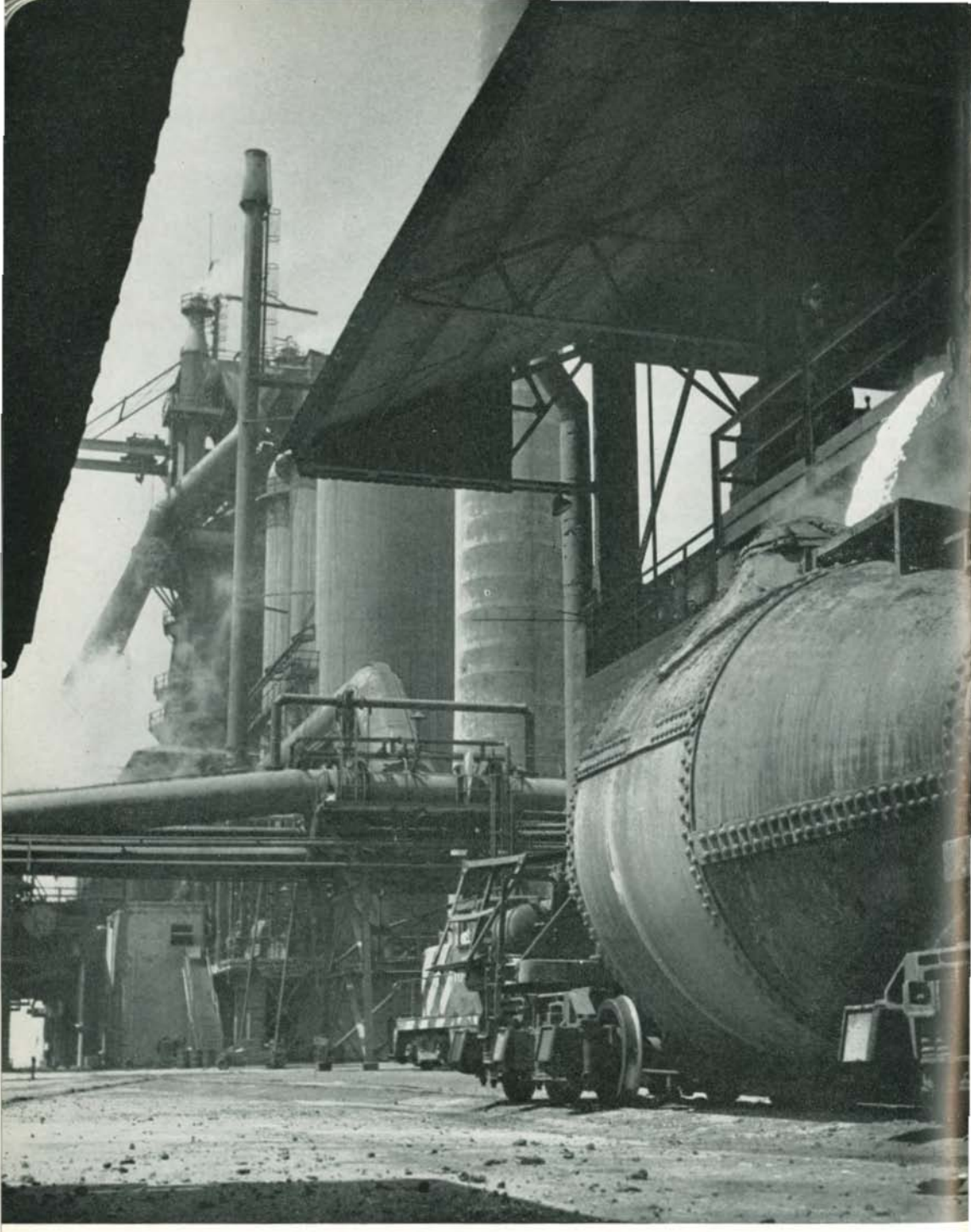
Further information regarding the properties and availability of these sheets will be furnished upon inquiry.

KAISER FREE MACHINING STEELS

Kaiser Free Machining Steels are furnished in several analyses and grades to provide the degree of machinability desired and to meet the physical requirements of the finished product.

Free machining steels may be purchased as bars for cold drawing, forging and machining, and as plate for machining and heat treating.

Inquiries are invited for these steels.



Molten pig iron is transferred in 150-ton torpedo ladles from the blast furnaces to the open hearths or to the pig casting machines.

PIG IRON

PIG IRON

Pig iron is the product resulting from the reduction of iron ore in the blast furnace. It is classified and graded according to its intended uses.

Kaiser Steel Corporation produces Basic Pig Iron largely for its own use in the manufacture of steel. Merchant pig iron is offered for general sale in both basic and foundry analyses. It is sold by the gross ton (2240 lbs.) and is available for either truck or rail shipment in quantities of 50 tons or more.

BASIC PIG IRON

Basic Pig Iron is used in making steel by the basic open hearth process. Inquiries are invited on any specifications covering Basic Pig Iron. The following ranges are normally produced at Fontana:

	Range
Silicon	.90/1.75
Sulphur	.05 max.
Phosphorous	.20/.35
Manganese	.40/1.00

Basic grade notched pigs are produced in weights averaging 60 pounds each.

FOUNDRY PIG IRON

Foundry Pig Iron is used for remelting to produce a wide variety of iron castings such as:

(1) Light, thin castings, including stove plate, radiator castings, plumbing supplies and hardware specialties.
(2) Miscellaneous light and heavy castings which are to be machined.
(3) Heavy castings not to be machined.
(4) Chilled castings.
(5) Castings requiring density of grain and dependable strength for steam and hydraulic cylinders and similar uses.

The silicon, phosphorous and manganese limits of Foundry Pig Iron are modified to meet the special requirements of these various products and uses. The extreme ranges of foundry grades being maintained in stock are as follows:

	Range
Silicon	1.75/3.25
Sulphur	.05 max.
Phosphorous	.17/.70
Manganese	.60/1.00

Silicon is available in ranges of .25 points. Phosphorous and manganese are supplied in .20 point ranges. Notched foundry pigs weigh an average of 40 pounds each.

Volatile-bearing gases from the coke ovens are processed in by-products plant (background) for the recovery of creosote oil, ammonium sulphate, phenol, benzol and other chemicals.

BY-PRODUCTS

BY-PRODUCTS

Coke is made from coal by heating in sealed ovens in the absence of air. During the hot process of coke formation in the Kaiser coke ovens, valuable by-products are volatilized and driven off the coal. These gases are carried by large overhead collecting pipes to the by-products department where they are recovered and purified by a series of complex chemical processes. Kaiser by-products have proven an important new source of supply to the chemical, plastic, explosive, paint and other industries of the West. The following products are now being marketed by Kaiser Steel Corporation as a result of the Fontana by-product operation:

BENZOL

(C_6H_6)

Industrial Pure Benzene (Benzol) to be commonly known as "Industrial Pure Benzol"

Benzol is used in the manufacture of paint, varnish, lacquer, synthetic drugs, perfumes, organic chemicals, indigo dyes, dry cleaning preparations, paint and varnish removers, solvent for celluloid and rubber, and also for enriching gasoline.

TOLUOL

$(CH_3C_6H_5)$

Industrial Pure Toluene (Toluol) to be commonly known as "Industrial Pure Toluol"

Toluol is used in the manufacture of intermediates, organic chemicals, explosives, stains and enamels, and as a solvent for rubbe , varnishes and resin.

CRUDE HEAVY SOLVENT

Crude Heavy Solvent is used in the manufacture of rubber solvents, linoleum, oil cloth and as a general solvent in the manufacture of paint, varnish and enamels.

XYLOL

$C_6H_4\ (CH_3)_2$

Nitration Xylene (Xylol) to be commonly known as "Industrial Xylol"

Xylol is used in the manufacture of dye stuffs, intermediates, organic chemicals and as a solvent in making rubber, cement, lacquer and varnishes.

CRUDE PHENOL

Crude Phenol is used, without further refining, to make Phenol Aldehyde resins for phenolic plybonds. These are adhesives in film form which make lasting and mildew resisting synthetic resin bonds for veneer or plies of wood. It is also used to make industrial phenolic plastics.

CREOSOTE OIL AND CREOSOTE COAL TAR SOLUTIONS

These Creosote products are used principally in the wood preserving industries in treating poles and railroad ties. They are also used extensively in the manufacture of roofing and waterproof materials, and by insecticide manufacturers.

AMMONIUM SULPHATE

$(NH_4)_2\ SO_4$

Ammonium Sulphate is used principally as an ingredient in almost all fertilizers or as a simple for direct application to the soil.

By-Products are available at Fontana, California, in tank car quantities, or for shipment by convenient truck and trailer, to nearby points.

Another trainload of Basalt-Kaiser steel line pipe heads for gas producing country where the 40′ lengths will be welded into a continuous state-spanning pipe line, bringing gas service to thousands of new users.

SPECIFICATIONS

STANDARD SPECIFICATIONS

Kaiser Steel Corporation is regularly producing steel products to both standard and special specifications including but not limited to those briefly described on the following pages.

A.S.T.M. SPECIFICATIONS

Steel for Bridges and Buildings
A.S.T.M. Designation A 7-49T

This specification is used for plates, shapes and bars. It provides a minimum yield point that is one-half of the tensile strength but not less than 33,000 lbs. per square inch, except in the case of rolled base plates over 2" in thickness for bearing purposes. These are specified to a carbon range of .20/.35%. A tensile strength of 60/72,000 lbs. per square inch is provided. The steel must withstand a 180 degree bend around a pin, the diameter of which is related to the thickness of the test specimen as detailed in the A.S.T.M. specification. Physical tests are not required for rolled base plates over 2" in thickness which are to be used for bearing purposes.

Structural Silicon Steel
A.S.T.M. Designation A 94-49T

This specification covers a special high-strength structural steel intended primarily for use as main stress-carrying structural members: Material ordered to this specification must meet a tensile range requirement of 80,000 to 95,000 lbs. per square inch with a minimum yield point of 45,000 lbs. per square inch. The maximum carbon content is .40% and the silicon content must not be under .20% on ladle analysis.

Structural Steel for Locomotives and Cars
A.S.T M. Designation A 113-49aT

This specification is divided into three divisions, based on tensile strength requirements. It is a standard specification for car material with the following applicable tensile ranges:

	Tensile Strength, Psi
Structural steel for cars	50,000 to 65,000 lbs.
Structural steel for locomotives . . .	55,000 to 65,000 lbs.
Plates for cold pressing	48,000 to 58,000 lbs.

Carbon-Silicon Steel Plates of Ordinary Tensile Ranges
A.S.T.M. Designation A 201-49T

This specification covers carbon-silicon steel plates in two ordinary tensile ranges designated as Grades A and B. Grade A calls for a tensile strength of 55/65,000 lbs. per square inch, and Grade B, 60/70,000 lbs. per square inch. It is a specification for steel for locomotive boiler shells, stationary boilers and other pressure vessels, and is intended particularly for fusion welding. A definite silicon content is specified. Under this specification, the maximum thickness of flange quality plates is two inches. The maximum thickness of firebox quality plates is 12 inches when made to the Grade A specification, and 6 inches when made to the Grade B specification.

Carbon-Silicon Steel Plates of High Tensile Strength
A.S.T.M. Designation A 212-49T

This specification covers carbon-silicon steel plates in two high tensile strength ranges as follows: Grade A, tensile strength 65/77,000 lbs. per square inch, and Grade B, tensile strength 70/82,000 lbs. per square inch. It is a specification for flange and firebox quality steel plates for use in locomotive boiler shells, stationary boilers and other pressure vessels. Under this specification, the maximum thickness of flange quality plates is two inches and of A and B firebox quality plates, 4 inches. A definite silicon content is specified and the steel is suitable for fusion welding.

Carbon Steel Structural Plate
A.S.T.M. Designation A-283-49T

This specification covers four grades of carbon steel plate of structural quality for general applications in thicknesses up to 2″ inclusive. The specification prescribes four grades. A to D, in which the ranges of tensile strength increase by increments of 5,000 lbs. as follows:

	Tensile Strength, Psi	Min. Yield Strength, Psi
Grade A	45,000 to 50,000	24,000
Grade B	50,000 to 60,000	27,000
Grade C	55,000 to 65,000	30,000
Grade D	60,000 to 72,000	33,000

Bend requirements are related to the thickness but for Grades A, B and C plate ¾″ thick and lighter must bend flat upon itself, while for Grade D a 180° bend is required to be made around a pin having a diameter ½ the plate thickness.

Carbon Steel Plates of Low and Intermediate Tensile Strength for Flange and Firebox Qualties.
A.S.T.M. Designation A-285-49T

These specifications cover three grades of carbon steel plate of flange and firebox qualities of low and intermediate tensile strengths intended for fusion welding for use in pressure vessels. The maximum thickness of plates covered by these specifications is 2″. These specifications cover three grades of plates in both flange and firebox quality with tensile strengths and minimum yield strengths as follows:

	Tensile Strength, Psi	Min. Yield Strength, Psi
Grade A	45,000 to 55,000	24,000
Grade B	50,000 to 60,000	27,000
Grade C	55,000 to 65,000	30,000

The tensile test taken from the top of firebox plate is allowed to exceed these limits by a maximum of 5,000 psi. Bend tests are taken from the middle of the top of the plate at right angles to the direction of rolling. Bend requirements are dependent upon plate thickness, and plate including 1″ in thickness must make a 180° bend around a pin equal to the plate thickness. A maximum manganese content of .80 per cent is established and maximum carbon con-

tents are set up for the grades and thicknesses of firebox quality to insure strength and weldability.

Low Alloy Structural Steel
A.S.T.M. Designation A-242-49T

This specification covers low alloy structural steel for welded or riveted construction, intended primarily for use as stress carrying material of structural members where savings in weight and atmospheric corrosion resistance are important. This specification is limited to material not under 3/16" and not over 2" thick.

A maximum carbon content of 0.20 per cent and maximum manganese of 1.25 per cent is prescribed, while the sulphur present must not exceed .05 per cent. Alloying elements are added to improve the corrosion resistance and develop physical properties as required by the specification. The principal physical property characteristic of the steel is its high ratio of yield strength to tensile strength as illustrated by the specification requirements.

Thickness	Min. Tensile Strength	Min. Yield Strength
3/16" to 3/4" incl.	70,000 psi.	50,000 psi.
Over 3/4" to 1 1/2" incl.	66,000 psi.	45,000 psi.
Over 1 1/2" to 2" incl.	63,000 psi.	40,000 psi.

Bend requirements of the specification for plate 3/16" to 3/4" thick inclusive are met when 180° bends are made over a pin equal the thickness of the material. (Kaisaloy meets all the requirements of this specification.)

New Billet Steel Bars for Concrete Reinforcement
A.S.T.M. Designation A 15-39

This specification is the generally accepted standard for this class of material and covers three grades of deformed and cold twisted bars, namely, structural, intermediate and hard. Open Hearth, Electric Furnace and Bessemer Steel are permitted by the specifications, the phosphorus being the only element shown in the specification subject to limitation. The tensile requirement for the structural grade is 55,000 to 75,000 lbs. per square inch and for the intermediate grade, 70,000 to 90,000 lbs. per square inch. The hard grade must conform to a minimum tensile requirement of 80,000 lbs. per square inch.

Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement
A.S.T.M. Designation A 305-49

This specification defines the dimensional requirements for deformed concrete reinforcement bars, including the maximum spacing of the deformations, their minimum height and position relative to the axis. The requirements are based on recommendations of the Committee of Reinforced Concrete Research of the American Iron and Steel Institute, that the design of the deformation shall provide for a bearing area of the deformations against the concrete, in square inches per lineal inch length of bar when projected on a plane normal to the axis of the bar, of approximately 15% of the nominal size of the bar expressed in inches.

Standard Specification for Hot Rolled Carbon Steel Bars
A.S.T.M. Designation A 107-49T

This specification covers hot rolled carbon steel bars produced in accordance with good mill practice for general purposes including heat treatments. The sections covered are rounds, squares, and hexagons of all sizes, and flats.

Welded and Seamless Pipe for Special Uses
A.S.T.M. Designation A-53-47

This specification covers black and galvanized, welded or seamless nominal wall steel pipe intended for bending, coiling, flanging, or other special purposes. Because of the varied applications for pipe made to this specification, the end use must be given so that the manufacturer is able to supply the correct chemical analysis. The tensile requirements are as follows:

	Furnace-Welded		Seamless or Electric-Resistance-Welded	
	Acid-Bessemer	Open-Hearth or Electric-Furnace	Grade A	Grade B
Tensile strength, min., psi	50,000	45,000	48,000	60,000
Yield Point, min., psi	30,000	25,000	30,000	35,000

Pipe 2″ and under in diameter shall stand 90° bend tests if ordered for bending, and 180° bend tests if ordered for coiling. All sizes are subject to controlled flattening and hydrostatic tests as detailed in the specification.

Kaiser Steel Corporation produces butt-welded pipe, either black or galvanized, on its continuous weld mill to meet this specification in nominal sizes ½″ to 4″. However, butt-welded pipe is not intended for flanging.

Welded and Seamless Steel Pipe for Ordinary Uses
A.S.T.M. Designation A-120-47

This specification covers black and galvanized, welded or seamless, nominal wall steel pipe intended for ordinary uses in steam, water, gas, and air lines, but not intended for close coiling, bending, or hot temperature service. It covers pipe made to three wall thickness classifications: "standard weight", "extra strong", and "double extra strong". No mechanical tests are specified, but each length must be hydrostatically tested to a pressure which varies directly with the diameter and thickness classification of the pipe. Kaiser Steel Corporation makes butt-welded pipe either black or galvanized on its continuous weld mill to meet this specification in nominal sizes ½″ to 4″.

Electric Resistance Welded Steel Pipe
A.S.T.M. Designation A-135-46

This specification covers two grades of electric resistance welded steel pipe 30″ and under in diameter, intended for conveying liquids, gas, or vapors. Tensile requirements are as follows: Grade A minimum tensile strength 48,000 psi, and minimum yield point 30,000 psi; Grade B minimum tensile strength 60,000 psi, and minimum yield point 35,000 psi. Standard flattening tests and hydrostatic tests up to 2,500 psi are performed on each length of pipe. Kaiser

Steel Corporation makes electric resistance welded steel pipe to this specification in sizes 5 9/16" through 14" O. D.

ELECTRIC FUSION WELDED STEEL PIPE
A.S.T.M. Designation A-139-46

This specification covers two grades of electric fusion welded straight-seam or spiral-seam steel pipe 4" to but not including 30" in diameter with nominal wall thicknesses up to 5/8" inclusive, and is intended for conveying liquid, gas, or vapors, but only Grade A is adapted for flanging and bending. Tensile requirements are as follows: Grade A minimum tensile strength 48,000 psi and minimum yield point 30,000 psi; Grade B minimum tensile strength 60,000 psi, and minimum yield point 35,000 psi. Standard flattening tests and hydrostatic tests up to 2,500 psi are performed on each length of pipe.

Kaiser Steel Corporation makes pipe to this specification in sizes 8 5/8" to 22" O. D. inclusive.

A.P.I. SPECIFICATIONS

LINE PIPE
A.P.I. Standard 5L

This specification covers seamless and welded steel pipe, seamless and welded open hearth iron pipe, and welded wrought iron pipe suitable for use in conveying gas, water, and oil, and made by the seamless, electric weld, lap-welded or butt-welded process. Chemical requirements and physical properties are indicated for the various classifications and grades in the accompanying table:

	CHEMICAL REQUIREMENTS					
STEEL PIPE	Carbon % Max.	Manganese % Min.	Manganese % Max.	Phos. % Max.	Sulphur % Max.	Yield Strength Min. psi	Tensile Strength Min. psi
SEAMLESS OR ELECTRIC WELDED							
Grade A.....	.30		.90	.045	.060	30,000	48,000
Grade B.....30	.35		1.50	.045	.060	35,000	60,000
Grade C.....	.35		1.50	.045	.060	45,000	75,000
LAP WELDED OR BUTT WELDED							
Electric-Furnace.....30			.60	.045	.060	25,000	45,000
Open Hearth—Class 1...30			.60	.045	.060	25,000	45,000
—Class 2...30			.60	.080	.060	28,000	48,000
Bessemer.....30			.60	.110	.065	30,000	50,000
IRON PIPE						24,000	42,000

Pipe made to this specification is also subject to flattening tests and hydrostatic pressure tests, with bend tests performed on sizes 2 3/8" and under in diameter. Kaiser Steel Corporation is prepared to meet this specification with butt-welded pipe in nominal sizes 1/2" to 4", and electric resistance welded pipe 5 9/16" to 14" O. D.

HIGH TEST LINE PIPE
A.P.I. Standard 5LX

The purpose of this specification is to provide standards for more rigorously tested line pipe having greater tensile and bursting strengths than pipe manfactured for A.P.I. Standard 5L. It may be manufactured by either the seamless, electric-flash welding, continuous electric resistance welding or submerged

arc welding methods. Various grades of pipe made under this specification are designated by the letter X followed by the first two digits of the specified minimum yield strength, i.e., X42 designates the grade having a specified minimum yield strength of 42,000 psi. Chemical and physical properties of the three most commonly used grades are given below:

	CHEMICAL				PHYSICAL	
	Carbon Max. %	Manganese Max. %	Phosphorus Max. %	Sulphur Max. %	Minimum Tensile Strength	Minimum Yield Strength
X42.....	.30	1.25	.045	.060	60,000 psi	42,000 psi
X46.....	.30	1.25	.045	.060	65,000 psi	46,000 psi
X52.....	.30	1.25	.045	.060	72,000 psi	52,000 psi

This pipe is also subject to controlled flattening and hydrostatic pressure tests, with bend tests performed upon agreement between the purchaser and the manufacturer. Kaiser Steel Corporation meets this specification with electric resistance weld pipe sizes 5 9/16" to 14" O.D. and submerged arc welded pipe sizes 22" to 30" O.D. Sizes 8 5/8" to 22" are also made to all applicable parts of this specification except that the one pass submerged arc weld method is used.

A. A. R. SPECIFICATIONS

Blooms, Billets and Slabs for Forgings
A.A.R. Specification M-105-45

Requirements of this specification are covered by A.S.T.M. Specification A-273-44T for carbon steel and A.S.T.M. Specification A-274-44T for alloy steel.

Steel Bars, Carbon, for Railway Springs
A.A.R. Specification M-114-42

This specification covers carbon steel bars to be used for the manufacture of railway springs and provides for a carbon range of .90/1.05%, and a minimum silicon content of .15%.

Steel, Structural Shapes, Plates and Bars
A.A.R. Specification M-116-42

This specification covers structural steel shapes, plates (except boiler and firebox plates) and bars intended primarily for use in locomotive and car construction. There are three grades shown in the specification: namely, Grade A, tensile strength 60,000 to 72,000 lbs. per square inch; Grade B, tensile strength 50,000 to 62,000 lbs. per square inch, and Grade C, Cold Pressing Quality for plates only, tensile strength 48/58,000 lbs. per square inch.

OTHER SPECIFICATIONS

In addition to the commonly used specifications listed above, there are a number of other standard specifications for carbon steels produced by Kaiser Steel Corporation. Our metallurgists are also prepared to advise customers in the case of requirements not covered by standard specifications.

Kaiser Steel Corporation regularly produces steel to the specifications of the American Iron & Steel Institute (A.I.S.I. steels) listed below:

LADLE CHEMICAL RANGES AND LIMITS

BASIC OPEN HEARTH CARBON STEELS

Subject to Permissible Variation for Check Analysis

TABLE 94

AISI No.	CHEMICAL COMPOSITION LIMITS, PER CENT				Corresponding SAE No.
	C	Mn	P Max.	S Max.	
C 1008	0.10 max.	0.25/0.50	0.040	0.050	1008
C 1010	0.08/0.13	0.30/0.60	0.040	0.050	1010
C 1012	0.10/0.15	0.30/0.60	0.040	0.050	....
C 1015	0.13/0.18	0.30/0.60	0.040	0.050	1015
C 1016	0.13/0.18	0.60/0.90	0.040	0.050	1016
C 1017	0.15/0.20	0.30/0.60	0.040	0.050	1017
C 1018	0.15/0.20	0.60/0.90	0.040	0.050	1018
C 1019	0.15/0.20	0.70/1.00	0.040	0.050	1019
C 1020	0.18/0.23	0.30/0.60	0.040	0.050	1020
C 1021	0.18/0.23	0.60/0.90	0.040	0.050	....
C 1022	0.18/0.23	0.70/1.00	0.040	0.050	1022
C 1023	0.20/0.25	0.30/0.60	0.040	0.050	....
C 1024	0.19/0.25	1.35/1.65	0.040	0.050	1024
C 1025	0.22/0.28	0.30/0.60	0.040	0.050	1025
C 1026	0.22/0.28	0.60/0.90	0.040	0.050	....
C 1027	0.22/0.29	1.20/1.50	0.040	0.050	1027
C 1029	0.25/0.31	0.60/0.90	0.040	0.050	....
C 1030	0.28/0.34	0.60/0.90	0.040	0.050	1030
C 1033	0.30/0.36	0.70/1.00	0.040	0.050	1033
C 1035	0.32/0.38	0.60/0.90	0.040	0.050	1035
C 1036	0.30/0.37	1.20/1.50	0.040	0.050	1036
C 1037	0.35/0.42	0.40/0.70	0.040	0.050	....
C 1038	0.35/0.42	0.60/0.90	0.040	0.050	1038
C 1039	0.37/0.44	0.70/1.00	0.040	0.050	1039
C 1040	0.37/0.44	0.60/0.90	0.040	0.050	1040
C 1041	0.36/0.44	1.35/1.65	0.040	0.050	1041
C 1042	0.40/0.47	0.60/0.90	0.040	0.050	1042
C 1043	0.40/0.47	0.70/1.00	0.040	0.050	1043
C 1045	0.43/0.50	0.60/0.90	0.040	0.050	1045
C 1046	0.43/0.50	0.70/1.00	0.040	0.050	1046
C 1049	0.46/0.53	0.60/0.90	0.040	0.050	1049
C 1050	0.48/0.55	0.60/0.90	0.040	0 050	1050
C 1052	0.47/0.55	1.20/1.50	0.040	0.050	1052
C 1053	0.48/0.55	0.70/1.00	0.040	0.050	....
C 1055	0.50/0.60	0.60/0.90	0.040	0.050	1055
C 1060	0.55/0.65	0.60/0.90	0.040	0.050	1060
C 1065	0.60/0.70	0.60/0.90	0.040	0.050	1065
C 1069	0.65/0.75	0.40/0.70	0.040	0.050	....
C 1070	0.65/0.75	0.60/0.90	0.040	0.050	1070
C 1072	0.65/0.76	1.00/1.30	0.040	0.050	....
C 1075	0.70/0.80	0.40/0.70	0.040	0.050	....
C 1078	0.72/0.85	0.30/0.60	0.040	0.050	1078
C 1080	0.75/0.88	0.60/0.90	0.040	0.050	1080
C 1084	0.80/0.93	0.60/0.90	0.040	0.050	....
C 1085	0.80/0.93	0.70/1.00	0.040	0.050	1085
C 1086	0.82/0.95	0.30/0.50	0.040	0.050	1086
C 1090	0.85/0.98	0.60/0.90	0.040	0.050	1090
C 1095	0.90/1.03	0.30/0.50	0.040	0.050	1095

USEFUL INFORMATION ABOUT STEEL

16

STANDARD CLASSIFICATION OF FLAT ROLLED CARBON STEEL PRODUCTS

HOT ROLLED

Widths, Inches	THICKNESSES, INCHES								
	0.2300 and Thicker	0.2299 to 0.2031	0.2030 to 0.1800	0.1799 to 0.0568	0.0567 to 0.0449	0.0448 to 0.0344	0.0343 to 0.0255	0.0254 to 0.0142	0.0141 and Thinner
To 3½.....	Bar	Bar	Strip	Strip	Strip	Strip	Strip	Sheet*	Sheet*
Over 3½ to 6 incl.	Bar	Bar	Strip	Strip	Strip	Strip	Sheet*	Sheet*	Sheet*
Over 6 to 12 incl.	Plate	Strip	Strip	Strip	Sheet	Sheet*	Sheet*	Sheet*	Sheet*
Over 12 to 32 incl.	Plate	Sheet	Sheet	Sheet	Sheet	Sheet*	Sheet*	Sheet*	
Over 32 to 48 incl.	Plate	Sheet	Sheet	Sheet	Sheet	Sheet*	Sheet*	Sheet*	Sheet*
Over 48.....	Plate	Plate	Plate	Sheet	Sheet	Sheet*	Sheet*	Sheet*	Sheet*

*Hot rolled annealed.

COLD ROLLED

Widths, Inches	THICKNESSES, INCHES		
	0.2500 and Thicker	0.2499 to 0.0142	0.0141 and Thinner
Over ½ to 12 incl....	Bar	Strip	Strip
Over 12 to 24 incl...	Strip (1)	Strip (1)	Strip (1)
Over 12 to 24 incl...	Sheet (2)	Sheet (2)	Black Plate (2)
Over 24 to 32 incl...	Sheet	Sheet	Tin Mill Black Plate
Over 32.....	Sheet	Sheet	Sheet

(1) When a particular temper or a special edge or finish is specified.

(2) When no special temper, edge or finish is specified.

EFFECTS OF ALLOYING ELEMENTS ON STEEL

ALUMINUM

Aluminum has been used as an alloy in steels to promote nitriding but its major use in steel making is as a deoxidizer. It may be used alone, as in low carbon steels where exceptional drawability is desired, or more commonly in conjunction with other deoxidizers. It effectively restricts grain growth and its use as a deoxidizer to control grain size is widely practiced in the steel industry.

VANADIUM

Vanadium is a mild deoxidizer and its addition to steel results in fine grain structure which is maintained at high temperature. It has very strong carbide forming tendencies and very effectively promotes strength at high temperatures. Vanadium steels have improved fatigue values and excellent response to heat treatment. In unhardened steels it is particularly beneficial in strengthening the metal.

CHROMIUM

Chromium contributes to the heat treatment of steel by increasing its strength and hardness. Its carbides are very stable and chromium may be added to high carbon steels subject to prolonged anneals to prevent graphitization. Chromium increases resistance to corrosion and abrasion and chromium steels maintain strength at elevated temperatures.

MOLYBDENUM

Molybdenum has a pronounced effect in promoting hardenability. It raises the coarsening temperature of steel, increases the high temperature strength, improves the resistance to creep and enhances the corrosion resistance of stainless steels.

NICKEL

Nickel is soluble in iron and, in combination with other elements, improves the hardenability of steel and toughness after tempering. It is especially effective in strengthening unhardened steels and improving impact strength at low temperatures. It is used in conjunction with chromium in stainless steels.

SULPHUR

Sulphur is added to steel to increase machinability. Because of its tendency to segregate it may decrease the ductility of low carbon drawing steel. Its detrimental effect in hot rolling is offset by manganese.

PHOSPHOROUS

Phosphorous strengthens steel but reduces its ductility. It improves the machinability of high sulphur steels and under some conditions may confer some increase in corrosion resistance.

SILICON

Silicon is one of the principal steel deoxidizers and is commonly added to steel for this purpose although in amounts up to about 2.5% it increases the hardenability of steels. Specified coarse grain steels are silicon killed. In lower carbon electrical steels, silicon is used to promote the crystal structure desired in annealed sheets.

IRON

Iron is the principal element and makes up the body of steel. In commercial production iron always contains varying quantities of other elements. Production of pure iron is accomplished with difficulty and generally in small quantities. Iron does not have great strength, is soft, ductile and can be appreciably hardened only by cold work.

CARBON

Carbon, although not generally considered an alloying element, is by far the most important element in steel. As carbon is added to steel up to about .90 per cent its response to heat treatment and its depth of hardening increases. In the "as rolled" condition, increasing the carbon content increases the hardness, strength and abrasion resistance of steel but its ductility, toughness, impact properties and machinability decrease.

MANGANESE

Manganese makes it possible to roll hot steel by its chemical interaction with sulphur and oxygen. It is next in importance to carbon as an alloying element. It has a strengthening effect upon iron and also a beneficial effect upon steel by increasing its response to heat treatment. It increases the machinability of free machining steels but tends to decrease the ductility of low carbon drawing steels.

TITANIUM

Titanium is an extremely effective carbide former and is used in stainless steels to stabilize the steel by holding carbon in combination. Titanium is used for special single coat enameling steels. In low alloy structural steels its use in combination with other alloys promotes fine grain structure and improves the strength of the steel in the "as rolled" condition.

HARDNESS CONVERSION TABLE

Approximate Relations Between Brinell, Rockwell, Shore and Vickers Hardnesses and the Tensile Strengths of Carbon and Alloy Steels.

Brinell		Vickers Diamond Pyramid Hardness No.	Rockwell		Shore Scleroscope No.	Tensile Strength 1000 psi
Dia. in mm., 3000 kg. Load 10 mm. Ball	Hardness No.		C 150 kg. Load Brale Penetrator	B 100 kg. Load 1/16" Diamond Ball		
2.25	745	840	65.3	...	91	...
2.30	712	...	...	...	...	...
2.35	682	737	61.7	...	84	...
2.40	653	697	60.0	...	81	...
2.45	627	667	58.7	...	79	323
2.50	601	640	57.3	...	77	309
2.55	578	615	56.0	...	75	297
2.60	555	591	54.7	...	73	285
2.65	534	569	53.5	...	71	274
2.70	514	547	52.1	...	70	263
2.75	495	528	51.0	...	68	253
2.80	477	508	49.6	...	66	243
2.85	461	491	48.5	...	65	235
2.90	444	472	47.1	...	63	225
2.95	429	455	45.7	...	61	217
3.00	415	440	44.5	...	59	210
3.05	401	425	43.1	...	58	202
3.10	388	410	41.8	...	56	195
3.15	375	396	40.4	...	54	188
3.20	363	383	39.1	...	52	182
3.25	352	372	37.9	(110.0)	51	176
3.30	341	360	36.6	(109.0)	50	170
3.35	331	350	35.5	(108.5)	48	166
3.40	321	339	34.3	(108.0)	47	160
3.45	311	328	33.1	(107.5)	46	155
3.50	302	319	32.1	(107.0)	45	150
3.55	293	309	30.9	(106.0)	43	145
3.60	285	301	29.9	(105.5)	...	141
3.65	277	292	28.8	(104.5)	41	137
3.70	269	284	27.6	(104.0)	40	133
3.75	262	276	26.6	(103.0)	39	129
3.80	255	269	25.4	(102.0)	38	126
3.85	248	261	24.2	(101.0)	37	122
3.90	241	253	22.8	100.0	36	118
3.95	235	247	21.7	99.0	35	115
4.00	229	241	20.5	98.2	34	111
4.05	223	234	(18.8)	97.3	...	...
4.10	217	228	(17.5)	96.4	33	105
4.15	212	222	(16.0)	95.5	...	102
4.20	207	218	(15.2)	94.6	32	100

HARDNESS CONVERSION TABLE

(Continued)

Brinell		Vickers Diamond Pyramid Hardness No.	Rockwell		Shore Scleroscope No.	Tensile Strength 1000 psi
Dia. in mm., 3000 kg. Load 10 mm. Ball	Hardness No.		C 150 kg. Load Brale Penetrator	B 100 kg. Load 1/16" Diamond Ball		
4.25	202	212	(13.8)	93.8	31	98
4.30	197	207	(12.7)	92.8	30	95
4.35	192	202	(11.5)	91.9	29	93
4.40	187	196	(10.0)	90.7	...	90
4.45	183	192	(9.0)	90.0	28	89
4.50	179	188	(8.0)	89.0	27	87
4.55	174	182	(6.4)	87.8	...	85
4.60	170	178	(5.4)	86.8	26	83
4.65	166	175	(4.4)	86.0	...	81
4.70	163	171	(3.3)	85.0	25	79
4.80	156	163	(0.9)	82.9	...	76
4.90	149	156	...	80.8	23	73
5.00	143	150	...	78.7	22	71
5.10	137	143	...	76.4	21	67
5.20	131	137	...	74.0	...	65
5.30	126	132	...	72.0	20	63
5.40	121	127	...	69.8	19	60
5.50	116	122	...	67.6	18	58
5.60	112	117	...	65.7	15	56

Values in ( ) are beyond normal range and are given for information only.

COMPARATIVE APPROXIMATE PHYSICAL PROPERTIES OF COMMERCIAL IRON, ROLLED STEEL AND CAST IRON

Name	Approximate Per Cent Carbon	Physical Properties				Brinell Hardness
		Specific Gravity	Weight per Cu. Ft.	Melting Point Deg. Fahr.	Average Coefficient of Expansion per Deg. Fahr. 70° to 600° F.	
Iron.....	0.03	7.86	491	2790	.0000072	60
Soft Steel....	0.10	7.85	490	2780	.0000074	120
Medium Steel.	0.25	7.85	490	2765	.0000072	150
Hard Steel...	0.40	7.84	489	2740	.0000067	180
Tool Steel....	0.90	7.82	488	2700	.0000064	260
Gray Cast Iron	3.50	7.20	446	2000±	.0000059	150

COMPARATIVE APPROXIMATE MECHANICAL PROPERTIES OF COMMERCIAL IRON, ROLLED STEEL AND CAST IRON

Name	Approximate Per Cent Carbon	Mechanical Properties				Brinell Hardness
		Ultimate Strength Lb. per Sq. In.	Yield Strength Lb. per Sq. In.	Elongation in 2 In. Per Cent	Modulus of Elasticity Lb. per Sq. In.	
Iron.....	0.03	44000	27500	46	29,500,000	60
Soft Steel.....	0.10	50000	30000	35	29,100,000	120
Medium Steel..	0.25	60000	36000	30	28,900,000	150
Hard Steel....	0.40	80000	50000	25	28,600,000	180
Tool Steel.....	0.90	130000	75000	8	28,000,000	260
Gray Cast Iron.	3.50	22000	17000	..	13,000,000	150

PROPERTIES OF STEELS AT LOW TEMPERATURES

The lowering of the temperature of steels below room temperature is generally accompanied by an increase in the tensile strength and yield point and a lesser decrease in elongation and reduction of area as measured in a tension test bar. The property which is affected most by lowering temperature is the resistance to shock.

TENSION TEST PROPERTIES—There is a large amount of data available on tension test results on various compositions at low temperatures. Selected results are given in Table 1 covering carbon steels and alloy steels.

TENSILE STRENGTH OF STEELS AT LOW TEMPERATURES

SOME CARBON STEELS

Authority	Material	Treatment °F.	Test Temp., °F.	Tensile Strength, psi	Yield Point, psi	Elong., % in 2 In.	Red. Area, %	Brinell
Colbeck MacGillivray Manning	Iron C 0.035%	As rec'd.	Room —4 —58 —94 —148 —184 —292	45,700 53,750 59,400 61,700 66,800 77,000 112,000	..... 30,700 42,200 43,400 57,200 66,700	27.9 42.0 43.0 37.5 26.5 17.0 Nil	73.2 75.0 74.0 72.0 70.0 68.0 Nil	.. ..
Colbeck, etc.	C 0.13%	As rec'd.	Room —85 —292	66,300 80,700 121,300	54,700 67,700	29.7 33.6 26.5	71.8 70.3 55.0	.. .. ..
Hadfield	Carbon steel C 0.14%, Mn 0.07%	Annealed 1472	Room —296 —423	45,700 137,000 155,000	42,700 155,000	27.5 7.5 0.3	77.5 ..... 2.5	114 281 326
Sands	C 0.21%	As rec'd.	Room —114	62,600 69,000	39,800 47,780	35.5 35.5	53.0 56.8	.. ..
Bull	Carbon forging C 0.26%, Mn 0.46%		Room —114	57,300 72,840	38,940 50,325	34.0 36.0	54.7 53.2	.. ..
Hadfield	Carbon steel C 0.37%, Mn 0.20%	Annealed 1472	Room —296 —423	76,200 148,000 151,000	 151,000	20.0 17.0 Nil	63.0 39.0 Nil	157 294 316
Strauss	C 0.40%	Annealed	Room Liq. air	79,400 139,400	45,800 114,100	30.8 7.3	49.0 7.1	.. ..

TENSILE STRENGTH OF STEELS AT LOW TEMPERATURES

SOME CARBON STEELS

Authority	Material	Treatment °F.	Test Temp., °F.	Tensile Strength, psi	Yield Point, psi	Elong., % in 2 In.	Red. Area, %	Brinell
Strauss	C 0.40%	Treated	Room	104,400	76,900	25.0	61.3	..
			Liq. air	160,400	150,000	9.8	9.4	..
Bull	Carbon forging C 0.40%, Mn 0.52%		Room	77,440	44,670	29.0	45.3	..
			—114	83,310	47,075	30.8	44.9	..
Hadfield	Carbon steel C 0.78%, Mn 0.10%	Annealed 1472	Room	99,000	95,000	12.0	35.0	194
			—296	154,700	.....	Nil	.....	325
			—423	123,000	123,000	0.2	Nil	244

SOME ALLOY STEELS

Colbeck etc.	C 0.33% Cr 0.67% Ni 2.45% Mo 0.64%	1560 1185 oil tempered	Room	152,000	137,700	14.0	65.0	..
			—6	154,500	141,000	15.6	64.0	..
			—76	164,000	143,300	14.0	63.0	..
			—90	163,000	145,500	15.6	62.0	..
			—141	170,000	149,000	16.4	61.0	..
			—292	201,500	183,500	17.0	63.0	..
Hadfield	C 0.35% Cr 0.71% Ni 3.34%	Oil quench, 1200 tempered	Room	146,000	133,000	13.5	59.5	..
			—423	243,000	243,000	4.5	48.5	..
Nickel Steel Topics	C 1.27% Mn12.69%		Room	148,000	77,800	44.5	39.0	..
			—296	137,000	.....	2.5	.....	..
			—426	146,000	146,000	Nil	Nil	..
Colbeck, etc.	C 0.06%, Cr 13.45% Ni 10.05% Mn 4.07%	Water quenched 2010	Room	80,400	38,500	59.5	75.5	..
			—292	197,500	89,500	47.0	60.0	..
Nickel Steel Topics	C 0.56% Ni 24.6%		Room	120,500	.....	20.4	.....	..
			—112	160,000	.....	14.1	.....	..
Russell	Ni 26%	Annealed	Room	99,800	52,900	38.3	52.1	..
			Liq. air	205,000	157,800	11.5	9.7	..
Russell	C 0.56% Ni 24.6% Mn 1.18%		—64	120,500	71,200	20.4	67.4	..
			—112	160,000	105,000	14.1	64.0	..

EXPANSION OF STEEL BY HEAT

The coefficient of linear expansion is the change in length, per unit of length, for a change of one degree of temperature. The coefficient of surface expansion is approximately two times the linear coefficient, and the coefficient of volume expansion for solids, is approximately three times the linear coefficient.

The change in length of a bar as the result of a change in temperature can be expressed as etl, where e is the coefficient of linear expansion, t the change in temperature, and l the length of the bar.

The following table gives the coefficient of linear expansion for 1° F. of temperature change.

Example: A bar of hard steel is 30′ long at 50° F. Find the length at 110° F. assuming the ends are free to move.

Change of length = etl = .0000067 × 60 × 30 = .01206

The length at 110° F. = 30.01206.

APPROXIMATE COEFFICIENTS OF EXPANSION PER 1 DEGREE FAHRENHEIT TEMPERATURE CHANGE

Name	Approximate Per Cent Carbon	Coefficients
Iron	0.03	.0000072
Soft Steel	0.10	.0000074
Medium Steel	0.25	.0000072
Hard Steel	0.40	.0000067
Tool Steel	0.90	.0000064
Gray Cast Iron	3.50	.0000059

THE EFFECT OF HEAT ON STRUCTURAL STEEL

Structural carbon steel such as A.S.T.M. A-7 increases in strength with a rise in temperature until, at approximately 550° F., it is about 25% stronger than at normal temperatures. At 800° F. its strength is approximately the same as at normal temperatures. At temperatures above 800° F., however, its strength falls off rapidly.

JUDGING TEMPERATURE BY COLOR

The following temper colors appear on the surface of steel when heated to the corresponding temperatures.

°F	°C	Temper Color
380-400	200	Pale yellow
420-440	220	Straw yellow
460-480	240	Yellowish brown
500-540	270	Bluish purple
540-560	285	Violet
560-580	300	Pale blue
600-640	325	Blue
		Visible Color
1000	540	Black
1100	590	Faint dark red
1200	650	Cherry red (dark)
1300	700	Cherry red (med.)
1400	760	Red
1500	815	Light red
1600	870	Reddish orange
1700	930	Orange
1800	980	Changes
1900	1040	to
2000	1090	Pale orange lemon
2100	1150	Lemon
2200	1205	Light lemon
2300	1260	Yellow
2400	1315	Light yellow
2500	1370	Yellowish gray: "white"

NOTE: The colors are for medium daylight. "Color temperatures" are useful as a rough guide though with practice surprising accuracy can be secured as long as the conditions are held constant.

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
1/4	.16	.21	.27	.32	.37	.43	.48
1/2	.32	.43	.53	.64	.74	.85	.96
3/4	.48	.64	.80	.96	1.12	1.28	1.43
1	.64	.85	1.06	1.28	1.49	1.70	1.91
1 1/4	.80	1.06	1.33	1.59	1.86	2.13	2.39
1 1/2	.96	1.28	1.59	1.91	2.23	2.55	2.87
1 3/4	1.12	1.49	1.86	2.23	2.60	2.98	3.35
2	1.28	1.70	2.13	2.55	2.98	3.40	3.83
2 1/4	1.43	1.91	2.39	2.87	3.35	3.83	4.30
2 1/2	1.59	2.13	2.66	3.19	3.72	4.25	4.78
2 3/4	1.75	2.34	2.92	3.51	4.09	4.68	5.26
3	1.91	2.55	3.19	3.83	4.46	5.10	5.74
3 1/4	2.07	2.76	3.45	4.14	4.83	5.53	6.22
3 1/2	2.23	2.98	3.72	4.46	5.21	5.95	6.69
3 3/4	2.39	3.19	3.98	4.78	5.58	6.38	7.17
4	2.55	3.40	4.25	5.10	5.95	6.80	7.65
4 1/4	2.71	3.61	4.52	5.42	6.32	7.23	8.13
4 1/2	2.87	3.83	4.78	5.74	6.69	7.65	8.61
4 3/4	3.03	4.04	5.05	6.06	7.07	8.08	9.08
5	3.19	4.25	5.31	6.38	7.44	8.50	9.56
5 1/4	3.35	4.46	5.58	6.69	7.81	8.93	10.0
5 1/2	3.51	4.68	5.84	7.01	8.18	9.35	10.5
5 3/4	3.67	4.89	6.11	7.33	8.55	9.78	11.0
6	3.83	5.10	6.38	7.65	8.93	10.2	11.5
6 1/4	3.98	5.31	6.64	7.97	9.30	10.6	12.0
6 1/2	4.14	5.53	6.91	8.29	9.67	11.1	12.4
6 3/4	4.30	5.74	7.17	8.61	10.0	11.5	12.9
7	4.46	5.95	7.44	8.93	10.4	11.9	13.4
7 1/4	4.62	6.16	7.70	9.24	10.8	12.3	13.9
7 1/2	4.78	6.38	7.97	9.56	11.2	12.8	14.3
7 3/4	4.94	6.59	8.23	9.88	11.5	13.2	14.8
8	5.10	6.80	8.50	10.2	11.9	13.6	15.3
8 1/4	5.26	7.01	8.77	10.5	12.3	14.0	15.8
8 1/2	5.42	7.23	9.03	10.8	12.6	14.5	16.3
8 3/4	5.58	7.44	9.30	11.2	13.0	14.9	16.7
9	5.74	7.65	9.56	11.5	13.4	15.3	17.2

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.53	.58	.64	.69	.74	.80	.85
1/2	1.06	1.17	1.28	1.38	1.49	1.59	1.70
3/4	1.59	1.75	1.91	2.07	2.23	2.39	2.55
1	2.13	2.34	2.55	2.76	2.98	3.19	3.40
1 1/4	2.66	2.92	3.19	3.45	3.72	3.98	4.25
1 1/2	3.19	3.51	3.83	4.14	4.46	4.78	5.10
1 3/4	3.72	4.09	4.46	4.83	5.21	5.58	5.95
2	4.25	4.68	5.10	5.53	5.95	6.38	6.80
2 1/4	4.78	5.26	5.74	6.22	6.69	7.17	7.65
2 1/2	5.31	5.84	6.38	6.91	7.44	7.97	8.50
2 3/4	5.84	6.43	7.01	7.60	8.18	8.77	9.35
3	6.38	7.01	7.65	8.29	8.93	9.56	10.2
3 1/4	6.91	7.60	8.29	8.98	9.67	10.4	11.1
3 1/2	7.44	8.18	8.93	9.67	10.4	11.2	11.9
3 3/4	7.97	8.77	9.56	10.4	11.2	12.0	12.8
4	8.50	9.35	10.2	11.1	11.9	12.8	13.6
4 1/4	9.03	9.93	10.8	11.7	12.6	13.6	14.5
4 1/2	9.56	10.5	11.5	12.4	13.4	14.3	15.3
4 3/4	10.1	11.1	12.1	13.1	14.1	15.1	16.2
5	10.6	11.7	12.8	13.8	14.9	15.9	17.0
5 1/4	11.2	12.3	13.4	14.5	15.6	16.7	17.9
5 1/2	11.7	12.9	14.0	15.2	16.4	17.5	18.7
5 3/4	12.2	13.4	14.7	15.9	17.1	18.3	19.6
6	12.8	14.0	15.3	16.6	17.9	19.1	20.4
6 1/4	13.3	14.6	15.9	17.3	18.6	19.9	21.3
6 1/2	13.8	15.2	16.6	18.0	19.3	20.7	22.1
6 3/4	14.3	15.8	17.2	18.7	20.1	21.5	23.0
7	14.9	16.4	17.9	19.3	20.8	22.3	23.8
7 1/4	15.4	17.0	18.5	20.0	21.6	23.1	24.7
7 1/2	15.9	17.5	19.1	20.7	22.3	23.9	25.5
7 3/4	16.5	18.1	19.8	21.4	23.1	24.7	26.4
8	17.0	18.7	20.4	22.1	23.8	25.5	27.2
8 1/4	17.5	19.3	21.0	22.8	24.5	26.3	28.1
8 1/2	18.1	19.9	21.7	23.5	25.3	27.1	28.9
8 3/4	18.6	20.5	22.3	24.2	26.0	27.9	29.8
9	19.1	21.0	23.0	24.9	26.8	28.7	30.6

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
9¼	5.90	7.86	9.83	11.8	13.8	15.7	17.7
9½	6.06	8.08	10.1	12.1	14.1	16.2	18.2
9¾	6.22	8.29	10.4	12.4	14.5	16.6	18.7
10	6.38	8.50	10.6	12.8	14.9	17.0	19.1
10¼	6.53	8.71	10.9	13.1	15.3	17.4	19.6
10½	6.69	8.93	11.2	13.4	15.6	17.9	20.1
10¾	6.85	9.14	11.4	13.7	16.0	18.3	20.6
11	7.01	9.35	11.7	14.0	16.4	18.7	21.0
11¼	7.17	9.56	12.0	14.3	16.7	19.1	21.5
11½	7.33	9.78	12.2	14.7	17.1	19.6	22.0
11¾	7.49	9.99	12.5	15.0	17.5	20.0	22.5
12	7.65	10.2	12.8	15.3	17.9	20.4	23.0
12½	7.97	10.6	13.3	15.9	18.6	21.3	23.9
13	8.29	11.1	13.8	16.6	19.3	22.1	24.9
13½	8.61	11.5	14.3	17.2	20.1	23.0	25.8
14	8.93	11.9	14.9	17.9	20.8	23.8	26.8
14½	9.24	12.3	15.4	18.5	21.6	24.7	27.7
15	9.56	12.8	15.9	19.1	22.3	25.5	28.7
15½	9.88	13.2	16.5	19.8	23.1	26.4	29.6
16	10.2	13.6	17.0	20.4	23.8	27.2	30.6
16½	10.5	14.0	17.5	21.0	24.5	28.1	31.6
17	10.8	14.5	18.1	21.7	25.3	28.9	32.5
17½	11.2	14.9	18.6	22.3	26.0	29.8	33.5
18	11.5	15.3	19.1	23.0	26.8	30.6	34.4
18½	11.8	15.7	19.7	23.6	27.5	31.5	35.4
19	12.1	16.2	20.2	24.2	28.3	32.3	36.3
19½	12.4	16.6	20.7	24.9	29.0	33.2	37.3
20	12.8	17.0	21.3	25.5	29.8	34.0	38.3
20½	13.1	17.4	21.8	26.1	30.5	34.9	39.2
21	13.4	17.9	22.3	26.8	31.2	35.7	40.2
21½	13.7	18.3	22.8	27.4	32.0	36.6	41.1
22	14.0	18.7	23.4	28.1	32.7	37.4	42.1
22½	14.3	19.1	23.9	28.7	33.5	38.3	43.0
23	14.7	19.6	24.4	29.3	34.2	39.1	44.0
23½	15.0	20.0	25.0	30.0	35.0	40.0	44.9
24	15.3	20.4	25.5	30.6	35.7	40.8	45.9

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
9¼	19.7	21.6	23.6	25.6	27.5	29.5	31.5
9½	20.2	22.2	24.2	26.2	28.3	30.3	32.3
9¾	20.7	22.8	24.9	26.9	29.0	21.1	33.2
10	21.3	23.4	25.5	27.6	29.8	31.9	34.0
10¼	21.8	24.0	26.1	28.3	30.5	32.7	34.9
10½	22.3	24.5	26.8	29.0	31.2	33.5	35.7
10¾	22.8	25.1	27.4	29.7	32.0	34.3	36.6
11	23.4	25.7	28.1	30.4	32.7	35.1	37.4
11¼	23.9	26.3	28.7	31.1	33.5	35.9	38.3
11½	24.4	26.9	29.3	31.8	34.2	36.7	39.1
11¾	25.0	27.5	30.0	32.5	35.0	37.5	40.0
12	25.5	28.1	30.6	33.2	35.7	38.3	40.8
12½	26.6	29.2	31.9	34.5	37.2	39.8	42.5
13	27.6	30.4	33.2	35.9	38.7	41.4	44.2
13½	28.7	31.6	34.4	37.3	40.2	43.0	45.9
14	29.8	32.7	35.7	38.7	41.7	44.6	47.6
14½	30.8	33.9	37.0	40.1	43.1	46.2	49.3
15	31.9	35.1	38.3	41.4	44.6	47.8	51.0
15½	32.9	36.2	39.5	42.8	46.1	49.4	52.7
16	34.0	37.4	40.8	44.2	47.6	51.0	54.4
16½	35.1	38.6	42.1	45.6	49.1	52.6	56.1
17	36.1	39.7	43.4	47.0	50.6	54.2	57.8
17½	37.2	40.9	44.6	48.3	52.1	55.8	59.5
18	38.3	42.1	45.9	49.7	53.6	57.4	61.2
18½	39.3	43.2	47.2	51.1	55.0	59.0	62.9
19	40.4	44.4	48.5	52.5	56.5	60.6	64.6
19½	41.4	45.6	49.7	53.9	58.0	62.2	66.3
20	42.5	46.8	51.0	55.3	59.5	63.8	68.0
20½	43.6	57.9	52.3	56.6	61.0	65.3	69.7
21	44.6	49.1	53.6	58.0	62.5	66.9	71.4
21½	45.7	50.3	54.8	59.4	64.0	68.5	73.1
22	46.8	51.4	56.1	60.8	65.5	70.1	74.8
22½	47.8	52.6	57.4	62.2	66.9	71.7	76.5
23	48.9	53.8	58.7	63.5	68.4	73.3	78.2
23½	49.9	54.9	59.9	64.9	69.9	74.9	79.9
24	51.0	56.1	61.2	66.3	71.4	76.5	81.6

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
25	15.9	21.3	26.6	31.9	37.2	42.5	47.8
26	16.6	22.1	27.6	33.2	38.7	44.2	49.7
27	17.2	23.0	28.7	34.4	40.2	45.9	51.6
28	17.9	23.8	29.8	35.7	41.7	47.6	53.6
29	18.5	24.7	30.8	37.0	43.1	49.3	55.5
30	19.1	25.5	31.9	38.3	44.6	51.0	57.4
31	19.8	26.4	32.9	39.5	46.1	52.7	59.3
32	20.4	27.2	34.0	40.8	47.6	54.4	61.2
33	21.0	28.1	35.1	42.1	49.1	56.1	63.1
34	21.7	28.9	36.1	43.4	50.6	57.8	65.0
35	22.3	29.8	37.2	44.6	52.1	59.5	66.9
36	23.0	30.6	38.3	45.9	53.6	61.2	68.9
37	23.6	31.5	39.3	47.2	55.0	62.9	70.8
38	24.2	32.3	40.4	48.5	56.5	64.6	72.7
39	24.9	33.2	41.4	49.7	58.0	66.3	74.6
40	25.5	34.0	42.5	51.0	59.5	68.0	76.5
41	26.1	34.9	43.6	52.3	61.0	69.7	78.4
42	26.8	35.7	44.6	53.6	62.5	71.4	80.3
43	27.4	36.6	45.7	54.8	64.0	73.1	82.2
44	28.1	37.4	46.8	56.1	65.5	74.8	84.2
45	28.7	38.3	47.8	57.4	66.9	76.5	86.1
46	29.3	39.1	48.9	58.7	68.4	78.2	88.0
47	30.0	40.0	49.9	59.9	69.9	79.9	89.9
48	30.6	40.8	51.0	61.2	71.4	81.6	91.8
49	31.2	41.7	52.1	62.5	72.9	83.3	93.7
50	31.9	42.5	53.1	63.8	74.4	85.0	95.6
51	32.5	43.4	54.2	65.0	75.9	86.7	97.5
52	33.2	44.2	55.3	66.3	77.4	88.4	99.5
53	33.8	45.1	56.3	67.6	78.8	90.1	101
54	34.4	45.9	57.4	68.9	80.3	91.8	103
55	35.1	46.8	58.4	70.1	81.8	93.5	105
56	35.7	47.6	59.5	71.4	83.3	95.2	107
57	36.3	48.5	60.6	72.7	84.8	96.9	109
58	37.0	49.3	61.6	74.0	86.3	98.6	111
59	37.6	50.2	62.7	75.2	87.8	100	113
60	38.3	51.0	63.8	76.5	89.3	102	115

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
25	53.1	58.4	63.8	69.1	74.4	79.7	85.0
26	55.3	60.8	66.3	71.8	77.4	82.9	88.4
27	57.4	63.1	68.9	74.6	80.3	86.1	91.8
28	59.5	65.5	71.4	77.4	83.3	89.3	95.2
29	61.6	67.8	74.0	80.1	86.3	92.4	98.6
30	63.8	70.1	76.5	82.9	89.3	95.6	102
31	65.9	72.5	79.1	85.6	92.2	98.8	105
32	68.0	74.8	81.6	88.4	95.2	102	109
33	70.1	77.1	84.2	91.2	98.2	105	112
34	72.3	79.5	86.7	93.9	101	108	116
35	74.4	81.8	89.3	96.1	104	112	119
36	76.5	84.2	91.8	99.5	107	115	122
37	78.6	86.5	94.4	102	110	118	126
38	80.8	88.8	96.9	105	113	121	129
39	82.9	91.2	99.5	108	116	124	133
40	85.0	93.5	102	111	119	128	136
41	87.1	95.8	105	113	122	131	139
42	89.3	98.2	107	116	125	134	143
43	91.4	101	110	119	128	137	146
44	93.5	103	112	122	131	140	150
45	95.6	105	115	124	134	143	153
46	97.8	108	117	127	137	147	156
47	99.9	110	120	130	140	150	160
48	102	112	122	133	143	153	163
49	104	115	125	135	146	156	167
50	106	117	128	138	149	159	170
51	108	119	130	141	152	163	173
52	111	122	133	144	155	166	177
53	113	124	135	146	158	169	180
54	115	126	138	149	161	172	184
55	117	129	140	152	164	175	187
56	119	131	143	155	167	179	190
57	121	133	145	158	170	182	194
58	123	136	148	160	173	185	197
59	125	138	151	163	176	188	201
60	128	140	153	166	179	191	204

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
61	38.9	51.9	64.8	77.8	90.7	104	117
62	39.5	52.7	65.9	79.1	92.2	105	119
63	40.2	53.6	66.9	80.3	93.7	107	121
64	40.8	54.4	68.0	81.6	95.2	109	122
65	41.4	55.3	69.1	82.9	96.7	111	124
66	42.1	56.1	70.1	84.2	98.2	112	126
67	42.7	57.0	71.2	85.4	99.7	114	128
68	43.4	57.8	72.3	86.7	101	116	130
69	44.0	58.7	73.3	88.0	103	117	132
70	44.6	59.5	74.4	89.3	104	119	134
71	45.3	60.4	75.4	90.5	106	121	136
72	45.9	61.2	76.5	91.8	107	122	138
73	46.5	62.1	77.6	93.1	109	124	140
74	47.2	62.9	78.6	94.4	110	126	142
75	47.8	63.8	79.7	95.6	112	128	143
76	48.5	64.6	80.8	96.9	113	129	145
77	49.1	65.5	81.8	98.2	115	131	147
78	49.7	66.3	82.9	99.5	116	133	149
79	50.4	67.2	83.9	101	118	134	151
80	51.0	68.0	85.0	102	119	136	153
81	51.6	68.9	86.1	103	121	138	155
82	52.3	69.7	87.1	105	122	139	157
83	52.9	70.6	88.2	106	124	141	159
84	53.6	71.4	89.3	107	125	143	161
85	54.2	72.3	90.3	108	126	145	163
86	54.8	73.1	91.4	110	128	146	165
87	55.5	74.0	92.4	111	129	148	166
88	56.1	74.8	93.5	112	131	150	168
89	56.7	75.7	94.6	114	132	151	170
90	57.4	76.5	95.6	115	134	153	172
91	....	77.4	96.7	116	135	155	174
92	....	78.2	97.8	117	137	156	176
93	....	79.1	98.8	119	138	158	178
94	....	79.9	99.9	120	140	160	180
95	....	80.8	101	121	141	162	182
96	....	81.6	102	122	143	163	184

WEIGHT OF RECTANGULAR SECTIONS

POUNDS PER LINEAR FOOT

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
61	130	143	156	169	182	194	207
62	132	145	158	171	185	198	211
63	134	147	161	174	187	201	214
64	136	150	163	177	190	204	218
65	138	152	166	180	193	207	221
66	140	154	168	182	196	210	224
67	142	157	171	185	199	214	228
68	145	159	173	188	202	217	231
69	147	161	176	191	205	220	235
70	149	164	179	193	208	223	238
71	151	166	181	196	211	226	241
72	153	168	184	199	214	230	245
73	155	171	186	202	217	233	248
74	157	173	189	204	220	236	252
75	159	175	191	207	223	239	255
76	162	178	194	210	226	242	258
77	164	180	196	213	229	245	262
78	166	182	199	216	232	249	265
79	168	185	202	218	235	252	269
80	170	187	204	221	238	255	272
81	172	189	207	224	241	258	275
82	174	192	209	227	244	261	279
83	176	194	212	229	247	265	282
84	179	196	214	232	250	268	286
85	181	199	217	235	253	271	289
86	183	201	219	238	256	274	292
87	185	203	222	240	259	277	296
88	187	206	224	243	262	281	299
89	189	208	227	246	265	284	303
90	191	210	230	249	268	287	306
91	193	213	232	251	271	290	309
92	196	215	235	254	274	293	313
93	198	217	237	257	277	296	316
94	200	220	240	260	280	300	320
95	202	222	242	262	283	303	323
96	204	224	245	265	286	306	326

MANUFACTURERS' STANDARD GAGE FOR STEEL SHEETS

Thickness equivalents are based on 0.0014945 in. per oz. per sq. ft.; 0.023912 in. per lb. per sq. ft. (reciprocal of 41.820 lb. per sq. ft. per in. thick); 3.443329 in. per lb. per sq. in.

Manufacturers' Standard Gage No.	Ounces per Square Foot	Pounds per Square Inch	Pounds per Square Foot	Inch Equivalent for Steel Sheet Thickness	Manufacturers' Standard Gauge No.
3	160	0.069444	10.0000	0.2391	3
4	150	.065104	9.3750	.2242	4
5	140	.060764	8.7500	.2092	5
6	130	.056424	8.1250	.1943	6
7	120	.052083	7.5000	.1793	7
8	110	.047743	6.8750	.1644	8
9	100	.043403	6.2500	.1495	9
10	90	.039062	5.6250	.1345	10
11	80	.034722	5.0000	.1196	11
12	70	.030382	4.3750	.1046	12
13	60	.026042	3.7500	.0897	13
14	50	.021701	3.1250	.0747	14
15	45	.019531	2.8125	.0673	15
16	40	.017361	2.5000	.0598	16
17	36	.015625	2.2500	.0538	17
18	32	.013889	2.0000	.0478	18
19	28	.012153	1.7500	.0418	19
20	24	.010417	1.5000	.0359	20
21	22	.0095486	1.3750	.0329	21
22	20	.0086806	1.2500	.0299	22
23	18	.0078125	1.1250	.0269	23
24	16	.0069444	1.0000	.0239	24
25	14	.0060764	0.87500	.0209	25
26	12	.0052083	.75000	.0179	26
27	11	.0047743	.68750	.0164	27
28	10	.0043403	.62500	.0149	28
29	9	.0039062	.56250	.0135	29
30	8	.0034722	.50000	.0120	30
31	7	.0030382	.43750	.0105	31
32	6.5	.0028212	.40625	.0097	32
33	6	.0026042	.37500	.0090	33
34	5.5	.0023872	.34375	.0082	34
35	5	.0021701	.31250	.0075	35
36	4.5	.0018531	.28125	.0067	36
37	4.25	.0018446	.26562	.0064	37
38	4	.0017361	.25000	.0060	38

THICKNESS AND WEIGHT EQUIVALENTS FOR STEEL SHEETS

Weight equivalents are based on 41.820 lb. per sq. ft. per inch thick; 0.2904167 lb. per sq. in. per inch thick.

Thickness Inches	WEIGHT		Thickness Inches	WEIGHT	
	Lb. per Sq. In.	Lb. per Sq. Ft.		Lb. per Sq. In.	Lb. per Sq. Ft.
0.2490	0.072314	10.413	0.2080	0.060407	8.6986
.2480	.072023	10.371	.2070	.060116	8.6567
.2470	.071733	10.330	.2060	.059826	8.6149
			.2050	.059535	8.5731
.2460	.071443	10.288	.2040	.059245	8.5313
.2450	.071152	10.246	.2030	.058955	8.4895
.2440	.070862	10.204	.2020	.058664	8.4476
.2430	.070571	10.162			
.2420	.070281	10.120	.2010	.058374	8.4058
.2410	.069990	10.079	.2000	.058083	8.3640
.2400	.069700	10.037	.1990	.057793	8.3222
.2390	.069410	9.9950	.1980	.057503	8.2804
.2380	.069119	9.9532	.1970	.057212	8.2385
.2370	.068829	9.9113	.1960	.056922	8.1967
.2360	.068538	9.8695	.1950	.056631	8.1549
.2350	.068248	9.8277	.1940	.056341	8.1131
.2340	.067958	9.7859	.1930	.056050	8.0713
.2330	.067667	9.7441	.1920	.055760	8.0294
.2320	.067377	9.7022	.1910	.055470	7.9876
			.1900	.055179	7.9458
.2310	.067086	9.6604	.1890	.054889	7.9040
.2300	.066796	9.6186	.1880	.054598	7.8622
.2290	.066505	9.5768	.1870	.054308	7.8203
.2280	.066215	9.5350			
.2270	.065925	9.4931	.1860	.054018	7.7785
.2260	.065634	9.4513	.1850	.053727	7.7367
.2250	.065344	9.4095	.1840	.053437	7.6949
.2240	.065053	9.3677	.1830	.053146	7.6531
.2230	.064763	9.3259	.1820	.052856	7.6112
.2220	.064473	9.2840	.1810	.052565	7.5694
.2210	.064182	9.2422	.1800	.052275	7.5276
.2200	.063892	9.2004	.1790	.051985	7.4858
.2190	.063601	9.1586	.1780	.051694	7.4440
.2180	.063311	9.1168	.1770	.051404	7.4021
.2170	.063020	9.0749	.1760	.051113	7.3603
			.1750	.050823	7.3185
.2160	.062730	9.0331	.1740	.050533	7.2767
.2150	.062440	8.9913	.1730	.050242	7.2349
.2140	.062149	8.9495	.1720	.049952	7.1930
.2130	.061859	8.9077			
.2120	.061568	8.8658	.1710	.049661	7.1512
.2110	.061278	8.8240	.1700	.049371	7.1094
.2100	.060988	8.7822	.1690	.049080	7.0676
.2090	.060697	8.7404	.1680	.048790	7.0258

THICKNESS AND WEIGHT EQUIVALENTS FOR STEEL SHEETS

Thickness Inches	WEIGHT		Thickness Inches	WEIGHT	
	Lb per Sq In.	Lb per Sq. Ft.		Lb. per Sq. In.	Lb. per Sq. Ft.
0.1670	0.048500	6.9839	0.1250	0.036302	5.2275
.1660	.048209	6.9421	.1240	.036012	5.1857
.1650	.047919	6.9003	.1230	.035721	5.1439
.1640	.047628	6.8585			
.1630	.047338	6.8167	.1220	.035431	5.1020
.1620	.047048	6.7748	.1210	.035140	5.0602
.1610	.046757	6.7330	.1200	.034850	5.0184
.1600	.046467	6.6912	.1190	.034560	4.9766
.1590	.046176	6.6494	.1180	.034269	4.9348
.1580	.045886	6.6076	.1170	.033979	4.8929
.1570	.045595	6.5657	.1160	.033688	4.8511
.1560	.045305	6.5239	.1150	.033398	4.8093
.1550	.045015	6.4821	.1140	.033108	4.7675
.1540	.044724	6.4403	.1130	.032817	4.7257
.1530	.044434	6.3985	.1120	.032527	4.6838
			.1110	.032236	4.6420
.1520	.044143	6.3566	.1100	.031946	4.6002
.1510	.043853	6.3148	.1090	.031655	4.5584
.1500	.043563	6.2730	.1080	.031365	4.5166
.1490	.043272	6.2312			
.1480	.042982	6.1894	.1070	.031075	4.4747
.1470	.042691	6.1475	.1060	.030784	4.4329
.1460	.042401	6.1057	.1050	.030494	4.3911
.1450	.042110	6.0639	.1040	.030203	4.3493
.1440	.041820	6.0221	.1030	.029913	4.3075
.1430	.041530	5.9803	.1020	.029623	4.2656
.1420	.041239	5.9384	.1010	.029332	4.2238
.1410	.049049	5.8966	.1000	.029042	4.1820
.1400	.040658	5.8548	.0990	.028751	4.1402
.1390	.040368	5.8130	.0980	.028461	4.0984
.1380	.040078	5.7712	.0970	.028170	4.0565
			.0960	.027880	4.0147
.1370	.039787	5.7293	.0950	.027590	3.9729
.1360	.039497	5.6875	.0940	.027299	3.9311
.1350	.039206	5.6457	.0930	.027009	3.8893
.1340	.038916	5.6039			
.1330	.038625	5.5621	.0920	.026718	3.8474
.1320	.038335	5.5202	.0910	.026428	3.8056
.1310	.038045	5.4784	.0900	.026138	3.7638
.1300	.037754	5.4366	.0890	.025847	3.7220
.1290	.037464	5.3948	.0880	.025557	3.6802
.1280	.037173	5.3530	.0870	.025266	3.6383
.1270	.036883	5.3111	.0860	.024976	3.5965
.1260	.036593	5.2693	.0850	.024685	3.5547

THICKNESS AND WEIGHT EQUIVALENTS FOR STEEL SHEETS

Thickness Inches	WEIGHT	
	Lb. per Sq. In.	Lb. per Sq. Ft.
0.0840	0.024395	3.5129
.0830	.024105	3.4711
.0820	.023814	3.4292
.0810	.023524	3.3874
.0800	.023233	3.3456
.0790	.022943	3.3038
.0780	.022653	3.2620
.0770	.022362	3.2201
.0760	.022072	3.1783
.0750	.021781	3.1365
.0740	.021491	3.0947
.0730	.021200	3.0529
.0720	.020910	3.0110
.0710	.020620	2.9692
.0700	.020329	2.9274
.0690	.020039	2.8856
.0680	.019748	2.8438
.0670	.019458	2.8019
.0660	.019168	2.7601
.0650	.018877	2.7183
.0640	.018587	2.6765
.0630	.018296	2.6347
.0620	.018006	2.5928
.0610	.017715	2.5410
.0600	.017425	2.5092
.0590	.017135	2.4674
.0580	.016844	2.4256
.0570	.016554	2.3837
.0560	.016263	2.3419
.0550	.015973	2.3001
.0540	.015683	2.2583
.0530	.015392	2.2165
.0520	.015102	2.1746
.0510	.014811	2.1328
.0500	.014521	2.0910
.0490	.014230	2.0492
.0480	.013940	2.0074
.0470	.013650	1.9655
.0460	.013359	1.9237
.0450	.013069	1.8819
.0440	.012778	1.8401

Thickness Inches	WEIGHT	
	Lb. per Sq. In.	Lb. per Sq. Ft.
0.0430	0.012488	1.7983
.0420	.012198	1.7564
.0410	.011907	1.7146
.0400	.011617	1.6728
.0395	.011471	1.6519
.0390	.011326	1.6310
.0385	.011181	1.6101
.0380	.011036	1.5892
.0375	.010891	1.5682
.0370	.010745	1.5473
.0365	.010600	1.5264
.0360	.010455	1.5055
.0355	.010310	1.4846
.0350	.010165	1.4637
.0345	.010019	1.4428
.0340	.0098742	1.4219
.0335	.0097290	1.4010
.0330	.0095838	1.3801
.0325	.0094385	1.3592
.0320	.0092933	1.3382
.0315	.0091481	1.3173
.0310	.0090029	1.2964
.0305	.0088577	1.2755
.0300	.0087125	1.2546
.0295	.0085673	1.2337
.0290	.0084221	1.2128
.0285	.0082769	1.1919
.0280	.0081317	1.1710
.0275	.0079865	1.1500
.0270	.0078413	1.1291
.0265	.0076960	1.1082
.0260	.0075508	1.0873
.0255	.0074056	1.0664
.0250	.0072604	1.0455

To determine the weight equivalent of any thinner sheet, multiply its thickness by ten; find this amount in the table; then divide its corresponding weight by ten.

WEIGHT AND THICKNESS RANGES FOR THE RESPECTIVE GAGES FOR CARBON STEEL SHEETS

Manufacturers' Standard Gage No.	Pounds per Square Foot	Thickness Inch
3	10.312–9.688	0.2465–.2317
4	9.687–9.063	.2316–.2168
5	9.062–8.438	.2167–.2018
6	8.437–7.813	.2017–.1869
7	7.812–7.188	.1868–.1719
8	7.187–6.563	.1718–.1570
9	6.562–5.938	.1569–.1420
10	5.937–5.313	.1419–.1271
11	5.312–4.688	.1270–.1121
12	4.687–4.063	.1120–.0972
13	4.062–3.438	.0971–.0822
14	3.437–2.969	.0821–.0710
15	2.968–2.657	.0709–.0636
16	2.656–2.375	.0635–.0568
17	2.374–2.125	.0567–.0509
18	2.124–1.875	.0508–.0449
19	1.874–1.625	.0448–.0389
20	1.624–1.438	.0388–.0344
21	1.437–1.313	.0343–.0314
22	1.312–1.188	.0313–.0284
23	1.187–1.063	.0283–.0255
24	1.062–0.938	.0254–.0225
25	.937– .813	.0224–.0195
26	.812– .719	.0194–.0172
27	.718– .657	.0171–.0157
28	.656– .594	.0156–.0142
29	.593– .532	.0141–.0128
30	.531– .469	.0127–.0113
31	.468– .422	.0112–.0101
32	.421– .391	.0100–.0094
33	.390– .360	.0093–.0086
34	.359– .329	.0085–.0079
35	.328– .297	.0078–.0071
36	.296– .274	.0070–.0066
37	.273– .258	.0065–.0062
38	.257– .243	.0061–.0058

The foregoing table shows the upper and lower limits for unit weight and thickness for each number of the manufacturers' standard gage table. These ranges should not be used as tolerances.

Sheets specified to a manufacturers' standard gage number are produced to the inch equivalent for that gage number as shown in Table 95. Sheets specified to unit weight are produced to the corresponding thickness as shown in Table 95 or in Table 96 if an intermediate unit weight is specified.

GLOSSARY OF SOME COMMON STEEL TERMS

ACID BRITTLENESS—The brittleness induced in steel, especially wire or sheet, when pickled in dilute acid for the purpose of removing scale or upon electroplating. This brittleness is commonly attributed to the absorption of hydrogen.

ACID STEEL—Steel melted in a furnace with an acid (siliceous) bottom and lining and under a slag which is dominantly siliceous.

AGING—A change in a metal or alloy by which its structure recovers from an unstable or metastable condition produced by quenching or by cold working. Aging takes place slowly at room temperature but may be accelerated by a slight increase in temperature.

ALLOY—A mixture with metallic properties composed of two or more elements of which at least one is a metal.

ALLOY ELEMENTS—Chemical elements comprising an alloy; in steels usually limited to the metallic elements added to steel to modify its properties.

ANNEALING—A term used to describe the heating and cooling cycle of steel in the solid state. Annealing usually implies slow cooling. The purpose of annealing is to remove stresses, to induce softness, to alter ductility, to change the crystalline structure and to alter the electric, magnetic or other physical and mechanical properties.

BASIC STEEL—Steel melted in a furnace with a basic bottom and lining and under a slag which is dominantly basic.

BESSEMER PROCESS—A process for making steel by blowing air through molten pig iron contained in a suitable vessel. The process is one of rapid oxidation mainly of silicon and carbon.

BLAST FURNACE—A furnace for the production of pig iron in which the iron ore, coke and limestone are placed and the ore reduced by the burning of the coke and hot gases introduced by the blast.

BLISTER—A defect in metal produced by gas bubbles either on the surface or formed beneath the surface. Very fine blisters are called pinhead or pepper blisters.

BLOOM—(slab, billet, sheet bar)—Semifinished products of rectangular cross-section with rounded corners, hot rolled from ingots.

BLOWHOLE—A hole produced during the solidification of metal by evolved gas which, in failing to escape, is held in pockets.

BLUE ANNEALING—A process of annealing sheets after rolling. The sheets, if fairly heavy, are allowed to cool slowly after the hot rolling; if of lighter gage, as is usually the case, they are passed singly through an open furnace for heating to the proper annealing temperature. As the name indicates, the sheets have a bluish-black appearance.

BLUE BRITTLENESS—Brittleness occurring in steel when in temperature range of 400° to 700° F., or when cold after being worked within this temperature range.

BOX ANNEALING—Softening steel by heating, usually at a subcritical temperature, in a suitable closed metal box or pot to protect it from oxidation, employing a slow heating and cooling cycle; also called close annealing or pot annealing.

BRIGHT ANNEALING—A process of annealing, usually with reducing gases, such that surface oxidation is reduced to a minimum, thereby yielding a relatively bright surface.

BRINELL HARDNESS—A hardness number determined by applying a known load to the surface of the material to be tested through a hardened steel ball of known diameter. The diameter of the resulting permanent impression is measured.

BURNING—The heating of a metal to temperatures sufficiently close to the melting point to cause permanent injury. Such injury may be caused by the melting of the more fusible constituents, by the penetration of gases such as oxygen into the metal with consequent reactions, or perhaps by the segregation of elements already present in the metal.

CARBON STEEL—Steel which owes its properties chiefly to various percentages of carbon without substantial amounts of other alloying elements; also known as ordinary steel or straight carbon or plain carbon steel.

CARBURIZING—Adding carbon to the surface of steel by heating the metal below its melting point in contact with carbonaceous solids, liquids or gases.

CASE HARDENING—A process of surface hardening involving a change in the composition of the outer layer of an iron-base alloy by inward diffusion from a gas or liquid followed by appropriate heat treatment.

CAST IRON—An alloy of iron containing so much carbon that, as cast, it is not appreciably malleable at any temperature.

COLD WORKING—Plastic deformation of a metal at a temperature low enough to insure strain hardening.

CONTROLLED COOLING—A process by which steel is cooled from a high temperature in a predetermined manner to avoid hardening, cracking or internal damage.

CRITICAL RANGE—The structural changes which occur in steel take place at different temperatures known as critical points, depending upon whether the steel is being heated or cooled. The range between critical points on heating and on cooling is known as the critical range.

CUP FRACTURE—The form of fracture of a tension test specimen when the exterior portion is extended and the interior relatively depressed, so that it looks like a cup, as the name implies.

CYANIDING—Surface hardening by carbon and nitrogen absorption of an iron base alloy article or portion of it by heating at a suitable temperature in contact with a cyanide salt, followed by quenching.

DECARBURIZATION—The loss of carbon at the surface of steel which is subjected to high temperatures such as hot rolling, forging or heat treating.

DEOXIDIZING—The removal of oxygen from molten metal or the reducing of scale (oxide of iron) on the surface.

DUCTILITY—The property of a metal which allows it to be permanently deformed in tension before final rupture.

ELASTIC LIMIT—The greatest unit stress to which a material may be subjected without a permanent deformation remaining upon complete release of the stress.

ELONGATION—The amount of permanent extension in a ruptured tensile-test specimen, usually expressed as a percentage of the original gage length. It may also refer to the amount of extension at any stage in any process which continuously elongates a body, as in rolling.

ENDURANCE LIMIT—A limiting stress, below which metal will withstand without fracture an indefinitely large number of cycles of stress.

FATIGUE—A phenomenon of the progressive fracture of a metal by means of a crack which spreads under repeated cycles of stress.

FIBRE—A characteristic of wrought metal manifested by a fibrous or woody appearance of fractures and indicating directional properties. Fiber is caused chiefly by the extension in the direction of working of the constituents of the metal, both metallic and nonmetallic.

FIBER STRESS—Local unit stress at a point or line on a section over which stress is not uniform, such as the cross section of a beam under a bending load.

FLAKES—Flakes are internal fissures in steel forgings or rolled products. In a fractured or etched surface or test piece they appear as sizable areas of silvery brightness and coarser grain size than their surroundings.

FLAME HARDENING—A process of hardening steel by heating the surface above the transformation temperature range by means of a high temperature flame, followed by rapid cooling.

FRACTURE—The irregular surface produced when a piece of metal is ruptured or broken.

FRACTURE TEST—Breaking a piece of metal for the purpose of examining the fractured surface to determine the structure or carbon content of the metal or the presence of internal defects.

FULL ANNEALING—A softening process in which metal is heated to a temperature above the transformation range and after being held for a proper time at this temperature is cooled slowly to a temperature below the transformation range.

GRAY CAST IRON—A cast iron which, as cast, has combined or cementitic carbon not in excess of a eutectoid percentage, the balance of the carbon occurring as graphite flakes. The term "gray iron" is derived from the characteristic gray fracture.

HARDENABILITY—The ability of a steel to reach a desired hardness, usually measured by the depth to which the steel will harden under defined conditions of heating and cooling.

HARDENING—A process of increasing the hardness of metal by suitable treatment usually involving heating and cooling.

HEAT TREATMENT—A combination of operations involving the heating and cooling of a metal or an alloy in the solid state for the purpose of obtaining certain desirable conditions or properties.

HOT TOP (sinkhead)—A heat insulated reservoir for excess metal on top of an ingot mold or casting mold which feeds the shrinkage of the ingot or the casting.

IMPACT TEST—A test in which one or more blows are given to a specimen. The results are usually expressed in terms of energy absorbed or number of blows of a given intensity required to break the specimen.

JOMINY TEST—The Jominy test is used to determine end-quench hardenability. It involves water quenching under closely controlled conditions, one end of a one inch diameter specimen of the steel under test and measuring the degree of hardness at regular distances from the quenched end along the side.

KILLED STEEL—Steel which has been deoxidized with silicon and aluminum to such a degree that there is no gas evolution upon solidification resulting in a compact steel free of blowholes.

LAP—A surface defect appearing as a seam caused from folding over hot metal fins or sharp corners and then rolling or forging, but not welding, them into the surface.

MECHANICAL PROPERTIES—Those properties that reveal the reaction, elastic

and inelastic, of a material to an applied force, or that involve the relationship between stress and strain; for example, modulus of elasticity, tensile strength, fatigue limit.

MECHANICAL WORKING—Subjecting metal to pressure exerted by rolls, presses, or hammers to change its form, or to affect the structure and therefore the mechanical and physical properties.

MODULUS OF ELASTICITY—The ratio within the limit of elasticity, of the stress to the corresponding strain. The stress in pounds per square inch is divided by the elongation in fractions of an inch for each inch of the original gage length of the specimen.

NITRIDING—Adding nitrogen to iron-base alloys by heating the metal in contact with ammonia gas, or other suitable nitrogenous material.

NORMALIZING—Heating iron-base alloys to approximately 100° F. above the critical temperature range followed by cooling to below that range in still air at ordinary temperature.

OPEN HEARTH—A furnace for the manufatcure of steel using gaseous fuel and preheated air. The process is one of oxidization of impurities by the combustion gases, principally CO_2. Steel made by the open hearth method.

PATENTING—Heating iron-base alloys above the critical temperature range followed by cooling below that range in air, or in molten lead or a molten mixture of nitrates or nitrites maintained at a temperature usually between 800–1050° F., depending on the carbon content of the steel and the properties required of the finished product.

PERMANENT SET—Permanent deformation.

PHYSICAL PROPERTIES—Those properties familiarly discussed in physics, exclusive of those described under mechanical properties; for example, density, electrical conductivity, coefficient of thermal expansion.

PHYSICAL TESTING—Testing methods by which physical properties are determined.

PICKLING—Removal of foreign substances, notably iron oxides, from the surface of steel by bathing in acid solutions.

PIERCING—Producing a hole in metal by forcing an instrument through it. Usually refers to making steel tubes from solid steel bars.

PIG IRON—The product of the blast furnace which is made by the reduction of iron ore.

PIPE—A cavity formed in metal (especially ingots) formed during the solidification of the last portion of liquid metal. Contraction of the metal causes this cavity or pipe.

PIT—A sharp depression in the surface of metal.

QUENCHING AND TEMPERING—The procedure of heating a specimen to the proper austenitizing temperature, holding it at that temperature for a period long enough to effect the desired change in crystalline structure and then quenching it in a suitable medium such as water, oil or air. After quenching, the specimen is reheated to a predetermined temperature below the critical range and then cooled under suitable conditions.

REDUCTION OF AREA—The difference between the original cross-sectional area and the least cross-sectional area after rupture, expressed as a percentage of the original area.

RIMMED STEEL—Incompletely deoxidized steel normally containing less than 0.25% carbon. During solidification, evolution of gas occurs which main-

tains a liquid top until a side and bottom "rim" of considerable thickness has formed.

ROCKWELL HARDNESS TEST—The measure of the hardness of a substance by determining the depth of penetration of a penetrator into the specimen under certain arbitrary fixed conditions. The penetrator may be a steel ball or a diamond spherocone.

SCARFING—One method for removing seams and other surface defects with chisel or gouge, so that the defects will not be worked into the finished product. If the defects are removed by means of gas cutting the term "scarfing" is used. Scarfing is often employed simply to remove metal apart from defects.

SCLEROSCOPE—A machine which gives a comparative hardness value of a material by measuring the rebound of a diamond tipped hammer which falls freely from a set height.

SECONDARY HARDENING—Hardness developed by tempering high alloy steels.

SEMI-KILLED STEEL—A steel less completely deoxidized than killed steel but developing sufficient gas evolution internally in solidifying to replace the central pipe with a substantially equivalent volume of deep-seated blowholes.

SHORTNESS—Brittleness in metal.

SPALLING—The cracking and flaking of small particles of metal from the surface.

SPHEROIDIZING—Prolonged heating of iron-base alloys at a temperature in the neighborhood of, but generally slightly below the critical temperature range, usually followed by relatively slow cooling.

STEEL—Malleable alloy of iron and carbon, usually containing substantial quantities of manganese.

STRESS RELIEVING—A process of reducing internal residual stresses in a metal by heating to a suitable temperature and holding for a proper time at that temperature. This treatment is used to relieve stresses induced by welding, casting, quenching, normalizing or cold working.

TEMPER COLORS—The colors which appear on the surface of steel when heated at a low temperature in an oxidizing atmosphere.

TEMPERING—Reheating hardened steel to some temperature below the lower critical temperature, followed by any desired rate of cooling.

TENSILE STRENGTH—The maximum load per unit of original cross-sectional area sustained by a material during a tension test.

TENSION TEST—A test in which a specimen is broken by applying an increasing load to the two ends.

WELD—A localized coalescence of metal wherein coalescence is produced by heating to suitable temperatures, with or without the application of pressure, and with or without the use of filler metal.

WELDABILITY—The capacity of a metal to be welded under the fabrication conditions imposed into a specific, suitably designed structure and to perform satisfactorily in the intended service.

WELD BEAD—A weld deposit resulting from the introduction of filler metal.

WELD METAL—That portion of a weld which has been melted during welding.

WHITE CAST IRON—Contains carbon in the combined form. The presence of iron carbide (Fe_3C), cementite, makes this metal hard and brittle, and the absence of graphite gives the fracture a white color.

WORK HARDNESS—Hardness developed in metal resulting from cold working.

WROUGHT IRON—A ferrous material aggregated from a solidifying mass of pasty particles of highly refined metallic iron with which is incorporated, without subsequent fusion, a minutely and uniformly distributed quantity of slag.

YIELD POINT—The load per unit area at which a marked increase in deformation of the specimen occurs without increase of load. It is the stress at which a marked increase in strain occurs without an increase in stress.

YIELD STRENGTH—Stress corresponding to some fixed permanent deformation.

TUBULAR PRODUCTS INFORMATION

The following list of simple rules will be found useful for many practical calculations in the use of pipe:

To find the area of a pipe, square the diameter and multiply by .7854.

Doubling the diameter of a pipe increases its capacity four times.

Friction of liquids in pipes increases as the square of the velocity.

To reduce pounds pressure to feet head, multiply by 2.3.

To reduce heads in feet to pressure in pounds, multiply by .433.

A cubic foot of water weighs 62½ pounds and contains 1728 cubic inches or 7½ U.S. gallons. One cubic inch weighs .0361 pounds.

Approximately, every foot elevation of a column of water produces a pressure of ½ pound per square inch (actual .433).

A "miner's inch" of water is approximately equal to a supply of 12 gallons per minute. In California, 9 gallons.

The gallons per minute which a pipe will deliver equals .0408 times the square of the diameter, multiplied by the velocity in feet per minute.

To find the capacity of a pipe or cylinder in gallons, multiply the square of the diameter in inches by the length in inches and by .0034.

The weight of water in any length pipe is obtained by multiplying the length in feet by the square of the diameter in inches, and by .34.

To find the discharge from any pipe in cubic feet per minute, square the diameter and multiply by the velocity in feet per minute and by .00545.

One U.S. gallon of water weighs 8⅓ pounds and contains 231 cubic inches. An imperial gallon weighs 10 pounds and contains 277 cubic inches.

To find the diameter of a pipe in inches, divide the gallons per minute by the velocity in feet per minute, and multiply the square root of the quotient by 4.95.

To find the capacity of a given tank or cistern in U.S. gallons, square the diameter (in feet), and multiply by .7854, multiply by the height in feet, and by 7.48.

To find the discharge in U.S. gallons per minute from any pipe, square the diameter in inches, multiply by the velocity in feet per second and by 2.448.

The discharge from a pipe in cubic feet per second is equal to the mean velocity in feet per second multiplied by the area of cross section of pipe in square feet.

Sharp angles or sudden bends in pipes cause great increase in friction, consequently increased power is necessary to maintain the rate of flow. Where a change of direction is desired, the friction is minimized by the use of long, easy curves.

Petroleum weighs 6½ lbs. per U.S. gallon. There are 42 gallons to the barrel.

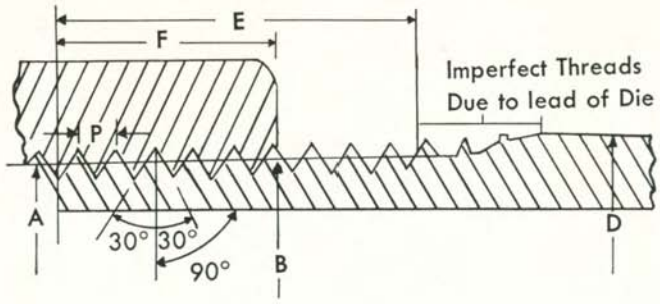
The resistance of friction in the flow of water through pipes of uniform diameters is independent of the pressure and increases directly as the length and square of the velocity of the flow, and inversely as the diameter of the pipe. With wooden pipes the friction is 2.75 times greater than in metallic.

Suction Lift means the vertical distance from the level of the water supply to the center of the pump, to which must be added the loss due to friction of the water in the suction pipe.

Discharge Head means the vertical distance from the center of the pump to the center of the discharge outlet where the water is delivered, to which must be added the loss due to friction of the water in the discharge pipe.

Total Head means the sum of the suction lift, discharge head, and all friction loss in both suction and discharge pipes.

AMERICAN STANDARD TAPER PIPE THREADS



Dimensions, in Inches

Nominal Pipe Size	A Pitch Diameter at End of Male Thread	B Pitch Diameter at End of Female Thread	D Outside Diameter of Pipe	E Length of Effective Thread	F Normal Engagement by hand between Male and Female Thread	P Pitch of Thread	Depth of Thread	No. Thrds. per Inch
½	0.75843	0.77843	0.840	0.5337	0.320	0.07143	0.05714	14
¾	0.96768	0.98887	1.050	0.5457	0.339	0.07143	0.05714	14
1	1.21363	1.23863	1.315	0.6828	0.400	0.08696	0.06957	11½
1¼	1.55713	1.58338	1.660	0.7068	0.420	0.08696	0.06957	11½
1½	1.79609	1.82234	1.900	0.7235	0.420	0.08696	0.06957	11½
2	2.26902	2.29627	2.375	0.7565	0.436	0.08696	0.06957	11½
2½	2.71953	2.76216	2.875	1.1375	0.682	0.12500	0.10000	8
3	3.34063	3.38850	3.500	1.2000	0.766	0.12500	0.10000	8
3½	3.83750	3.88881	4.000	1.2500	0.821	0.12500	0.10000	8
4	4.33438	4.38713	4.500	1.3000	0.844	0.12500	0.10000	8
5	5.39073	5.44929	5.563	1.4063	0.937	0.12500	0.10000	8
6	6.44609	6.50597	6.625	1.5125	0.958	0.12500	0.10000	8
8	8.43359	8.50003	8.625	1.7125	1.063	0.12500	0.10000	8
10	10.54531	10.62094	10.750	1.9250	1.210	0.12500	0.10000	8
12	12.53281	12.61781	12.750	2.1250	1.360	0.12500	0.10000	8

LENGTH OF PIPE IN BENDS

Radius of Bends	Length of Pipe, Inches				
	90° Bends	180° Bends	270° Bends	360° Bends	540° Bends
1 In.	1½	3	4¾	6¼	9½
2 In.	3	6¼	9½	12½	18¾
3 In.	4¾	9½	14¼	18¾	28¼
4 In.	6¼	12½	18¾	25¼	37¾
5 In.	7¾	15¾	23½	31½	47¼
6 In.	9½	18¾	28¼	37¾	56½
7 In.	11	22	33	44	66
8 In.	12½	25¼	37¾	50¼	75½
9 In.	14¼	28¼	42½	56½	84¾
10 In.	15¾	31½	47¼	62¾	94¼
11 In.	17¼	34½	51¾	69	103¾
1 Ft.	18¾	37¾	56½	75½	113
2 Ft.	37¾	75½	113	150¾	226¼
3 Ft.	56½	113	169½	226¼	339¼
4 Ft.	75½	150¾	226¼	301½	452½
5 Ft.	94¼	188½	282¾	377	565½
6 Ft.	113	226¼	339¼	452½	678½
7 Ft.	132	263¾	395¾	527¾	791½
8 Ft.	150¾	301½	452½	603	904¾
9 Ft.	169½	339¼	509	678½	1017¾
10 Ft.	188½	377	565½	754	1131
11 Ft.	207¼	414¾	622	829½	1244
12 Ft.	226¼	452½	678½	904¾	1357¼
13 Ft.	245	490	735¼	980¼	1470¼
14 Ft.	263¾	527¾	791½	1055½	1583½
15 Ft.	282¾	565½	848¼	1131	1696½
16 Ft.	301½	603	904¾	1206¼	1809½
17 Ft.	320½	640¾	961¼	1281¾	1922½
18 Ft.	339¼	678½	1017¾	1357¼	2035¾
19 Ft.	358	716¼	1074½	1432½	2148¾
20 Ft.	377	754	1131	1508	2262

EXPANSION IN STEEL PIPE LINES

Inches of Linear Expansion per 100 Feet

The expansion for any length of pipe may be found by the following method: From the table below, obtain the difference in increased length at the minimum and maximum temperatures, divide this result by 100 to obtain the increase in length per foot, and multiply by the length of the line in feet.

Temperature Degrees F.	Linear Expansion per 100 Feet, Inches	Temperature Degrees F.	Linear Expansion per 100 Feet, Inches
20	.150	520	4.390
40	.300	540	4.590
60	.455	560	4.780
80	.610	580	4.975
100	.770	600	5.170
120	.915	620	5.365
140	1.075	640	5.565
160	1.235	660	5.765
180	1.400	680	5.965
200	1.570	700	6.170
220	1.730	720	6.375
240	1.890	740	6.580
260	2.065	760	6.790
280	2.230	780	6.990
300	2.410	800	7.210
320	2.590	820	7.415
340	2.760	840	7.630
360	2.935	860	7.840
380	3.110	880	8.055
400	3.290	900	8.280
420	3.465	920	8.495
440	3.650	940	8.720
460	3.835	960	8.945
480	4.020	980	9.170
500	4.210	1000	9.400

IRRIGATION TABLE

Discharge Inches	Gallons per Minute	Cubic Feet per Second	Number of Acres Irrigated in 12 Hours' Pumping			
			1 Inch Deep	2 Inches Deep	3 Inches Deep	4 Inches Deep
1	20	.045	.529	.2645	.1765	.1324
1½	50	.11	1.328	.664	.4425	.332
2	100	.22	2.65	1.325	.883	.6625
2½	150	.33	3.98	1.991	1.328	.995
3	225	.50	5.97	2.985	1.99	1.492
4	300	.67	7.96	3.98	2.655	1.99
4	400	.89	10.61	5.305	3.535	2.652
5	700	1.56	18.58	9.28	6.18	4.64
6	900	2.01	23.85	11.95	7.96	5.97
8	1200	2.68	31.82	15.92	10.61	7.95
8	1600	3.57	42.35	21.20	14.15	10.61
10	3000	6.68	79.50	39.75	26.50	19.88
12	4500	10.03	119.30	59.70	39.75	20.85
16	6000	13.36	159.10	79.60	53.00	39.75
16	7000	15.61	185.70	92.80	61.90	46.45
16	8500	18.95	225.50	112.80	75.20	56.35
20	10000	22.25	265.00	132.50	88.30	66.25
20	14000	31.15	371.00	185.50	123.70	92.75

Discharge Inches	Gallons per Minute	Cubic Feet per Second	Number of Acres Irrigated in 12 Hours' Pumping			
			6 Inches Deep	8 Inches Deep	10 Inches Deep	12 Inches Deep
1	20	.045	.0883	.0663	.0529	.0442
1½	50	.11	.221	.166	.1328	.1105
2	100	.22	.442	.3313	.265	.221
2½	150	.33	.664	.4975	.398	.332
3	225	.50	.994	.747	.597	.4975
4	300	.67	1.327	.995	.796	.663
4	400	.89	1.770	1.328	1.061	.884
5	700	1.56	3.095	2.32	1.858	1.548
6	900	2.01	3.98	2.975	2.385	1.99
8	1200	2.68	5.305	3.975	3.182	2.65
8	1600	3.57	7.075	5.305	4.235	3.535
10	3000	6.68	13.25	9.94	7.95	6.625
12	4500	10.03	19.90	14.93	11.93	9.95
16	6000	13.36	26.52	19.89	15.91	13.26
16	7000	15.61	30.95	23.20	18.57	15.47
16	8500	18.95	37.60	28.19	22.55	18.79
20	10000	22.25	44.20	33.15	26.50	22.10
20	14000	31.15	61.80	46.35	37.10	30.95

FRICTION OF WATER IN PIPES

Loss of Head in Feet Due to Friction, per 100 Feet of Ordinary Pipe

Gal. per Min.	Size Pipe, Inches											
	½		¾		1		1¼		1½		2	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
1	1.05	2.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	2.10	7.4	1.20	1.9	.....	.....	.....	.....	.....	.....	.....	.....
3	3.16	15.8	1.80	4.1	1.12	1.26	.....	.....	.....	.....	.....	.....
4	4.21	27.0	2.41	7.0	1.49	2.14	0.86	0.57	0.63	0.26	.....	.....
5	5.26	41.0	3.01	10.5	1.86	3.25	1.07	0.84	0.79	0.39	.....	.....
10	10.52	147.0	6.02	38.0	3.72	11.7	2.14	3.05	1.57	1.43	1.02	0.50
15	.....	.....	9.02	80.0	5.60	25.0	3.2	6.50	2.36	3.0	1.53	1.0
20	.....	.....	12.03	136.0	7.44	42.0	4.29	11.1	3.15	5.2	2.04	1.82
25	.....	.....	.....	.....	9.30	64.0	5.36	16.6	3.94	7.8	2.55	2.73
30	.....	.....	.....	.....	11.15	89.0	6.43	23.5	4.72	11.0	3.06	3.84
35	.....	.....	.....	.....	13.02	119.0	7.51	31.2	5.51	14.7	3.57	5.1
40	.....	.....	.....	.....	14.88	152.0	8.58	40.0	6.3	18.8	4.08	6.6
45	.....	.....	.....	.....	.....	.....	9.65	50.	7.08	23.2	4.60	8.2
50	.....	.....	.....	.....	.....	.....	10.72	60.	7.87	28.4	5.11	9.9
70	.....	.....	.....	.....	.....	.....	15.01	113.	11.02	53.0	7.15	18.4
90	.....	.....	.....	.....	.....	.....	.....	.....	14.17	84.0	9.19	29.4
100	.....	.....	.....	.....	.....	.....	.....	.....	15.74	102.0	10.21	35.8
120	.....	.....	.....	.....	.....	.....	.....	.....	18.89	143.0	12.25	50.0
140	.....	.....	.....	.....	.....	.....	.....	.....	22.04	190.0	14.30	67.0
160	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.34	86.0
180	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.38	107.0
200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20.42	129.0
220	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22.47	154.0
240	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24.51	182.0
260	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	26.55	211.0

Vel.—velocity feet per second.
Fric.—friction head in feet.

FRICTION OF WATER IN PIPES

Loss of Head in Feet Due to Friction, per 100 Feet of Ordinary Pipe

Gal. per Min.	Size Pipe, Inches											
	2½		3		4		5		6		8	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
10	0.65	0.17	0.45	0.07	.....	.....	.....	.....	.....	.....	.....	.....
15	0.98	0.36	0.68	0.15	.....	.....	.....	.....	.....	.....	.....	.....
20	1.31	0.61	0.91	0.25	.....	.....	.....	.....	.....	.....	.....	.....
25	1.63	0.92	1.13	0.38	.....	.....	.....	.....	.....	.....	.....	.....
30	1.96	1.29	1.36	0.54	.....	.....	.....	.....	.....	.....	.....	.....
35	2.29	1.72	1.59	0.71	.....	.....	.....	.....	.....	.....	.....	.....
40	2.61	2.20	1.82	0.91	1.02	0.22	.....	.....	.....	.....	.....	.....
45	2.94	2.80	2.05	1.15	1.17	0.28	.....	.....	.....	.....	.....	.....
50	3.27	3.32	2.27	1.38	1.28	0.34	.....	.....	.....	.....	.....	.....
70	4.58	6.2	3.18	2.57	1.79	0.63	1.14	0.21	.....	.....	.....	.....
75	.....	.....	.....	.....	1.92	0.73	1.22	0.24	.....	.....	.....	.....
90	5.88	9.8	4.09	4.08	.....	.....	.....	.....	.....	.....	.....	.....
100	6.54	12.0	4.54	4.96	2.55	1.23	1.63	0.39	1.14	0.14	.....	.....
120	7.84	16.8	5.45	7.0	3.06	1.71	1.96	0.57	1.42	0.25	.....	.....
125	.....	.....	.....	.....	3.19	1.86	2.04	0.64	1.48	0.28	.....	.....
140	9.15	22.3	6.35	9.2	.....	.....	.....	.....	.....	.....	.....	.....
150	.....	.....	.....	.....	3.84	2.55	2.45	0.88	1.71	0.32	.....	.....
160	10.46	29.0	7.26	11.8	.....	.....	.....	.....	.....	.....	.....	.....
175	.....	.....	.....	.....	4.45	3.36	2.86	1.18	2.00	0.48	.....	.....
180	11.76	35.7	8.17	14.8	.....	.....	.....	.....	.....	.....	.....	.....
200	13.07	43.1	9.08	17.8	5.11	4.37	3.27	1.48	2.28	0.62	.....	.....
220	14.38	52.0	9.99	21.3	.....	.....	.....	.....	.....	.....	.....	.....
225	.....	.....	.....	.....	6.32	6.61	3.67	1.86	2.57	0.74	.....	.....
240	15.69	61.0	10.89	25.1	.....	.....	.....	.....	.....	.....	.....	.....
250	.....	.....	.....	.....	6.40	6.72	4.08	2.24	2.80	0.92	1.60	0.22
260	16.99	70.0	11.80	29.1	.....	.....	.....	.....	.....	.....	.....	.....
270	.....	.....	.....	.....	6.90	7.70	4.42	2.60	3.03	1.13	1.70	0.25
275	.....	.....	.....	.....	7.03	7.99	4.50	2.72	3.06	1.15	1.73	0.27
280	18.30	81.0	12.71	33.4	.....	.....	.....	.....	.....	.....	.....	.....
300	19.61	92.0	13.62	38.0	7.66	9.38	4.90	3.15	3.40	1.29	1.90	0.36
350	.....	.....	.....	.....	8.90	12.32	5.72	4.19	3.98	1.69	2.20	0.41
400	.....	.....	.....	.....	10.20	15.82	6.54	5.33	4.54	2.21	2.60	0.56
450	.....	.....	.....	.....	11.50	19.74	7.35	6.65	5.12	2.74	2.92	0.64
470	.....	.....	.....	.....	12.16	22.40	7.78	7.42	5.49	3.12	3.07	0.77
475	.....	.....	.....	.....	12.30	22.96	7.88	7.22	5.55	3.21	3.10	0.79
500	.....	.....	.....	.....	12.77	24.08	8.17	8.12	5.60	3.26	3.20	0.81
550	.....	.....	.....	.....	.....	.....	8.99	9.66	6.16	3.93	3.52	0.98
600	.....	.....	.....	.....	.....	.....	9.80	11.34	6.72	4.70	3.84	1.16
650	.....	.....	.....	.....	.....	.....	10.62	13.16	7.28	5.50	4.16	1.34
700	.....	.....	.....	.....	.....	.....	11.44	15.12	7.84	6.38	4.46	1.54
750	.....	.....	.....	.....	.....	.....	12.26	17.22	8.50	7.00	4.80	1.74
800	.....	.....	.....	.....	.....	.....	.....	.....	9.08	7.90	5.12	1.97
850	.....	.....	.....	.....	.....	.....	.....	.....	9.58	8.75	5.48	2.28
900	.....	.....	.....	.....	.....	.....	.....	.....	10.30	10.11	5.75	2.46
950	.....	.....	.....	.....	.....	.....	.....	.....	10.72	10.71	6.06	2.87
1000	.....	.....	.....	.....	.....	.....	.....	.....	11.32	12.04	6.40	3.02
1050	.....	.....	.....	.....	.....	.....	.....	.....	11.90	13.30	6.70	3.21
1100	.....	.....	.....	.....	.....	.....	.....	.....	12.50	14.31	7.03	3.51
1150	.....	.....	.....	.....	.....	.....	.....	.....	12.95	15.34	7.35	3.84
1200	.....	.....	.....	.....	.....	.....	.....	.....	13.52	16.69	7.67	4.26
1250	.....	.....	.....	.....	.....	.....	.....	.....	14.10	18.20	8.00	4.45
1500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.60	6.27
2000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.70	10.71

FRICTION OF WATER IN PIPES

Loss of Head in Feet Due to Friction, per 100 Feet of Ordinary Pipe

Gallons per Minute	Size Pipe, Inches											
	10		12		14		15		16		20	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
450	1.80	0.21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
470	1.92	0.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
475	1.94	0.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
500	2.04	0.28	1.42	0.11	.....	.....	.....	.....	.....	.....	.....	.....
550	2.25	0.33	1.57	0.14	.....	.....	.....	.....	.....	.....	.....	.....
600	2.46	0.39	1.71	0.15	.....	.....	.....	.....	.....	.....	.....	.....
650	2.66	0.46	1.85	0.19	1.37	.09	.....	.....	.....	.....	.....	.....
700	2.86	0.52	2.00	0.22	1.47	.10	.....	.....	.....	.....	.....	.....
750	3.06	0.59	2.13	0.24	1.58	.11	.....	.....	.....	.....	.....	.....
800	3.28	0.67	2.27	0.27	1.68	.13	.....	.....	.....	.....	.....	.....
850	3.48	0.75	2.41	0.31	1.79	.14	.....	.....	.....	.....	.....	.....
900	3.68	0.83	2.56	0.34	1.89	.16	.....	.....	.....	.....	.....	.....
950	3.88	0.91	2.70	0.35	2.00	.16	1.73	.12	.....	.....	.....	.....
1000	4.08	1.01	2.84	0.41	2.10	.19	1.82	.14	.....	.....	.....	.....
1050	4.29	1.09	2.98	0.48	2.20	.22	1.91	.16	.....	.....	.....	.....
1100	4.50	1.20	3.13	0.49	2.31	.23	2.00	.16	.....	.....	.....	.....
1150	4.71	1.34	3.27	0.53	2.42	.25	2.09	.17	.....	.....	.....	.....
1200	4.91	1.46	3.41	0.57	2.52	.26	2.18	.19	.....	.....	.....	.....
1250	5.11	1.51	3.55	0.62	2.63	.29	2.28	.20	1.99	.15	.....	.....
1500	6.10	2.09	4.20	0.85	3.15	.39	2.73	.28	2.39	.24	.....	.....
2000	8.10	3.50	5.60	1.43	4.20	.66	3.64	.47	3.19	.39	.....	.....
2500	10.10	5.33	7.00	2.18	5.25	1.01	4.55	.72	3.99	.56	.....	.....
3000	12.10	7.42	8.40	3.39	6.30	1.57	5.46	1.12	4.79	.80	3.08	.27
3500	14.10	10.08	9.80	3.92	7.35	1.82	6.37	1.29	5.59	1.04	3.59	.35
4000	.....	.....	11.35	5.32	8.40	2.47	7.28	1.76	6.38	1.34	4.10	.45
4200	.....	.....	11.93	6.30	8.82	2.92	7.64	2.08	6.72	1.45	4.32	.50
4500	.....	.....	12.78	6.75	9.45	3.13	8.19	2.23	7.20	1.65	4.62	.56
5000	.....	.....	14.20	8.15	10.50	3.78	9.10	2.69	7.96	2.02	5.13	.68
5500	.....	.....	.....	.....	11.55	4.50	10.01	3.16	8.78	2.39	5.64	.82
6000	.....	.....	.....	.....	12.60	5.40	10.92	3.79	9.56	2.84	6.15	.96
6500	.....	.....	.....	.....	13.65	6.14	11.83	4.30	10.36	3.32	6.66	1.01
7000	.....	.....	.....	.....	14.70	6.65	12.74	4.66	11.12	3.68	7.18	1.28
7200	.....	.....	.....	.....	.....	.....	13.10	4.95	11.50	3.96	7.38	1.35
7500	.....	.....	.....	.....	.....	.....	13.65	5.60	11.95	4.28	7.66	1.45
8000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.17	1.63
8500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.68	1.83
9000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.20	2.04
9500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.70	2.23
10000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.40	2.53

FRICTION OF WATER IN PIPES

Loss of Head in Feet Due to Friction, per 100 Feet of Ordinary Pipe

Gallons per Minute	Size Pipe, Inches			
	24		30	
	Velocity	Friction	Velocity	Friction
2000	1.42	.05	....	....
2500	1.77	.07	....	....
3000	2.13	.10	....	....
3500	2.49	.14	1.56	.04
4000	2.85	.18	1.81	.06
4200	....	....	....	....
4500	3.20	.22	2.04	.08
5000	3.54	.27	2.26	.09
5500	3.90	.33	2.50	.11
6000	4.25	.39	2.72	.13
6500	4.61	.45	2.95	.15
7000	4.97	.52	3.18	.17
7200	....	....	....	....
7500	5.32	.59	3.42	.20
8000	5.68	.66	3.63	.22
8500	6.03	.74	3.86	.25
9000	6.35	.81	4.08	.27
9500	6.74	.91	4.31	.30
10000	7.07	.98	4.54	.33
10500	7.45	1.10	4.76	.37
11000	7.80	1.20	5.00	.40
11500	8.16	1.29	5.21	.43
12000	8.50	1.40	5.44	.47
12500	8.86	1.52	5.67	.51
13000	9.22	1.63	5.91	.54
13500	9.60	1.75	6.13	.58
14000	9.95	1.87	6.36	.63
14500	10.3	2.00	6.61	.68
15000	10.63	2.12	6.81	.72
16000	11.38	2.40	7.36	.83
17000	12.09	2.70	7.73	.91
18000	12.76	2.97	8.18	1.00
19000	13.50	3.26	8.66	1.11
20000	14.20	3.60	9.09	1.22
21000	14.90	3.96	9.54	1.34
22000	....	....	10.0	1.47
23000	....	....	10.45	1.59
24000	....	....	10.90	1.71
25000	....	....	11.35	1.85
26000	....	....	11.80	1.97
27000	....	....	12.26	2.12
28000	....	....	12.73	2.28

GLOSSARY OF PIPE FITTING TERMS

BACKING RING—A strip of metal used to prevent weld splatter from entering a pipe when making a butt-welded joint and to ensure complete penetration of the weld to the inside of the pipe wall.

BACK-PRESSURE VALVE—A valve similar to a low-pressure safety valve which is set to maintain a certain back pressure on feed heaters, oiling systems, or other devices requiring a constant operating pressure irrespective of pressure variations of the supply. The back-pressure valve is arranged to relieve any excess supply to atmosphere or elsewhere, and it opens and closes automatically as required to produce this result.

BELL AND SPIGOT JOINT—The usual term for the joint in cast-iron pipe. Each piece is made with an enlarged diameter or bell at one end into which the plain or spigot end of another piece is inserted when laying. The joint is then made tight by cement, oakum, lead, rubber or other suitable substance, which is driven in or calked into the bell and around the spigot.

BLANK FLANGE—A flange that is not drilled but is otherwise complete. Compare "Blind Flange."

BLEEDER—A small cock or valve to draw off water of condensation from a run of piping. A small connection to obtain circulation in warming up a line.

BLIND FLANGE—A flange used to close the end of a pipe. It produces a blind end which is also known as a dead end. Compare "Blank Flange."

BONNET—A cover used to guide and enclose the tail end of a valve spindle.

BRANCH ELL—Used to designate an elbow having a back outlet in line with one of the outlets of the "run." It is also called a heel outlet elbow.

BRANCH PIPE—A very general term used to signify a pipe that is equipped with one or more branches. Such pipes are used so frequently that they have acquired common names such as tees, crosses, side or back outlet elbows, manifolds, double-branch elbows, etc. The term branch pipe is generally restricted to such as do not conform to usual dimensions.

BRANCH TEE (HEADER)—A tee having many side branches. (See Manifold.)

BULL HEAD TEE—A tee the branch of which is larger than the run.

BUSHING—A pipe fitting for the purpose of connecting a pipe with a fitting of larger size, being a hollow plug with internal and external threads to suit the different diameters.

BUTT WELD—Welded along a seam that is butted edge to edge and not scarfed or lapped. A term used to designate pipe made by this process. Also applied to circumferential pipe joints made by the fusion-welding process.

BY-PASS—A small passage around a large valve for warming up a line. An emergency connection around a reducing valve, trap, etc., to use in case they are out of commission.

CLOSE NIPPLE—One the length of which is about twice the length of a standard pipe thread and is without any shoulder.

COMPANION FLANGE—A pipe flange suited to connect with another companion flange or with a flanged valve or fitting. A loose flange which is attached to a pipe by threading, Van Stoning, welding, or similar method as distinguished from a flange which is cast integral with a fitting or pipe.

COUPLING—A threaded sleeve used to connect two pipes. Commercial couplings are threaded inside to suit the exterior thread of the pipe. The term coupling is occasionally used to mean any jointing device and may be applied to either straight or reducing sizes.

CROSS—A pipe fitting with four branches arranged in pairs, each pair on one axis, and the axes at right angles. When the outlets are otherwise arranged the fittings are branch pipes or specials.

CROSS-OVER—A small fitting with a double offset, or shaped like the letter U with the ends turned out. It is only made in small sizes and used to pass the flow of one pipe past another when the pipes are in the same plane.

CROSS-OVER TEE—A fitting made along lines similar to the cross-over, but having at one end two openings in a tee-head the plane of which is at right angles to the plane of the cross-over bend.

CROSS VALVE—A valve fitted on a transverse pipe so as to open communication at will between two parallel lines of piping. It is used in connection with oil and water pumping arrangements, especially on ship board.

CROTCH—A fitting that has the general shape of the letter Y. Caution should be exercised not to confuse the crotch and wye.

DOUBLE BRANCH ELBOW—A fitting that, in a manner, looks like a tee, or as if two elbows had been shaved and then placed together, forming a shape something like the letter Y or a crotch.

DOUBLE SWEEP TEE—A tee made with easy curves between body and branch, i.e., the center of the curve between run and branch lies outside the body.

DRY JOINT—One made without gasket or packing or smear of any kind, as a ground joint.

ELBOW (ELL)—A fitting that makes an angle between adjacent pipes. The angle is always 90 degrees, unless another angle is stated. (See Branch, Service, and Union Ell.)

EXTRA HEAVY—When applied to pipe, means pipe thicker than standard pipe; when applied to valves and fittings, indicates construction suitable for a working pressure of 250 pounds per square inch.

FURNACE WELD—A term applied to the process of making butt-welded or lap-welded pipe in which the skelp is heated in a furnace preparatory to welding by passing through rolls.

FUSION WELD—The union of metals by fusion, using an oxy-acetylene torch, the electric arc, or thermit reaction. With the first two methods, the edges to be joined usually are chamfered or beveled to give an included angle of 45 to 90 degrees which is filled in with fused metal from a welding rod. This is also known as an "autogenous weld."

GALVANIZING—A process by which the surface of iron or steel is covered with a layer of zinc.

HEADER—A large pipe into which one set of boilers, heaters or tanks is connected by suitable nozzles or tees, or similar large pipes from which a number of smaller ones lead to consuming points.

HYDROSTATIC JOINT—Used in large water mains, in which sheet lead is forced tightly into the bell of a pipe by means of the hydrostatic pressure of a liquid.

LAPPED JOINT—Same as Van Stone. A type of pipe joint made by using loose flanges on lengths of pipe whose ends are lapped over to give a bearing surface for a gasket or metal-to-metal joint.

LAP WELD—Welded along a scarfed longitudinal seam in which one part is overlapped by the other. A term used to designate pipe made by this process.

LEAD JOINT—Generally used to signify the connection between pipes which

is made by pouring molten lead into the annular space between a bell and spigot, and then making the lead tight by calking.

LEAD WOOL—A material used in place of molten lead for making pipe joints. It is lead fiber, about as coarse as fine excelsior, and when made in a strand, it can be calked into the joints, making them very solid.

LINE PIPE—Special brand of pipe that employs recessed and taper thread couplings, and usually a greater length of thread than the American standard. The pipe is also subjected to higher test.

MALLEABLE IRON—Cast iron which has been heat-treated in a malleableizing oven to relieve its brittleness. The process somewhat improves the tensile strength and enables the material to stretch to a limited extent without breaking.

MANIFOLD—(1) A fitting with numerous branches used to convey fluids between a large pipe and several smaller pipes. (See Branch Tee.) (2) A header for a coil.

MATHESON JOINT—A wrought pipe joint made by enlarging one end of the pipe to form a suitable lead recess, similar to the bell end of a cast-iron pipe, and which receives the male or spigot end of the next length. Practically the same style of a joint as used for cast-iron pipe.

MILL LENGTH—Also known as "random length." The usual run-of-mill pipe is 16 to 20 ft. in length. Line pipe and pipe for power-plant use are sometimes made in double lengths of 30 to 35 ft.

NEEDLE VALVE—A valve provided with a long tapering point in place of the ordinary valve disk. The tapering point permits fine graduation of the opening. At times called a needle point valve.

NIPPLE—A tubular pipe fitting usually threaded on both ends and under 12 inches in length. (See Close, Short, Shoulder and Space Nipple.)

NONRETURN VALVE—A stop valve whose disk can move independently of the stem so that the valve can act as a check. Such valves are largely used between boilers and headers to prevent steam from the header entering the boiler in case of tube failure or other trouble necessitating shutdown. The name "stop and check valve" is often applied to this type.

NOZZLE—As applied to piping, this term refers to a flanged connection on a boiler, tank, or manifold consisting of a pipe flange, a short neck, and a riveted or welded attachment to the boiler or other vessel.

PIPE—The name "pipe" is applied to tubular products of dimensions and materials commonly used for pipe lines and connections, formerly designated as "iron pipe size" (IPS). The outside diameter of all weights and kinds of IPS pipe is of necessity the same for a given pipe size on account of threading.

REDUCER—A fitting having a larger size at one end than at the other. They are always threaded inside, unless specified flanged or for some special joint.

RELIEF VALVE—A valve arranged to provide an automatic relief in case of excess pressure. It may be either spring loaded or of the dead-weight type.

RESISTANCE WELD—Method of manufacturing pipe by bending a plate into circular form and passing electric current through the material to obtain a welding heat.

RUN—(1) A length of pipe that is made of more than one piece of pipe. (2) The portion of any fitting having its ends "in line" or nearly so, in contradistinction to the branch or side opening, as of a tee. The two main openings of an ell also indicate its run.

RUST JOINT—Employed to secure rigid connection. The joint is made by packing an intervening space tightly with a stiff paste which oxidizes the iron,

the whole rusting together and hardening into a solid mass. It generally cannot be separated except by destroying some of the pieces.

SADDLE FLANGE—Also known as "tank flange" or "boiler flange." A curved flange shaped to fit a boiler, tank, or other vessel, and receive a threaded pipe. A saddle flange is usually riveted or welded to the vessel.

SAFETY VALVE—A relief valve for expansive fluids provided with a huddling ring and chamber to control the amount of blow-back before the valve reseats.

SEAMLESS—Pipe formed by piercing and rolling a solid billet or cupping from a plate is termed "seamless."

SEMI-STEEL—A high grade of cast iron made by the addition of steel scrap to pig iron in the cupola or electric furnace. More correctly described as "high-strength gray iron." It is used to some extent for valve bodies and fittings.

SERVICE ELL—An elbow having an outside thread on one end. Also known as a street ell.

SERVICE PIPE—A pipe connecting mains with a dwelling.

SERVICE TEE—A tee having an inside thread on one end and on the branch, but an outside thread on the other end of the run. It is also known as a street tee.

SHORT NIPPLE—One whose length is a little greater than that of two threaded lengths or somewhat longer than a close nipple. It always has some unthreaded portion between the two threads.

SHOULDER NIPPLE—A nipple of any length, which has a portion of pipe between two pipe threads. As generally used, however, it is a nipple about halfway between the length of a close nipple and a short nipple.

SKELP—A piece of plate prepared by forming and bending, ready for welding into pipe. Flat plates when used for butt-welded pipe are called "skelp."

SOURCE NIPPLE—A short length of heavy-walled pipe between steam lines and the first valve of by-pass drain or instrument connections.

SPACE NIPPLE—A nipple with a portion of pipe or shoulder between the two threads. It may be of any length long enough to allow a shoulder.

SPIRAL RIVETED—A method of manufacturing pipe by coiling a plate into a helix and riveting together the overlapped edges.

SPIRAL WELDED—A method of manufacturing pipe by coiling a plate into a helix and fusion-welding the overlapped or abutted edges.

STOP AND CHECK VALVE—See Nonreturn Valve.

STOP VALVE—A valve of the gate or globe type used to shut off a line.

STRESS RELIEVING—A term applied to the process of heating welded assemblies and pipe joints to a temperature of 1100 to 1300 F to permit locked-in stresses to relieve themselves through creep.

TEE—A fitting, either cast or wrought, that has one side outlet at right angles to the run. A single outlet branch pipe. (See Branch, Bull Head, Cross-over, Double Sweep and Service.)

UNION—The usual trade term for a device used to connect pipes. It commonly consists of three pieces which are, first, the thread end fitted with exterior and interior threads; second, the bottom end fitted with interior threads and a small exterior shoulder; and third, the ring which has an inside flange at one end while the other end has an inside thread like that on the exterior of the thread end. A gasket is placed between the thread and bottom ends, which are drawn together by the ring. Unions are very extensively used, because they permit of connections with little disturbance of the pipe positions.

UNION JOINT—A pipe coupling, usually threaded, which permits disconnection without disturbing other sections.

WELDING FITTINGS—Wrought- or forged-steel elbows, tees reducers, heads saddles, and the like, beveled for butt welding to pipe. Fittings with hubs or with ends counterbored for fillet welding to pipe are used to some extent for small pipe sizes.

WELDING-END VALVES—Valves without end flanges and with ends tapered and beveled for butt welding to pipe. Small valves may be counterbored to provide sockets for fillet welding to pipe.

WIPED JOINT—A lead joint in which the molten solder is poured upon the desired place, after scraping and fitting the parts together. The joint is wiped up by hand with a moleskin or cloth pad while the metal is in a plastic condition.

WROUGHT PIPE—The term "wrought pipe" refers to both wrought steel and wrought iron. Wrought in this sense means "worked" as in the process of forming furnace-welded pipe from skelp, or seamless pipe from plates or billets. The expression "wrought pipe" is thus used as a distinction from cast pipe. Wrought pipe in this sense should not be confused with "wrought-iron pipe" which is only one variety of wrought pipe. When "wrought-iron pipe" is referred to, it should be designated by its complete name.

WYE (Y)—A fitting that has one side outlet at any angle other than 90 degrees. The angle is usually 45 degrees, unless another angle is specified. The fitting is usually indicated by the letter Y.

REFERENCE TABLES

ENGINEERING CONVERSION FACTORS

Multiply	by	to obtain
centimeters	3.28083×10^{-2}	feet
"	.3937	inches
cubic centimeters	3.53145×10^{-5}	cubic feet
" "	6.102×10^{-2}	cubic inches
cubic feet	2.8317×10^{-4}	cubic centimeters
" "	2.8317×10^{-2}	cubic meters
" "	6.22905	gallons, British Imperial
" "	28.3170	liters
" "	2.38095×10^{-2}	tons, British Shipping
" "	.025	tons, U. S. Shipping
cubic inches	16.38716	cubic centimeters
cubic meters	35.3145	cubic feet
" "	1.30794	cubic yards
cubic yards	.764559	cubic meters
degrees, Fahr. (less 32° F.)	.5556	degrees, Centigrade
" Centigrade	1.8	degrees, Fahrenheit (less 32° F.)
feet	30.4801	centimeters
"	.304801	meters
"	304.801	millimeters
gallons, U. S.	3.78543	liters
grams, metric	2.20462×10^{-3}	pounds, avoirdupois
inches	2.54001	centimeters
"	2.54001×10^{-2}	meters
"	25.4001	millimeters
kilograms	2.20462	pounds
"	9.84206×10^{-4}	long tons
"	1.10231×10^{-3}	short tons
meters	3.28083	feet
"	39.37	inches
"	1.09361	yards
millimeters	3.28083×10^{-3}	feet
"	3.937×10^{-2}	inches
pounds, avoirdupois	453.592	grams, metric
" "	.453592	kilograms
" "	4.464×10^{-4}	tons, long
" "	4.53592×10^{-4}	tons, metric
pounds per foot	1.48816	kilograms per meter
pounds per square foot	4.88241	kilograms per square meter
pounds per square inch	7.031×10^{-2}	kilograms per square centimeter
" " " "	7.031×10^{-4}	kilograms per square millimeter
square inches	6.45163	square centimeters
" "	645.163	square millimeters
tons, long	1016.05	kilograms
" "	2240.	pounds
" "	1.01605	tons, metric
" "	1.120	tons, short
tons, metric	2204.62	pounds
" "	.98421	tons, long
" "	1.10231	tons, short
tons, short	907.185	kilograms
" "	.892857	tons, long
" "	.907185	tons, metric

WEIGHTS AND MEASURES

English and Metric Equivalents

1 pound (lb.)	= 453.6 grams.
100 lb.	= 45.36 kilos.
112 lb.	= 50.80 kilos.
1 net ton (2000 lb.)	= 907.2 kilos.
1 gross ton (2240 lb.)	= 1016 kilos.
1 kilo	= 2.2046 lb.
100 kilos	= 220.46 lb.
1 metric ton (1000 kilos)	= 2204.6 lbs. = 0.9842 gross ton = 1.1023 net tons.
1 inch	= 25.40 millimeters.
1 foot (12 inches)	= 30.48 centimeters.
1 yard (3 feet)	= 91.44 centimeters.
1 mile (1760 yards)	= 1609.35 meters.
1 millimeter	= 0.03937 inch.
1 centimeter	= 0.3937 inch.
1 meter	= 39.37 inches = 3.2808 feet.
1 kilometer	= 0.62137 mile = 1093.6 yards.
1 square inch	= 6.4516 square centimeters. = 645.16 square millimeters.
1 square foot	= 0.0929 square meter.
1 square yard	= 0.8361 square meter.
1 square millimeter	= 0.00155 square inch.
1 square centimeter	= 0.155 square inch.
1 square meter	= 10.7639 square feet. = 1.196 square yards.
1 pound per foot	= 1.4882 kilos per meter.
1 pound per yard	= 0.4961 kilo per meter.
1 pound per square inch	= 0.0703 kilo per square centimeter.
1 pound per square foot	= 4.8825 kilos per square meter.
1 kilo per meter	= 0.6720 pound per foot.
1 kilo per square millimeter	= 1422.32 pounds per square inch.
1 kilo per square centimeter	= 14.2232 pounds per square inch.
1 kilo per square meter	= 0.2048 pound per square foot. = 1.8433 pounds per square yard.

DECIMAL EQUIVALENTS

Decimals of an inch for each 64th of an inch. With Millimeter Equivalents

Fraction	1/64ths	Decimal	Millimeters	Fraction	1/64ths	Decimal	Millimeters
..	1	.01563	0.397	..	33	.51563	13.097
1/32	2	.03125	0.794	17/32	34	.53125	13.494
..	3	.04688	1.191	..	35	.54688	13.891
1/16	4	.0625	1.588	9/16	36	.5625	14.288
..	5	.07813	1.984	..	37	.57813	14.684
3/32	6	.09375	2.381	19/32	38	.59375	15.081
..	7	.10938	2.778	..	39	.60938	15.478
1/8	8	.125	3.175	5/8	40	.625	15.875
..	9	.14063	3.572	..	41	.64063	16.272
5/32	10	.15625	3.969	21/32	42	.65625	16.669
..	11	.17188	4.366	..	43	.67188	17.066
3/16	12	.1875	4.763	11/16	44	.6875	17.463
..	13	.20313	5.159	..	45	.70313	17.859
7/32	14	.21875	5.556	23/32	46	.71875	18.256
..	15	.23438	5.953	..	47	.73438	18.653
1/4	16	.250	6.350	3/4	48	.750	19.050
..	17	.26563	6.747	..	49	.76563	19.447
9/32	18	.28125	7.144	25/32	50	.78125	19.844
..	19	.29688	7.541	..	51	.79688	20.241
5/16	20	.3125	7.938	13/16	52	.8125	20.638
..	21	.32813	8.334	..	53	.82813	21.034
11/32	22	.34375	8.731	27/32	54	.84375	21.431
..	23	.35938	9.128	..	55	.85938	21.828
3/8	24	.375	9.525	7/8	56	.875	22.225
..	25	.39063	9.922	..	57	.89063	22.622
13/32	26	.40625	10.319	29/32	58	.90625	23.019
..	27	.42188	10.716	..	59	.92188	23.416
7/16	28	.4375	11.113	15/16	60	.9375	23.813
..	29	.45313	11.509	..	61	.95313	24.209
15/32	30	.46875	11.906	31/32	62	.96875	24.606
..	31	.48438	12.303	..	63	.98438	25.003
1/2	32	.500	12.700	1	64	1.000	25.400

METRIC CONVERSION

Millimeters into Inches

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
1	0.0394	38	1.4961	75	2.9527
2	0.0787	39	1.5354	76	2.9921
3	0.1181	40	1.5748	77	3.0315
4	0.1575	41	1.6142	78	3.0709
5	0.1968	42	1.6535	79	3.1102
6	0.2362	43	1.6929	80	3.1496
7	0.2756	44	1.7323	81	3.1890
8	0.3150	45	1.7716	82	3.2283
9	0.3543	46	1.8110	83	3.2677
10	0.3937	47	1.8504	84	3.3071
11	0.4331	48	1.8898	85	3.3464
12	0.4724	49	1.9291	86	3.3858
13	0.5118	50	1.9685	87	3.4252
14	0.5512	51	2.0079	88	3.4646
15	0.5905	52	2.0472	89	3.5039
16	0.6299	53	2.0866	90	3.5433
17	0.6693	54	2.1260	91	3.5827
18	0.7087	55	2.1653	92	3.6220
19	0.7480	56	2.2047	93	3.6614
20	0.7874	57	2.2441	94	3.7008
21	0.8268	58	2.2835	95	3.7401
22	0.8661	59	2.3228	96	3.7795
23	0.9055	60	2.3622	97	3.8189
24	0.9449	61	2.4016	98	3.8583
25	0.9842	62	2.4409	99	3.8976
26	1.0236	63	2.4803	100	3.9370
27	1.0630	64	2.5197	200	7.8740
28	1.1024	65	2.5590	300	11.8110
29	1.1417	66	2.5984	400	15.7480
30	1.1811	67	2.6378	500	19.6850
31	1.2205	68	2.6772	600	23.6220
32	1.2598	69	2.7165	700	27.5590
33	1.2992	70	2.7559	800	31.4960
34	1.3386	71	2.7953	900	35.4330
35	1.3779	72	2.8346	1000	39.3700
36	1.4173	73	2.8740		
37	1.4567	74	2.9134		

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
1/4	.047	.063	.078	.094	.109	.125	.141
1/2	.094	.125	.156	.188	.219	.250	.281
3/4	.141	.188	.234	.281	.328	.375	.422
1	.188	.250	.313	.375	.438	.500	.563
1 1/4	.234	.313	.391	.469	.547	.625	.703
1 1/2	.281	.375	.469	.563	.656	.750	.844
1 3/4	.328	.438	.547	.656	.766	.875	.984
2	.375	.500	.625	.750	.875	1.00	1.13
2 1/4	.422	.563	.703	.844	.984	1.13	1.27
2 1/2	.469	.625	.781	.938	1.09	1.25	1.41
2 3/4	.516	.688	.859	1.03	1.20	1.38	1.55
3	.563	.750	.938	1.13	1.31	1.50	1.69
3 1/4	.609	.813	1.02	1.22	1.42	1.63	1.83
3 1/2	.656	.875	1.09	1.31	1.53	1.75	1.97
3 3/4	.703	.938	1.17	1.41	1.64	1.88	2.11
4	.750	1.00	1.25	1.50	1.75	2.00	2.25
4 1/4	.797	1.06	1.33	1.59	1.86	2.13	2.39
4 1/2	.844	1.13	1.41	1.69	1.97	2.25	2.53
4 3/4	.891	1.19	1.48	1.78	2.09	2.38	2.67
5	.938	1.25	1.56	1.88	2.19	2.50	2.81
5 1/4	.984	1.31	1.64	1.97	2.30	2.63	2.95
5 1/2	1.03	1.38	1.72	2.06	2.41	2.75	3.09
5 3/4	1.08	1.44	1.80	2.16	2.52	2.88	3.23
6	1.13	1.50	1.88	2.25	2.63	3.00	3.38
6 1/4	1.17	1.56	1.95	2.34	2.73	3.13	3.52
6 1/2	1.22	1.63	2.03	2.44	2.84	3.25	3.66
6 3/4	1.27	1.69	2.10	2.53	2.95	3.38	3.80
7	1.31	1.75	2.19	2.63	3.06	3.50	3.94
7 1/4	1.36	1.81	2.27	2.72	3.17	3.63	4.08
7 1/2	1.41	1.88	2.34	2.81	3.28	3.75	4.22
7 3/4	1.45	1.94	2.42	2.91	3.39	3.88	4.36
8	1.50	2.00	2.50	3.00	3.50	4.00	4.50
8 1/4	1.55	2.06	2.58	3.09	3.61	4.13	4.64
8 1/2	1.59	2.13	2.66	3.19	3.72	4.25	4.78
8 3/4	1.64	2.19	2.73	3.28	3.83	4.38	4.92
9	1.69	2.25	2.81	3.38	3.94	4.50	5.06

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
1/4	.156	.172	.188	.203	.219	.234	.250
1/2	.313	.344	.375	.406	.438	.469	.500
3/4	.469	.516	.563	.609	.656	.703	.750
1	.625	.688	.750	.813	.875	.938	1.00
1 1/4	.781	.859	.938	1.02	1.09	1.17	1.25
1 1/2	.938	1.03	1.13	1.22	1.31	1.41	1.50
1 3/4	1.09	1.20	1.31	1.42	1.53	1.64	1.75
2	1.25	1.38	1.50	1.63	1.75	1.88	2.00
2 1/4	1.41	1.55	1.69	1.83	1.97	2.11	2.25
2 1/2	1.56	1.72	1.88	2.03	2.19	2.34	2.50
2 3/4	1.72	1.89	2.06	2.23	2.41	2.58	2.75
3	1.88	2.06	2.25	2.44	2.63	2.81	3.00
3 1/4	2.03	2.23	2.44	2.64	2.84	3.05	3.25
3 1/2	2.19	2.41	2.63	2.84	3.06	3.28	3.50
3 3/4	2.34	2.58	2.81	3.05	3.28	3.52	3.75
4	2.50	2.75	3.00	3.25	3.50	3.75	4.00
4 1/4	2.66	2.92	3.19	3.45	3.72	3.98	4.25
4 1/2	2.81	3.09	3.38	3.66	3.94	4.22	4.50
5 3/4	2.97	3.27	3.56	3.86	4.16	4.45	4.75
5	3.13	3.44	3.75	4.06	4.38	4.69	5.00
5 1/4	3.28	3.61	3.94	4.27	4.59	4.92	5.25
5 1/2	3.44	3.78	4.13	4.47	4.81	5.16	5.50
5 3/4	3.59	3.95	4.31	4.67	5.03	5.39	5.75
6	3.75	4.13	4.50	4.88	5.25	5.63	6.00
6 1/4	3.91	4.30	4.69	5.08	5.47	5.86	6.25
6 1/2	4.06	4.47	4.88	5.28	5.69	6.09	6.50
6 3/4	4.22	4.64	5.06	5.48	5.91	6.33	6.75
7	4.38	4.81	5.25	5.69	6.13	6.56	7.00
7 1/4	4.53	4.98	5.44	5.89	6.34	6.80	7.25
7 1/2	4.69	5.16	5.63	6.09	6.56	7.03	7.50
7 3/4	4.84	5.33	5.81	6.30	6.78	7.27	7.75
8	5.00	5.50	6.00	6.50	7.00	7.50	8.00
8 1/4	5.16	5.67	6.19	6.70	7.22	7.73	8.25
8 1/2	5.31	5.84	6.38	6.91	7.44	7.97	8.50
8 3/4	5.47	6.02	6.56	7.11	7.66	8.20	8.75
9	5.63	6.19	6.75	7.31	7.88	8.44	9.00

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
9 1/4	1.73	2.31	2.89	3.47	4.05	4.63	5.20
9 1/2	1.78	2.38	2.97	3.56	4.16	4.75	5.34
9 3/4	1.83	2.44	3.05	3.66	4.27	4.88	5.48
10	1.88	2.50	3.13	3.75	4.38	5.00	5.63
10 1/4	1.92	2.56	3.20	3.84	4.48	5.13	5.77
10 1/2	1.97	2.63	3.28	3.94	4.59	5.25	5.91
10 3/4	2.02	2.69	3.36	4.03	4.70	5.38	6.05
11	2.06	2.75	3.44	4.13	4.81	5.50	6.19
11 1/4	2.11	2.81	3.52	4.22	4.92	5.63	6.33
11 1/2	2.16	2.88	3.59	4.31	5.03	5.75	6.47
11 3/4	2.20	2.94	3.67	4.41	5.14	5.88	6.61
12	2.25	3.00	3.75	4.50	5.25	6.00	6.75
12 1/2	2.34	3.13	3.91	4.69	5.47	6.25	7.03
13	2.44	3.25	4.06	4.88	5.69	6.50	7.31
13 1/2	2.53	3.38	4.22	5.06	5.91	6.75	7.59
14	2.63	3.50	4.38	5.25	6.13	7.00	7.88
14 1/2	2.72	3.63	4.53	5.44	6.34	7.25	8.16
15	2.81	3.75	4.69	5.63	6.56	7.50	8.44
15 1/2	2.91	3.88	4.84	5.81	6.78	7.75	8.72
16	3.00	4.00	5.00	6.00	7.00	8.00	9.00
16 1/2	3.09	4.13	5.16	6.19	7.22	8.25	9.28
17	3.19	4.25	5.31	6.38	7.44	8.50	9.56
17 1/2	3.28	4.38	5.47	6.56	7.66	8.75	9.84
18	3.38	4.50	5.63	6.75	7.88	9.00	10.13
18 1/2	3.47	4.63	5.78	6.94	8.09	9.25	10.41
19	3.56	4.75	5.94	7.13	8.31	9.50	10.69
19 1/2	3.66	4.88	6.09	7.31	8.53	9.75	10.97
20	3.75	5.00	6.25	7.50	8.75	10.00	11.25
20 1/2	3.84	5.13	6.41	7.69	8.97	10.25	11.53
21	3.94	5.25	6.56	7.88	9.19	10.50	11.81
21 1/2	4.03	5.38	6.72	8.06	9.41	10.75	12.09
22	4.13	5.50	6.88	8.25	9.63	11.00	12.38
22 1/2	4.22	5.63	7.03	8.44	9.84	11.25	12.66
23	4.31	5.75	7.19	8.63	10.06	11.50	12.94
23 1/2	4.41	5.88	7.34	8.81	10.28	11.75	13.22
24	4.50	6.00	7.50	9.00	10.50	12.00	13.50

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
9¼	5.78	6.36	6.94	7.52	8.09	8.67	9.25
9½	5.94	6.53	7.13	7.72	8.31	8.91	9.50
9¾	6.09	6.70	7.31	7.92	8.53	9.14	9.75
10	6.25	6.88	7.50	8.13	8.75	9.38	10.00
10¼	6.41	7.05	7.69	8.33	8.97	9.61	10.25
10½	6.56	7.22	7.88	8.53	9.19	9.84	10.50
10¾	6.72	7.39	8.06	8.73	9.41	10.08	10.75
11	6.88	7.56	8.25	8.94	9.63	10.31	11.00
11¼	7.03	7.73	8.44	9.14	9.84	10.55	11.25
11½	7.19	7.91	8.63	9.34	10.06	10.78	11.50
11¾	7.34	8.08	8.81	9.55	10.28	11.02	11.75
12	7.50	8.25	9.00	9.75	10.50	11.25	12.00
12½	7.81	8.59	9.38	10.16	10.94	11.72	12.50
13	8.13	8.94	9.75	10.56	11.38	12.19	13.00
13½	8.44	9.28	10.13	10.97	11.81	12.66	13.50
14	8.75	9.63	10.50	11.38	12.25	13.13	14.00
14½	9.06	9.97	10.88	11.78	12.69	13.59	14.50
15	9.38	10.31	11.25	12.19	13.13	14.06	15.00
15½	9.69	10.66	11.63	12.59	13.56	14.53	15.50
16	10.00	11.00	12.00	13.00	14.00	15.00	16.00
16½	10.31	11.34	12.38	13.41	14.44	15.47	16.50
17	10.63	11.69	12.75	13.81	14.88	15.94	17.00
17½	10.94	12.03	13.13	14.22	15.31	16.41	17.50
18	11.25	12.38	13.50	14.63	15.75	16.88	18.00
18½	11.56	12.72	13.88	15.03	16.19	17.34	18.50
19	11.88	13.06	14.25	15.44	16.63	17.81	19.00
19½	12.19	13.41	14.63	15.84	17.06	18.28	19.50
20	12.50	13.75	15.00	16.25	17.50	18.75	20.00
20½	12.81	14.09	15.38	16.66	17.94	19.22	20.50
21	13.13	14.44	15.75	17.06	18.38	19.69	21.00
21½	13.44	14.78	16.13	17.47	18.81	20.16	21.50
22	13.75	15.13	16.50	17.88	19.25	20.63	22.00
22½	14.06	15.47	16.88	18.28	19.69	21.09	22.50
23	14.38	15.81	17.25	18.69	20.13	21.56	23.00
23½	14.69	16.16	17.63	19.09	20.56	22.03	23.50
24	15.00	16.50	18.00	19.50	21.00	22.50	24.00

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
25	4.69	6.25	7.81	9.38	10.94	12.50	14.06
26	4.88	6.50	8.13	9.75	11.38	13.00	14.63
27	5.06	6.75	8.44	10.13	11.81	13.50	15.19
28	5.25	7.00	8.75	10.50	12.25	14.00	15.75
29	5.44	7.25	9.06	10.88	12.69	14.50	16.31
30	5.63	7.50	9.38	11.25	13.13	15.00	16.88
31	5.81	7.75	9.69	11.63	13.56	15.50	17.44
32	6.00	8.00	10.00	12.00	14.00	16.00	18.00
33	6.19	8.25	10.31	12.38	14.44	16.50	18.56
34	6.38	8.50	10.63	12.75	14.88	17.00	19.13
35	6.56	8.75	10.94	13.13	15.31	17.50	19.69
36	6.75	9.00	11.25	13.50	15.75	18.00	20.25
37	6.94	9.25	11.56	13.88	16.19	18.50	20.81
38	7.13	9.50	11.88	14.25	16.63	19.00	21.38
39	7.31	9.75	12.19	14.63	17.06	19.50	21.94
40	7.50	10.00	12.50	15.00	17.50	20.00	22.50
41	7.69	10.25	12.81	15.38	17.94	20.50	23.06
42	7.88	10.50	13.13	15.75	18.38	21.00	23.63
43	8.06	10.75	13.44	16.13	18.81	21.50	24.19
44	8.25	11.00	13.75	16.50	19.25	22.00	24.75
45	8.44	11.25	14.06	16.88	19.69	22.50	25.31
46	8.63	11.50	14.38	17.25	20.13	23.00	25.88
47	8.81	11.75	14.69	17.63	20.56	23.50	26.44
48	9.00	12.00	15.00	18.00	21.00	24.00	27.00
49	9.19	12.25	15.31	18.38	21.44	24.50	27.56
50	9.38	12.50	15.63	18.75	21.88	25.00	28.13
51	9.56	12.75	15.94	19.13	22.31	25.50	28.69
52	9.75	13.00	16.25	19.50	22.75	26.00	29.25
53	9.94	13.25	16.56	19.88	23.19	26.50	29.81
54	10.13	13.50	16.88	20.25	23.63	27.00	30.38
55	10.31	13.75	17.19	20.63	24.06	27.50	30.94
56	10.50	14.00	17.50	21.00	24.50	28.00	31.50
57	10.69	14.25	17.81	21.38	24.94	28.50	32.06
58	10.88	14.50	18.13	21.75	25.38	29.00	32.63
59	11.06	14.75	18.44	22.13	25.81	29.50	33.19
60	11.25	15.00	18.75	22.50	26.25	30.00	33.75

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
25	15.63	17.19	18.75	20.31	21.88	23.44	25.00
26	16.25	17.88	19.50	21.13	22.75	24.38	26.00
27	16.88	18.56	20.25	21.94	23.63	25.31	27.00
28	17.50	19.25	21.00	22.75	24.50	26.25	28.00
29	18.13	19.94	21.75	23.56	25.38	27.19	29.00
30	18.75	20.63	22.50	24.38	26.25	28.13	30.00
31	19.38	21.31	23.25	25.19	27.13	29.06	31.00
32	20.00	22.00	24.00	26.00	28.00	30.00	32.00
33	20.63	22.69	24.75	26.81	28.88	30.94	33.00
34	21.25	23.38	25.50	27.63	29.75	31.88	34.00
35	21.88	24.06	26.25	28.44	30.63	32.81	35.00
36	22.50	24.75	27.00	29.25	31.50	33.75	36.00
37	23.13	25.44	27.75	30.06	32.38	34.69	37.00
38	23.75	26.13	28.50	30.88	33.25	35.63	38.00
39	24.38	26.81	29.25	31.69	34.13	36.56	39.00
40	25.00	27.50	30.00	32.50	35.00	37.50	40.00
41	25.63	28.19	30.75	33.31	35.88	38.44	41.00
42	26.25	28.88	31.50	34.13	36.75	39.38	42.00
43	26.88	29.56	32.25	34.94	37.63	40.31	43.00
44	27.50	30.25	33.00	35.75	38.50	41.25	44.00
45	28.13	30.94	33.75	36.56	39.38	42.19	45.00
46	28.75	31.63	34.50	37.38	40.25	43.13	46.00
47	29.38	32.31	35.25	38.19	41.13	44.06	47.00
48	30.00	33.00	36.00	39.00	42.00	45.00	48.00
49	30.63	33.69	36.75	39.81	42.88	45.94	49.00
50	31.25	34.38	37.50	40.63	43.75	46.88	50.00
51	31.88	35.06	38.25	41.44	44.63	47.81	51.00
52	32.50	35.75	39.00	42.25	45.50	48.75	52.00
53	33.13	36.44	39.75	43.06	46.38	49.69	53.00
54	33.75	37.13	40.50	43.88	47.25	50.63	54.00
55	34.38	37.81	41.25	44.69	48.13	51.56	55.00
56	35.00	38.50	42.00	45.50	49.00	52.50	56.00
57	35.63	39.19	42.75	46.31	49.88	53.44	57.00
58	36.25	39.88	43.50	47.13	50.75	54.38	58.00
59	36.88	40.56	44.25	47.94	51.63	55.31	59.00
60	37.50	41.25	45.00	48.75	52.50	56.25	60.00

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	3/16	1/4	5/16	3/8	7/16	1/2	9/16
61	11.44	15.25	19.06	22.88	26.69	30.50	34.31
62	11.63	15.50	19.38	23.25	27.13	31.00	34.88
63	11.81	15.75	19.69	23.63	27.56	31.50	35.44
64	12.00	16.00	20.00	24.00	28.00	32.00	36.00
65	12.19	16.25	20.31	24.38	28.44	32.50	36.56
66	12.38	16.50	20.63	24.75	28.88	33.00	37.13
67	12.56	16.75	20.94	25.13	29.31	33.50	37.69
68	12.75	17.00	21.25	25.50	29.75	34.00	38.25
69	12.94	17.25	21.56	25.88	30.19	34.50	38.81
70	13.13	17.50	21.88	26.25	30.63	35.00	39.38
71	13.31	17.75	22.19	26.63	31.06	35.50	39.94
72	13.50	18.00	22.50	27.00	31.50	36.00	40.50
73	13.69	18.25	22.81	27.38	31.94	36.50	41.06
74	13.88	18.50	23.13	27.75	32.38	37.00	41.63
75	14.06	18.75	23.44	28.13	32.81	37.50	42.19
76	14.25	19.00	23.75	28.50	33.25	38.00	42.75
77	14.44	19.25	24.06	28.88	33.69	38.50	43.31
78	14.63	19.50	24.38	29.25	34.13	39.00	43.88
79	14.81	19.75	24.69	29.63	34.56	39.50	44.44
80	15.00	20.00	25.00	30.00	35.00	40.00	45.00
81	15.19	20.25	25.31	30.38	35.44	40.50	45.56
82	15.38	20.50	25.63	30.75	35.88	41.00	46.13
83	15.56	20.75	25.94	31.13	36.31	41.50	46.69
84	15.75	21.00	26.25	31.50	36.75	42.00	47.25
85	15.94	21.25	26.56	31.88	37.19	42.50	47.81
86	16.13	21.50	26.88	32.25	37.63	43.00	48.38
87	16.31	21.75	27.19	32.63	38.06	43.50	48.94
88	16.50	22.00	27.50	33.00	38.50	44.00	49.50
89	16.69	22.25	27.81	33.38	38.94	44.50	50.06
90	16.88	22.50	28.13	33.75	39.38	45.00	50.63
91	....	22.75	28.44	34.13	39.81	45.50	51.19
92	....	23.00	28.75	34.50	40.25	46.00	51.75
93	....	23.25	29.06	34.88	40.69	46.50	52.31
94	....	23.50	29.38	35.25	41.13	47.00	52.88
95	....	23.75	29.69	35.63	41.56	47.50	53.44
96	....	24.00	30.00	36.00	42.00	48.00	54.00

AREA OF RECTANGULAR SECTIONS

SQUARE INCHES

Width Inches	THICKNESS, INCHES						
	5/8	11/16	3/4	13/16	7/8	15/16	1
61	38.13	41.94	45.75	49.56	53.38	57.19	61.00
62	38.75	42.63	46.50	50.38	54.25	58.13	62.00
63	39.38	43.31	47.25	51.19	55.13	59.06	63.00
64	40.00	44.00	48.00	52.00	56.00	60.00	64.00
65	40.63	44.69	48.75	52.81	56.88	60.94	65.00
66	41.25	45.38	49.50	53.63	57.75	61.88	66.00
67	41.88	46.06	50.25	54.44	58.63	62.81	67.00
68	42.50	46.75	51.00	55.25	59.50	63.75	68.00
69	43.13	47.44	51.75	56.06	60.38	64.69	69.00
70	43.75	48.13	52.50	56.88	61.25	65.63	70.00
71	44.38	48.81	53.25	57.69	62.13	66.56	71.00
72	45.00	49.50	54.00	58.50	63.00	67.50	72.00
73	45.63	50.19	54.75	59.31	63.88	68.44	73.00
74	46.25	50.88	55.50	60.13	64.75	69.38	74.00
75	46.88	51.56	56.25	60.94	65.63	70.31	75.00
76	47.50	52.25	57.00	61.75	66.50	71.25	76.00
77	48.13	52.94	57.75	62.56	67.38	72.19	77.00
78	48.75	53.63	58.50	63.38	68.25	73.13	78.00
79	49.38	54.31	59.25	64.19	69.13	74.06	79.00
80	50.00	55.00	60.00	65.00	70.00	75.00	80.00
81	50.63	55.69	60.75	65.81	70.88	75.94	81.00
82	51.25	56.38	61.50	66.63	71.75	76.88	82.00
83	51.88	57.06	62.25	67.44	72.63	77.81	83.00
84	52.50	57.75	63.00	68.25	73.50	78.75	84.00
85	53.13	58.44	63.75	69.06	74.38	79.69	85.00
86	53.75	59.13	64.50	69.88	75.25	80.63	86.00
87	54.38	59.81	65.25	70.69	76.13	81.56	87.00
88	55.00	60.50	66.00	71.50	77.00	82.50	88.00
89	55.63	61.19	66.75	72.31	77.88	83.44	89.00
90	56.25	61.88	67.50	73.13	78.75	84.38	90.00
91	56.88	62.56	68.25	73.94	79.63	85.31	91.00
92	57.50	63.25	69.00	74.75	80.50	86.25	92.00
93	58.13	63.94	69.75	75.56	81.38	87.19	93.00
94	58.75	64.63	70.50	76.38	82.25	88.13	94.00
95	59.38	65.31	71.25	77.19	83.13	89.06	95.00
96	60.00	66.00	72.00	78.00	84.00	90.00	96.00

INTERCONVERSION TABLE FOR UNITS OF ENERGY

Multiply by

To Convert from	To B.t.u.	To Cal.	To Ft.–Lb.	To Ft. Tons	To Kg-m.	To Hp-hr.	To Kw-hr.	To Joules (abs.)	To Lb. C.	To Lb. H_2O
B.t.u. (mean).....	1.00	0.252	778.000	0.389001	107.563	0.0_33929	0.0_32931	1054.8	0.046876	0.001031
Calories (mean)..	3.968	1.000	3091.36	1.544	426.84	0.001559	0.001163	4185	0.0_32729	0.004089
Ft.-lb.	0.001285	0.0_33239	1.000	0.000500	0.1383	0.0_65050	0.0_63767	1.355	0.0_78840	0.0_51325
Ft. Tons.....	2.571	0.6478	2000.00	1.000	276.511	0.001010	0.0_37535	2712.59	0.0_31768	0.002649
Kg-m.....	0.009297	0.002343	7.23301	0.003617	1.000	0.0_53653	0.0_52725	9.806	0.0_66394	0.0_59580
Hp-hr.....	2544.99	641.327	1980000	990.004	273747	1.000	0.746000	2685600	0.1750	2.62261
Kw-hr.....	3411.57	859.702	2654200	1327.10	366959	1.34041	1.000	3600000	0.2346	3.51562
Joules (absolute)..	0.0_39477	0.0_32389	0.737356	0.0_33687	0.101937	0.0_63725	0.0_62778	1.000	0.0_76518	0.0_69766
Lbs. C.....	14544	3665	113150_3	5658	1564396	5.714	4.263	153470_3	1.000	14.98
Lbs. H_2O.....	970.40	244.537	754971	377.487	104379	0.381270	0.284424	1023966	0.06674	1.000

NOTE: The small subnumeral following a zero indicates that the zero is to be taken that number of times, thus, 0.0_41428 is equivalent to 0.0001428.

The ton used is 2000 lb. "Lb. C" refers to pounds of carbon oxidized, 100% efficiency equivalent to the corresponding number of heat units. "Lb. H_2O" refers to pounds of water evaporated at 100°C. (212°F.) at 100% efficiency.

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