ARTICLE IV
WELDING DATA

QW-400 VARIABLES

QW-401 General

Each welding variable described in this Article is applicable as an essential, supplemental essential, or nonessential variable for procedure qualification when referenced in QW-250 for each specific welding process. Essential variables for performance qualification are referenced in QW-350 for each specific welding process. A change from one welding process to another welding process is an essential variable and requires requalification.

QW-401.1 Essential Variable (Procedure). A change in a welding condition which will affect the mechanical properties (other than notch toughness) of the weldment (for example, change in P-Number, welding process, filler metal, electrode, preheat or postweld heat treatment, etc.).

QW-401.2 Essential Variable (Performance). A change in a welding condition which will affect the ability of a welder to deposit sound weld metal (such as a change in welding process, deletion of backing, electrode, F-Number, technique, etc.).

QW-401.3 Supplemental Essential Variable (Procedure). A change in a welding condition which will affect the notch-toughness properties of a weldment (for example, change in welding process, uphill or down vertical welding, heat input, preheat or PWHT, etc.).

When a procedure has been previously qualified to satisfy all requirements other than notch toughness, it is then necessary only to prepare an additional test coupon using the same procedure with the same essential variables, but additionally with all of the required supplementary essential variables, with the coupon long enough to provide the necessary notch-toughness specimens.

When a procedure has been previously qualified to satisfy all requirements including notch toughness, but one or more supplementary essential variable is changed, then it is only necessary to prepare an additional test coupon using the same welding procedure and the new supplementary essential variable(s), with the coupon long enough to provide the necessary notch-toughness specimens. If a previously qualified weld procedure has satisfactory notch-toughness values in the weld metal, then it is necessary only to test notch-toughness specimens from the heat affected zone when such are required.

QW-401.4 Nonessential Variable (Procedure). A change in a welding condition which will *not* affect the mechanical properties of a weldment (such as joint design, method of back gouging or cleaning, etc.)

QW-401.5 The welding data includes the welding variables grouped as joints, base metals, filler metals, position, preheat, postweld heat treatment, gas, electrical characteristics, and technique. For convenience, variables for each welding process are summarized in QW-416 for performance qualification.

QW-402 Joints

QW-402.1 A change in the type of groove (Vee-groove, U-groove, single-bevel, double-bevel, etc.).

QW-402.2 The addition or deletion of a backing.

QW-402.3 A change in the nominal composition of the backing.

QW-402.4 The deletion of the backing in single-welded groove welds. Double-welded groove welds are considered welding with backing.

QW-402.5 The addition of a backing or a change in its nominal composition.

QW-402.6 An increase in the fit-up gap, beyond that initially qualified.

QW-402.7 The addition of backing.

QW-402.8 A change in nominal size or shape of the stud at the section to be welded.

QW-402.9 In stud welding, a change in shielding as a result of ferrule or flux type.

QW-402.10 A change in the specified root spacing.

QW-402.11 The addition or deletion of nonmetallic retainers or nonfusing metal retainers.

QW-402.12 The welding procedure qualification test shall duplicate the joint configuration to be used in production within the limits listed, except that pipe or tube to pipe or tube may be used for qualification of a pipe or tube to other shapes, and solid round to solid round may be used for qualification of a solid round to other shapes:

(a) any change exceeding ±10 deg in the angle measured for the plane of either face to be joined, to the axis of rotation;

(b) a change in cross-sectional area of the weld joint greater than 10%;

(c) a change in the outside diameter of the cylindrical weld interface of the assembly greater than ±10%;

(d) a change from solid to tubular cross section at the joint or vice versa regardless of QW-402.12(b).

QW-402.13 A change in the joint from spot to projection to seam or vice versa.

QW-402.14 A decrease in the center-to-center distance when the welds overlap. An increase or decrease of more than 10% in the spacing of the welds when they are within two diameters of each other.

QW-402.15 A change in the size or shape of the projection in projection welding.

QW-402.16 A decrease in the distance between the approximate weld interface and the final surface of the production corrosion-resistant or hard-facing weld metal overlay below the minimum thickness qualified as shown in QW-462.5(a) through QW-462.5(e). There is no limit on the maximum thickness for corrosion-resistant or hard-facing weld metal overlay that may be used in production.

QW-402.17 An increase in the thickness of the production spray fuse hard-facing deposit above the thickness deposited on the procedure qualification test coupon.

QW-402.18 When the joint is a lap joint, the following additional variables shall apply:

(a) a change of more than 10% in the distance to the edge of the material;

(b) a change of more than 10% in the joint overlap;

(c) a change in the number of layers of material;

(d) a change in the method of surface conditioning at the metal-to-metal interfaces.

QW-403 Base Metals

QW-403.1 A change from a base metal listed under one P-Number in QW/QB-422 to a metal listed under another P-Number or to any other base metal. When joints are made between two base metals that have different P-Numbers, a procedure qualification shall be made for the applicable combination of P-Numbers, even though qualification tests have been made for each of the two base metals welded to itself.

QW-403.2 The maximum thickness qualified is the thickness of the test coupon.

QW-403.3 Where the measurement of penetration can be made by visual or mechanical means, requalification is required where the base metal thickness differs by 20% from that of the test coupon thickness when the test coupon thickness is 1 in. (25 mm) and under, and 10% when the test coupon thickness is over 1 in. (25 mm) Where the measurement of penetration cannot be made, requalification is required where the base metal thickness differs by 10% from that of the test coupon when the test coupon thickness is 1 in. (25 mm) and under, and 5% when the test coupon thickness is over 1 in. (25 mm).

QW-403.4 Welding procedure qualifications shall be made using a base metal of the same type or grade or another base metal listed in the same group (see QW/QB-422) as the base metal to be used in production welding. When joints are to be made between base metals from two different groups, a procedure qualification must be made for the applicable combination of base metals, even though procedure qualification tests have been made for each of the two base metals welded to itself.

QW-403.5 Welding procedure qualifications shall be made using a base metal of the same type or grade or another base metal listed in the same P-Number and Group Number (see QW/QB-422) as the base metal to be used in production welding. A procedure qualification shall be made for each P-Number and Group Number combination of base metals, even though procedure qualification tests have been made for each of the two base metals welded to itself. If, however, the procedure specification for welding the combination of base metals specifies the same essential variables, including electrode or filler metal, as both specifications for welding each base metal to itself, such that base metals is the only change, then the procedure specification for welding the combination of base metals is also qualified. In addition, when base metals of two different P-Number Group Number combinations are qualified

using a single test coupon, that coupon qualifies the welding of those two P-Number Group Numbers to themselves as well as to each other using the variables qualified. This variable does not apply when impact testing of the heat-affected zone is not required by other Sections.

QW-403.6 The minimum base metal thickness qualified is the thickness of the test coupon T or $\frac{5}{8}$ in. (16 mm), whichever is less. However, where T is less than $\frac{1}{4}$ in. (6 mm), the minimum thickness qualified is $\frac{1}{2}T$. This limitation does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding.

QW-403.7 For the multipass processes of shielded metal-arc, submerged-arc, gas tungsten-arc, and gas metal-arc, the maximum thickness qualified for $1\frac{1}{2}$ in. (38 mm) and over thickness T of the test coupon of QW-451.1 shall be 8 in. (203 mm) for the conditions shown in QW-451.1. For thicknesses greater than 8 in. (203 mm), the maximum thicknesses of base metal and deposited weld metal qualified is 1.33T or 1.33t, as applicable.

QW-403.8 A change in base metal thickness beyond the range qualified in QW-451, except as otherwise permitted by QW-202.4(b).

QW-403.9 For single-pass or multipass welding in which any pass is greater than $\frac{1}{2}$ in. (13 mm) thick, an increase in base metal thickness beyond 1.1 times that of the qualification test coupon.

QW-403.10 For the short-circuiting transfer mode of the gas metal-arc process, when the qualification test coupon thickness is less than $\frac{1}{2}$ in. (13 mm), an increase in thickness beyond 1.1 times that of the qualification test coupon. For thicknesses of $\frac{1}{2}$ in. (13 mm) and greater, use QW-451.1 or QW-451.2, as applicable.

QW-403.11 Base metals specified in the WPS shall be qualified by a procedure qualification test which was made using base metals in accordance with QW-424.

QW-403.12 A change from a base metal listed under one P-Number of QW/QB-422 to a base metal listed under another P-Number. When joints are made between two base metals that have different P-Numbers, requalification is required even though the two base metals have been independently qualified using the same procedure. When the melt-in technique is used for joining P-No. 1, P-No. 3, P-No. 4, and P-No. 5A, a procedure qualification test with one P-Number metal shall also qualify for that P-Number metal welded to each of the lower P-Number metals, but not vice versa.

QW-403.13 A change from one P-No. 5 to any other P-No. 5 (viz P-No. 5A to P-No. 5B or P-No. 5C or vice versa). A change from P-No. 9A to P-No. 9B but not vice versa. A change from one P-No. 10 to any other P-No. 10 (viz P-No. 10A to P-No. 10B or P-No. 10C, etc., or vice versa).

QW-403.15 Welding procedure qualifications for laser beam welding and electron beam welding shall be made using a base metal of the same type or grade or another base metal listed in the same P-Number (and the same group where given — see QW/QB-422) as the base metal to be used in production welding. When joints are to be made between base metals from two different P-Numbers (or two different groups), a procedure qualification must be made for the applicable combination of base metals even though procedure qualification tests have been made for each of the two base metals welded to itself.

QW-403.16 A change in the pipe diameter beyond the range qualified in QW-452, except as otherwise permitted in QW-303.1, QW-303.2, QW-381(c), or QW-382(c). 01

QW-403.17 In stud welding, a change in combination of base metal listed under one P-Number in QW/QB-422 and stud metal P-Number (as defined in Note below), or to any other base metal/stud metal combination.

NOTE: Stud metal shall be classified by nominal chemical composition and can be assigned a P-Number when it meets the nominal composition of any one of the P-Number metals.

QW-403.18 A change from one P-Number to any other P-Number or to a base metal not listed in QW/QB-422, except as permitted in QW-423, and in QW-420.2.

QW-403.19 A change to another base material type or grade (type or grade are materials of the same nominal chemical analysis and mechanical property range, even though of different product form), or to any other base material type or grade. When joints are made between two different types or grades of base material, a procedure qualification must be made for the applicable combinations of materials, even though procedure qualification tests have been made for each of the two base materials welded to itself.

QW-403.20 A change from a base metal, listed under one P-Number in QW/QB-422, to a metal listed under another P-Number or to any other base metal; from a

base metal of one subgroup to any other grouping in P-No. 10 or 11.

QW-403.21 The addition or deletion of a coating, plating or cladding, or a change in the nominal chemical analysis or thickness range of the plating or cladding, or a change in type of coating as specified in the WPS.

QW-403.22 A change in the nominal base metal thickness exceeding 5% of any outer sheet thickness or 10% of the nominal thickness of the total joint from that qualified.

QW-403.23 A change in base metal thickness beyond the range qualified in QW-453.

QW-404 Filler Metals

QW-404.1 A change in the cross-sectional area of the filler metal added (excluding buttering) or in the wire-feed speed greater than ±10% beyond that qualified.

QW-404.2 A decrease in the thickness or change in nominal specified chemical analysis of weld metal buttering beyond that qualified. (Buttering or surfacing is the deposition of weld metal on one or both faces of the joint prior to preparation of the joint for final electron beam welding.)

QW-404.3 A change in the size of the filler metal.

QW-404.4 A change from one F-Number in QW-432 to any other F-Number or to any other filler metal not listed in QW-432.

QW-404.5 (Applicable only to ferrous metals.) A change in the chemical composition of the weld deposit from one A-Number to any other A-Number in QW-442. Qualification with A-No. 1 shall qualify for A-No. 2 and vice versa.

The weld metal chemical composition may be determined by any of the following.

(a) For all welding processes — from the chemical analysis of the weld deposit taken from the procedure qualification test coupon.

(b) For SMAW, GTAW, and PAW — from the chemical analysis of the weld deposit prepared according to the filler metal specification, or from the chemical composition as reported either in the filler metal specification or the manufacturer's or supplier's certificate of compliance.

(c) For GMAW and EGW — from the chemical analysis of the weld deposit prepared according to the filler metal specification or the manufacturer's or supplier's certificate of compliance when the shielding gas used was the same as that used to weld the procedure qualification test coupon.

(d) For SAW — from the chemical analysis of the weld deposit prepared according to the filler metal specification or the manufacturer's or supplier's certificate of compliance when the flux used was the same as that used to weld the procedure qualification test coupon.

In lieu of an A-Number designation, the nominal chemical composition of the weld deposit shall be indicated on the WPS and on the PQR. Designation of nominal chemical composition may also be by reference to the AWS classification (where such exists), the manufacturer's trade designation, or other established procurement documents.

QW-404.6 A change in the nominal size of the electrode or electrodes specified in the WPS.

QW-404.7 A change in the nominal diameter of the electrode to over $\frac{1}{4}$ in. (6 mm). This limitation does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding.

QW-404.8 Addition or deletion, or a change in nominal amount or composition of supplementary deoxidation material (in addition to filler metal) beyond that qualified. (Such supplementary metal may be required for weld metal deoxidation for some metals being welded.)

QW-404.9

(a) A change in the indicator for minimum tensile strength (e.g., the 7 in F7A2-EM12K) when the flux wire combination is classified in Section II, Part C.

(b) A change in either the flux trade name or wire trade name when neither the flux nor the wire is classified in Section II, Part C.

(c) A change in the flux trade name when the wire is classified in Section II, Part C but the flux is not classified. A change in the wire classification within the requirements of QW-404.5 does not require requalification.

(d) A change in the flux trade name for A-No. 8 deposits.

QW-404.10 Where the alloy content of the weld metal is largely dependent upon the composition of the flux used, any change in any part of the welding procedure which would result in the important alloying elements in the weld metal being outside of the specification range of chemistry given in the Welding Procedure Specification. If there is evidence that the production welds are not being made in accordance with the

procedure specification, the authorized inspector may require that a check be made on the chemical composition of the weld metal. Such a check shall preferably be made on a production weld.

QW-404.12 A change in the SFA specification filler metal classification or to a filler metal not covered by an SFA specification, or from one filler metal not covered by an SFA specification to another which is not covered by an SFA specification.

When a filler metal conforms to an SFA specification classification, requalification is not required if a change is made in any of the following:

(a) from a filler metal which is designated as moisture-resistant to one which is not designated as moisture-resistant and vice-versa (i.e., from E7018R to E7018);

(b) from one diffusible hydrogen level to another (i.e., from E7018-H8 to E7018-H16);

(c) for carbon, low alloy, and stainless steel filler metals having the same minimum tensile strength and the same nominal chemical composition, a change from one low hydrogen coating type to another low hydrogen coating type (i.e., a change among EXX15, 16, or 18 or EXXX15, 16, or 17 classifications);

(d) from one position-usability designation to another for flux cored electrodes (i.e., a change from E70T-1 to E71T-1 or vice versa);

(e) from a classification which requires impact testing to the same classification which has a suffix which indicates that impact testing was performed at a lower temperature or exhibited greater toughness at the required temperature or both, as compared to the classification which was used during procedure qualification (i.e., a change from E7018 to E7018-1).

(f) from the classification qualified to another filler metal within the same SFA specification when the weld metal is exempt from Impact Testing by other Sections.

This exemption does not apply to hard-facing and corrosion-resistant overlays.

QW-404.14 The deletion or addition of filler metal.

QW-404.15 A change from one F-Number in QW-432 to any other F-Number or to any other filler metal, except as permitted in QW-433.

QW-404.17 A change in the type of flux or composition of the flux.

QW-404.18 A change from wire to plate electrodes, and vice versa.

QW-404.19 A change from consumable guide to nonconsumable guide, and vice versa.

QW-404.20 Any change in the method by which filler metal is added, such as preplaced shim, top strip, wire, wire feed, or prior weld metal buttering of one or both joint faces.

QW-404.21 For filler metal additions, any change from the nominal specified analysis of the filler metal qualified.

QW-404.22 The omission or addition of consumable inserts. Qualification in a single-welded butt joint, with or without consumable inserts, qualifies for fillet welds and single-welded butt joints with backing or double-welded butt joints. Consumable inserts that conform to SFA-5.30, except that the chemical analysis of the insert conforms to an analysis for any bare wire given in any SFA specification or AWS Classification, shall be considered as having the same F-Number as that bare wire as given in QW-432.

QW-404.23 A change from one of the following filler metal product forms to another:

(a) flux cored

(b) bare (solid) or metal cored

(c) powder

QW-404.24 The addition, deletion, or change of more than 10% in the volume of supplemental filler metal.

QW-404.27 Where the alloy content of the weld metal is largely dependent upon the composition of the supplemental filler metal (including powder filler metal for PAW), any change in any part of the welding procedure which would result in the important alloying elements in the weld metal being outside of the specification range of chemistry given in the Welding Procedure Specification.

QW-404.29 A change in the flux trade name and designation.

QW-404.30 A change in deposited weld metal thickness beyond the range qualified in QW-451 for procedure qualification or QW-452 for performance qualification, except as otherwise permitted in QW-303.1 and QW-303.2. When a welder is qualified using radiography, the thickness ranges of QW-452.1 apply.

QW-404.31 The maximum thickness qualified is the thickness of the test coupon.

QW-404.32 For the low voltage short-circuiting type of gas metal-arc process when the deposited weld metal thickness is less than $\frac{1}{2}$ in. (13 mm), an increase in deposited weld metal thickness beyond 1.1 times that of the qualification test deposited weld metal thickness.

For weld metal thicknesses of ½ in. (13 mm) and greater, use QW-451.1 or QW-451.2, or QW-452.1 or QW-452.2, as applicable.

QW-404.33 A change in the SFA specification filler metal classification, or, if not conforming to an AWS filler metal classification, a change in the manufacturer's trade name for the electrode or filler metal. When optional supplemental designators, such as those which indicate moisture resistance (i.e., XXXXR), diffusible hydrogen (i.e., XXXX H16, H8, etc.), and supplemental impact testing (i.e., XXXX-1 or EXXXXM), are specified on the WPS, only filler metals which conform to the classification with the optional supplemental designator(s) specified on the WPS shall be used.

QW-404.34 A change in flux type (i.e., neutral to active or vice versa) for multilayer deposits in P-No. 1 materials.

QW-404.35 A change in the flux/wire classification or a change in either the electrode or flux trade name when not classified in an SFA specification. Requalification is not required when a wire/flux combination conforms to an SFA specification and a change is made from one diffusible hydrogen level to another (i.e., a change from F7A2-EA1-A1H4 to F7A2-EA1-A1H16). This variable does not apply when the weld metal is exempt from impact testing by other Sections. This exemption does not apply to hard facing and corrosion-resistant overlays.

QW-404.36 When flux from recrushed slag is used, each batch or blend, as defined in SFA-5.01, shall be tested in accordance with Section II, Part C by either the manufacturer or user, or qualified as an unclassified flux in accordance with QW-404.9.

QW-404.37 A change in the composition of the deposited weld metal from one A-Number in QW-442 to any other A-Number, or to an analysis not listed in the table. Each AWS classification of A-No. 8 or A-No. 9 analysis of QW-442, or each nonferrous alloy in QW-432, shall require separate WPS qualification. A-Numbers may be determined in accordance with QW-404.5.

QW-404.38 A change in the nominal electrode diameter used for the first layer of deposit.

QW-404.39 For submerged-arc welding and electroslag welding, a change in the nominal composition or type of flux used. Requalification is not required for a change in flux particle size.

QW-404.41 A change of more than 10% in the powdered metal feed rate recorded on the PQR.

QW-404.42 A change of more than 5% in the particle size range of the powder.

QW-404.43 A change in the powdered metal particle size range recorded on the PQR.

QW-404.44 A change from a homogeneous powdered metal to a mechanical mixed powdered metal or vice versa.

QW-404.45 A change in the form of filler metal from solid to fabricated wire, flux-cored wire, powdered metal, or vice versa.

QW-404.46 A change in the powder feed rate range qualified.

QW-404.47 A change of more than 10% in the filler metal size and/or powder metal particle size.

QW-404.48 A change of more than 10% in the powder metal density.

QW-404.49 A change of more than 10% in the filler metal or powder metal feed rate.

QW-404.50 The addition or deletion of flux to the face of a weld joint for the purpose of affecting weld penetration. 01

QW-405 Positions

QW-405.1 The addition of other welding positions than those already qualified. See QW-120, QW-130, and QW-303.

QW-405.2 A change from any position to the vertical position uphill progression. Vertical-uphill progression (e.g., 3G, 5G, or 6G position) qualifies for all positions. In uphill progression, a change from stringer bead to weave bead. This limitation does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding.

QW-405.3 A change from upward to downward, or from downward to upward, in the progression specified for any pass of a vertical weld, except that the cover or wash pass may be up or down. The root pass may also be run either up or down when the root pass is removed to sound weld metal in the preparation for welding the second side.

QW-405.4 Except as specified below, the addition of other welding positions than already qualified.

(a) Qualification in the horizontal, vertical, or overhead position shall also qualify for the flat position. Qualification in the horizontal fixed position, 5G, shall

qualify for the flat, vertical, and overhead positions. Qualification in the horizontal, vertical, and overhead positions shall qualify for all positions. Qualification in the inclined fixed position, 6G, shall qualify for all positions.

(b) A fabricator who does production welding in a particular orientation may make the tests for procedure qualification in this particular orientation. Such qualifications are valid only for the positions actually tested, except that an angular deviation of ±15 deg is permitted in the inclination of the weld axis and the rotation of the weld face as defined in QW-461.1. A test specimen shall be taken from the test coupon in each special orientation.

(c) For hard-facing weld metal overlay, qualification in the 3G, 5G, or 6G positions, where 5G or 6G pipe coupons include at least one vertical segment completed utilizing the up-hill progression or a 3G plate coupon is completed utilizing the up-hill progression, shall qualify for all positions. Chemical analysis, hardness, and macro-etch tests required in QW-453 may be limited to a single, vertical up-hill overlaid segment as shown in QW-462.5(b).

(d) For hard-facing weld metal overlay, a change from vertical down to vertical up-hill progression shall require requalification.

QW-406 Preheat

QW-406.1 A decrease of more than 100°F (56°C) in the preheat temperature qualified. The minimum temperature for welding shall be specified in the WPS.

QW-406.2 A change in the maintenance or reduction of preheat upon completion of welding prior to any required postweld heat treatment.

QW-406.3 An increase of more than 100°F (56°C) in the maximum interpass temperature recorded on the PQR. This limitation does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding.

QW-406.4 A decrease of more than 100°F (56°C) in the preheat temperature qualified or an increase in the maximum interpass temperature recorded on the PQR. The minimum temperature for welding shall be specifed in the WPS.

QW-406.5 A change in the maintenance or reduction of preheat upon completion of spraying and prior to fusing.

QW-406.6 A change of more than 10% in the amplitude or number of preheating cycles from that qualified.

QW-407 Postweld Heat Treatment

QW-407.1 A separate procedure qualification is required for each of the following conditions.

(a) For P-No. 1, P-No. 3, P-No. 4, P-No. 5, P-No. 6, P-No. 9, P-No. 10, and P-No. 11 materials, the following postweld heat treatment conditions apply:

(1) No PWHT;

(2) PWHT below the lower transformation temperature;

(3) PWHT above the upper transformation temperature (e.g., normalizing);

(4) PWHT above the upper transformation temperature followed by heat treatment below the lower transformation temperature (e.g., normalizing or quenching followed by tempering);

(5) PWHT between the upper and lower transformation temperatures.

(b) For all other materials, the following postweld heat treatment conditions apply:

(1) No PWHT;

(2) PWHT within a specified temperature range.

QW-407.2 A change in the postweld heat treatment (see QW-407.1) temperature and time range.

The procedure qualification test shall be subjected to PWHT essentially equivalent to that encountered in the fabrication of production welds, including at least 80% of the aggregate times at temperature(s). The PWHT total time(s) at temperature(s) may be applied in one heating cycle.

QW-407.4 For a procedure qualification test coupon receiving a postweld heat treatment in which the upper transformation temperature is exceeded, the maximum qualified thickness for production welds is 1.1 times the thickness of the test coupon.

QW-407.5 A separate procedure qualification is required for each of the following conditions:

(a) No PWHT;

(b) A change of more than 10% in the number of post heating cycles following the welding interval;

(c) PWHT within a specified temperature and time range if heat treatment is performed separately from the welding operation.

QW-407.6 A change in postweld heat treatment condition in QW-407.1 or an increase of 25% or more in total time at postweld heat treating temperature.

QW-407.7 A change in the heat treatment temperature range qualified if heat treatment is applied after fusing.

QW-408 Gas

QW-408.1 The addition or deletion of trailing shielding gas and/or a change in its composition.

01 **QW-408.2** A separate procedure qualification is required for each of the following conditions:

(a) a change from a single shielding gas to any other single shielding gas;

(b) a change from a single shielding gas to a mixture of shielding gasses, and vice versa;

(c) a change in the specified percentage composition of a shielding gas mixture;

(d) the addition or omission of shielding gas.

The AWS classification of SFA 5.32 may be used to specify the shielding gas composition.

QW-408.3 A change in the specified flow rate range of the shielding gas or mixture of gases.

A02 **QW-408.4** A change in the composition of the orifice or shielding gas.

QW-408.5 The addition or deletion of gas backing, a change in backing gas composition, or a change in the specified flow rate range of the backing gas.

QW-408.6 Any change of environment shielding such as from vacuum to an inert gas, or vice versa.

QW-408.7 A change in the type of fuel gas.

QW-408.8 The omission of inert gas backing except that requalification is not required when welding a single-welded butt joint with a backing strip or a double-welded butt joint or a fillet weld. This exception does not apply to P-No. 51 through P-No. 53, P-No. 61 through P-No. 62, and P-No. 10I metals.

01 **QW-408.9** For groove welds in P-No. 41 through P-No. 47 and all welds of P-No. 10I, P-No. 10J, P-No. 10K, P-No. 51 through P-No. 53, and P-No. 61 through P-No. 62 metals, the deletion of backing gas or a change in the nominal composition of the backing gas from an inert gas to a mixture including non-inert gas(es).

01 **QW-408.10** For P-No. 10I, P-No. 10J, P-No. 10K, P-No. 51 through P-No. 53, and P-No. 61 through P-No. 62 metals, the deletion of trailing shielding gas, or a change in the nominal composition of the trailing gas from an inert gas to a mixture including non-inert gas(es), or a decrease of 10% or more in the trailing gas flow rate.

QW-408.11 The addition or deletion of one or more of the following: shielding gas, trailing shielding gas, backing gas, or plasma-removing gas.

QW-408.12 A change of more than 5% in the flow rate of one or more of the following: shielding gas, trailer shielding gas, backing gas, and plasma-removing gas.

QW-408.13 A change in the position or orientation of plasma-removing gas jet relative to the workpiece (e.g., coaxial transverse to beam).

QW-408.14 A change in the oxygen or fuel gas pressure beyond the range qualified.

QW-408.15 In gas metal-arc welding and gas tungsten-arc welding: a change from a single gas to any other single gas or to a mixture of gases, or vice versa; a change in specified percentage composition of gas mixture or omission of shielding gas; a decrease of 10% or more in the rate of flow of shielding gas or mixture.

QW-408.16 A change of more than 5% in the flow rate of the plasma-arc gas or powdered metal feed gas recorded on the PQR.

QW-408.17 A change in the plasma-arc gas, shielding gas, or powdered metal feed gas from a single gas to any other single gas, or to a mixture of gases, or vice versa.

QW-408.18 A change of more than 10% in the gas mixture composition of the plasma-arc gas, shielding gas, or powdered metal feed gas recorded on the PQR.

QW-408.19 A change in the nominal composition of the powder feed gas or (plasma-arc spray) plasma gas qualified.

QW-408.20 A change of more than 5% in the plasma gas flow rate range qualified.

QW-408.21 A change in the flow rate of the orifice or shielding gas. A02

QW-409 Electrical Characteristics

QW-409.1 An increase in heat input, or an increase in volume of weld metal deposited per unit length of weld, over that qualified. The increase may be measured by either of the following:

(a) Heat input [J/in. (J/mm)]

$$= \frac{\text{Voltage} \times \text{Amperage} \times 60}{\text{Travel Speed [in./min (mm/min)]}}$$

(b) Volume of Weld Metal = an increase in bead size or a decrease in length of weld bead per unit length of electrode.

The requirement for measuring the heat input or volume of deposited weld metal does not apply when the WPS is qualified with a PWHT above the upper transformation temperature or a solution anneal after welding austenitic materials.

QW-409.2 A change from spray arc, globular arc, or pulsating arc to short circuiting arc, or vice versa.

QW-409.3 The addition or deletion of pulsing current to dc power source.

QW-409.4 A change from ac to dc, or vice versa; and in dc welding, a change from electrode negative (straight polarity) to electrode positive (reverse polarity), or vice versa.

QW-409.5 A change of ±15% from the amperage or voltage ranges in the qualified WPS.

QW-409.6 A change in the beam current of more than ±5%, voltage of more than ±2%, welding speed of more than ±2%, beam focus current of more than ±5%, gun-to-work distance of more than ±5%, or a change in oscillation length or width of more than ±20% from those previously qualified.

QW-409.7 Any change in the beam pulsing frequency duration from that qualified.

QW-409.8 A change in the range of amperage, or except for SMAW and GTAW welding, a change in the range of voltage. A change in the range of electrode wire feed speed may be used as an alternative to amperage.

QW-409.9 A change in the arc timing of more than $\pm 1/10$ sec.

QW-409.10 A change in amperage of more than ±10%.

QW-409.11 A change in the power source from one model to another.

QW-409.12 A change in type or size of tungsten electrode.

QW-409.13 A change in the shape or dimensions of the welding electrode; a change from one RWMA (Resistance Welding Manufacturer's Association) class electrode material to another.

QW-409.14 Addition or deletion of upslope or downslope current control, or a change of more than 10% in the slope current time or amplitude.

QW-409.15 A change of more than 5% in the electrode pressure, the welding current, or the welding time cycle from that qualified, except that requalification is not required if there is a change of not more than 10% in either the electrode pressure or the welding current or the welding time cycle, provided the remaining two variables remain at the values qualified. A change from ac to dc or vice versa. The addition or deletion of pulsing current to a dc power source. When using pulsing dc current, a change of more than 5% in the pulse amplitude, width, or number of pulses per cycle from that qualified.

QW-409.16 A change from synchronous to asynchronous timing.

QW-409.17 A change in the power supply primary voltage or frequency, or in the transformer turns ratio, tap setting, choke position, secondary open circuit voltage or phase control setting.

QW-409.18 A change in the procedure or frequency of tip cleaning.

QW-409.19 Any change in the beam pulsing frequency and pulse duration from that qualified.

QW-409.20 Any change in the following variables: mode of operation (from pulsed to continuous and vice versa), energy distribution across the beam (i.e., multimode or gaussian).

QW-409.21 Any change in the following variables: a change of more than 5% in the power delivered to the work surface as measured by calorimeter or other equivalent methods; a change of more than 2% in the travel speed; a change of more than 2% of the ratio of the beam diameter to focal length; a change of more than 2% of the lens to work distance.

QW-409.22 An increase of more than 10% in the amperage used in application for the first layer.

QW-409.23 A change of more than 10% in the ranges of amperage or voltage qualified.

QW-409.24 A change of more than 10% in the filler wire wattage recorded on the PQR. Wattage is a function of current voltage, and stickout dimension.

QW-409.25 A change of more than 10% in the plasma-arc current or voltage recorded on the PQR.

QW-409.26 For the first layer only, an increase in heat input of more than 10% or an increase in volume

of weld metal deposited per unit length of weld of more than 10% over that qualified. The increase may be measured by either of the following:

(a) Heat input [J/in. (J/mm)]

$$= \frac{\text{Voltage} \times \text{Amperage} \times 60}{\text{Travel Speed [in./min (mm/min)]}}$$

(b) Volume of Weld Metal = an increase in bead size or a decrease in length of weld bead per unit length of electrode.

QW-410 Technique

QW-410.1 A change from the stringer bead technique to the weave bead technique, or vice versa.

QW-410.2 A change in the nature of the flame, oxidizing to reducing, or vice versa.

QW-410.3 A change in the orifice, cup, or nozzle size.

QW-410.4 A change in the welding technique, forehand to backhand, or vice versa.

QW-410.5 A change in the method of initial and interpass cleaning (brushing, grinding, etc.)

QW-410.6 A change in the method of back gouging.

QW-410.7 A change in width, frequency, or dwell time of oscillation, for machine or automatic welding only.

QW-410.8 A change in the contact tube to work distance.

QW-410.9 A change from multipass per side to single pass per side. This limitation does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding.

QW-410.10 A change from single electrode to multiple electrode, or vice versa, for machine or automatic welding only. This limitation does not apply when a WPS is qualified with a PWHT above the upper transformation temperature or when an austenitic material is solution annealed after welding.

QW-410.11 A change from closed chamber to out-of-chamber conventional torch welding in P-No. 51 through P-No. 53 metals, but not vice versa.

QW-410.12 A change from the melt-in technique to the keyhole technique of welding, or vice versa, or the inclusion of both techniques though each has been individually qualified.

QW-410.14 A change in the angle of the axis of the beam relative to the workpiece.

QW-410.15 A change in the spacing of multiple electrodes for machine or automatic welding.

QW-410.17 A change in the type of the welding equipment.

QW-410.18 An increase in the absolute pressure of the vacuum welding environment beyond that qualified.

QW-410.19 Any change in filament type, size, or shape.

QW-410.20 The addition of a wash pass.

QW-410.21 A change of welding from one side to welding from both sides, or vice versa.

QW-410.22 A change in either of the following stud welding parameters: a change of stud gun model; a change in the lift more than $\pm 1/32$ in. (0.8 mm).

QW-410.25 A change from manual or semiautomatic to machine or automatic welding and vice versa.

QW-410.26 The addition or deletion of peening.

QW-410.27 A change in the rotational speed producing a change in the outside surface velocity [ft/min (m/min)] greater than ± 10% of the outside surface velocity qualified.

QW-410.28 A change in the thrust load (lb) greater than ±10% of the thrust load qualified.

QW-410.29 A change in the rotational energy (lb-ft^2) greater than ±10% of the rotational energy qualified.

QW-410.30 Any change in upset dimension (overall loss in length of parts being joined) greater than ±10% of the upset qualified.

QW-410.31 A change in the method of preparing the base metal prior to welding (e.g., changing from mechanical cleaning to chemical cleaning or to abrasive cleaning, or vice versa).

QW-410.32 A change of more than 10% in the holding pressure prior to or after welding. A change of more than 10% in the electrode holding time.

QW-410.33 A change from one welding type to another, or modification of equipment, including Manufacturer, control panel, model number, electrical rating or capacity, type of electrical energy source, or method of applying pressure.

QW-410.34 Addition or deletion of an electrode cooling medium and where it is used.

QW-410.35 A change in the distance between arms or a change in the throat depth.

QW-410.37 A change from single to multiple pass or vice versa.

QW-410.38 A change from multiple-layer to single layer cladding/hardsurfacing, or vice versa.

QW-410.39 A change in the torch type or tip size.

QW-410.40 For submerged-arc welding and electroslag welding, the deletion of a supplementary device for controlling the magnetic field acting on the weld puddle.

QW-410.41 A change of more than 15% in the travel speed range recorded on the PQR.

QW-410.42 The addition or elimination of oscillation of the plasma torch or filler wires; a change from simple harmonic to constant velocity oscillating motion or vice versa; a change of more than 10% in oscillation displacement recorded on the PQR; however, a procedure qualified using a minimum oscillation displacement and a procedure qualified using a maximum oscillation displacement shall qualify for all weld bead oscillations in between, with all other essential variables remaining the same.

QW-410.43 For the torch or workpiece, a change of more than 10% in the travel speed range qualified.

QW-410.44 A change of more than 15% in the spray-torch to workpiece distance qualified.

QW-410.45 A change in the method of surface preparation of the base metal to be hard-faced (example: sandblasting versus chemical cleaning).

QW-410.46 A change in the spray-torch model or tip orifice size.

QW-410.47 A change of more than 10% in the fusing temperature range qualified. A change in the rate of cooling from the fusing temperature of more than 50°F/hr (28°C/hr), a change in the fusing method (example: torch, furnace, induction).

QW-410.48 A change in the constricted arc from transferable to nontransferable or vice versa.

QW-410.49 A change in the diameter of the plasma torch-arc constricting orifice.

QW-410.50 A change in the number of electrodes acting on the same welding puddle.

QW-410.51 The addition or elimination of oscillation of the electrode or electrodes.

QW-410.52 A change in the method of delivering the filler metal to the molten pool, such as from the leading or trailing edge of the torch, the sides of the torch, or through the torch.

QW-410.53 A change of more than 20% in the center-to-center weld bead distance.

QW-416
WELDING VARIABLES
Welder Performance

Paragraph[1]		Brief of Variables	Essential					
			OFW QW-352	SMAW QW-353	SAW QW-354	GMAW[2] QW-355	GTAW QW-356	PAW QW-357
QW-402 Joints	.4	– Backing		X		X	X	X
	.7	+ Backing	X					
QW-403 Base Metal	.2	Maximum qualified	X					
	.16	ϕ Pipe diameter		X	X	X	X	X
	.18	ϕ P-Number	X	X	X	X	X	X
QW-404 Filler Metals	.14	± Filler	X				X	X
	.15	ϕ F-Number	X	X	X	X	X	X
	.22	± Inserts					X	X
	.23	Solid or metal-cored to flux-cored					X	X
	.30	ϕ *t* Weld deposit		X	X	X	X	X
	.31	ϕ *t* Weld deposit	X					
	.32	*t* Limit (s. cir. arc)				X		
QW-405 Positions	.1	+ Position	X	X	X	X	X	X
	.3	ϕ ↑ ↓ Vert. welding		X		X	X	X
QW-408 Gas	.7	ϕ Type fuel gas	X					
	.8	– Inert backing				X	X	X
QW-409 Electrical	.2	ϕ Transfer mode				X		
	.4	ϕ Current or polarity					X	

Welding Processes:

OFW	Oxyfuel gas welding
SMAW	Shielded metal-arc welding
SAW	Submerged-arc welding
GMAW	Gas metal-arc welding
GTAW	Gas tungsten-arc welding
PAW	Plasma-arc welding

Legend:

ϕ	Change	*t*	Thickness
+	Addition	↑	Uphill
–	Deletion	↓	Downhill

NOTES:
(1) For description, see Section IV.
(2) Flux-cored arc welding as shown in QW-355, with or without additional shielding from an externally supplied gas or gas mixture, is included.

QW-420 Material Groupings

QW-420.1 P-Numbers. To reduce the number of welding and brazing procedure qualifications required, base metals have been assigned P-Numbers, and for ferrous base metals which have specified impact test requirements, Group Numbers within P-Numbers. These assignments are based essentially on comparable base metal characteristics, such as composition, weldability, brazeability, and mechanical properties, where this can logically be done. These assignments do not imply that base metals may be indiscriminately substituted for a base metal which was used in the qualification test without consideration of compatibility from the standpoint of metallurgical properties, postweld heat treatment, design, mechanical properties, and service requirements. Where notch toughness is a consideration, it is presupposed that the base metals meet the specific requirements.

Base Metal	Welding	Brazing
Steel and steel alloys	P-No. 1 through P-No. 11 incl. P-No. 5A, 5B, and 5C	P-No. 101 through P-No. 103
Aluminum and aluminum-base alloys	P-No. 21 through P-No. 25	P-No. 104 and P-No. 105
Copper and copper-base alloys	P-No. 31 through P-No. 35	P-No.107 and P-No. 108
Nickel and nickel-base alloys	P-No. 41 through P-No. 47	P-No. 110 through P-No. 112
Titanium and titanium-base alloys	P-No. 51 through P-No. 53	P-No. 115
Zirconium and zirconium-base alloys	P-No. 61 through P-No. 62	P-No. 117

When a base metal with a UNS number designation is assigned a P-Number or P-Number plus Group Number, then a base metal listed in a different ASME material specification with the same UNS number shall be considered that P-Number or P-Number plus Group Number. For example, SB-163, UNS N08800 is P-Number 45; therefore, all ASME specifications listing a base metal with the UNS N08800 designation shall be considered P-Number 45 (i.e., SB-407, SB-408, SB-514, etc.) whether or not these specifications are listed in QW/QB-422. Since a minimum tensile value is required for procedure qualification, only base metals listed in QW/QB-422 may be used for test coupons as defined in QW-424.

In those instances where materials in the 1971 Edition of this Section have been given different P-Numbers or assigned to Subgroups within a P-Number in the 1974 Edition of this Section, those procedure and performance qualifications will continue to be valid based on the new P-Number designation.

In the column heading "Minimum Specified Tensile, ksi" of QW/QB-422, the values given are those of the base metal specification, except as otherwise identified in QW-153 or QB-153. These are also the acceptance values for the room temperature tensile tests of the welding or brazing procedure qualification, except as otherwise allowed in QW-153 or QB-153.

QW-420.2 S-Numbers (Non-Mandatory). S-Numbers are a listing of materials which are acceptable for use by the ASME B31 Code for Pressure Piping, or by selected Boiler and Pressure Vessel Code Cases, but which are not included within ASME Boiler and Pressure Vessel Code Material Specifications (Section II). These materials are grouped in S-Number or S-Number plus Group Number groupings similar to the P-Number groupings. There is no mandatory requirement that S-Numbers be used. 01

Brazing or Welding Procedure Qualification with a base metal in one P-Number (or P-Number plus Group Number) or one S-Number (or S-Number plus Group Number), qualifies for all other base metals in the same S-Number grouping. Also, qualification with a base metal in one S-Number, or S-Number plus Group Number, qualifies for all other base metals in the same S-Number grouping. Qualifications for S-Number materials do not qualify corresponding P-Number materials. Base metals not assigned an S-Number or a P-Number shall require individual procedure qualification.

Material produced under an ASTM specification shall be considered to have the same S-Number or S-Number plus Group Number as that of the P-Number or P-Number plus Group Number assigned to the same grade or type material in the corresponding ASME specification (i.e., SA-240 Type 304 is assigned P-Number 8, Group Number 1; therefore, A 240 Type 304 is considered S-Number 8, Group Number 1). Additionally, when a base metal with a UNS number designation is assigned an S-Number or S-Number plus Group Number, then a base metal listed in a different material specification with the same UNS number shall be considered that S-Number or S-Number plus Group Number. Since a minimum tensile value is required for procedure qualification, only base metals listed in QW/QB-422 may be used for test coupons.

For Performance Qualification of brazers, welders, brazing operators, and welding operators, the requirements for P-Numbers of base metals shall also be applied to the same S-Numbers of base metals. Qualification with P-Numbers in accordance with QB-310.3 and QW-403.18 qualifies for corresponding S-Numbers and vice versa.

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-36	...	K02600	58	1	1	...	...	101	...	C–Mn–Si	Plate, bar, & shapes
SA-53	Type F	...	48	1	1	...	...	101	...	C	Furnace welded pipe
SA-53	Type S, Gr. A	K02504	48	1	1	...	...	101	...	C	Smls. pipe
SA-53	Type E, Gr. A	K02504	48	1	1	...	...	101	...	C	Resistance welded pipe
SA-53	Type E, Gr. B	K03005	60	1	1	...	...	101	...	C–Mn	Resistance welded pipe
SA-53	Type S, Gr. B	K03005	60	1	1	...	...	101	...	C–Mn	Smls. pipe
SA-105	...	K03504	70	1	2	...	...	101	...	C–Si	Flanges & fittings
SA-106	A	K02501	48	1	1	...	...	101	...	C–Si	Smls. pipe
SA-106	B	K03006	60	1	1	...	...	101	...	C–Si	Smls. pipe
SA-106	C	K03501	70	1	2	...	...	101	...	C–Si	Smls. pipe
A 108	1015 CW	G10150	60	...	...	1	1	...	101	C	Bar
A 108	1018 CW	G10180	60	...	...	1	1	...	101	C	Bar
A 108	1020 CW	G10200	60	...	...	1	1	...	101	C	Bar
SA-134	SA283 Gr. A	...	45	1	1	...	...	101	...	C	Welded pipe
SA-134	SA283 Gr. B	...	50	1	1	...	...	101	...	C	Welded pipe
SA-134	SA283 Gr. C	K02401	55	1	1	...	...	101	...	C	Welded pipe
SA-134	SA283 Gr. D	K02702	60	1	1	...	...	101	...	C	Welded pipe
SA-134	SA285 Gr. A	K01700	45	1	1	...	...	101	...	C	Welded pipe
SA-134	SA285 Gr. B	K02200	50	1	1	...	...	101	...	C	Welded pipe
SA-134	SA285 Gr. C	K02801	55	1	1	...	...	101	...	C	Welded pipe
SA-135	A	...	48	1	1	...	...	101	...	C	E.R.W. pipe
SA-135	B	...	60	1	1	...	...	101	...	C	E.R.W. pipe
A 139	A	...	48	...	...	1	1	...	101	C	Welded pipe
A 139	B	K03003	60	...	...	1	1	...	101	C	Welded pipe
A 139	C	K03004	60	...	...	1	1	...	101	C	Welded pipe
A 139	D	K03010	60	...	...	1	1	...	101	C	Welded pipe
A 139	E	K03012	66	...	...	1	1	...	101	C	Welded pipe
A 148	90–60	...	90	...	...	4	3	...	103	...	Castings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
A 167	Type 301	S30100	75	...	...	8	1	...	102	17Cr–7Ni	Plate, sheet, & strip
A 167	Type 302	S30200	75	...	...	8	1	...	102	18Cr–8Ni	Plate, sheet, & strip
A 167	Type 302B	S30215	75	...	...	8	1	...	102	18Cr–8Ni–2Si	Plate, sheet, & strip
A 167	Type 304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Plate, sheet, & strip
A 167	Type 304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Plate, sheet, & strip
A 167	Type 305	S30500	70	...	...	8	1	...	102	18Cr–11Ni	Plate, sheet, & strip
A 167	Type 308	S30800	75	...	...	8	2	...	102	20Cr–10Ni	Plate, sheet, & strip
A 167	Type 309	S30900	75	...	...	8	2	...	102	23Cr–12Ni	Plate, sheet, & strip
A 167	Type 309S	S30908	75	...	...	8	2	...	102	23Cr–12Ni	Plate, sheet, & strip
A 167	Type 310	S31000	75	...	...	8	2	...	102	25Cr–20Ni	Plate, sheet, & strip
A 167	Type 310S	S31008	75	...	...	8	2	...	102	25Cr–20Ni	Plate, sheet, & strip
A 167	Type 316L	S31603	70	...	...	8	1	...	102	16Cr–12Ni–2Mo	Plate, sheet, & strip
A 167	Type 317	S31700	75	...	...	8	1	...	102	18Cr–13Ni–3Mo	Plate, sheet, & strip
A 167	Type 317L	S31703	75	...	...	8	1	...	102	18Cr–13Ni–3Mo	Plate, sheet, & strip
A 167	Type 321	S32100	75	...	...	8	1	...	102	18Cr–10Ni–Ti	Plate, sheet, & strip
A 167	Type 347	S34700	75	...	...	8	1	...	102	18Cr–10Ni–Cb	Plate, sheet, & strip
A 167	Type 348	S34800	75	...	...	8	1	...	102	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-178	A	K01200	47	1	1	...	...	101	...	C	E.R.W. tube
SA-178	C	K03503	60	1	1	...	...	101	...	C	E.R.W. tube
SA-178	D	...	70	1	2	...	...	101	...	C–Mn–Si	E.R.W. tube
SA-179	...	K01200	47	1	1	...	...	101	...	C	Smls. tube
SA-181	Cl. 60	K03502	60	1	1	...	...	101	...	C–Si	Pipe flange & fittings
SA-181	Cl. 70	K03502	70	1	2	...	...	101	...	C–Si	Pipe flange & fittings
SA-182	F12, Cl. 1	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Forgings
SA-182	F12, Cl. 2	K11564	70	4	1	...	...	102	...	1Cr–0.5Mo	Forgings
SA-182	F11, Cl. 2	K11572	70	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-182	F11, Cl. 3	K11572	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-182	F11, Cl. 1	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-182	F2	K12122	70	3	2	...	...	101	...	0.5Cr–0.5Mo	Forgings
SA-182	F1	K12822	70	3	2	...	...	101	...	C–0.5Mo	Forgings
SA-182	F22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-182	F22, Cl. 3	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-182	FR	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Forgings
SA-182	F21	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Forgings
SA-182	F3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-182	F22V	K31835	85	5C	1	...	...	102	...	2.25Cr–1Mo–V	Forgings
SA-182	F5	K41545	70	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-182	F5a	K42544	90	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-182	F9	K90941	85	5B	1	...	...	102	...	9Cr–1Mo	Forgings
SA-182	F91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Forgings
SA-182	F6a, Cl. 1	K91151	70	6	1	...	...	102	...	13Cr	Forgings
SA-182	F6a, Cl. 2	K91151	85	6	3	...	...	102	...	13Cr	Forgings
SA-182	FXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Forgings
SA-182	FXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Forgings
SA-182	F304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Forgings > 5 in. (127 mm)
SA-182	F304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-182	F304L	S30403	65	8	1	...	...	102	...	18Cr–8Ni	Forgings > 5 in. (127 mm)
SA-182	F304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-182	F304H	S30409	70	8	1	...	...	102	...	18Cr–8Ni	Forgings > 5 in. (127 mm)
SA-182	F304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-182	F304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-182	F304LN	S30453	70	8	1	...	...	102	...	18Cr–8Ni–N	Forgings > 5 in. (127 mm)
SA-182	F304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-182	F46	S30600	78	8	1	...	...	102	...	18Cr–15Ni–4Si	Forgings
SA-182	F45	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Forgings
SA-182	F310	S31000	70	8	2	...	...	102	...	25Cr–20Ni	Forgings > 5 in. (127 mm)
SA-182	F310	S31000	75	8	2	...	...	102	...	25Cr–20Ni	Forgings
SA-182	F50	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Forgings
SA-182	F44	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Forgings
SA-182	F316	S31600	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings > 5 in. (127 mm)

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-182	F316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-182	F316L	S31603	65	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings > 5 in. (127 mm)
SA-182	F316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-182	F316H	S31609	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings > 5 in. (127 mm)
SA-182	F316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-182	F316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-182	F316LN	S31653	70	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings > 5 in. (127 mm)
SA-182	F316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-182	F317	S31700	70	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings > 5 in. (127 mm)
SA-182	F317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings
SA-182	F317L	S31703	65	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings > 5 in. (127 mm)
SA-182	F317L	S31703	70	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings
SA-182	F51	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Forgings
SA-182	F321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings > 5 in. (127 mm)
SA-182	F321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-182	F321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings > 5 in. (127 mm)
SA-182	F321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-182	F55	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Forgings
SA-182	F10	S33100	80	8	2	...	...	102	...	20Ni–8Cr	Forgings
SA-182	F347	S34700	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in. (127 mm)
SA-182	F347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F347H	S34709	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in. (127 mm)
SA-182	F347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F348	S34800	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in. (127 mm)
SA-182	F348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F348H	S34809	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in. (127 mm)
SA-182	F348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F6b	S41026	110	6	3	...	...	102	...	13Cr–0.5Mo	Forgings
SA-182	F6NM	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Forgings
SA-182	F429	S42900	60	6	2	...	...	102	...	15Cr	Forgings
SA-182	F430	S43000	60	7	2	...	...	102	...	17Cr	Forgings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-182	FXM–27Cb	S44627	60	10I	1	...	...	102	...	27Cr–1Mo	Forgings
A 182	F6a, Cl. 3	S41000	110	...	...	6	3	...	102	13Cr	Forgings
A 182	F6a, Cl. 4	S41000	130	...	...	6	3	...	102	13Cr	Forgings
A 182	S34565	S34565	115	...	...	8	4	...	...	24Cr–17Ni–6Mn–4.5Mo–N	Forgings
SA-192	...	K01201	47	1	1	...	...	101	...	C–Si	Smls. tube
SA-199	T11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Smls. tube
SA-199	T22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Smls. tube
SA-199	T4	K31509	60	5A	1	...	...	102	...	2.25Cr–0.5Mo–0.75Si	Smls. tube
SA-199	T21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Smls. tube
SA-199	T5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Smls. tube
SA-199	T9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Smls. tube
SA-199	T91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Smls. tube
SA-202	A	K11742	75	4	1	...	...	101	...	0.5Cr–1.25Mn–Si	Plate
SA-202	B	K12542	85	4	1	...	...	101	...	0.5Cr–1.25Mn–Si	Plate
SA-203	A	K21703	65	9A	1	...	...	101	...	2.5Ni	Plate
SA-203	B	K22103	70	9A	1	...	...	101	...	2.5Ni	Plate
SA-203	D	K31718	65	9B	1	...	...	101	...	3.5Ni	Plate
SA-203	E	K32018	70	9B	1	...	...	101	...	3.5Ni	Plate
SA-203	F	K32018	75	9B	1	...	...	101	...	3.5Ni	Plate > 2 in. (51 mm)
SA-203	F	K32018	80	9B	1	...	...	101	...	3.5Ni	Plate, 2 in. (51 mm) & under
SA-204	A	K11820	65	3	1	...	...	101	...	C–0.5Mo	Plate
SA-204	B	K12020	70	3	2	...	...	101	...	C–0.5Mo	Plate
SA-204	C	K12320	75	3	2	...	...	101	...	C–0.5Mo	Plate
SA-209	T1b	K11422	53	3	1	...	...	101	...	C–0.5Mo	Smls. tube
SA-209	T1	K11522	55	3	1	...	...	101	...	C–0.5Mo	Smls. tube
SA-209	T1a	K12023	60	3	1	...	...	101	...	C–0.5Mo	Smls. tube
SA-210	A–1	K02707	60	1	1	...	...	101	...	C–Si	Smls. tube
SA-210	C	K03501	70	1	2	...	...	101	...	C–Mn–Si	Smls. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 211	A570-30	K02502	49	...	...	1	1	...	101	C	Welded pipe
A 211	A570-33	K02502	52	...	...	1	1	...	101	C	Welded pipe
A 211	A570-40	K02502	55	...	...	1	1	...	101	C	Welded pipe
SA-213	T2	K11547	60	3	1	...	...	101	...	0.5Cr–0.5Mo	Smls. tube
SA-213	T12	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Smls. tube
SA-213	T11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Smls. tube
SA-213	T17	K12047	60	10B	1	...	...	102	...	1Cr–V	Smls. tube
SA-213	T22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Smls. tube
SA-213	T21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Smls. tube
SA-213	T5c	K41245	60	5B	1	...	...	102	...	5Cr–0.5Mo–Ti	Smls. tube
SA-213	T5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Smls. tube
SA-213	T5b	K51545	60	5B	1	...	...	102	...	5Cr–0.5Mo–Si	Smls. tube
SA-213	T9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Smls. tube
SA-213	T91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Smls. tube
SA-213	TP201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Smls. tube
SA-213	TP202	S20200	90	8	3	...	...	102	...	18Cr–5Ni–9Mn	Smls. tube
SA-213	XM-19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Smls. tube
SA-213	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Smls. tube
SA-213	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Smls. tube
SA-213	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Smls. tube
SA-213	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Smls. tube
SA-213	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Smls. tube
SA-213	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Smls. tube
SA-213	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Smls. tube
SA-213	TP309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Smls. tube
SA-213	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. tube
SA-213	TP309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. tube
SA-213	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Smls. tube
SA-213	TP310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Smls. tube
SA-213	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. tube
SA-213	TP310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-213	TP310MoLN	S31050	78	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Smls. tube, $t > 1/4$ in. (6 mm)
SA-213	TP310MoLN	S31050	84	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Smls. tube, $t \leq 1/4$ in. (6 mm)
SA-213	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. tube
SA-213	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. tube
SA-213	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. tube
SA-213	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. tube
SA-213	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. tube
SA-213	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Smls. tube
SA-213	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Smls. tube
SA-213	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. tube
SA-213	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. tube
SA-213	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	XM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Smls. tube
SA-214	...	K01807	47	1	1	...	...	101	...	C	E.R.W. tube
SA-216	WCA	J02502	60	1	1	...	...	101	...	C–Si	Castings
SA-216	WCC	J02503	70	1	2	...	...	101	...	C–Mn–Si	Castings
SA-216	WCB	J03002	70	1	2	...	...	101	...	C–Si	Castings
SA-217	WC6	J12072	70	4	1	...	...	102	...	1.25Cr–0.5Mo	Castings
SA-217	WC4	J12082	70	4	1	...	...	101	...	1Ni–0.5Cr–0.5Mo	Castings
SA-217	WC1	J12524	65	3	1	...	...	101	...	C–0.5Mo	Castings
SA-217	WC9	J21890	70	5A	1	...	...	102	...	2.25Cr–1Mo	Castings
SA-217	WC5	J22000	70	4	1	...	...	101	...	0.75Ni–1Mo–0.75Cr	Castings
SA-217	C5	J42045	90	5B	1	...	...	102	...	5Cr–0.5Mo	Castings
SA-217	C12	J82090	90	5B	1	...	...	102	...	9Cr–1Mo	Castings
SA-217	CA15	J91150	90	6	3	...	...	102	...	13Cr	Castings
SA-225	D	K12004	75	10A	1	...	...	101	...	Mn–0.5Ni–V	Plate > 3 in. (76 mm)

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-225	D	K12004	80	10A	1	...	...	101	...	Mn–0.5Ni–V	Plate, 3 in. (76 mm) & under
SA-225	C	K12524	105	10A	1	...	...	101	...	Mn–0.5Ni–V	Plate
SA-226	...	K01201	47	1	1	...	...	101	...	C–Si	E.R.W. tube
SA-234	WPB	K03006	60	1	1	...	...	101	...	C–Si	Piping fitting
SA-234	WPC	K03501	70	1	2	...	...	101	...	C–Si	Piping fitting
SA-234	WP11, Cl. 1	...	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Piping fitting
SA-234	WP12, Cl. 1	K12062	60	4	1	...	...	101	...	1Cr–0.5Mo	Piping fitting
SA-234	WP1	K12821	55	3	1	...	...	101	...	C–0.5Mo	Piping fitting
SA-234	WP22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Piping fitting
SA-234	WPR	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Piping fitting
SA-234	WP5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Piping fitting
SA-234	WP9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Piping fitting
SA-234	WP91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Piping fitting
SA-240	Type 201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Plate, sheet, & strip
SA-240	Type 202	S20200	90	8	3	...	...	102	...	18Cr–5Ni–9Mn	Plate, sheet, & strip
SA-240	...	S20400	95	8	3	...	...	102	...	16Cr–9Mn–2Ni–N	Plate, sheet, & strip
SA-240	Type XM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Plate
SA-240	Type XM–19	S20910	105	8	3	...	...	102	...	22Cr–13Ni–5Mn	Sheet & strip
SA-240	Type XM–17	S21600	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Plate
SA-240	Type XM–17	S21600	100	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Sheet & strip
SA-240	Type XM–18	S21603	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Plate
SA-240	Type XM–18	S21603	100	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Sheet & strip
SA-240	S21800	S21800	95	8	3	...	...	102	...	18Cr–8Ni–4Si–N	Plate, sheet, & strip
SA-240	Type XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Plate, sheet, & strip
SA-240	Type 302	S30200	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-240	Type XM–21	S30452	85	8	1	...	...	102	...	18Cr–8Ni–N	Plate
SA-240	Type XM–21	S30452	90	8	1	...	...	102	...	18Cr–8Ni–N	Sheet & strip
SA-240	Type 304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-240	Type 305	S30500	70	8	1	...	...	102	...	18Cr–11Ni	Plate, sheet, & strip
SA-240	S30600	S30600	78	8	1	...	...	102	...	18Cr–15Ni–4Si	Plate, sheet, & strip
SA-240	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Plate, sheet, & strip
SA-240	Type 309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Plate, sheet, & strip
SA-240	Type 309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Plate, sheet, & strip
SA-240	Type 309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Plate, sheet, & strip
SA-240	Type 309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Plate, sheet, & strip
SA-240	Type 310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Plate, sheet, & strip
SA-240	Type 310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Plate, sheet, & strip
SA-240	Type 310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Plate, sheet, & strip
SA-240	Type 310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Plate, sheet, & strip
SA-240	Type 310MoLN	S31050	80	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Plate, sheet, & strip
SA-240	S31200	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Plate, sheet, & strip
SA-240	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Plate, sheet, & strip
SA-240	S31260	S31260	100	10H	1	...	...	102	...	25Cr–6.5Ni–3Mo–N	Plate, sheet, & strip
SA-240	Type 316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-240	Type 316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-240	Type 316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-240	Type 316Ti	S31635	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Ti	Plate, sheet, & strip
SA-240	Type 316Cb	S31640	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Cb	Plate, sheet, & strip
SA-240	Type 316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Plate, sheet, & strip
SA-240	Type 316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Plate, sheet, & strip
SA-240	Type 317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Plate, sheet, & strip
SA-240	Type 317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Plate, sheet, & strip
SA-240	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Plate, sheet, & strip
SA-240	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Plate, sheet, & strip
SA-240	S31753	S31753	80	8	1	...	...	102	...	18Cr–13Ni–3Mo–N	Plate, sheet, & strip
SA-240	S31803	S31803	90	10H	1	...	...	...	...	22Cr–5Ni–3Mo–N	Plate, sheet, & strip
SA-240	Type 321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Plate, sheet, & strip
SA-240	Type 321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Plate, sheet, & strip
SA-240	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Plate, sheet, & strip
SA-240	S32760	S32760	108	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Plate, sheet, & strip

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-240	Type 329	S32900	90	10H	1	...	...	102	...	26Cr–4Ni–Mo	Plate, sheet, & strip
SA-240	S32950	S32950	100	10H	1	...	...	102	...	26Cr–4Ni–Mo–N	Plate, sheet, & strip
SA-240	Type 347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type 347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type 348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type 348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type XM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Plate, sheet, & strip
SA-240	Type 405	S40500	60	7	1	...	...	102	...	12Cr–1Al	Plate, sheet, & strip
SA-240	Type 409	S40900	55	7	1	...	...	102	...	11Cr–Ti	Plate, sheet, & strip
SA-240	...	S40910	55	7	1	...	...	102	...	11Cr–Ti	Plate, sheet, & strip
SA-240	...	S40920	55	7	1	...	...	102	...	11Cr–Ti	Plate, sheet, & strip
SA-240	...	S40930	55	7	1	...	...	102	...	11Cr–Ti	Plate, sheet, & strip
SA-240	Type 410	S41000	65	6	1	...	...	102	...	13Cr	Plate, sheet, & strip
SA-240	Type 410S	S41008	60	7	1	...	...	102	...	13Cr	Plate, sheet, & strip
SA-240	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Plate, sheet, & strip
SA-240	Type 429	S42900	65	6	2	...	...	102	...	15Cr	Plate, sheet, & strip
SA-240	Type 430	S43000	65	7	2	...	...	102	...	17Cr	Plate, sheet, & strip
SA-240	Type 439	S43035	60	7	2	...	...	102	...	18Cr–Ti	Plate, sheet, & strip
SA-240	S44400	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Plate, sheet, & strip
SA-240	Type XM–33	S44626	68	10I	1	...	...	102	...	27Cr–1Mo–Ti	Plate, sheet, & strip
SA-240	Type XM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Plate, sheet, & strip
SA-240	S44635	S44635	90	10I	1	...	...	102	...	25Cr–4Ni–4Mo–Ti	Plate, sheet, & strip
SA-240	S44660	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Plate, sheet, & strip
SA-240	S44700	S44700	80	10J	1	...	...	102	...	29Cr–4Mo	Plate, sheet, & strip
SA-240	S44800	S44800	80	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Plate, sheet, & strip
A 240	S34565	S34565	115	...	...	8	4	...	...	24Cr–17Ni–6Mn–4.5Mo–N	Plate, sheet, & strip
SA-249	TP201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Welded tube
SA-249	TP202	S20200	90	8	3	...	...	102	...	18Cr–5Ni–9Mn	Welded tube
SA-249	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Welded tube
SA-249	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Welded tube
SA-249	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-249	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-249	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-249	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-249	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-249	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Welded tube
SA-249	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Welded tube
SA-249	TP309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Welded tube
SA-249	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded tube
SA-249	TP309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded tube
SA-249	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Welded tube
SA-249	TP310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Welded tube
SA-249	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded tube
SA-249	TP310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded tube
SA-249	TP310MoLN	S31050	78	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded tube, $t > 1/4$ in. (6 mm)
SA-249	TP310MoLN	S31050	84	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded tube, $t \leq 1/4$ in. (6 mm)
SA-249	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Welded tube
SA-249	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-249	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-249	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-249	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-249	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-249	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded tube
SA-249	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded tube
SA-249	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Welded tube
SA-249	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Welded tube
SA-249	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded tube
SA-249	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded tube
SA-249	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Welded tube
SA-250	T1b	K11422	53	3	1	...	...	101	...	C–0.5Mo	E.R.W. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-250	T1	K11522	55	3	1	...	...	101	...	C–0.5Mo	E.R.W. tube
SA-250	T2	K11547	60	3	1	...	...	101	...	0.5Cr–0.5Mo	E.R.W. tube
SA-250	T11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	E.R.W. tube
SA-250	T1a	K12023	60	3	1	...	...	101	...	C–0.5Mo	E.R.W. tube
SA-250	T22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	E.R.W. tube
A 254	Cl.1	K01001	42	...	...	...	...	...	101	C	Cu brazed tube
A 254	Cl.2	K01001	42	...	...	...	...	...	101	C	Cu brazed tube
SA-266	4	K03017	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-266	1	K03506	60	1	1	...	...	101	...	C–Si	Forgings
SA-266	2	K03506	70	1	2	...	...	101	...	C–Si	Forgings
SA-266	3	K05001	75	1	2	...	...	101	...	C–Si	Forgings
SA-268	TP405	S40500	60	7	1	...	...	102	...	12Cr–1Al	Smls. & welded tube
SA-268	S40800	S40800	55	7	1	...	...	102	...	12Cr–Ti	Smls. & welded tube
SA-268	TP409	S40900	55	7	1	...	...	102	...	11Cr–Ti	Smls. & welded tube
SA-268	TP410	S41000	60	6	1	...	...	102	...	13Cr	Smls. & welded tube
SA-268	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Smls. & welded tube
SA-268	TP429	S42900	60	6	2	...	...	102	...	15Cr	Smls. & welded tube
SA-268	TP430	S43000	60	7	2	...	...	102	...	17Cr	Smls. & welded tube
SA-268	TP439	S43035	60	7	2	...	...	102	...	18Cr–Ti	Smls. & welded tube
SA-268	TP430Ti	S43036	60	7	1	...	...	102	...	18Cr–Ti–Cb	Smls. & welded tube
SA-268	18Cr–2Mo	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Smls. & welded tube
SA-268	TP446–2	S44600	65	10I	1	...	...	102	...	27Cr	Smls. & welded tube
SA-268	TP446–1	S44600	70	10I	1	...	...	102	...	27Cr	Smls. & welded tube
SA-268	TPXM–33	S44626	68	10I	1	...	...	102	...	27Cr–1Mo–Ti	Smls. & welded tube
SA-268	TPXM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Smls. & welded tube
SA-268	25–4–4	S44635	90	10I	1	...	...	102	...	25Cr–4Ni–4Mo–Ti	Smls. & welded tube
SA-268	26–3–3	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Smls. & welded tube
SA-268	29–4	S44700	80	10J	1	...	...	102	...	29Cr–4Mo	Smls. & welded tube
SA-268	S44735	S44735	75	10J	1	...	...	102	...	29Cr–4Mo–Ti	Smls. & welded tube
SA-268	29–4–2	S44800	80	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Smls. & welded tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 269	TP316	S31600	75	...	...	8	1	...	102	16Cr–12Ni–2Mo	Smls. & welded tube
A 269	TP316L	S31603	70	...	...	8	1	...	102	16Cr–12Ni–2Mo	Smls. & welded tube
A 269	TP304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Smls. & welded tube
A 269	TP304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Smls. & welded tube
A 271	TP304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Smls. tube
A 271	TP304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Smls. tube
A 276	TP304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Bar
A 276	TP304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Bar
A 276	TP316	S31600	75	...	...	8	1	...	102	16Cr–12Ni–2Mo	Bar
A 276	TP316L	S31603	70	...	...	8	1	...	102	16Cr–12Ni–2Mo	Bar
A 276	TP410	S41000	65	...	...	6	1	...	102	13Cr	Bar
SA-283	A	K01400	45	1	1	...	...	101	...	C	Plate
SA-283	B	K01702	50	1	1	...	...	101	...	C	Plate
SA-283	C	K02401	55	1	1	...	...	101	...	C	Plate
SA-283	D	K02702	60	1	1	...	...	101	...	C	Plate
SA-285	A	K01700	45	1	1	...	...	101	...	C	Plate
SA-285	B	K02200	50	1	1	...	...	101	...	C	Plate
SA-285	C	K02801	55	1	1	...	...	101	...	C	Plate
SA-299	...	K02803	75	1	2	...	...	101	...	C–Mn–Si	Plate
SA-302	A	K12021	75	3	2	...	...	101	...	Mn–0.5Mo	Plate
SA-302	B	K12022	80	3	3	...	...	101	...	Mn–0.5Mo	Plate
SA-302	C	K12039	80	3	3	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-302	D	K12054	80	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-312	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Smls. & welded pipe
SA-312	TPXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Smls. & welded pipe
SA-312	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Smls. & welded pipe
SA-312	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Smls. & welded pipe
SA-312	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Smls. & welded pipe
SA-312	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Smls. & welded pipe
SA-312	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Smls. & welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-312	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Smls. & welded pipe
SA-312	S30600	S30600	78	8	1	...	...	102	...	18Cr–15Ni–4Si	Smls. & welded pipe
SA-312	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Smls. & welded pipe
SA-312	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Smls. & welded pipe
SA-312	TP309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Smls. & welded pipe
SA-312	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. & welded pipe
SA-312	TP309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. & welded pipe
SA-312	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Smls. & welded pipe
SA-312	TP310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Smls. & welded pipe
SA-312	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. & welded pipe
SA-312	TP310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. & welded pipe
SA-312	TP310MoLN	S31050	78	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded pipe, $t > 1/4$ in. (6 mm)
SA-312	TP310MoLN	S31050	84	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded pipe, $t \leq 1/4$ in. (6 mm)
SA-312	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Smls. & welded pipe
SA-312	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. & welded pipe
SA-312	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. & welded pipe
SA-312	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. & welded pipe
SA-312	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. & welded pipe
SA-312	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. & welded pipe
SA-312	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Smls. & welded pipe
SA-312	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Smls. & welded pipe
SA-312	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Smls. & welded pipe
SA-312	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Smls. & welded pipe
SA-312	TP321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe $> 3/8$ in. (10 mm)
SA-312	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe $\leq 3/8$ in. (10 mm)
SA-312	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-312	TP321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe $> 3/8$ in. (10 mm)

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-312	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe ≤ $^3/_8$ in. (10 mm)
SA-312	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-312	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Smls. & welded pipe
A 312	S34565	S34565	115	...	...	8	4	...	...	24Cr–17Ni–6Mn–4.6Mo–N	Smls. & welded pipe
A 331	8620 CW	G86200	90	...	...	3	3	...	102	0.5Ni–0.5Cr–Mo	Bar
SA-333	6	K03006	60	1	1	...	...	101	...	C–Mn–Si	Smls. & welded pipe
SA-333	1	K03008	55	1	1	...	...	101	...	C–Mn	Smls. & welded pipe
SA-333	10	...	80	1	3	...	...	101	...	C–Mn–Si	Smls. & welded pipe
SA-333	4	K11267	60	4	2	...	...	102	...	0.75Cr–0.75Ni–Cu–Al	Smls. & welded pipe
SA-333	7	K21903	65	9A	1	...	...	101	...	2.5Ni	Smls. & welded pipe
SA-333	9	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Smls. & welded pipe
SA-333	3	K31918	65	9B	1	...	...	101	...	3.5Ni	Smls. & welded pipe
SA-333	8	K81340	100	11A	1	...	...	101	...	9Ni	Smls. & welded pipe
SA-334	6	K03006	60	1	1	...	...	101	...	C–Mn–Si	Welded tube
SA-334	1	K03008	55	1	1	...	...	101	...	C–Mn	Welded tube
SA-334	7	K21903	65	9A	1	...	...	101	...	2.5Ni	Welded tube
SA-334	9	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Welded tube
SA-334	3	K31918	65	9B	1	...	...	101	...	3.5Ni	Welded tube
SA-334	8	K81340	100	11A	1	...	...	101	...	9Ni	Welded tube
SA-335	P1	K11522	55	3	1	...	...	101	...	C–0.5Mo	Smls. pipe
SA-335	P2	K11547	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Smls. pipe
SA-335	P12	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Smls. pipe
SA-335	P15	K11578	60	3	1	...	...	101	...	1.5Si–0.5Mo	Smls. pipe
SA-335	P11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Smls. pipe
SA-335	P22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Smls. pipe
SA-335	P21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Smls. pipe
SA-335	P5c	K41245	60	5B	1	...	...	102	...	5Cr–0.5Mo–Ti	Smls. pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-335	P5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Smls. pipe
SA-335	P5b	K51545	60	5B	1	...	...	102	...	5Cr–0.5Mo–Si	Smls. pipe
SA-335	P9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Smls. pipe
SA-335	P91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Smls. pipe
SA-336	F6	S41000	85	6	3	...	...	102	...	13Cr	Forgings
SA-336	F12	K11564	70	4	1	...	...	102	...	1Cr–0.5Mo	Forgings
SA-336	F11, Cl. 1	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-336	F11, Cl. 2	K11572	70	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-336	F11, Cl. 3	K11572	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-336	F1	K12520	70	3	2	...	...	101	...	C–0.5Mo	Forgings
SA-336	F22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-336	F22, Cl. 3	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-336	F21, Cl. 1	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Forgings
SA-336	F21, Cl. 3	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Forgings
SA-336	F3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-336	F22V	K31835	85	5C	1	...	...	102	...	2.25Cr–1Mo–V	Forgings
SA-336	F5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-336	F5A	K42544	80	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-336	F9	K90941	85	5B	1	...	...	102	...	9Cr–1Mo	Forgings
SA-336	F91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Forgings
SA-336	F46	S30600	78	8	1	...	...	102	...	18Cr–15Ni–4Si	Forgings
SA-336	FXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Forgings
SA-336	FXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Forgings
SA-336	F304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-336	F304L	S30403	65	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-336	F304H	S30409	70	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-336	F304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-336	F304LN	S30453	70	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-336	F310	S31000	75	8	2	...	...	102	...	25Cr–20Ni	Forgings
SA-336	F316	S31600	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-336	F316L	S31603	65	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-336	F316H	S31609	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-336	F316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-336	F316LN	S31653	70	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-336	F321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-336	F321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-336	F347	S34700	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-336	F347H	S34709	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-336	F348	S34800	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-336	F348H	S34809	65	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-350	LF1	K03009	60	1	1	...	...	101	...	C–Mn–Si	Forgings
SA-350	LF2	K03011	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-350	LF5, Cl. 1	K13050	60	9A	1	...	...	101	...	1.5Ni	Forgings
SA-350	LF5, Cl. 2	K13050	70	9A	1	...	...	101	...	1.5Ni	Forgings
SA-350	LF9	K22036	63	9A	1	...	...	101	...	2Ni–1Cu	Forgings
SA-350	LF3	K32025	70	9B	1	...	...	101	...	3.5Ni	Forgings
SA-351	CF3	J92500	70	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF3A	J92500	77	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF8	J92600	70	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF8A	J92600	77	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF8C	J92710	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Castings
SA-351	CF3M	J92800	70	8	1	...	...	102	...	18Cr–12Ni–2Mo	Castings
SA-351	CF8M	J92900	70	8	1	...	...	102	...	18Cr–12Ni–2Mo	Castings
SA-351	CF10	J92590	70	8	1	...	...	102	...	19Cr–9Ni–0.5Mo	Castings
SA-351	CF10M	J92901	70	8	1	...	...	102	...	19Cr–9Ni–2Mo	Castings
SA-351	CG8M	J93000	75	8	1	...	...	102	...	19Cr–10Ni–3Mo	Castings
SA-351	CK3MCuN	J93254	80	8	4	...	...	102	...	20Cr–18Ni–6Mo	Castings
SA-351	CE8MN	J93345	95	10H	1	...	...	102	...	24Cr–10Ni–Mo–N	Castings
SA-351	CD4MCu	J93370	100	10H	1	...	...	102	...	25Cr–5Ni–2Mo–3Cu	Castings
SA-351	CD3MWCuN	J93380	100	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Castings
SA-351	CH8	J93400	65	8	2	...	...	102	...	25Cr–12Ni	Castings
SA-351	CH20	J93402	70	8	2	...	...	102	...	25Cr–12Ni	Castings
SA-351	CG6MMN	J93790	85	8	3	...	...	102	...	22Cr–12Ni–5Mn	Castings
SA-351	CK20	J94202	65	8	2	...	...	102	...	25Cr–20Ni	Castings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-351	CN7M	N08007	62	45	...	...	...	111	...	28Ni–19Cr–Cu–Mo	Castings
SA-351	CT15C	N08151	63	45	...	...	...	111	...	32Ni–45Fe–20Cr–Cb	Castings
SA-351	CN3MN	J94651	80	45	...	...	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Castings
A 351	CA15	...	90	...	...	6	3	...	102	13Cr	Castings
A 351	CE20N	...	80	...	...	8	2	...	102	25Cr–8Ni–N	Castings
A 351	CF10MC	J92971	70	...	...	8	1	...	102	16Cr–14Ni–2Mo	Castings
A 351	CH10	J93401	70	...	...	8	2	...	102	25Cr–12Ni	Castings
A 351	HK30	J94203	65	...	...	8	2	...	102	25Cr–20Ni–0.5Mo	Castings
A 351	HK40	J94204	62	...	...	8	2	...	102	25Cr–20Ni–0.5Mo	Castings
A 351	HT30	N08603	65	...	...	45	...	...	111	35Ni–15Cr–0.5Mo	Castings
SA-352	LCA	J02504	60	1	1	...	...	101	...	C–Si	Castings
SA-352	LCC	J02505	70	1	2	...	...	101	...	C–Mn–Si	Castings
SA-352	LCB	J03003	65	1	1	...	...	101	...	C–Si	Castings
SA-352	LC1	J12522	65	3	1	...	...	101	...	C–0.5Mo	Castings
SA-352	LC2	J22500	70	9A	1	...	...	101	...	2.5Ni	Castings
SA-352	LC3	J31550	70	9B	1	...	...	101	...	3.5Ni	Castings
SA-352	LC4	J41500	70	9C	1	...	...	101	...	4.5Ni	Castings
SA-352	LC2–1	J42215	105	11A	5	...	...	102	...	3Ni–1.5Cr–0.5Mo	Castings
SA-352	CA6NM	J91540	110	6	4	...	...	102	...	13Cr–4Ni	Castings
SA-353	...	K81340	100	11A	1	...	...	101	...	9Ni	Plate
SA-358	XM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Fusion welded pipe
SA-358	XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Fusion welded pipe
SA-358	304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Fusion welded pipe
SA-358	304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Fusion welded pipe
SA-358	304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Fusion welded pipe
SA-358	304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Fusion welded pipe
SA-358	304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Fusion welded pipe
SA-358	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Fusion welded pipe
SA-358	309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-358	309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Fusion welded pipe
SA-358	310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Fusion welded pipe
SA-358	310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Fusion welded pipe
SA-358	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Fusion welded pipe
SA-358	316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Fusion welded pipe
SA-358	316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Fusion welded pipe
SA-358	316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Fusion welded pipe
SA-358	316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Fusion welded pipe
SA-358	316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Fusion welded pipe
SA-358	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Fusion welded pipe
SA-358	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Fusion welded pipe
SA-358	321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Fusion welded pipe
SA-358	347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Fusion welded pipe
SA-358	348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Fusion welded pipe
SA-369	FPA	K02501	48	1	1	...	...	101	...	C–Si	Forged pipe
SA-369	FPB	K03006	60	1	1	...	...	101	...	C–Mn–Si	Forged pipe
SA-369	FP1	K11522	55	3	1	...	...	101	...	C–0.5Mo	Forged pipe
SA-369	FP2	K11547	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Forged pipe
SA-369	FP12	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Forged pipe
SA-369	FP11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forged pipe
SA-369	FP22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Forged pipe
SA-369	FP21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Forged pipe
SA-369	FP5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Forged pipe
SA-369	FP9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Forged pipe
SA-369	FP91	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Forged pipe
SA-372	A	K03002	60	1	1	...	...	101	...	C–Si	Forgings
SA-372	B	K04001	75	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-376	16–8–2H	S16800	75	8	1	...	...	102	...	16Cr–8Ni–2Mo	Smls. pipe
SA-376	TP304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Smls. pipe ≥ 0.812 in. (21 mm)

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-376	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Smls. pipe < 0.812 in. (21 mm)
SA-376	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Smls. pipe
SA-376	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Smls. pipe
SA-376	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Smls. pipe
SA-376	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. pipe
SA-376	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. pipe
SA-376	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. pipe
SA-376	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. pipe
SA-376	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Smls. pipe
SA-376	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Smls. pipe
SA-376	TP321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe > $^3/_8$ in. (10 mm)
SA-376	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe ≤ $^3/_8$ in. (10 mm)
SA-376	TP321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe > $^3/_8$ in. (10 mm)
SA-376	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe ≤ $^3/_8$ in. (10 mm)
SA-376	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. pipe
SA-376	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. pipe
SA-376	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. pipe
A 381	Y35	K03013	60	...	...	1	1	...	101	C	Welded pipe
A 381	Y42	...	60	...	...	1	1	...	101	C	Welded pipe
A 381	Y48	...	62	...	...	1	1	...	101	C	Welded pipe > $^3/_8$ in. (10 mm)
A 381	Y46	...	63	...	...	1	1	...	101	C	Welded pipe
A 381	Y50	...	64	...	...	1	1	...	101	C	Welded pipe > $^3/_8$ in. (10 mm)
A 381	Y52	...	66	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in. (10 mm)

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 381	Y56	...	71	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in. (10 mm)
A 381	Y52	...	72	...	...	1	2	...	101	C	Welded pipe, to $^3/_8$ in. (10 mm)
A 381	Y56	...	75	...	...	1	2	...	101	C	Welded pipe, to $^3/_8$ in. (10 mm)
A 381	Y60	...	75	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in. (10 mm)
A 381	Y60	...	78	...	...	1	2	...	101	C	Welded pipe ≤ $^3/_8$ in. (10 mm)
SA-387	12, Cl. 1	K11757	55	4	1	...	...	102	...	1Cr–0.5Mo	Plate
SA-387	12, Cl. 2	K11757	65	4	1	...	...	102	...	1Cr–0.5Mo	Plate
SA-387	11, Cl. 1	K11789	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Plate
SA-387	11, Cl. 2	K11789	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Plate
SA-387	Gr. 2, Cl. 1	K12143	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Plate
SA-387	Gr. 2, Cl. 2	K12143	70	3	2	...	...	101	...	0.5Cr–0.5Mo	Plate
SA-387	22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-387	22, Cl. 2	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-387	21, Cl. 1	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Plate
SA-387	21, Cl. 2	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Plate
SA-387	5, Cl. 1	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Plate
SA-387	5, Cl. 2	K41545	75	5B	1	...	...	102	...	5Cr–0.5Mo	Plate
SA-387	Gr. 91, Cl. 2	K90901	85	5B	2	...	...	102	...	9Cr–1Mo–V	Plate
SA-403	WPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Wrought piping fittings
SA-403	WP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Wrought piping fittings
SA-403	WP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Wrought piping fittings
SA-403	WP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Wrought piping fittings
SA-403	WP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Wrought piping fittings
SA-403	WP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Wrought piping fittings
SA-403	WP309	S30900	75	8	2	...	...	102	...	23Cr–12Ni	Wrought piping fittings
SA-403	WP310	S31000	75	8	2	...	...	102	...	25Cr–20Ni	Wrought piping fittings
SA-403	WP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Wrought piping fittings
SA-403	WP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Wrought piping fittings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-403	...	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Wrought piping fittings
SA-403	WP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Wrought piping fittings
SA-403	WP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Wrought piping fittings
SA-403	WP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Wrought piping fittings
SA-403	WP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Wrought piping fittings
SA-403	WP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Wrought piping fittings
SA-403	WP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Wrought piping fittings
SA-403	WP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Wrought piping fittings
SA-403	WP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-403	WP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-403	WP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-403	WP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
A 403	S34565	S34565	115	...	...	8	4	...	...	24Cr–17Ni–6Mn–4.5Mo–N	Wrought piping fittings
SA-409	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-409	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-409	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Welded pipe
SA-409	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Welded pipe
SA-409	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded pipe
SA-409	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Welded pipe
SA-409	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded pipe
SA-409	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Welded pipe
SA-409	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-409	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-409	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded pipe
SA-409	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Welded pipe
SA-409	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Welded pipe
SA-409	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-409	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-409	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-414	A	K01501	45	1	1	...	...	101	...	C	Sheet
SA-414	B	K02201	50	1	1	...	...	101	...	C	Sheet
SA-414	C	K02503	55	1	1	...	...	101	...	C	Sheet

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-414	D	K02505	60	1	1	...	...	101	...	C–Mn	Sheet
SA-414	E	K02704	65	1	1	...	...	101	...	C–Mn	Sheet
SA-414	F	K03102	70	1	2	...	...	101	...	C–Mn	Sheet
SA-414	G	K03103	75	1	2	...	...	101	...	C–Mn	Sheet
SA-420	WPL6	K03006	60	1	1	...	...	101	...	C–Mn–Si	Piping fitting
SA-420	WPL9	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Piping fitting
SA-420	WPL3	K31918	65	9B	1	...	...	101	...	3.5Ni	Piping fitting
SA-420	WPL8	K81340	100	11A	1	...	...	101	...	9Ni	Piping fitting
SA-423	1	K11535	60	4	2	...	...	102	...	0.75Cr–0.5Ni–Cu	Smls. & welded tube
SA-423	2	K11540	60	4	2	...	...	102	...	0.75Ni–0.5Cu–Mo	Smls. & welded tube
SA-426	CP15	J11522	60	3	1	...	...	101	...	C–0.5Mo–Si	Centrifugal cast pipe
SA-426	CP2	J11547	60	3	1	...	...	101	...	0.5Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP12	J11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP11	J12072	70	4	1	...	...	102	...	1.25Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP1	J12521	65	3	1	...	...	101	...	C–0.5Mo	Centrifugal cast pipe
SA-426	CP22	J21890	70	5A	1	...	...	102	...	2.25Cr–1Mo	Centrifugal cast pipe
SA-426	CP21	J31545	60	5A	1	...	...	102	...	3Cr–1Mo	Centrifugal cast pipe
SA-426	CP5	J42045	90	5B	1	...	...	102	...	5Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP5b	J51545	60	5B	1	...	...	102	...	5Cr–1.5Si–0.5Mo	Centrifugal cast pipe
SA-426	CP9	J82090	90	5B	1	...	...	102	...	9Cr–1Mo	Centrifugal cast pipe
SA-426	CPCA15	J91150	90	6	3	...	...	102	...	13Cr	Centrifugal cast pipe
SA-430	FP16–8–2H	S16800	70	8	1	...	...	102	...	16Cr–8Ni–2Mo	Forged pipe
SA-430	FP304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Forged pipe
SA-430	FP304H	S30409	70	8	1	...	...	102	...	18Cr–8Ni	Forged pipe
SA-430	FP304N	S30451	75	8	1	...	...	102	...	18Cr–8Ni–N	Forged pipe
SA-430	FP316	S31600	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forged pipe
SA-430	FP316H	S31609	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forged pipe
SA-430	FP316N	S31651	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forged pipe
SA-430	FP321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forged pipe
SA-430	FP321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forged pipe
SA-430	FP347	S34700	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forged pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-430	FP347H	S34709	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forged pipe
A 441	1	K12211	70	...	...	1	2	...	101	Mn–Cu–V	Shapes
A 441	2	K12211	70	...	...	1	2	...	101	Mn–Cu–V	Shapes
A 446	A	...	45	...	...	1	1	...	101	C	Sheet
SA-451	CPF8	J92600	70	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPF8A	J92600	77	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPF8C	J92710	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Centrifugal cast pipe
SA-451	CPF8M	J92900	70	8	1	...	...	102	...	18Cr–12Ni–2Mo	Centrifugal cast pipe
SA-451	CPF3	J92500	70	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPF3M	J92800	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Centrifugal cast pipe
SA-451	CPF3A	J92500	77	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPH8	J93400	65	8	2	...	. . .	102	...	25Cr–12Ni	Centrifugal cast pipe
SA-451	CPH20	J93402	70	8	2	...	...	102	...	25Cr–12Ni	Centrifugal cast pipe
SA-451	CPK20	J94202	65	8	2	...	...	102	...	25Cr–20Ni	Centrifugal cast pipe
A 451	CPF10MC	J92971	70	...	...	8	1	...	102	16Cr–14Ni–2Mo	Centrifugal cast pipe
A 451	CPE20N	...	80	...	...	8	2	...	102	25Cr–8Ni–N	Centrifugal cast pipe
SA-452	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-452	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Centrifugal cast pipe
SA-452	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Centrifugal cast pipe
SA-455	...	K03300	70	1	2	...	...	101	...	C–Mn–Si	Plate > 0.580–0.750 in. (15–19 mm)
SA-455	...	K03300	73	1	2	...	...	101	...	C–Mn–Si	Plate > 0.375–0.580 in. (10–15 mm)
SA-455	...	K03300	75	1	2	...	...	101	...	C–Mn–Si	Plate, up to 0.375 in. (10 mm)
SA-479	XM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Bars & shapes
SA-479	XM–17	S21600	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Bars & shapes

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-479	XM–18	S21603	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Bars & shapes
SA-479	S21800	S21800	95	8	3	...	...	102	...	18Cr–8Ni–4Si–N	Bars & shapes
SA-479	XM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Bars & shapes
SA-479	XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Bars & shapes
SA-479	302	S30200	75	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Bars & shapes
SA-479	304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Bars & shapes
SA-479	S30600	S30600	78	8	1	...	...	102	...	18Cr–15Ni–4Si	Bars & shapes
SA-479	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Bars & shapes
SA-479	309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Bars & shapes
SA-479	309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Bars & shapes
SA-479	310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Bars & shapes
SA-479	310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Bars & shapes
SA-479	S31254	S31254	95	8	4	...	...	102	...	20Cr–18Ni–6Mo	Bars & shapes
SA-479	316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Bars & shapes
SA-479	316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Bars & shapes
SA-479	316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Bars & shapes
SA-479	316Ti	S31635	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Ti	Bars & shapes
SA-479	316Cb	S31640	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Cb	Bars & shapes
SA-479	316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Bars & shapes
SA-479	316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Bars & shapes
SA-479	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Bars & shapes
SA-479	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Bars & shapes
SA-479	321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Bars & shapes
SA-479	321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Bars & shapes
SA-479	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Bars & shapes
SA-479	347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding P-No.	Welding Group No.	Welding S-No.	Welding Group No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SA-479	348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	403	S40300	70	6	1	...	...	102	...	12Cr	Bars & shapes
SA-479	405	S40500	60	7	1	...	...	102	...	12Cr–1Al	Bars & shapes
SA-479	410	S41000	70	6	1	...	...	102	...	13Cr	Bars & shapes
SA-479	414	S41400	115	6	4	...	...	102	...	12.5Cr–2Ni–Si	Bars & shapes
SA-479	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Bars & shapes
SA-479	430	S43000	70	7	2	...	...	102	...	17Cr	Bars & shapes
SA-479	439	S43035	70	7	2	...	...	102	...	18Cr–Ti	Bars & shapes
SA-479	S44400	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Bars & shapes
SA-479	XM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Bars & shapes
SA-479	S44700	S44700	70	10J	1	...	...	102	...	29Cr–4Mo	Bars & shapes
SA-479	S44800	S44800	70	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Bars & shapes
SA-487	Gr. 16, Cl. A	J31200	70	1	2	...	...	101	...	Low C–Mn–Ni	Castings
SA-487	Gr. 1, Cl. A	J13002	85	10A	1	...	...	101	...	Mn–V	Castings
SA-487	Gr. 1, Cl. B	J13002	90	10A	1	...	...	101	...	Mn–V	Castings
SA-487	Gr. 2, Cl. A	J13005	85	3	3	...	...	101	...	Mn–0.25Mo–V	Castings
SA-487	Gr. 2, Cl. B	J13005	90	3	3	...	...	101	...	Mn–0.25Mo–V	Castings
SA-487	Gr. 4, Cl. A	J13047	90	3	3	...	...	101	...	0.5Ni–0.5Cr–0.25Mo–V	Castings
SA-487	Gr. 4, Cl. B	J13047	105	11A	3	...	...	101	...	0.5Ni–0.5Cr–0.25Mo–V	Castings
SA-487	Gr. 4, Cl. E	J13047	115	11A	3	...	...	101	...	0.5Ni–0.5Cr–0.25Mo–V	Castings
SA-487	Gr. 8, Cl. A	J22091	85	5C	1	...	...	102	...	2.25Cr–1Mo	Castings
SA-487	Gr. 8, Cl. C	J22091	100	5C	4	...	...	102	...	2.25Cr–1Mo	Castings
SA-487	Gr. 8, Cl. B	J22091	105	5C	4	...	...	102	...	2.25Cr–1Mo	Castings
SA-487	CA15M Cl. A	J91151	90	6	3	...	...	102	...	13Cr–Mo	Castings
SA-487	CA15 Cl. C	J91150	90	6	3	...	...	102	...	13Cr	Castings
SA-487	CA15 Cl. B	J91171	90	6	3	...	...	102	...	13Cr	Castings
SA-487	CA15 Cl. D	J91171	100	6	3	...	...	102	...	13Cr	Castings
SA-487	CA6NM Cl. B	J91540	100	6	4	...	...	102	...	13Cr–4Ni	Castings
SA-487	CA6NM Cl. A	J91540	110	6	4	...	...	102	...	13Cr–4Ni	Castings
SA-494	CX2MW	N26022	80	44	...	...	...	112	...	59Ni–22Cr–14Mo–4Fe–3W	Castings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 494	CW-6M	N30107	72	...	...	44	...	...	112	56Ni–19Mo–18Cr–2Fe	Castings
A 500	C	K02705	62	...	...	1	1	...	101	C	Tube
A 500	B	K03000	58	...	...	1	1	...	101	C	Tube
A 501	...	K03000	58	...	...	1	1	...	101	C	Tube
SA-508	3, Cl. 1	K12042	80	3	3	...	...	101	...	0.75Ni–0.5Mo–Cr–V	Forgings
SA-508	3, Cl. 2	K12042	90	3	3	...	...	102	...	0.75Ni–0.5Mo–Cr–V	Forgings
SA-508	2, Cl. 1	K12766	80	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-508	2, Cl. 2	K12766	90	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-508	1	K13502	70	1	2	...	...	101	...	C–Si	Forgings
SA-508	1A	...	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-508	22, Cl. 3	K21590	85	5C	1	...	...	...	...	2.25Cr–1Mo	Forgings
SA-508	4N, Cl. 3	K22375	90	3	3	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	4N, Cl. 1	K22375	105	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	4N, Cl. 2	K22375	115	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-508	5, Cl. 1	K42365	105	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	5, Cl. 2	K42365	115	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-513	1008	G10080	42	1	1	...	...	101	...	C	Tube
SA-513	1010	G10100	45	1	1	...	...	101	...	C	Tube
SA-513	1015	G10150	48	1	1	...	...	101	...	C	Tube
A 513	1015 CW	G10150	65	...	...	1	1	...	101	C	Tube
A 513	1020 CW	G10200	70	...	...	1	2	...	101	C	Tube
A 513	1025 CW	G10250	75	...	...	1	2	...	101	C	Tube
A 513	1026 CW	G10260	80	...	...	1	3	...	101	C	Tube
A 514	F	K11576	110	...	...	11B	3	...	101	0.75Ni–0.5Cr–0.5Mo–V	Plate, $2^1/_2$ in. (64 mm) max.
A 514	J	K11625	110	...	...	11B	6	...	101	C–0.5Mo	Plate, $1^1/_4$ in. (32 mm) max.
A 514	B	K11630	110	...	...	11B	4	...	101	0.5Cr–0.2Mo–V	Plate, $1^1/_4$ in. (32 mm) max.
A 514	D	K11662	110	...	...	11B	5	...	101	1Cr–0.2Mo–Si	Plate, $1^1/_4$ in. (32 mm) max.
A 514	A	K11856	110	...	...	11B	1	...	101	0.5Cr–0.25Mo–Si	Plate, $1^1/_4$ in. (32 mm) max.
A 514	E	K21604	100	...	...	11B	2	...	102	1.75Cr–0.5Mo–Cu	Plate > $2^1/_2$–6 in. (64–152 mm), incl.
A 514	E	K21604	110	...	...	11B	2	...	102	1.75Cr–0.5Mo–Cu	Plate, $2^1/_2$ in. (64 mm) max.

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 514	P	K21650	100	...	...	11B	8	...	102	1.25Ni–1Cr–0.5Mo	Plate > $2^1/_2$–6 in. (64–152 mm), incl.
A 514	P	K21650	110	...	...	11B	8	...	102	1.25Ni–1Cr–0.5Mo	Plate, $2^1/_2$ in. (64 mm) max.
A 514	Q	...	100	...	...	11B	9	...	102	1.3Ni–1.3Cr–0.5Mo–V	Plate > $2^1/_2$–6 in. (64–152 mm), incl.
A 514	Q	...	110	...	...	11B	9	...	102	1.3Ni–1.3Cr–0.5Mo–V	Plate, $2^1/_2$ in. (64 mm) max.
SA-515	60	K02401	60	1	1	...	...	101	...	C–Si	Plate
SA-515	65	K02800	65	1	1	...	...	101	...	C–Si	Plate
SA-515	70	K03101	70	1	2	...	...	101	...	C–Si	Plate
SA-516	55	K01800	55	1	1	...	...	101	...	C–Si	Plate
SA-516	60	K02100	60	1	1	...	...	101	...	C–Mn–Si	Plate
SA-516	65	K02403	65	1	1	...	...	101	...	C–Mn–Si	Plate
SA-516	70	K02700	70	1	2	...	...	101	...	C–Mn–Si	Plate
SA-517	F	K11576	115	11B	3	...	...	101	...	0.75Ni–0.5Cr–0.5Mo–V	Plate ≤ $2^1/_2$ in. (64 mm)
SA-517	J	K11625	115	11B	6	...	...	101	...	C–0.5Mo	Plate ≤ $1^1/_4$ in. (32 mm)
SA-517	B	K11630	115	11B	4	...	...	101	...	0.5Cr–0.2Mo–V	Plate ≤ $1^1/_4$ in. (32 mm)
SA-517	A	K11856	115	11B	1	...	...	101	...	0.5Cr–0.25Mo–Si	Plate ≤ $1^1/_4$ in. (32 mm)
SA-517	E	K21604	105	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Plate > $2^1/_2$–6 in. (64–152 mm)
SA-517	E	K21604	115	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Plate ≤ $2^1/_2$ in. (64 mm)
SA-517	P	K21650	105	11B	8	...	...	102	...	1.25Ni–1Cr–0.5Mo	Plate > $2^1/_2$–4 in. (64–102 mm)
SA-517	P	K21650	115	11B	8	...	...	102	...	1.25Ni–1Cr–0.5Mo	Plate ≤ $2^1/_2$ in. (64 mm)
A 519	1018 HR	G10180	50	...	...	1	1	...	101	C	Tube
A 519	1018 CW	G10180	70	...	...	1	2	...	101	C	Tube
A 519	1020 HR	G10200	50	...	...	1	1	...	101	C	Tube
A 519	1020 CW	G10200	70	...	...	1	2	...	101	C	Tube
A 519	1022 HR	G10220	50	...	...	1	1	...	101	C	Tube
A 519	1022 CW	G10220	70	...	...	1	2	...	101	C	Tube
A 519	1025 HR	G10250	55	...	...	1	1	...	101	C	Tube
A 519	1025 CW	G10250	75	...	...	1	2	...	101	C	Tube
A 519	1026 HR	G10260	55	...	...	1	1	...	101	C	Tube
A 519	1026 CW	G10260	75	...	...	1	2	...	101	C	Tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 521	Cl. CC	...	60	...	...	1	1	...	101	C	Forgings
A 521	Cl. CE	...	75	...	...	1	2	...	101	C	Forgings
SA-522	Type II	K71340	100	11A	1	...	...	101	...	8Ni	Forgings
SA-522	Type I	K81340	100	11A	1	...	...	101	...	9Ni	Forgings
SA-524	II	K02104	55	1	1	...	...	101	...	C–Mn–Si	Smls. pipe
SA-524	I	K02104	60	1	1	...	...	101	...	C–Mn–Si	Smls. pipe
SA-533	Type A, Cl. 1	K12521	80	3	3	...	...	101	...	Mn–0.5Mo	Plate
SA-533	Type A, Cl. 2	K12521	90	3	3	...	...	101	...	Mn–0.5Mo	Plate
SA-533	Type A, Cl. 3	K12521	100	11A	4	...	...	101	...	Mn–0.5Mo	Plate
SA-533	Type D, Cl. 1	K12529	80	3	3	...	...	101	...	Mn–0.5Mo–0.25Ni	Plate
SA-533	Type D, Cl. 2	K12529	90	3	3	...	...	101	...	Mn–0.5Mo–0.25Ni	Plate
SA-533	Type D, Cl. 3	K12529	100	11A	4	...	...	101	...	Mn–0.5Mo–0.25Ni	Plate
SA-533	Type B, Cl. 1	K12539	80	3	3	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-533	Type B, Cl. 2	K12539	90	3	3	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-533	Type B, Cl. 3	K12539	100	11A	4	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-533	Type C, Cl. 1	K12554	80	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-533	Type C, Cl. 2	K12554	90	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-533	Type C, Cl. 3	K12554	100	11A	4	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-537	Cl. 1	K12437	65	1	2	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$–4 in. (64–102 mm)
SA-537	Cl. 1	K12437	70	1	2	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. (64 mm) & under
SA-537	Cl. 2	K12437	70	1	3	...	...	101	...	C–Mn–Si	Plate > 4–6 in. (102–152 mm), incl.
SA-537	Cl. 2	K12437	75	1	3	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$–4 in. (64–102 mm)
SA-537	Cl. 2	K12437	80	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. (64 mm) & under
SA-537	Cl. 3	K12437	70	1	3	...	...	101	...	C–Mn–Si	Plate > 4 in. (102 mm)
SA-537	Cl. 3	K12437	75	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. < $t \leq$ 4 in. (64 mm < $t \leq$ 102 mm)
SA-537	Cl. 3	K12437	80	1	3	...	...	101	...	C–Mn–Si	Plate ≤ $2^1/_2$ in. (64 mm)

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-541	1	K03506	70	1	2	...	...	101	...	C–Si	Forgings
SA-541	1A	...	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-541	11, Cl. 4	K11572	80	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-541	3, Cl. 1	K12045	80	3	3	...	...	101	...	0.5Ni–0.5Mo–V	Forgings
SA-541	3, Cl. 2	K12045	90	3	3	...	...	101	...	0.5Ni–0.5Mo–V	Forgings
SA-541	2, Cl. 1	K12765	80	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-541	2, Cl. 2	K12765	90	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-541	22, Cl. 3	K21390	85	5C	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-541	22, Cl. 4	K21390	105	5C	4	...	...	102	...	2.25Cr–1Mo	Forgings
SA-541	22, Cl. 5	K21390	115	5C	5	...	...	102	...	2.25Cr–1Mo	Forgings
SA-541	3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-541	22V	K31835	85	5C	1	...	...	...	...	2.25Cr–1Mo–V	Forgings
SA-542	B, Cl. 4a	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 4	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 4	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 4a	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 3	K21590	95	5C	3	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 3	K21590	95	5C	3	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 1	K21590	105	5C	4	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 1	K21590	105	5C	4	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 2	K21590	115	5C	5	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 2	K21590	115	5C	5	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	C, Cl. 4	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 4a	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 3	K31830	95	5C	3	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 1	K31830	105	5C	4	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 2	K31830	115	5C	5	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	D, Cl. 4a	K31835	85	5C	1	...	...	...	...	2.25Cr–1Mo–V	Plate
SA-543	B Cl. 3	K42339	90	11A	5	...	...	102	...	3Ni–1.75Cr–0.5Mo	Plate
SA-543	B Cl. 1	K42339	105	11A	5	...	...	102	...	3Ni–1.75Cr–0.5Mo	Plate
SA-543	B Cl. 2	K42339	115	11B	10	...	...	102	...	3Ni–1.75Cr–0.5Mo	Plate
SA-543	C Cl. 3	K42338	90	11A	5	...	...	102	...	2.75Ni–1.5Cr–0.5Mo	Plate

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-543	C Cl. 1	K42338	105	11A	5	...	...	102	...	2.75Ni–1.5Cr–0.5Mo	Plate
SA-543	C Cl. 2	K42338	115	11B	10	...	...	102	...	2.75Ni–1.5Cr–0.5Mo	Plate
SA-553	II	K71340	100	11A	1	...	...	101	...	8Ni	Plate
SA-553	I	K81340	100	11A	1	...	...	101	...	9Ni	Plate
SA-556	A2	K01807	47	1	1	...	...	101	...	C	Smls. tube
SA-556	B2	K02707	60	1	1	...	...	101	...	C–Si	Smls. tube
SA-556	C2	K03006	70	1	2	...	...	101	...	C–Si	Smls. tube
SA-557	A2	K01807	47	1	1	...	...	101	...	C	E.R.W. tube
SA-557	B2	K03007	60	1	1	...	...	101	...	C	E.R.W. tube
SA-557	C2	K03505	70	1	2	...	...	101	...	C–Mn	E.R.W. tube
SA-562	...	K11224	55	1	1	...	...	101	...	C–Mn–Ti	Plate
A 570	30	K02502	49	...	...	1	1	...	101	C	Sheet & strip
A 570	33	K02502	52	...	...	1	1	...	101	C	Sheet & strip
A 570	36	K02502	53	...	...	1	1	...	101	C	Sheet & strip
A 570	40	K02502	55	...	...	1	1	...	101	C	Sheet & strip
A 570	45	K02507	60	...	...	1	1	...	101	C	Sheet & strip
A 570	50	K02507	65	...	...	1	1	...	101	C	Sheet & strip
A 572	42	...	60	...	...	1	1	...	101	C–Mn–Si	Plate & shapes
A 572	50	...	65	...	...	1	1	...	101	C–Mn–Si	Plate & shapes
A 572	60	...	75	...	...	1	2	...	101	C–Mn–Si	Plate & shapes
A 573	58	...	58	...	...	1	1	...	101	C	Plate
A 573	65	...	65	...	...	1	1	...	101	C	Plate
A 573	70	...	70	...	...	1	2	...	101	C	Plate
A 575	M 1008	...	...	...	...	1	1	...	101	C	Bar
A 575	M 1010	...	...	...	...	1	1	...	101	C	Bar
A 575	M 1012	...	...	...	...	1	1	...	101	C	Bar
A 575	M 1015	...	...	...	...	1	1	...	101	C	Bar
A 575	M 1017	...	...	...	...	1	1	...	101	C	Bar

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding P-No.	Welding Group No.	Welding S-No.	Welding Group No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
A 575	M 1020	...	...	...	...	1	1	...	101	C	Bar
A 575	M 1023	...	...	...	...	1	1	...	101	C	Bar
A 575	M 1025	...	...	...	...	1	1	...	101	C	Bar
A 576	G10080	...	...	...	...	1	1	...	101	C	Bar
A 576	G10100	...	...	...	...	1	1	...	101	C	Bar
A 576	G10120	...	...	...	...	1	1	...	101	C	Bar
A 576	G10150	...	...	...	...	1	1	...	101	C	Bar
A 576	G10160	...	...	...	...	1	1	...	101	C	Bar
A 576	G10170	...	...	...	...	1	1	...	101	C	Bar
A 576	G10180	...	...	...	...	1	1	...	101	C	Bar
A 576	G10190	...	...	...	...	1	1	...	101	C	Bar
A 576	G10200	...	...	...	...	1	1	...	101	C	Bar
A 576	G10210	...	...	...	...	1	1	...	101	C	Bar
A 576	G10220	...	...	...	...	1	1	...	101	C	Bar
A 576	G10230	...	...	...	...	1	1	...	101	C	Bar
A 576	G10250	...	...	...	...	1	1	...	101	C	Bar
SA-587	...	K11500	48	1	1	...	...	101	...	C	E.R.W. pipe
A 588	A, a	K11430	63	...	...	3	1	...	101	Mn–0.5Cr–0.3Cu–Si–V	Plate & bar
A 588	A, b	K11430	67	...	...	3	1	...	101	Mn–0.5Cr–0.3Cu–Si–V	Plate & bar
A 588	A, c	K11430	70	...	...	3	1	...	101	Mn–0.5Cr–0.3Cu–Si–V	Plate & shapes
A 588	B, a	K12043	63	...	...	3	1	...	101	Mn–0.6Cr–0.3Cu–Si–V	Plate & bar
A 588	B, b	K12043	67	...	...	3	1	...	101	Mn–0.6Cr–0.3Cu–Si–V	Plate & bar
A 588	B, c	K12043	70	...	...	3	1	...	101	Mn–0.6Cr–0.3Cu–Si–V	Plate & shapes
SA-592	F	K11576	105	11B	3	...	...	101	...	0.75Ni–0.5Cr–0.5Mo–V	Forgings, $2^1/_2$–4 in. (64–102 mm)
SA-592	F	K11576	115	11B	3	...	...	101	...	0.75Ni–0.5Cr–0.5Mo–V	Forgings, $2^1/_2$ in. (64 mm) & under
SA-592	E	K11695	105	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Forgings, $2^1/_2$–4 in. (64–102 mm)
SA-592	E	K11695	115	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Forgings, $2^1/_2$ in. (64 mm) & under

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-592	A	K11856	105	11B	1	...	...	101	...	0.5Cr–0.25Mo–Si	Forgings, $2^1/_2$–4 in. (64–102 mm)
SA-592	A	K11856	115	11B	1	...	...	101	...	0.5Cr–0.25Mo–Si	Forgings, $2^1/_2$ in. (64 mm) & under
A 611	A	G10170	42	...	...	1	1	...	101	C	Sheet
A 611	B	G10170	45	...	...	1	1	...	101	C	Sheet
A 611	C	G10170	48	...	...	1	1	...	101	C	Sheet
SA-612	...	K02900	81	10C	1	...	...	101	...	C–Mn–Si	Plate > $^1/_2$–1 in. (13–25 mm)
SA-612	...	K02900	83	10C	1	...	...	101	...	C–Mn–Si	Plate, $^1/_2$ in. (13 mm) & under
A 618	II, b	K12609	67	...	...	1	2	...	101	Mn–Cu–V	Tube > $^3/_4$–$1^1/_2$ in. (19–38 mm)
A 618	II, a	K12609	70	...	...	1	2	...	101	Mn–Cu–V	Tube, $^3/_4$ in. (19 mm) & under
A 618	III	K12700	65	...	...	1	1	...	101	Mn–V	Tube
SA-620	...	K00040	40	1	1	...	...	101	...	C	Sheet
A 633	A	K01802	63	...	...	1	1	...	101	Mn–Cb	Plate & shapes
A 633	C b	K12000	65	...	...	1	1	...	101	Mn–Cb	Plate > $2^1/_2$–4 in. (64–102 mm), shapes
A 633	C a	K12000	70	...	...	1	2	...	101	Mn–Cb	Plate to $2^1/_2$ in. (64 mm), shapes
A 633	D b	K12037	65	...	...	1	1	...	101	Mn–Cr–Ni–Cu	Plate > $2^1/_2$–4 in. (64–102 mm), shapes
A 633	D a	K12037	70	...	...	1	2	...	101	Mn–Cr–Ni–Cu	Plate to $2^1/_2$ in. (64 mm), shapes
A 633	E	K12202	80	...	...	1	3	...	101	C–Mn–Si–V	Plate & shapes
SA-645	...	K41583	95	11A	2	...	...	101	...	5Ni–0.25Mo	Plate
SA-660	WCA	J02504	60	1	1	...	...	101	...	C–Si	Centrifugal cast pipe
SA-660	WCC	J02505	70	1	2	...	...	101	...	C–Mn–Si	Centrifugal cast pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-660	WCB	J03003	70	1	2	...	...	101	...	C–Si	Centrifugal cast pipe
SA-662	A	K01701	58	1	1	...	...	101	...	C–Mn–Si	Plate
SA-662	C	K02007	70	1	2	...	...	101	...	C–Mn–Si	Plate
SA-662	B	K02203	65	1	1	...	...	101	...	C–Mn–Si	Plate
A 663	...	...	...	...	...	1	1	...	101	C	Bar
SA-666	201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Plate, sheet, & strip
SA-666	XM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Plate, sheet, & strip
SA-666	302	S30200	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-666	304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-666	304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-666	304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-666	304LN	S30453	80	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-666	316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-666	316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-666	316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Plate, sheet, & strip
A 668	Cl. B	G10200	60	...	...	1	1	...	101	C	Forgings
A 668	Cl. C	G10250	66	...	...	1	1	...	101	C	Forgings
A 668	Cl. D	G10300	75	...	...	1	2	...	101	C–Mn	Forgings
A 668	Cl. F b	...	85	...	...	1	3	...	101	C–Mn	Forgings > 4–10 in. (102–254 mm)
A 668	Cl. F a	...	90	...	...	1	3	...	101	C–Mn	Forgings, to 4 in. (102 mm)
A 668	Cl. K b	...	100	...	...	4	3	...	101	C	Forgings > 7–10 in. (178–254 mm)
A 668	Cl. K a	...	105	...	...	4	3	...	101	C	Forgings, to 7 in. (178 mm)
A 668	Cl. L c	...	110	...	...	4	3	...	101	C	Forgings > 7–10 in. (178–254 mm)
A 668	Cl. L b	...	115	...	...	4	3	...	101	C	Forgings > 4–7 in. (102–178 mm)
A 668	Cl. L a	...	125	...	...	4	3	...	101	C	Forgings, to 4 in. (102 mm)
SA-671	CC60	K02100	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-671	CE55	K02202	55	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CD70	K12437	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CD80	K12437	80	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CB60	K02401	60	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-671	CE60	K02402	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CC65	K02403	65	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CC70	K02700	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CB65	K02800	65	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-671	CA55	K02801	55	1	1	...	...	101	...	C	Fusion welded pipe
SA-671	CK75	K02803	75	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CB70	K03101	70	1	2	...	...	101	...	C–Si	Fusion welded pipe
SA-672	A45	K01700	45	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	C55	K01800	55	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	B55	K02001	55	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	C60	K02100	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	A50	K02200	50	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	E55	K02202	55	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	D70	K12437	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	D80	K12437	80	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	B60	K02401	60	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	E60	K02402	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	C65	K02403	65	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	C70	K02700	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	B65	K02800	65	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	A55	K02801	55	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	N75	K02803	75	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	B70	K03101	70	1	2	...	...	101	...	C–Si	Fusion welded pipe
SA-672	L65	K11820	65	3	1	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-672	L70	K12020	70	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-672	H75	K12021	75	3	2	...	...	101	...	Mn–0.5Mo	Fusion welded pipe
SA-672	H80	K12022	80	3	3	...	...	101	...	Mn–0.5Mo	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-672	L75	K12320	75	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-672	J100	K12521	100	11A	4	...	...	101	...	Mn–0.5Mo	Fusion welded pipe
SA-672	J80	K12554	80	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Fusion welded pipe
SA-672	J90	K12554	90	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Fusion welded pipe
SA-675	45	...	45	1	1	...	...	101	...	C	Bar
SA-675	50	...	50	1	1	...	...	101	...	C	Bar
SA-675	55	...	55	1	1	...	...	101	...	C	Bar
SA-675	60	...	60	1	1	...	...	101	...	C	Bar
SA-675	65	...	65	1	1	...	...	101	...	C	Bar
SA-675	70	...	70	1	2	...	...	101	...	C	Bar
A 675	75	...	75	...	...	1	2	...	101	C	Bar
SA-688	XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Welded tube
SA-688	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-688	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-688	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-688	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-688	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-688	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-688	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-688	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-691	CMSH–70	K12437	65	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe > $2^1/_2$–4 in. (64–102 mm)
SA-691	CMSH–70	K12437	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe ≤ $2^1/_2$ in. (64 mm)
SA-691	CMSH–80	K12437	75	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe > $2^1/_2$–4 in. (64–102 mm)
SA-691	CMSH–80	K12437	80	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe ≤ $2^1/_2$ in. (64 mm)
SA-691	CMS–75	K02803	75	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-691	1CR, Cl. 1	K11757	55	4	1	...	...	102	...	1Cr–0.5Mo	Fusion welded pipe
SA-691	1CR, Cl. 2	K11757	65	4	1	...	...	102	...	1Cr–0.5Mo	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-691	1.25CR, Cl. 1	K11789	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Fusion welded pipe
SA-691	1.25CR, Cl. 2	K11789	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Fusion welded pipe
SA-691	CM–65	K11820	65	3	1	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-691	CM–70	K12020	70	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-691	0.5CR, Cl. 1	K12143	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Fusion welded pipe
SA-691	0.5CR, Cl. 2	K12143	70	3	2	...	...	101	...	0.5Cr–0.5Mo	Fusion welded pipe
SA-691	CM–75	K12320	75	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-691	2.25CR, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Fusion welded pipe
SA-691	2.25CR, Cl. 2	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Fusion welded pipe
SA-691	3CR, Cl. 1	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Fusion welded pipe
SA-691	3CR, Cl. 2	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Fusion welded pipe
SA-691	5CR, Cl. 1	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Fusion welded pipe
SA-691	5CR, Cl. 2	K41545	75	5B	1	...	...	102	...	5Cr–0.5Mo	Fusion welded pipe
A 691	9CR, Cl. 2	...	85	...	...	5B	2	...	...	9Cr-1Mo-V	Fusion welded pipe
A 694	F42	K03014	60	...	...	1	1	...	101	C–Mn	Forgings
A 694	F46	K03014	60	...	...	1	1	...	101	C–Mn	Forgings
A 694	F52	K03014	66	...	...	1	1	...	101	C–Mn	Forgings
A 694	F56	K03014	68	...	...	1	2	...	101	C–Mn	Forgings
A 694	F60	K03014	75	...	...	1	2	...	101	C–Mn	Forgings
A 694	F65	K03014	77	...	...	1	2	...	101	C–Mn	Forgings
A 694	F70	K03014	82	...	...	1	3	...	101	C–Mn	Forgings
SA-695	Type B, Gr. 35	K03504	60	1	1	...	...	101	...	C–Mn–Si	Bar
SA-695	Type B, Gr. 40	K03504	70	1	2	...	...	101	...	C–Mn–Si	Bar
SA-696	B	K03200	60	1	1	...	...	101	...	C–Mn–Si	Bar
SA-696	C	K03200	70	1	2	...	...	101	...	C–Mn–Si	Bar
A 714	Gr. V, Tp. E	K22035	65	...	...	9A	1	...	102	2Ni–1Cu	Smls. & welded pipe
A 714	Gr. V	K22035	65	...	...	9A	1	...	102	2Ni–1Cu	Smls. & welded pipe
SA-724	A	K11831	90	1	4	...	...	101	...	C–Mn–Si	Plate
SA-724	B	K12031	95	1	4	...	...	101	...	C–Mn–Si	Plate

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-724	C	K12037	90	1	4	...	...	101	...	C–Mn–Si	Plate
SA-727	...	K02506	60	1	1	...	...	101	...	C–Mn–Si	Forgings
SA-731	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Smls. & welded pipe
SA-731	TP439	S43035	60	7	2	...	...	102	...	18Cr–Ti	Smls. & welded pipe
SA-731	18Cr–2Mo	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Smls. & welded pipe
SA-731	TPXM–33	S44626	65	10I	1	...	...	102	...	27Cr–1Mo–Ti	Smls. & welded pipe
SA-731	TPXM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Smls. & welded pipe
SA-731	S44660	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Smls. & welded pipe
SA-731	S44700	S44700	80	10J	1	...	...	102	...	29Cr–4Mo	Smls. & welded pipe
SA-731	S44800	S44800	80	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Smls. & welded pipe
SA-737	B	K12001	70	1	2	...	...	101	...	C–Mn–Si–Cb	Plate
SA-737	C	K12202	80	1	3	...	...	101	...	C–Mn–Si–V	Plate
SA-738	A	K12447	75	1	2	...	...	101	...	C–Mn–Si	Plate
SA-738	B	K12001	85	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. (64 mm) & under
SA-738	C	...	70	1	3	...	...	101	...	C–Mn–Si	Plate > 4–6 in. (102–152 mm), incl.
SA-738	C	...	75	1	3	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$–4 in. (64–102 mm)
SA-738	C	...	80	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. (64 mm) & under
SA-739	B11	K11797	70	4	1	...	...	102	...	1.25Cr–0.5Mo	Bar
SA-739	B22	K21390	75	5A	1	...	...	102	...	2.25Cr–1Mo	Bar
SA-765	I	K03046	60	1	1	...	...	101	...	C–Mn–Si	Forgings
SA-765	II	K03047	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-765	III	K32026	70	9B	1	...	...	101	...	3.5Ni	Forgings
SA-789	S31200	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Smls. & welded tube
SA-789	S31260	S31260	100	10H	1	...	...	102	...	25Cr–6.5Ni–3Mo–N	Smls. & welded tube
SA-789	S31500	S31500	92	10H	1	...	...	102	...	18Cr–5Ni–3Mo–N	Smls. & welded tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-789	S31803	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Smls. & welded tube
SA-789	S32304	S32304	87	10H	1	...	...	102	...	23Cr–4Ni–Mo–Cu–N	Smls. & welded tube > 1 in. (25 mm)
SA-789	S32304	S32304	100	10H	1	...	...	102	...	23Cr–4Ni–Mo–Cu–N	Smls. & welded tube ≤ 1 in. (25 mm)
SA-789	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Smls. & welded tube
SA-789	S32750	S32750	116	10H	1	...	...	102	...	25Cr–7Ni–4Mo–N	Smls. & welded tube
SA-789	S32900	S32900	90	10H	1	...	...	102	...	26Cr–4Ni–Mo	Smls. & welded tube
SA-789	S32950	S32950	100	10H	1	...	...	102	...	26Cr–4Ni–Mo–N	Smls. & welded tube
SA-789	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Smls. & welded tube
SA-790	S31200	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Smls. & welded pipe
SA-790	S31260	S31260	100	10H	1	...	...	102	...	25Cr–6.5Ni–3Mo–N	Smls. & welded pipe
SA-790	S31500	S31500	92	10H	1	...	...	102	...	18Cr–5Ni–3Mo–N	Smls. & welded pipe
SA-790	S31803	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Smls. & welded pipe
SA-790	S32304	S32304	87	10H	1	...	...	102	...	23Cr–4Ni–Mo–Cu–N	Smls. & welded pipe
SA-790	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Smls. & welded pipe
SA-790	S32750	S32750	116	10H	1	...	...	102	...	25Cr–7Ni–4Mo–N	Smls. & welded tube
SA-790	S32900	S32900	90	10H	1	...	...	102	...	26Cr–4Ni–Mo	Smls. & welded pipe
SA-790	S32950	S32950	100	10H	1	...	...	102	...	26Cr–4Ni–Mo–N	Smls. & welded pipe
SA-790	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Smls. & welded tube
SA-803	TP439	S43035	60	7	2	...	...	102	...	18Cr–Ti	Welded tube
SA-803	26–3–3	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Welded tube
SA-813	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Welded pipe
SA-813	TPXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Welded pipe
SA-813	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Welded pipe
SA-813	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-813	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-813	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-813	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

				Welding				Brazing			
Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	P-No.	Group No.	S-No.	Group No.	P-No.	S-No.	Nominal Composition	Product Form
SA-813	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Welded pipe
SA-813	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Welded pipe
SA-813	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Welded pipe
SA-813	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded pipe
SA-813	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Welded pipe
SA-813	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded pipe
SA-813	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Welded pipe
SA-813	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-813	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-813	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-813	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded pipe
SA-813	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded pipe
SA-813	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded pipe
SA-813	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded pipe
SA-813	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-813	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-813	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Welded pipe
SA-814	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Cold worked welded pipe
SA-814	TPXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Cold worked welded pipe
SA-814	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Cold worked welded pipe
SA-814	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Cold worked welded pipe
SA-814	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Cold worked welded pipe
SA-814	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Cold worked welded pipe
SA-814	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Cold worked welded pipe
SA-814	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Cold worked welded pipe
SA-814	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Cold worked welded pipe
SA-814	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Cold worked welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-814	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Cold worked welded pipe
SA-814	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Cold worked welded pipe
SA-814	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Cold worked welded pipe
SA-814	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Cold worked welded pipe
SA-814	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Cold worked welded pipe
SA-814	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Cold worked welded pipe
SA-814	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Cold worked welded pipe
SA-814	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Cold worked welded pipe
SA-814	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Cold worked welded pipe
SA-814	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Cold worked welded pipe
SA-814	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Cold worked welded pipe
SA-814	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Cold worked welded pipe
SA-814	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Cold worked welded pipe
SA-814	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Cold worked welded pipe
SA-815	S31803	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Fittings
SA-815	S41500	S41500	110	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Fittings
SA-815	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Fittings
SA-832	21V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-832	22V	K31835	85	5C	1	...	...	...	...	2.25Cr–1Mo–V	Plate
SA-836	...	...	55	1	1	...	...	101	...	C–Si–Ti	Forgings
A 890	CD3MWCuN	J93380	100	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Castings
A 928	...	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Welded pipe
API 5L	A25, Cl. I	...	45	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	A25, Cl. II	...	45	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	A	...	48	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding P-No.	Welding Group No.	Welding S-No.	Welding Group No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
API 5L	B	...	60	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X42	...	60	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X46	...	63	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X52	...	66	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X56	...	71	...	...	1	2	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X60	...	75	...	...	1	2	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X65	...	77	...	...	1	2	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X70	...	82	...	...	1	3	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X80	...	90	...	...	1	4	...	101	C–Mn	Smls. & welded pipe & tubes
MSS SP-75	WPHY-42	...	60	...	...	1	1	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-46	...	63	...	...	1	1	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-52	...	66	...	...	1	1	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-56	...	71	...	...	1	2	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-60	...	75	...	...	1	2	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-65	...	77	...	...	1	2	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-70	...	82	...	...	1	3	...	101	C–Mn	Smls./welded fittings
SA/CSA-G40.21	Gr. 38W	...	60	1	1	...	...	101	...	C–Mn–Si	Plate, bar, & shapes
SA/CSA-G40.21	Gr. 44W	...	60	1	1	...	...	101	...	C–Mn–Si	Plate, bar, & shapes
SA/EN 10028-2	295GH	...	64	1	1	...	...	101	...	C–Mn–Si	Plate > 4 in. (102 mm)
SA/EN 10028-2	295GH	...	67	1	1	...	...	101	...	C–Mn–Si	Plate ≤ 4 in. (102 mm)
SA/EN 10028-3	P275NH	...	53.5	1	1	...	...	101	...	C	Plate > 2 in. ≤ 4 in.
SA/EN 10028-3	P275NH	...	56.5	1	1	...	...	101	...	C	Plate ≤ 2 in.

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
B 16	C36000	...	48	...	...	...	107	65Cu–Zn–3Pb	Rod ≤ 1 in. (25 mm)
B 16	C36000	...	44	...	...	...	107	65Cu–Zn–3Pb	Rod > 1–2 in. (25–51 mm), incl.
B 16	C36000	...	40	...	...	...	107	65Cu–Zn–3Pb	Rod > 2 in. (51 mm)
B 16	C36000	...	44	...	...	...	107	65Cu–Zn–3Pb	Bar ≤ 1 in. (25 mm)
B 16	C36000	...	40	...	...	...	107	65Cu–Zn–3Pb	Bar > 1 in. (25 mm)
B 26	A24430	...	17	...	21	...	104	Al–Si	Castings
B 26	A03560	T71	25	...	21	...	104	Al–Si	Castings
B 26	A03560	T6	30	...	21	...	104	Al–Si	Castings
SB-42	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. pipe
SB-42	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. pipe
SB-42	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. pipe
SB-43	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. pipe
SB-61	C92200	...	30	...	...	107	...	88Cu–Sn–Zn–Pb	Castings
SB-62	C83600	...	28	...	...	107	...	85Cu–5Sn–5Zn–5Pb	Castings
B 68	C10200	102	30	...	31	...	107	99.95Cu–P	Tube
B 68	C12000	120	30	...	31	...	107	99.9Cu–P	Tube
B 68	C12200	122	30	...	31	...	107	99.9Cu–P	Tube
SB-75	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. tube
SB-75	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-75	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. tube
B 85	...	...	...	...	31	...	107	...	Die castings
B 88	C10200	102	30	...	31	...	107	99.95Cu–P	Tube
B 88	C12000	120	30	...	31	...	107	99.9Cu–P	Tube
B 88	C12200	122	30	...	31	...	107	99.9Cu–P	Tube
SB-96	C65500	...	50	33	...	107	...	97Cu–3.3Si	Plate, sht, strip, & bar

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-98	C65100	...	40	33	...	107	...	98.5Cu–1.5Si	Rod, bar, & shapes
SB-98	C65500	...	52	33	...	107	...	97Cu–3Si	Rod, bar, & shapes
SB-98	C66100	...	52	33	...	107	...	94Cu–3Si	Rod, bar, & shapes
SB-111	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. tube
SB-111	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-111	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-111	C14200	...	30	31	...	107	...	99.4Cu–As–P	Smls. tube
SB-111	C19200	...	38	31	...	107	...	99.7Cu–Fe–P	Smls. tube
SB-111	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. tube
SB-111	C28000	...	50	32	...	107	...	60Cu–40Zn	Smls. tube
SB-111	C44300	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06As	Smls. tube
SB-111	C44400	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06Sb	Smls. tube
SB-111	C44500	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06P	Smls. tube
SB-111	C60800	...	50	35	...	108	...	95Cu–5Al	Smls. tube
SB-111	C68700	...	50	32	...	108	...	78Cu–20Zn–2Al	Smls. tube
SB-111	C70400	...	38	34	...	107	...	95Cu–5Ni	Smls. tube
SB-111	C70600	...	40	34	...	107	...	90Cu–10Ni	Smls. tube
SB-111	C71000	...	45	34	...	107	...	80Cu–20Ni	Smls. tube
SB-111	C71500	...	52	34	...	107	...	70Cu–30Ni	Smls. tube
SB-111	C71640	...	63	34	...	107	...	66Cu–30Ni–2Fe–2Mn	Smls. tube
SB-111	C72200	...	45	34	...	107	...	80Cu–16Ni–0.75Fe–0.5Cr	Smls. tube
SB-127	N04400	...	70	42	...	110	...	67Ni–30Cu	Plate, sheet, & strip
SB-135	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. tube
SB-148	C95200	...	65	35	...	108	...	88Cu–9Al-3Fe	Castings
SB-148	C95400	...	75	35	...	108	...	85Cu–11Al-4Fe	Castings
B 148	C95300	...	65	...	35	...	108	89Cu–10Al–1Fe	Castings
B 148	C95500	...	90	...	35	...	108	82Cu–11Al–4Fe–3Mn	Castings
B 148	C95600	...	60	...	35	...	108	90Cu–7Al–3Si	Castings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-150	C61400	...	70	35	...	108	...	90Cuñ7Alñ3Fe	Rod & bar
SB-150	C62300	...	75	35	...	108	...	88Cuñ9Alñ3Fe	Rod (round)
SB-150	C63000	...	85	35	...	108	...	81Cuñ10Alñ5Niñ3Fe	Rod & bar
SB-150	C64200	...	70	35	...	108	...	91Cuñ7Alñ2Si	Rod & bar
SB-151	C70600	...	38	34	...	107	...	90Cuñ10Ni	Rod & bar
SB-152	C10200	...	30	31	...	107	...	99.95CuñP	Plt, sht, strip, & bar
SB-152	C10400	...	30	31	...	107	...	99.95Cu + Ag	Plt, sht, strip, & bar
SB-152	C10500	...	30	31	...	107	...	99.95Cu + Ag	Plt, sht, strip, & bar
SB-152	C10700	...	30	31	...	107	...	99.95Cu + Ag	Plt, sht, strip, & bar
SB-152	C11000	...	30	31	...	107	...	99.90Cu	Plt, sht, strip, & bar
SB-152	C12200	...	30	31	...	107	...	99.9CuñP	Plt, sht, strip, & bar
SB-152	C12300	...	30	31	...	107	...	99.9CuñP	Plt, sht, strip, & bar
SB-152	C12500	...	30	31	...	107	...	99.88Cu	Plt, sht, strip, & bar
SB-152	C14200	...	30	31	...	107	...	99.4CuñAsñP	Plt, sht, strip, & bar
SB-160	N02200	...	55	41	...	110	...	99.0Ni	Rod & bar
SB-160	N02201	...	50	41	...	110	...	99.0NiñLow C	Rod & bar
SB-161	N02200	...	55	41	...	110	...	99.0Ni	Smls. pipe & tube
SB-161	N02201	...	50	41	...	110	...	99.0NiñLow C	Smls. pipe & tube
SB-162	N02200	...	55	41	...	110	...	99.0Ni	Plate, sheet, & strip
SB-162	N02201	...	50	41	...	110	...	99.0NiñLow C	Plate, sheet, & strip
SB-163	N02200	...	55	41	...	110	...	99.0Ni	Smls. tube
SB-163	N02201	...	50	41	...	110	...	99.0NiñLow C	Smls. tube
SB-163	N04400	...	70	42	...	110	...	67Niñ30Cu	Smls. tube
SB-163	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Smls. tube
SB-163	N06690	...	85	43	...	111	...	58Niñ29Crñ9Fe	Smls. tube
SB-163	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Smls. tube
SB-163	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Smls. tube
SB-163	N08811	...	65	45	...	...	...	33Niñ42Feñ21CrñAlñTi	Smls. tube
SB-163	N08825	...	85	45	...	111	...	42Niñ21.5Crñ3Moñ2.3Cu	Smls. tube
SB-164	N04400	...	70	42	...	110	...	67Niñ30Cu	Rod, bar, & wire

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-164	N04405	...	70	42	...	110	...	67Niñ30Cu	Rod, bar, & wire
SB-165	N04400	...	70	42	...	110	...	67Niñ30Cu	Smls. pipe & tube
SB-166	N06045	...	90	46	...	...	...	46Niñ27Crñ23Feñ2.75Si	Rod, bar, & wire
SB-166	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Rod, bar, & wire
SB-166	N06690	...	85	43	...	111	...	58Niñ29Crñ9Fe	Rod, bar, & wire
SB-167	N06045	...	90	46	...	...	...	46Niñ27Crñ23Feñ2.75Si	Smls. pipe & tube
SB-167	N06600	...	75	43	...	111	...	72Niñ15Crñ8Fe	Smls. pipe & tube
SB-167	N06690	...	75	43	...	111	...	58Niñ29Crñ9Fe	Smls. pipe & tube
SB-168	N06045	...	90	46	...	...	...	46Niñ27Crñ23Feñ2.75Si	Plate, sheet, & strip
SB-168	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Plate, sheet, & strip
SB-168	N06690	...	85	43	...	111	...	58Niñ29Crñ9Fe	Plate, sheet, & strip
SB-169	C61400	...	65	35	...	108	...	90Cuñ7Alñ3Fe	Plt, sht, strip, & bar
SB-171	C36500	...	40	32	...	107	...	60Cuñ39ZnñPb	Plate & sheet
SB-171	C44300	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06As	Plate & sheet
SB-171	C44400	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06Sb	Plate & sheet
SB-171	C44500	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06P	Plate & sheet
SB-171	C46400	...	50	32	...	107	...	60Cuñ39ZnñSn	Plate & sheet
SB-171	C46500	...	50	32	...	107	...	60Cuñ39ZnñAs	Plate & sheet
SB-171	C61400	...	65	35	...	108	...	90Cuñ7Alñ3Fe	Plate & sheet > 2ñ5 in. (51ñ127 mm), incl.
SB-171	C61400	...	70	35	...	108	...	90Cuñ7Alñ3Fe	Plate & sheet ≤ 2 in. (51 mm)
SB-171	C63000	...	80	35	...	108	...	81Cuñ10Alñ5Niñ3Fe	Plate & sheet > $3\frac{1}{2}$ñ5 in. (89ñ127 mm), incl.
SB-171	C63000	...	85	35	...	108	...	81Cuñ10Alñ5Niñ3Fe	Plate & sheet > 2ñ3.5 in. (51ñ89 mm), incl.
SB-171	C63000	...	90	35	...	108	...	81Cuñ10Alñ5Niñ3Fe	Plate & sheet ≤ 2 in. (51 mm)
SB-171	C70600	...	40	34	...	107	...	90Cuñ10Ni	Plate & sheet
SB-171	C71500	...	45	34	...	107	...	70Cuñ30Ni	Plate & sheet > 2.5ñ5 in. (64ñ127 mm), incl.
SB-171	C71500	...	50	34	...	107	...	70Cuñ30Ni	Plate & sheet ≤ 2.5 in. (64 mm)
SB-187	C10200	060	28	31	...	...	...	99.95CuñP	Rod & bar
SB-187	C11000	060	28	31	...	...	...	99.9Cu	Rod & bar
SB-209	A91060	1060	8	21	...	104	...	99.60Al	Plate & sheet

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-209	A91100	1100	11	21	...	104	...	99.0AlñCu	Plate & sheet
SB-209	A93003	3003	14	21	...	104	...	AlñMnñCu	Plate & sheet
SB-209	A93004	3004	22	22	...	104	...	AlñMnñMg	Plate & sheet
SB-209	A95052	5052	25	22	...	105	...	Alñ2.5Mg	Plate & sheet
SB-209	A95083	5083	36	25	...	105	...	Alñ4.4MgñMn	Plate & sheet > 7ñ8 in. (178ñ203 mm), incl.
SB-209	A95083	5083	37	25	...	105	...	Alñ4.4MgñMn	Plate & sheet > 5ñ7 in. (127ñ178 mm), incl.
SB-209	A95083	5083	38	25	...	105	...	Alñ4.4MgñMn	Plate & sheet > 3ñ5 in. (76ñ127 mm), incl.
SB-209	A95083	5083	39	25	...	105	...	Alñ4.4MgñMn	Plate & sheet > 1.5ñ3 in. (38ñ76 mm), incl.
SB-209	A95083	5083	40	25	...	105	...	Alñ4.4MgñMn	Plate & sheet > 0.05ñ1.5 in. (1.3ñ38 mm), incl.
SB-209	A95086	5086	34	25	...	105	...	Alñ4.0MgñMn	Plate & sheet > 2ñ3 in. (51ñ76 mm), incl.
SB-209	A95086	5086	35	25	...	105	...	Alñ4.0MgñMn	Plate & sheet > 0.05ñ2 in. (1.3ñ51 mm), incl.
SB-209	A95154	5154	30	22	...	105	...	Alñ3.5Mg	Plate & sheet
SB-209	A95254	5254	30	22	...	105	...	Alñ3.5Mg	Plate & sheet
SB-209	A95454	5454	31	22	...	105	...	Alñ2.7MgñMn	Plate & sheet
SB-209	A95456	5456	38	25	...	105	...	Alñ5.1MgñMn	Plate & sheet > 7ñ8 in. (178ñ203 mm), incl.
SB-209	A95456	5456	39	25	...	105	...	Alñ5.1MgñMn	Plate & sheet > 5ñ7 in. (127ñ178 mm), incl.
SB-209	A95456	5456	40	25	...	105	...	Alñ5.1MgñMn	Plate & sheet > 3ñ5 in. (76ñ127 mm), incl.
SB-209	A95456	5456	41	25	...	105	...	Alñ5.1MgñMn	Plate & sheet > 1.5ñ3 in. (38ñ76 mm), incl.
SB-209	A95456	5456	42	25	...	105	...	Alñ5.1MgñMn	Plate & sheet > 0.05ñ1.5 in. (1.3ñ38 mm), incl.
SB-209	A95652	5652	25	22	...	105	...	Alñ2.5Mg	Plate & sheet
SB-209	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Plate & sheet
SB-209	...	Alclad 3003	13	21	...	104	...	AlñMnñCu	Plate & sheet > 0.05 in. < 0.5 in. (> 1.3 mm < 13 mm)
SB-209	...	Alclad 3003	14	21	...	104	...	AlñMnñCu	Plate & sheet ≥ 0.5ñ3 in. (13ñ76 mm), incl.
SB-209	...	Alclad 3004	21	22	...	104	...	AlñMnñMg	Plate & sheet > 0.05 in. < 0.5 in. (>1.3 mm < 13 mm)
SB-209	...	Alclad 3004	22	22	...	104	...	AlñMnñMg	Plate & sheet ≥ 0.5ñ3 in. (13ñ76 mm), incl.
SB-209	...	Alclad 6061	24	23	...	105	...	AlñMgñSiñCu	Plate & sheet
B 209	A95050	5050	18	...	21	...	105	Alñ1.5Mg	Plate & sheet
SB-210	A91060	1060	8.5	21	...	104	...	99.60Al	Smls. tube
SB-210	...	Alclad 3003	13	21	...	104	...	AlñMnñCu	Smls. tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-210	A93003	3003	14	21	...	104	...	AlñMnñCu	Smls. tube
SB-210	A95052	5052	25	22	...	105	...	Alñ2.5Mg	Smls. tube
SB-210	A95154	5154	30	22	...	105	...	Alñ3.5Mg	Smls. tube
SB-210	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Smls. tube
SB-210	A96063	6063	17	23	...	105	...	AlñMgñSi	Smls. tube
B 210	A95083	5083	39	...	25	...	105	Alñ4.4MgñMn	Smls. tube
B 210	A95086	5086	35	...	25	...	105	Alñ4.0MgñMn	Smls. tube
B 210	A95456	5456	41	...	25	...	...	Alñ5.1MgñMn	Smls. tube
SB-211	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Bar, rod, & wire
SB-221	A91060	1060	8.5	21	...	104	...	99.60Al	Bar, rod, & shapes
SB-221	A91100	1100	11	21	...	104	...	99.0AlñCu	Bar, rod, & shapes
SB-221	A93003	3003	14	21	...	104	...	AlñMnñCu	Bar, rod, & shapes
SB-221	A95083	5083	39	25	...	105	...	Alñ4.4MgñMn	Bar, rod, & shapes
SB-221	A95154	5154	30	22	...	105	...	Alñ3.5Mg	Bar, rod, & shapes
SB-221	A95454	5454	31	22	...	105	...	Alñ2.7MgñMn	Bar, rod, & shapes
SB-221	A95456	5456	41	25	...	105	...	Alñ5.1MgñMn	Bar, rod, & shapes
SB-221	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Bar, rod, & shapes
SB-221	A96063	6063	17	23	...	105	...	AlñMgñSi	Bar, rod, & shapes
SB-234	A91060	1060	8.5	21	...	104	...	99.60Al	Smls. tube
SB-234	...	Alclad 3003	13	21	...	104	...	AlñMnñCu	Smls. tube
SB-234	A93003	3003	14	21	...	104	...	AlñMnñCu	Smls. tube
SB-234	A95052	5052	25	22	...	105	...	Alñ2.5Mg	Smls. tube
SB-234	A95454	5454	31	22	...	105	...	Alñ2.7MgñMn	Smls. tube
SB-234	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Smls. tube
SB-241	A91060	1060	8.5	21	...	104	...	99.60Al	Smls. pipe & tube
SB-241	A91100	1100	11	21	...	104	...	99.0AlñCu	Smls. pipe & tube
SB-241	...	Alclad 3003	13	21	...	104	...	AlñMnñCu	Smls. pipe & tube
SB-241	A93003	3003	14	21	...	104	...	AlñMnñCu	Pipe & tube
SB-241	A95052	5052	25	22	...	105	...	Alñ2.5Mg	Smls. pipe & tube
SB-241	A95083	5083	39	25	...	105	...	Alñ4.4MgñMn	Smls. pipe & tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-241	A95086	5086	35	25	...	105	...	AlñMgñMn	Smls. pipe & tube
SB-241	A95454	5454	31	22	...	105	...	AlñMgñMn	Smls. pipe & tube
SB-241	A95456	5456	41	25	...	105	...	AlñMgñMn	Smls. pipe & tube
SB-241	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Smls. pipe & tube
SB-241	A96063	6063	17	23	...	105	...	AlñMgñSi	Smls. pipe & tube
SB-247	A93003	3003	14	21	...	104	...	AlñMnñCu	Forgings
SB-247	A95083	5083	38	25	...	105	...	AlñMgñMn	Forgings
SB-247	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Forgings
SB-265	R50250	1	35	51	...	115	...	Ti	Plate, sheet, & strip
SB-265	R50400	2	50	51	...	115	...	Ti	Plate, sheet, & strip
SB-265	R50550	3	65	52	...	115	...	Ti	Plate, sheet, & strip
SB-265	R52400	7	50	51	...	115	...	TiñPd	Plate, sheet, & strip
SB-265	R53400	12	70	52	...	115	...	Tiñ0.3Moñ0.8Ni	Plate, sheet, & strip
SB-265	R56320	9	90	53	...	115	...	Tiñ3Alñ2.5V	Plate, sheet, & strip
SB-265	R52402	16	50	51	...	115	...	TiñPd	Plate, sheet, & strip
SB-265	R52250	11	35	51	...	115	...	TiñPd	Plate, sheet, & strip
SB-265	R52252	17	35	51	...	...	...	TiñPd	Plate, sheet, & strip
SB-271	C95200	...	65	35	...	108	...	88Cuñ9Alñ3Fe	Castings
SB-271	C95400	...	75	35	...	108	...	85Cuñ11Alñ4Fe	Castings
B 280	C10200	102	30	...	31	...	107	99.95CuñP	Smls. tube
B 280	C12000	120	30	...	31	...	107	99.9CuñP	Smls. tube
B 280	C12200	122	30	...	31	...	107	99.9CuñP	Smls. tube
B 283	C11000	Cu	33	...	31	...	107	99.9Cu	Forgings
B 283	C37700	Forging brass	46	...	...	...	107	60Cuñ38Znñ2Pb	Forgings > 1.5 in. (38 mm)
B 283	C37700	Forging brass	50	...	...	...	107	60Cuñ38Znñ2Pb	Forgings ≤ 1.5 in. (38 mm)
B 283	C46400	Naval brass	64	...	32	...	107	60Cuñ39ZnñSn	Forgings
B 283	C65500	High Si bronze	52	...	33	...	107	97Cuñ3Si	Forgings
B 283	C67500	Mn bronze	72	...	32	...	107	59Cuñ39ZnñFeñSn	Forgings
B 302	C12000	...	36	...	31	...	107	99.9CuñP	Pipe
B 302	C12200	...	36	...	31	...	107	99.9CuñP	Pipe

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-308	A96061	6061	24	23	...	105	...	AlñMgñSiñCu	Shapes
SB-315	C65500	...	50	33	...	107	...	97Cuñ3Si	Pipe & tube
SB-333	N10001	...	100	44	...	112	...	62Niñ28Moñ5Fe	Plate, sheet, & strip ≥ 0.1875ñ2.5 in. (4.8ñ64 mm), incl.
SB-333	N10001	...	115	44	...	112	...	62Niñ28Moñ5Fe	Plate, sheet, & strip < 0.1875 in. (48 mm)
SB-333	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Plate, sheet, & strip
SB-333	N10665	...	110	44	...	112	...	65Niñ28Moñ2Fe	Plate, sheet, & strip
SB-333	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMnñW	Plate, sheet, & strip
SB-335	N10001	...	100	44	...	112	...	62Niñ28Moñ5Fe	Rod > 1.5ñ3.5 in. (38ñ89 mm), incl.
SB-335	N10001	...	115	44	...	112	...	62Niñ28Moñ5Fe	Rod ≥ 0.3125ñ1.5 in. (8ñ38 mm), incl.
SB-335	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Rod
SB-335	N10665	...	110	44	...	112	...	65Niñ28Moñ2Fe	Rod
SB-335	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMnñW	Rod
SB-338	R50250	1	35	51	...	115	...	Ti	Smls. & welded tube
SB-338	R50400	2	50	51	...	115	...	Ti	Smls. & welded tube
SB-338	R50550	3	65	52	...	115	...	Ti	Smls. & welded tube
SB-338	R52400	7	50	51	...	115	...	TiñPd	Smls. & welded tube
SB-338	R52402	16	50	51	...	115	...	TiñPd	Smls. & welded tube
SB-338	R53400	12	70	52	...	115	...	Tiñ0.3Moñ0.8Ni	Smls. & welded tube
SB-338	R56320	9	90	53	...	115	...	Tiñ3Alñ2.5V	Smls. & welded tube
B 345	A91060	1060	8.5	...	21	...	104	99.60Al	Smls. pipe & tube
B 345	A93003	3003	14	...	21	...	104	AlñMnñCu	Smls. pipe & tube
B 345	A95083	5083	39	...	25	...	105	Alñ4.4MgñMn	Smls. pipe & tube
B 345	A95086	5086	37	...	25	...	105	Alñ4.0MgñMn	Smls. pipe & tube
B 345	A96061	6061	24	...	23	...	105	AlñMgñSiñCu	Smls. pipe & tube
B 345	A96063	6063	17	...	23	...	105	AlñMgñSi	Smls. pipe & tube
SB-348	R50250	1	35	51	...	115	...	Ti	Bars & billets
SB-348	R50400	2	50	51	...	115	...	Ti	Bars & billets
SB-348	R50550	3	65	52	...	115	...	Ti	Bars & billets
SB-348	R52400	7	50	51	...	115	...	TiñPd	Bars & billets
SB-348	R53400	12	70	52	...	115	...	Tiñ0.3Moñ0.8Ni	Bars & billets

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-348	R52402	16	50	51	...	...	...	TiñPd	Bars & billets
SB-348	R56320	9	90	53	...	115	...	Tiñ3Alñ2.5V	Bars & billets
A 351	N08603	HT30	65	...	45	...	111	35Niñ15Crñ0.5Mo	Castings
SA-351	J94651	CN3MN	80	45	...	111	...	46Feñ24Niñ21Crñ6MoñCuñN	Castings
SA-351	N08007	CN7M	62	45	...	111	...	28Niñ19CrñCuñMo	Castings
SA-351	N08151	CT15C	63	45	...	111	...	32Niñ45Feñ20CrñCb	Castings
SB-359	C10200	...	30	31	...	107	...	99.95CuñP	Smls. tube
SB-359	C12000	...	30	31	...	107	...	99.9CuñP	Smls. tube
SB-359	C12200	...	30	31	...	107	...	99.9CuñP	Smls. tube
SB-359	C14200	...	30	31	...	107	...	99.4CuñAs-P	Smls. tube
SB-359	C19200	...	38	31	...	107	...	99.7CuñFeñP	Smls. tube
SB-359	C23000	...	40	32	...	107	...	85Cuñ15Zn	Smls. tube
SB-359	C44300	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06As	Smls. tube
SB-359	C44400	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06Sb	Smls. tube
SB-359	C44500	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06P	Smls. tube
SB-359	C60800	...	50	35	...	108	...	95Cuñ5Al	Smls. tube
SB-359	C68700	...	50	32	...	108	...	78Cuñ20Znñ2Al	Smls. tube
SB-359	C70400	...	38	34	...	107	...	95Cuñ5Ni	Smls. tube
SB-359	C70600	...	40	34	...	107	...	90Cuñ10Ni	Smls. tube
SB-359	C71000	...	45	34	...	107	...	80Cuñ20Ni	Smls. tube
SB-359	C71500	...	52	34	...	107	...	70Cuñ30Ni	Smls. tube
B 361	A91060	WP1060	8	...	21	...	104	99.60Al	Fittings
B 361	A91100	WP1100	11	...	21	...	104	99.0AlñCu	Fittings
B 361	...	WP Alclad 3003	13	...	21	...	104	AlñMnñCu	Fittings
B 361	A93003	WP3003	14	...	21	...	104	AlñMnñCu	Fittings
B 361	A95083	5083	39	...	25	...	105	Alñ4.4MgñMn	Fittings
B 361	A95154	5154	30	...	22	...	105	Alñ3.5Mg	Fittings
B 361	A96061	WP6061	24	...	23	...	105	AlñMgñSiñCu	Fittings
B 361	A96063	WP6063	17	...	23	...	105	AlñMgñSi	Fittings
SB-363	R50250	WPT 1	35	51	...	115	...	Ti	Smls. & welded fittings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-363	R50400	WPT 2	50	51	...	115	...	Ti	Smls. & welded fittings
SB-363	R50550	WPT 3	65	52	...	115	...	Ti	Smls. & welded fittings
SB-363	R52400	7	50	51	...	115	...	TiñPd	Smls. & welded pipe
SB-363	R53400	12	70	52	...	115	...	Tiñ0.3Moñ0.8Ni	Smls. & welded pipe
SB-363	R56320	WPT-9	90	53	...	115	...	Tiñ3Alñ2.5V	Smls. & welded fittings
SB-366	N02200	...	55	41	...	110	...	99Ni	Fittings
SB-366	N02201	...	50	41	...	110	...	99Ni-Low C	Fittings
SB-366	N04400	...	70	42	...	110	...	67Niñ30Cu	Fittings
SB-366	N06002	...	100	43	...	111	...	47Niñ22Crñ18Feñ9Mo	Fittings
SB-366	N06007	...	90	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Fittings
SB-366	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Fittings
SB-366	N06030	...	85	45	...	111	...	40Niñ29Crñ15Feñ5Mo	Fittings
SB-366	N06045	...	90	46	...	111	...	46Niñ27Crñ23Feñ2.75Si	Fittings
SB-366	N06059	...	100	44	...	112	...	59Niñ23Crñ16Mo	Fittings
SB-366	N06230	...	110	47	...	...	...	53Niñ22Crñ14WñCoñFeñMo	Fittings
SB-366	N06455	...	100	44	...	112	...	61Niñ15Moñ16Cr	Fittings
SB-366	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Fittings
SB-366	N06625	...	110	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Fittings
SB-366	N06985	...	90	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Fittings
SB-366	N08020	...	80	45	...	111	...	35Niñ35Feñ20CrñCb	Fittings
SB-366	N08031	...	94	45	...	111	...	31Niñ33Feñ27Crñ6.5MoñCuñN	Fittings
SB-366	N08330	...	70	46	...	111	...	35Niñ19Crñ1.25Si	Fittings
SB-366	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Fittings
SB-366	N08825	...	85	45	...	111	...	42Niñ21.5Crñ3Moñ2.3Cu	Fittings
SB-366	N08925	...	87	45	...	111	...	25Niñ20Crñ6MoñCuñN	Fittings
SB-366	N10001	...	100	44	...	112	...	62Niñ28Moñ5Fe	Fittings
SB-366	N10003	...	100	44	...	112	...	70Niñ16Moñ7Crñ5Fe	Fittings
SB-366	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Fittings
SB-366	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Fittings
SB-366	N10665	...	110	44	...	112	...	65Niñ28Moñ2Fe	Fittings
SB-366	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMnñW	Fittings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-366	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Fittings
B 366	N08926	...	94	...	45	...	111	25Niñ20Crñ6MoñCuñN	Fittings
B 366	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Fittings
SB-367	R50400	Gr. Cñ2	50	51	...	115	...	Ti	Castings
SB-367	R50550	Gr. Cñ3	65	52	...	115	...	Ti	Castings
SB-369	C96200	...	45	34	...	107	...	87.5Cuñ10NiñFeñMn	Castings
SB-381	R50250	Fñ1	35	51	...	115	...	Ti	Forgings
SB-381	R50400	Fñ2	50	51	...	115	...	Ti	Forgings
SB-381	R50550	Fñ3	65	52	...	115	...	Ti	Forgings
SB-381	R52400	Fñ7	50	51	...	115	...	TiñPd	Forgings
SB-381	R52402	Fñ16	50	51	...	...	...	TiñPd	Forgings
SB-381	R53400	Fñ12	70	52	...	115	...	Tiñ0.3Moñ0.8Ni	Forgings
SB-381	R56320	Fñ9	90	53	...	115	...	Tiñ3Alñ2.5V	Forgings
SB-395	C10200	...	36	31	...	107	...	99.95CuñP	Smls. tube
SB-395	C12000	...	36	31	...	107	...	99.9CuñP	Smls. tube
SB-395	C12200	...	36	31	...	107	...	99.9CuñP	Smls. tube
SB-395	C14200	...	36	31	...	107	...	99.4CuñAsñP	Smls. tube
SB-395	C19200	...	38	31	...	107	...	99.7CuñFeñP	Smls. tube
SB-395	C23000	...	40	32	...	107	...	85Cuñ15Zn	Smls. tube
SB-395	C44300	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06As	Smls. tube
SB-395	C44400	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06Sb	Smls. tube
SB-395	C44500	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06P	Smls. tube
SB-395	C60800	...	50	35	...	108	...	95Cuñ5Al	Smls. tube
SB-395	C68700	...	50	32	...	108	...	78Cuñ20Znñ2Al	Smls. tube
SB-395	C70600	...	40	34	...	107	...	90Cuñ10Ni	Smls. tube
SB-395	C71000	...	45	34	...	107	...	80Cuñ20Ni	Smls. tube
SB-395	C71500	...	52	34	...	107	...	70Cuñ30Ni	Smls. tube
SB-407	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Smls. pipe & tube
SB-407	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Smls. pipe & tube
SB-407	N08811	...	65	45	...	111	...	33Niñ42Feñ21CrñAlñTi	Smls. pipe & tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-408	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Rod & bar
SB-408	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Rod & bar
SB-408	N08811	...	65	45	...	111	...	33Niñ42Feñ21CrñAlñTi	Rod & bar
SB-409	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Plate, sheet, & strip
SB-409	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Plate, sheet, & strip
SB-409	N08811	...	65	45	...	111	...	33Niñ42Feñ21CrñAlñTi	Plate, sheet, & strip
SB-423	N08825	...	75	45	...	111	...	42Niñ21.5Crñ3Moñ2.3Cu	Smls. pipe & tube
SB-424	N08825	...	85	45	...	111	...	42Niñ21.5Crñ3Moñ2.3Cu	Plate, sheet, & strip
SB-425	N08825	...	85	45	...	111	...	42Niñ21.5Crñ3Moñ2.3Cu	Rod & bar
SB-434	N10003	...	100	44	...	112	...	70Niñ16Moñ7Crñ5Fe	Plate, sheet, & strip
SB-435	N06002	...	95	43	...	111	...	47Niñ22Crñ9Moñ18Fe	Plate, sheet, & strip
SB-435	N06230	...	110	47	...	111	...	53Niñ22Crñ14WñCoñFeñMo	Plate, sheet, & strip
SB-435	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Plate, sheet, & strip
SB-435	R30556	...	100	45	...	111	...	21Niñ30Feñ22Crñ18Coñ3Moñ3W	Plate, sheet, & strip
SB-443	N06625	2	100	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Plate, sheet, & strip
SB-443	N06625	1	110	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Plate, sheet, & strip
SB-444	N06625	1	120	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Smls. Pipe & tube
SB-444	N06625	2	100	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Smls. Pipe & tube
SB-446	N06625	1	120	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Rod & bar
SB-446	N06625	2	100	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Rod & bar
SB-462	N08020	...	80	45	...	111	...	35Niñ35Feñ20CrñCb	Forgings
SB-462	N08367	...	95	45	...	111	...	46Feñ24Niñ21Crñ6MoñCuñN	Forgings
SB-463	N08020	...	80	45	...	111	...	35Niñ35Feñ20CrñCb	Plate, sheet, & strip
SB-463	N08024	...	80	45	...	111	...	37Niñ33Feñ23Crñ4Mo	Plate, sheet, & strip
SB-463	N08026	...	80	45	...	111	...	35Niñ30Feñ24Crñ6Moñ3Cu	Plate, sheet, & strip
SB-464	N08020	...	80	45	...	111	...	35Niñ35Feñ20CrñCb	Welded pipe
SB-464	N08024	...	80	45	...	111	...	37Niñ33Feñ23Crñ4Mo	Welded pipe

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-464	N08026	...	80	45	...	111	...	35Niñ30Feñ24Crñ6Moñ3Cu	Welded pipe
SB-466	C70600	...	38	34	...	107	...	90Cuñ10Ni	Smls. Pipe & tube
SB-466	C71000	...	45	34	...	107	...	80Cuñ20Ni	Smls. Pipe & tube
SB-466	C71500	...	50	34	...	107	...	70Cuñ30Ni	Smls. Pipe & tube
SB-467	C70600	...	38	34	...	107	...	90Cuñ10Ni	Welded pipe > 4.5 in. (114 mm) O.D.
SB-467	C70600	...	40	34	...	107	...	90Cuñ10Ni	Welded pipe ≤ 4.5 in. (114 mm) O.D.
SB-467	C71500	...	45	34	...	107	...	70Cuñ30Ni	Welded pipe > 4.5 in. (114 mm) O.D.
SB-467	C71500	...	50	34	...	107	...	70Cuñ30Ni	Welded pipe ≤ 4.5 in. (114 mm) O.D.
SB-468	N08020	...	80	45	...	111	...	35Niñ35Feñ20CrñCb	Welded tube
SB-468	N08024	...	80	45	...	111	...	37Niñ33Feñ23Crñ4Mo	Welded tube
SB-468	N08026	...	80	45	...	111	...	35Niñ30Feñ24Crñ6Moñ3Cu	Welded tube
SB-473	N08020	...	80	45	...	111	...	35Niñ35Feñ20CrñCb	Bar
B 491	A93003	3003	14	...	21	...	104	AlñMnñCu	Extruded tubes
SB-493	R60702	R60702	55	61	...	117	...	99.2Zr	Forgings
SB-493	R60705	R60705	70	62	...	117	...	95.5Zr+2.5Cb	Forgings
SA-494	N26022	CX2MW	80	44	...	...	...	59Niñ22Crñ14Moñ4Feñ3W	Castings
SB-505	C95200	...	68	35	...	108	...	88Cuñ9Alñ3Fe	Castings
SB-511	N08330	...	70	46	...	111	...	35Niñ19Crñ1.25Si	Bars & shapes
SB-514	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Welded pipe
SB-514	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Welded pipe
SB-515	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Welded tube
SB-515	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Welded tube
SB-515	N08811	...	65	45	...	...	...	33Niñ42Feñ21CrñAlñTi	Welded tube
SB-516	N06045	...	90	46	...	...	...	46Niñ27Crñ23Feñ2.75Si	Welded tube
SB-516	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Welded tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-517	N06045	...	90	46	...	...	...	46Niñ27Crñ23Feñ2.75Si	Welded pipe
SB-517	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Welded pipe
SB-523	R60702	R60702	55	61	...	117	...	99.2Zr	Smls. & welded tube
SB-523	R60705	R60705	80	62	...	117	...	95.5Zr+2.5Cb	Smls. & welded tube
SB-535	N08330	...	70	46	...	111	...	35Niñ19Crñ1.25Si	Smls. pipe
SB-536	N08330	...	70	46	...	111	...	35Niñ19Crñ1.25Si	Plate, sheet, & strip
SB-543	C12200	...	30	31	...	107	...	99.9CuñP	Welded tube
SB-543	C19400	...	45	31	...	107	...	97.5CuñP	Welded tube
SB-543	C23000	...	40	32	...	107	...	85Cuñ15Zn	Welded tube
SB-543	C44300	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06As	Welded tube
SB-543	C44400	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06Sb	Welded tube
SB-543	C44500	...	45	32	...	107	...	71Cuñ28Znñ1Snñ0.06P	Welded tube
SB-543	C68700	...	50	32	...	108	...	78Cuñ20Znñ2Al	Welded tube
SB-543	C70400	...	38	34	...	107	...	95Cuñ5Ni	Welded tube
SB-543	C70600	...	40	34	...	107	...	90Cuñ10Ni	Welded tube
SB-543	C71500	...	52	34	...	107	...	70Cuñ30Ni	Welded tube
SB-543	C71640	...	63	34	...	107	...	66Cuñ30Niñ2Feñ2Mn	Welded tube
B 547	...	Alclad 3003	13	...	21	...	104	AlñMnñCu	Welded tube
B 547	A93003	3003	14	...	21	...	104	AlñMnñCu	Welded tube
B 547	A95083	5083	40	...	25	...	105	Alñ4.4MgñMn	Welded tube
B 547	A95454	5454	31	...	22	...	105	Alñ2.7MgñMn	Welded tube
B 547	A96061	6061	24	...	23	...	105	AlñMgñSiñCu	Welded tube
SB-550	R60702	R60702	55	61	...	117	...	99.2Zr	Bar & wire
SB-550	R60705	R60705	80	62	...	117	...	95.5Zr+2.5Cb	Bar & wire
SB-551	R60702	R60702	55	61	...	117	...	99.2Zr	Plate, sheet, & strip
SB-551	R60705	R60705	80	62	...	117	...	95.5Zr+2.5Cb	Plate, sheet, & strip
SB-564	N04400	...	70	42	...	110	...	67Niñ30Cu	Forgings
SB-564	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Forgings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-564	N06045	...	90	46	...	...	...	46Niñ27Crñ23Feñ2.75Si	Forgings
SB-564	N06059	...	100	44	...	111	...	59Niñ23Crñ16Mo	Forgings
SB-564	N06230	...	110	47	...	...	...	53Niñ22Crñ14WñCoñFeñMo	Forgings
SB-564	N06600	...	80	43	...	111	...	72Niñ15Crñ8Fe	Forgings
SB-564	N06625	...	110	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Forgings > 4ñ10 in. (102ñ254 mm), incl.
SB-564	N06625	...	120	43	...	111	...	60Niñ22Crñ9Moñ3.5Cb	Forgings ≤ 4 in. (102 mm)
SB-564	N06690	...	85	43	...	...	...	58Niñ29Crñ9Fe	Forgings
SB-564	N08031	...	94	45	...	111	...	31Niñ31Feñ27Crñ7Mo	Forgings
SB-564	N08800	...	75	45	...	111	...	33Niñ42Feñ21Cr	Forgings
SB-564	N08810	...	65	45	...	111	...	33Niñ42Feñ21Cr	Forgings
SB-564	N08811	...	65	45	...	...	...	33Niñ42Feñ21CrñAlñTi	Forgings
SB-564	N08367	...	95	45	...	111	...	46Feñ24Niñ21Crñ6MoñCuñN	Forgings
SB-564	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Forgings
SB-564	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Forgings
SB-564	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMnñW	Forgings
SB-564	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Forgings
SB-564	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Forgings
B 564	N02200	...	55	...	41	...	110	99.0Ni	Forgings
SB-572	N06002	...	95	43	...	111	...	47Niñ22Crñ9Moñ18Fe	Rod
SB-572	N06230	...	110	47	...	111	...	53Niñ22Crñ14WñCoñFeñMo	Rod
SB-572	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Rod
SB-572	R30556	...	100	45	...	111	...	21Niñ30Feñ22Crñ18Coñ3Moñ3W	Rod
SB-573	N10003	...	100	44	...	112	...	70Niñ16Moñ7Crñ5Fe	Rod
SB-574	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Rod
SB-574	N06059	...	100	44	...	112	...	59Niñ23Crñ16Mo	Rod
SB-574	N06455	...	100	44	...	112	...	61Niñ16Moñ16Cr	Rod
SB-574	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Rod
SB-575	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Plate, sheet, & strip
SB-575	N06059	...	100	44	...	112	...	59Niñ23Crñ16Mo	Plate, sheet, & strip
SB-575	N06455	...	100	44	...	112	...	61Niñ16Moñ16Cr	Plate, sheet, & strip
SB-575	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Plate, sheet, & strip

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-581	N06007	...	85	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Rod > 0.75ñ3.5 in. (19ñ89 mm), incl.
SB-581	N06007	...	90	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Rod, 0.3125ñ0.75 in. (8ñ19 mm), incl.
SB-581	N06030	...	85	45	...	111	...	40Niñ29Crñ15Feñ5Mo	Rod
SB-581	N06975	...	85	45	...	111	...	49Niñ25Crñ18Feñ6Mo	Rod
SB-581	N06985	...	85	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Rod > 0.75ñ3.5 in. (19ñ89 mm), incl.
SB-581	N06985	...	90	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Rod, 0.3125ñ0.75 in. (8ñ19 mm), incl.
SB-581	N08031	...	94	45	...	111	...	31Niñ33Feñ27Crñ6.5MoñCuñN	Rod
SB-582	N06007	...	85	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Plate, sheet, & strip > 0.75ñ2.5 in. (19ñ64 mm), incl.
SB-582	N06007	...	90	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Plate, sheet, & strip ≤ 0.75 in. (19 mm)
SB-582	N06030	...	85	45	...	111	...	40Niñ29Crñ15Feñ5Mo	Plate, sheet, & strip
SB-582	N06975	...	85	45	...	111	...	49Niñ25Crñ18Feñ6Mo	Plate, sheet, & strip
SB-582	N06985	...	85	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Plate, sheet, & strip > 0.75ñ2.5 in. (19ñ64 mm), incl.
SB-582	N06985	...	90	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Plate, sheet, & strip ≤ 0.75 in. (19 mm)
SB-599	N08700	...	80	45	...	111	...	25Niñ47Feñ21Crñ5Mo	Plate, sheet, & strip
SB-619	N06002	...	100	43	...	111	...	47Niñ22Crñ9Moñ18Fe	Welded pipe
SB-619	N06007	...	90	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Welded pipe
SB-619	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Welded pipe
SB-619	N06030	...	85	45	...	111	...	40Niñ29Crñ15Feñ5Mo	Welded pipe
SB-619	N06059	...	100	44	...	112	...	59Niñ23Crñ16Mo	Welded pipe
SB-619	N06230	...	110	47	...	111	...	53Niñ22Crñ14WñCoñFeñMo	Welded pipe
SB-619	N06455	...	100	44	...	112	...	61Niñ16Moñ16Cr	Welded pipe
SB-619	N06975	...	85	45	...	111	...	49Niñ25Crñ18Feñ6Mo	Welded pipe
SB-619	N06985	...	90	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Welded pipe
SB-619	N08031	...	94	45	...	111	...	31Niñ33Feñ27Crñ6.5MoñCuñN	Welded pipe
SB-619	N08320	...	75	45	...	111	...	26Niñ22Crñ5MoñTi	Welded pipe
SB-619	N10001	...	100	44	...	112	...	62Niñ28Moñ5Fe	Welded pipe
SB-619	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Welded pipe
SB-619	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Welded pipe
SB-619	N10665	...	110	44	...	112	...	65Niñ28Moñ2Fe	Welded pipe

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-619	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMnñW	Welded pipe
SBñ619	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Welded pipe
SB-619	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Welded pipe
SB-619	R30556	...	100	45	...	111	...	21Niñ30Feñ22Crñ18Coñ3Moñ3W	Welded pipe
SB-620	N08320	...	75	45	...	111	...	26Niñ22Crñ5MoñTi	Plate, sheet, & strip
SB-621	N08320	...	75	45	...	111	...	26Niñ22Crñ5MoñTi	Rod
SB-622	N06002	...	100	43	...	111	...	47Niñ22Crñ9Moñ18Fe	Smls. pipe & tube
SB-622	N06007	...	90	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Smls. pipe & tube
SB-622	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Smls. pipe & tube
SB-622	N06030	...	85	45	...	111	...	40Niñ29Crñ15Feñ5Mo	Smls. pipe & tube
SB-622	N06059	...	100	44	...	112	...	59Niñ23Crñ16Mo	Smls. pipe & tube
SB-622	N06230	...	110	47	...	111	...	53Niñ22Crñ14WñCoñFeñMo	Smls. pipe & tube
SB-622	N06455	...	100	44	...	112	...	61Niñ16Moñ16Cr	Smls. pipe & tube
SB-622	N06975	...	85	45	...	111	...	49Niñ25Crñ18Feñ6Mo	Smls. pipe & tube
SB-622	N06985	...	90	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Smls. pipe & tube
SB-622	N08031	...	94	45	...	111	...	31Niñ33Feñ27Crñ6.5MoñCuñN	Smls. pipe & tube
SB-622	N08320	...	75	45	...	111	...	26Niñ22Crñ5MoñTi	Smls. pipe & tube
SB-622	N10001	...	100	44	...	112	...	62Niñ28Moñ5Fe	Smls. pipe & tube
SB-622	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Smls. pipe & tube
SB-622	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Smls. pipe & tube
SB-622	N10665	...	110	44	...	112	...	65Niñ28Moñ2Fe	Smls. pipe & tube
SB-622	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Smls pipe & tube
SB-622	R30556	...	100	45	...	111	...	21Niñ30Feñ22Crñ18Coñ3Moñ3W	Smls. pipe & tube
SB-622	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMoñW	Smls. pipe & tube
SB-622	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Smls. pipe & tube
B 625	N08926	...	87	...	45	...	111	25Niñ20Crñ6MoñCoñN	Plate, sheet, & strip
SB-625	N08031	...	94	45	...	111	...	31Niñ33Feñ27Crñ6.5MoñCuñN	Plate, sheet, & strip

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
SB-625	N08904	...	71	45	...	111	...	44Feñ25Niñ21CrñMo	Plate, sheet, & strip
SB-625	N08925	...	87	45	...	111	...	25Niñ20Crñ6MoñCuñN	Plate, sheet, & strip
SB-625	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Plate, sheet, & strip
SB-626	N06002	...	100	43	...	111	...	47Niñ22Crñ9Moñ18Fe	Welded tube
SB-626	N06007	...	90	45	...	111	...	47Niñ22Crñ19Feñ6Mo	Welded tube
SB-626	N06022	...	100	44	...	112	...	55Niñ21Crñ13.5Mo	Welded tube
SB-626	N06030	...	85	45	...	111	...	40Niñ29Crñ15Feñ5Mo	Welded tube
SB-626	N06059	...	100	44	...	112	...	59Niñ23Crñ16Mo	Welded tube
SB-626	N06230	...	110	47	...	111	...	53Niñ22Crñ14WñCoñFeñMo	Welded tube
SB-626	N06455	...	100	44	...	112	...	61Niñ16Moñ16Cr	Welded tube
SB-626	N06975	...	85	45	...	111	...	49Niñ25Crñ18Feñ6Mo	Welded tube
SB-626	N06985	...	90	45	...	111	...	47Niñ22Crñ20Feñ7Mo	Welded tube
SB-626	N08031	...	94	45	...	111	...	31Niñ33Feñ27Crñ6.5MoñCuñN	Welded tube
SB-626	N08320	...	75	45	...	111	...	26Niñ22Crñ5MoñTi	Welded tube
SB-626	N10001	...	100	44	...	112	...	62Niñ28Moñ5Fe	Welded tube
SB-626	N10276	...	100	44	...	112	...	54Niñ16Moñ15Cr	Welded tube
SB-626	N10629	...	110	44	...	...	...	66Niñ28Moñ3Feñ1.3Crñ0.25Al	Welded tube
SB-626	N10665	...	110	44	...	112	...	65Niñ28Moñ2Fe	Welded tube
SB-626	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Welded tube
SB-626	R30556	...	100	45	...	111	...	21Niñ30Feñ22Crñ18Coñ3Moñ3W	Welded tube
SB-626	N10675	...	110	44	...	112	...	65Niñ29.5Moñ2Crñ2FeñMnñW	Welded tube
SBñ626	N12160	...	90	46	...	...	...	37Niñ30Coñ28Crñ2.7Si	Welded tube
B 649	N08926	...	87	...	45	...	111	25Niñ20Crñ6MoñCuñN	Bar & wire
SB-649	N08904	...	71	45	...	111	...	44Feñ25Niñ21CrñMo	Bar & wire
SB-649	N08925	...	87	45	...	111	...	25Niñ20Crñ6MoñCuñN	Bar & wire
SB-649	R20033	...	109	45	...	...	...	33Crñ31Niñ32Feñ1.5Moñ0.6CuñN	Bar & Wire
SB-658	R60702	R60702	55	61	...	117	...	99.2Zr	Smls. & welded pipe
SB-658	R60705	R60705	80	62	...	117	...	95.5Zr+2.5Cb	Smls. & welded pipe
SB-668	N08028	...	73	45	...	111	...	31Niñ31Feñ29CrñMo	Smls. tube
SB-672	N08700	...	80	45	...	111	...	25Niñ47Feñ21Crñ5Mo	Bar & wire

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding P-No.	Welding S-No.	Brazing P-No.	Brazing S-No.	Nominal Composition	Product Form
B 673	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Welded pipe
SB-673	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Welded pipe
SB-673	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Welded pipe
SB-674	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Welded tube
SB-674	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Welded tube
B 674	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Welded tube
SB-675	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Welded pipe
SB-675	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Welded pipe
SB-676	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Welded tube
SB-676	N08367	...	100	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Welded tube
B 677	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Smls. pipe & tube
SB-677	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Smls. pipe & tube
SB-677	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Smls. pipe & tube
SB-688	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Plate, sheet, & strip
SB-688	N08367	...	104	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Plate, sheet, & strip $<3/16$ in. (4.8 mm)
SB-688	N08367	...	100	45	...	...	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Plate, sheet, & strip $\geq 3/16$ in. $\leq 3/4$ in. ($\geq$4.8 mm $\leq$ 19 mm)
SB-688	N08367	...	95	45	...	...	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Plate, sheet, & strip $>3/4$ in. (19 mm)
SB-690	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Smls. pipe & tube
SB-690	N08367	...	104	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Smls. pipe & tube
SB-691	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Rod, bar, & wire
SB-691	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Rod, bar, & wire
SB-704	N06625	...	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Welded tube
SB-704	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Welded tube
SB-705	N06625	...	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Welded pipe
SB-705	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Welded pipe

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

GENERAL NOTE: To convert from ksi to MPa, multiply tensile strength in table by 6.9.

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-709	N08028	...	73	45	...	111	...	31Ni–31Fe–29Cr–Mo	Plate, sheet, & strip
SB-710	N08330	...	70	46	...	111	...	35Ni–19Cr–1.25Si	Welded pipe
SB-729	N08020	...	80	45	...	...	111	35Ni–35Fe–20Cr–Cb	Smls. pipe & tube
B 725	N02200	...	55	...	41	...	110	99.0Ni	Welded pipe
B 819	C12200	C12200	30	...	...	...	107	99.9Cu–P	Wrought pipe
SB-861	R50250	1	35	51	...	115	...	Ti	Smls. pipe
SB-861	R50400	2	50	51	...	115	...	Ti	Smls. pipe
SB-861	R50550	3	65	52	...	115	...	Ti	Smls. pipe
SB-861	R52400	7	50	51	...	115	...	Ti–Pd	Smls. pipe
SB-861	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Smls. pipe
SB-861	R56320	9	90	53	...	115	...	Ti–3Al–2.5V	Smls. pipe
SB-862	R50250	1	35	51	...	115	...	Ti	Welded pipe
SB-862	R50400	2	50	51	...	115	...	Ti	Welded pipe
SB-862	R50550	3	65	52	...	115	...	Ti	Welded pipe
SB-862	R52400	7	50	51	...	115	...	Ti–Pd	Welded pipe
SB-862	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Welded pipe
SB-862	R56320	9	90	53	...	115	...	Ti–3Al–2.5V	Welded pipe
B 16.18	C83600	...	40	...	...	...	107	5Sn–5Zn–5Pb	Cast fittings
B 16.18	C83800	...	40	...	...	...	107	4Sn–6.5Zn–6Pb	Cast fittings
B 16.18	C84400	...	40	...	...	...	107	2.5Sn–8.5Zn–7Pb	Cast fittings
B 16.22	C10200	...	30	...	...	...	107	99.95Cu–P	Wrought pipe fittings
B 16.22	C12000	...	30	...	...	...	107	99.9Cu–P	Wrought pipe fittings
B 16.22	C12200	...	30	...	...	...	107	99.9Cu–P	Wrought pipe fittings
B 16.22	C23000	...	30	...	...	...	107	85Cu–15Zn	Wrought pipe fittings

QW-423 Alternate Base Materials for Welder Qualification

QW-423.1 Base material used for welder qualification may be substituted for the P-Number material specified in the WPS in accordance with the following.

Base Metal(s) for Welder Qualification	Qualified Production Base Metal(s)
P-No. 1 through P-No. 11, P-No. 34, or P-No. 41 through P-No. 47	P-No. 1 through P-No. 11, P-No. 34, P-No. 41 through P-No. 47 and unassigned metals of similar chemical composition to these metals
P-No. 21 through P-No. 25	P-No. 21 through P-No. 25
P-No. 51 through P-No. 53 or P-No. 61 through P-No. 62	P-No. 51 through P-No. 53 and P-No. 61 through P-No. 62

QW-423.2 Metals used for welder qualification conforming to national or international standards or specifications may be considered as having the same P- or S-Number as an assigned metal provided it meets the mechanical and chemical requirements of the assigned metal. The base metal specification and corresponding P- or S-Number shall be recorded on the qualification record.

QW-424 Base Metals Used for Procedure Qualification

QW-424.1 Base metals are assigned P-Numbers in QW/QB-422; metals which do not appear in QW/QB-422 are considered to be unassigned metals except as otherwise defined in QW-420.1 for base metals having the same UNS numbers. Unassigned metals shall be identified in the WPS and on the PQR by specification, type and grade, or by chemical analysis and mechanical properties. The minimum tensile strength shall be defined by the organization which specified the unassigned metal if the tensile strength of that metal is not defined by the material specification.

Base Metal(s) Used for Procedure Qualification Coupon	Base Metals Qualified
One metal from a P-Number to any metal from the same P-Number	Any metals assigned that P-Number
One metal from a P-Number to any metal from any other P-Number	Any metal assigned the first P-Number to any metal assigned the second P-Number
One metal from P-No. 3 to any metal from P-No. 3	Any P-No.3 metal to any metal from P-No. 3 or P-No. 1
One metal from P-No. 4 to any metal from P-No. 4	Any P-No. 4 metal to any metal from P-Nos. 4, 3, or 1
One metal from P-No. 5A to any metal from P-No. 5A	Any P-No. 5A metal to any metal from P-Nos. 5A, 4, 3, or 1 metals
One metal from P-No. 5A to a metal from P-No. 4, or P-No. 3, or P-No. 1	Any P-No. 5A metal to any metal assigned to P-No. 4, or P-No. 3, or P-No. 1
One metal from P-No. 4 to a metal from P-No. 3 or P-No. 1	Any P-No. 4 metal to any metal assigned to P-No. 3 or P-No. 1
Any unassigned metal to the same unassigned metal	The unassigned metal to itself
Any unassigned metal to any P-Number metal	The unassigned metal to any metal assigned to the same P-Number as the qualified metal
Any unassigned metal to any other unassigned metal	The first unassigned metal to the second unassigned metal

QW-430 F-NUMBERS

QW-431 General

The following F-Number grouping of electrodes and welding rods in QW-432 is based essentially on their usability characteristics, which fundamentally determine the ability of welders to make satisfactory welds with a given filler metal. This grouping is made to reduce the number of welding procedure and performance qualifications, where this can logically be done. The grouping does not imply that base metals or filler metals within a group may be indiscriminately substituted for a metal which was used in the qualification test without consideration of the compatibility of the base and filler metals from the standpoint of metallurgical properties, postweld heat treatment design and service requirements, and mechanical properties.

QW-432.1	Steel and Steel Alloys
QW-432.2	Aluminum and Aluminum-Base Alloys
QW-432.3	Copper and Copper-Base Alloys
QW-432.4	Nickel and Nickel-Base Alloys
QW-432.5	Titanium and Titanium Alloys
QW-432.6	Zirconium and Zirconium Alloys
QW-432.7	Hard-Facing Weld Metal Overlay

QW-432
F-NUMBERS
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Steel and Steel Alloys	
1	SFA-5.1	EXX20
1	SFA-5.1	EXX22
1	SFA-5.1	EXX24
1	SFA-5.1	EXX27
1	SFA-5.1	EXX28
1	SFA-5.4	EXXX(X)-25
1	SFA-5.4	EXXX(X)-26
1	SFA-5.5	EXX20-X
1	SFA-5.5	EXX27-X
2	SFA-5.1	EXX12
2	SFA-5.1	EXX13
2	SFA-5.1	EXX14
2	SFA-5.1	EXX19
2	SFA-5.5	E(X)XX13-X
3	SFA-5.1	EXX10
3	SFA-5.1	EXX11
3	SFA-5.5	E(X)XX10-X
3	SFA-5.5	E(X)XX11-X
4	SFA-5.1	EXX15
4	SFA-5.1	EXX16
4	SFA-5.1	EXX18
4	SFA-5.1	EXX18M
4	SFA-5.1	EXX48
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-15
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-16
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-17

QW-432
F-NUMBERS (CONT'D)
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Steel and Steel Alloys (cont'd)	
4	SFA-5.5	E(X)XX15-X
4	SFA-5.5	E(X)XX16-X
4	SFA-5.5	E(X)XX18-X
4	SFA-5.5	E(X)XX18M
4	SFA-5.5	E(X)XX18M1
5	SFA-5.4 austenitic and duplex	EXXX(X)-15
5	SFA-5.4 austenitic and duplex	EXXX(X)-16
5	SFA-5.4 austenitic and duplex	EXXX(X)-17
6	SFA-5.2	All classifications
6	SFA-5.9	All classifications
6	SFA-5.17	All classifications
6	SFA-5.18	All classifications
6	SFA-5.20	All classifications
6	SFA-5.22	All classifications
6	SFA-5.23	All classifications
6	SFA-5.25	All classifications
6	SFA-5.26	All classifications
6	SFA-5.28	All classifications
6	SFA-5.29	All classifications
6	SFA-5.30	INMs-X
6	SFA-5.30	IN5XX
6	SFA-5.30	IN3XX(X)
	Aluminum and Aluminum Alloys	
21	SFA-5.3	E1100
21	SFA-5.3	E3003
21	SFA-5.10	ER1100
21	SFA-5.10	R1100
21	SFA-5.10	ER1188
21	SFA-5.10	R1188
22	SFA-5.10	ER5183
22	SFA-5.10	R5183
22	SFA-5.10	ER5356
22	SFA-5.10	R5356
22	SFA-5.10	ER5554
22	SFA-5.10	R5554
22	SFA-5.10	ER5556
22	SFA-5.10	R5556
22	SFA-5.10	ER5654
22	SFA-5.10	R5654
23	SFA-5.3	E4043
23	SFA-5.10	ER4009
23	SFA-5.10	R4009
23	SFA-5.10	ER4010
23	SFA-5.10	R4010
23	SFA-5.10	R4011
23	SFA-5.10	ER4043
23	SFA-5.10	R4043
23	SFA-5.10	ER4047
23	SFA-5.10	R4047
23	SFA-5.10	ER4145

QW-432
F-NUMBERS (CONT'D)
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Aluminum and Aluminum Alloys (cont'd)	
23	SFA-5.10	R4145
23	SFA-5.10	ER4643
23	SFA-5.10	R4643
24	SFA-5.10	R206.0
24	SFA-5.10	R-C355.0
24	SFA-5.10	R-A356.0
24	SFA-5.10	R357.0
24	SFA-5.10	R-A357.0
25	SFA-5.10	ER2319
25	SFA-5.10	R2319
	Copper and Copper Alloys	
31	SFA-5.6	ECu
31	SFA-5.7	ERCu
32	SFA-5.6	ECuSi
32	SFA-5.7	ERCuSi-A
33	SFA-5.6	ECuSn-A
33	SFA-5.6	ECuSn-C
33	SFA-5.7	ERCuSn-A
34	SFA-5.6	ECuNi
34	SFA-5.7	ERCuNi
34	SFA-5.30	IN67
35	SFA-5.8	RBCuZn-A
35	SFA-5.8	RBCuZn-B
35	SFA-5.8	RBCuZn-C
35	SFA-5.8	RBCuZn-D
36	SFA-5.6	ECuAl-A2
36	SFA-5.6	ECuAl-B
36	SFA-5.7	ERCuAl-A1
36	SFA-5.7	ERCuAl-A2
36	SFA-5.7	ERCuAl-A3
37	SFA-5.6	ECuNiAl
37	SFA-5.6	ECuMnNiAl
37	SFA-5.7	ERCuNiAl
37	SFA-5.7	ERCuMnNiAl
	Nickel and Nickel Alloys	
41	SFA-5.11	ENi-1
41	SFA-5.14	ERNi-1
41	SFA-5.30	IN61
42	SFA-5.11	ENiCu-7
42	SFA-5.14	ERNiCu-7
42	SFA-5.14	ERNiCu-8
42	SFA-5.30	IN60

QW-432
F-NUMBERS (CONT'D)
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Nickel and Nickel Alloys (cont'd)	
43	SFA-5.11	ENiCrFe-1
43	SFA-5.11	ENiCrFe-2
43	SFA-5.11	ENiCrFe-3
43	SFA-5.11	ENiCrFe-4
43	SFA-5.11	ENiCrFe-7
43	SFA-5.11	ENiCrFe-9
43	SFA-5.11	ENiCrFe-10
43	SFA-5.11	ENiCrMo-2
43	SFA-5.11	ENiCrMo-3
43	SFA-5.11	ENiCrMo-6
43	SFA-5.11	ENiCrMo-12
43	SFA-5.11	ENiCrCoMo-1
43	SFA-5.14	ERNiCr-3
43	SFA-5.14	ERNiCr-4
43	SFA-5.14	ERNiCr-6
43	SFA-5.14	ERNiCrFe-5
43	SFA-5.14	ERNiCrFe-6
43	SFA-5.14	ERNiCrFe-7
43	SFA-5.14	ERNiCrFe-8
43	SFA-5.14	ERNiCrFe-11
43	SFA-5.14	ERNiCrCoMo-1
43	SFA-5.14	ERNiCrMo-2
43	SFA-5.14	ERNiCrMo-3
43	SFA-5.30	IN6A
43	SFA-5.30	IN62
43	SFA-5.30	IN82
44	SFA-5.11	ENiMo-1
44	SFA-5.11	ENiMo-3
44	SFA-5.11	ENiMo-7
44	SFA-5.11	ENiMo-8
44	SFA-5.11	ENiMo-9
44	SFA-5.11	ENiMo-10
44	SFA-5.11	ENiCrMo-4
44	SFA-5.11	ENiCrMo-5
44	SFA-5.11	ENiCrMo-7
44	SFA-5.11	ENiCrMo-10
44	SFA-5.11	ENiCrMo-13
44	SFA-5.11	ENiCrMo-14
44	SFA-5.14	ERNiMo-1
44	SFA-5.14	ERNiMo-2
44	SFA-5.14	ERNiMo-3
44	SFA-5.14	ERNiMo-7 (B2)
44	SFA-5.14	ERNiMo-8
44	SFA-5.14	ERNiMo-9
44	SFA-5.14	ERNiMo-10
44	SFA-5.14	ERNiCrMo-4
44	SFA-5.14	ERNiCrMo-7 (Alloy C4)
44	SFA-5.14	ERNiCrMo-10
44	SFA-5.14	ERNiCrMo-13
44	SFA-5.14	ERNiCrMo-14
44	SFA-5.14	ERNiCrWMo-1
45	SFA-5.11	ENiCrMo-1
45	SFA-5.11	ENiCrMo-9

QW-432
F-NUMBERS (CONT'D)
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Nickel and Nickel Alloys (cont'd)	
45	SFA-5.11	ENiCrMo-11
45	SFA-5.14	ERNiCrMo-1
45	SFA-5.14	ERNiCrMo-8
45	SFA-5.14	ERNiCrMo-9
45	SFA-5.14	ERNiCrMo-11
45	SFA-5.14	ERNiFeCr-1
	Titanium and Titanium Alloys	
51	SFA-5.16	ERTi-1
51	SFA-5.16	ERTi-2
51	SFA-5.16	ERTi-3
51	SFA-5.16	ERTi-4
52	SFA-5.16	ERTi-7
53	SFA-5.16	ERTi-9
53	SFA-5.16	ERTi-9ELI
54	SFA-5.16	ERTi-12
55	SFA-5.16	ERTi-5
55	SFA-5.16	ERTi-5ELI
55	SFA-5.16	ERTi-6
55	SFA-5.16	ERTi-6ELI
55	SFA-5.16	ERTi-15
	Zirconium and Zirconium Alloys	
61	SFA-5.24	ERZr2
61	SFA-5.24	ERZr3
61	SFA-5.24	ERZr4
	Hard-Facing Weld Metal Overlay	
71	SFA-5.13	All classifications
72	SFA-5.21	All classifications

QW-433 Alternate F-Numbers for Welder Performance Qualification

The following tables identify the filler metal or electrode that the welder used during qualification testing as "Qualified With," and the electrodes or filler metals that the welder is qualified to use in production welding as "Qualified For." See QW-432 for the F-Number assignments.

Qualified With → / Qualified For ↓	F-No. 1 With Backing	F-No. 1 Without Backing	F-No. 2 With Backing	F-No. 2 Without Backing	F-No. 3 With Backing	F-No. 3 Without Backing	F-No. 4 With Backing	F-No. 4 Without Backing	F-No. 5 With Backing	F-No. 5 Without Backing
F-No. 1 With Backing	X	X	X	X	X	X	X	X	X	X
F-No. 1 Without Backing		X								
F-No. 2 With Backing			X	X	X	X	X	X		
F-No. 2 Without Backing				X						
F-No. 3 With Backing					X	X	X	X		
F-No. 3 Without Backing						X				
F-No. 4 With Backing							X	X		
F-No. 4 Without Backing								X		
F-No. 5 With Backing									X	X
F-No. 5 Without Backing										X

Qualified With	Qualified For
Any F-No. 6	All F-No. 6 [Note (1)]
Any F-No. 21 through F-No. 25	All F-No. 21 through F-No. 25
Any F-No. 31, F-No. 32, F-No. 33, F-No. 35, F-No. 36, or F-No. 37	Only the same F-Number as was used during the qualification test
F-No. 34 or any F-No. 41 through F-No. 45	F-No. 34 and all F-No. 41 through F-No. 45
Any F-No. 51 through F-No. 54	All F-No. 51 through F-No. 54
Any F-No. 61	All F-No. 61
Any F-No. 71 through F-No. 72	Only the same F-Number as was used during the qualification test

NOTE:
(1) Deposited weld metal made using a bare rod not covered by an SFA Specification but which conforms to an analysis listed in QW-442 shall be considered to be classified as F-No. 6.

QW-440 WELD METAL CHEMICAL COMPOSITION

QW-441 General

Identification of weld metal chemical composition designated on the PQR and WPS shall be as given in QW-404.5.

QW-442
A-NUMBERS
Classification of Ferrous Weld Metal Analysis for Procedure Qualification

A-No.	Types of Weld Deposit	Analysis, % [Note (1)]					
		C	Cr	Mo	Ni	Mn	Si
1	Mild Steel	0.20	. . .	. . .	. . .	1.60	1.00
2	Carbon-Molybdenum	0.15	0.50	0.40–0.65	. . .	1.60	1.00
3	Chrome (0.4% to 2%)–Molybdenum	0.15	0.40–2.00	0.40–0.65	. . .	1.60	1.00
4	Chrome (2% to 6%)–Molybdenum	0.15	2.00–6.00	0.40–1.50	. . .	1.60	2.00
5	Chrome (6% to 10.5%)–Molybdenum	0.15	6.00–10.50	0.40–1.50	. . .	1.20	2.00
6	Chrome-Martensitic	0.15	11.00–15.00	0.70	. . .	2.00	1.00
7	Chrome-Ferritic	0.15	11.00–30.00	1.00	. . .	1.00	3.00
8	Chromium–Nickel	0.15	14.50–30.00	4.00	7.50–15.00	2.50	1.00
9	Chromium–Nickel	0.30	19.00–30.00	6.00	15.00–37.00	2.50	1.00
10	Nickel to 4%	0.15	. . .	0.55	0.80–4.00	1.70	1.00
11	Manganese–Molybdenum	0.17	. . .	0.25–0.75	0.85	1.25–2.25	1.00
12	Nickel–Chrome—Molybdenum	0.15	1.50	0.25–0.80	1.25–2.80	0.75–2.25	1.00

NOTE:
(1) Single values shown above are maximum.

QW-450 SPECIMENS

QW-451 Procedure Qualification Thickness Limits and Test Specimens

QW-451.1
GROOVE-WELD TENSION TESTS AND TRANSVERSE-BEND TESTS

Thickness T of Test Coupon Welded, in. (mm)	Range of Thickness T of Base Metal Qualified, in. (mm) [Notes (1) and (2)]		Thickness t of Deposited Weld Metal Qualified, in. (mm) [Notes (1) and (2)]	Type and Number of Tests Required (Tension and Guided-Bend Tests) [Note (2)]			
	Min.	Max.	Max.	Tension, QW-150	Side Bend, QW-160	Face Bend, QW-160	Root Bend, QW-160
Less than $^1/_{16}$ (1.6)	T	$2T$	$2t$	2	. . .	2	2
$^1/_{16}$ to $^3/_8$ (1.6 to 10), incl.	$^1/_{16}$ (1.6)	$2T$	$2t$	2	Note (3)	2	2
Over $^3/_8$ (10), but less than $^3/_4$ (19)	$^3/_{16}$ (4.8)	$2T$	$2t$	2	Note (3)	2	2
$^3/_4$ (19) to less than $1^1/_2$ (38)	$^3/_{16}$ (4.8)	$2T$	$2t$ when $t < {}^3/_4$ (19)	2 [Note (4)]	4	. . .	. . .
$^3/_4$ (19) to less than $1^1/_2$ (38)	$^3/_{16}$ (4.8)	$2T$	$2T$ when $t \geq {}^3/_4$ (19)	2 [Note (4)]	4	. . .	. . .
$1^1/_2$ (38) and over	$^3/_{16}$ (4.8)	8 (203) [Note (5)]	$2t$ when $t < {}^3/_4$ (19)	2 [Note (4)]	4	. . .	. . .
$1^1/_2$ (38) and over	$^3/_{16}$ (4.8)	8 (203) [Note (5)]	8 (203) [Note (5)] when $t \geq {}^3/_4$ (19)	2 [Note (4)]	4	. . .	. . .

NOTES:
(1) See QW-403 (.2, .3, .6, .9, .10), QW-404.32, and QW-407.4 for further limits on range of thickness qualified. Also, see QW-202 (.2, .3, .4) for allowable exceptions.
(2) For combination of welding procedures, see QW-200.4.
(3) Four side-bend tests may be substituted for the required face- and root-bend tests, when thickness T is $^3/_8$ in. (10 mm) and over.
(4) See QW-151 (.1, .2, .3) for details on multiple specimens when coupon thicknesses are over 1 in. (25 mm).
(5) For the welding processes of QW-403.7 only; otherwise per Note (1) or $2T$, or $2t$, whichever is applicable.

QW-451.2
GROOVE-WELD TENSION TESTS AND LONGITUDINAL-BEND TESTS

Thickness T of Test Coupon Welded, in. (mm)	Range of Thickness T of Base Metal Qualified, in. (mm) [Notes (1) and (2)]		Thickness t of Deposited Weld Metal Qualified, in. (mm) [Notes (1) and (2)]	Type and Number of Tests Required (Tension and Guided-Bend Tests) [Note (2)]		
	Min.	Max.	Max.	Tension, QW-150	Face Bend, QW-160	Root Bend, QW-160
Less than $^1/_{16}$ (1.6)	T	$2T$	$2t$	2	2	2
$^1/_{16}$ to $^3/_8$ (1.6 to 10), incl.	$^1/_{16}$ (1.6)	$2T$	$2t$	2	2	2
Over $^3/_8$ (10)	$^3/_{16}$ (4.8)	$2T$	$2t$	2	2	2

NOTES:
(1) See QW-403 (.2, .3, .6, .7, .9, .10), QW-404.32, and QW-407.4 for further limits on range of thickness qualified. These are also applicable to deposited weld metal thicknesses. Also, see QW-202 (.2, .3, .4) for allowable exceptions.
(2) For combination of welding procedures, see QW-200.4.

QW-451.3
FILLET-WELD TESTS

Type of Joint	Thickness of Test Coupons as Welded, in.	Range Qualified	Type and Number of Tests Required [QW-462.4(a) or QW-462.4(d)] Macro
Fillet	Per QW-462.4(a)	All fillet sizes on all base metal thicknesses and all diameters	5
Fillet	Per QW-462.4(d)		4

GENERAL NOTE: A production assembly mockup may be substituted in accordance with QW-181.1.1. When a production assembly mockup is used, the range qualified shall be limited to the fillet weld size, base metal thickness, and configuration of the mockup. Alternatively, multiple production assembly mockups may be qualified. The range of thickness of the base metal qualified shall be no less than the thickness of the thinner member tested and no greater than the thickness of the thicker member tested. The range for fillet weld sizes qualified shall be limited to no less than the smallest fillet weld tested and no greater than the largest fillet weld tested. The configuration of production assemblies shall be the same as that used in the production assembly mockup.

QW-451.4
FILLET WELDS QUALIFIED BY GROOVE-WELD TESTS

Thickness *T* of Test Coupon (Plate or Pipe) as Welded	Range Qualified	Type and Number of Tests Required
All groove tests	All fillet sizes on all base metal thicknesses and all diameters	Fillet welds are qualified when the groove weld is qualified in accordance with either QW-451.1 or QW-451.2 (see QW-202.2)

A02

QW-452 Performance Qualification Thickness Limits and Test Specimens

QW-452.1 Groove-Weld Transverse-Bend Test. The following tables identify the required type and number of tests and the thickness of weld metal qualified.

QW-452.1(a)
TEST SPECIMENS

Thickness of Weld Metal, in. (mm)	Type and Number of Examinations and Test Specimens Required			
	Visual Examination per QW-302.4	Side Bend QW-462.2 [Note (1)]	Face Bend QW-462.3(a) [Note (1)]	Root Bend QW-462.3(a) [Note (1)]
Less than 3/8 (10)	X	...	1	1
3/8 (10) to less than 3/4 (19)	X	2 [Note (2)]	Note (2)	Note (2)
3/4 (19) and over	X	2	...	...

GENERAL NOTE: The "Thickness of Weld Metal" is the total weld metal thickness of all welders and all processes in the test coupon.

NOTES:
(1) To qualify using positions 5G or 6G, a total of four bend specimens are required. To qualify using a combination of 2G and 5G in a single test coupon, a total of six bend specimens are required. See QW-302.3. The type of bend test shall be based on weld metal thickness.
(2) One face and root bend may be substituted for the two side bends.

QW-452.1(b)
THICKNESS OF WELD METAL QUALIFIED

Thickness, *t*, of Weld Metal in the Coupon, in. (mm) [Notes (1), (2)]	Thickness of Weld Metal Qualified [Note (3)]
All	2*t*
1/2 (13) and over with a minimum of three layers	Maximum to be welded

NOTES:
(1) When more than one welder and/or more than one process and more than one filler metal F-Number is used to deposit weld metal in a coupon, the thickness, *t*, of the weld metal in the coupon deposited by each welder with each process and each filler metal F-Number in accordance with the applicable variables under QW-404 shall be determined and used individually in the "Thickness, *t*, of Weld Metal in the Coupon" column to determine the "Thickness of Weld Metal Qualified."
(2) Two or more pipe test coupons with different weld metal thickness may be used to determine the weld metal thickness qualified and that thickness may be applied to production welds to the smallest diameter for which the welder is qualified in accordance with QW-452.3.
(3) Thickness of test coupon of 3/4 in. (19 mm) or over shall be used for qaulifying a combination of three or more welders each of whom may use the same or a different welding process.

QW-452.2
LONGITUDINAL-BEND TESTS

Type of Joint	Thickness Test Coupon Welded, in. (mm) [Note (1)]	Thickness *t* of Deposited Weld Metal Qualified, in. (mm)	Type and Number of Tests Required (Guided-Bend Tests) [Note (2)]	
		Max.	Face Bend, QW-462.3(b) [Note (3)]	Root Bend, QW-462.3(b) [Note (3)]
Groove	Up to $^3/_8$ (10), incl.	2*t*	1	1
Groove	Over $^3/_8$ (10)	*2t*	1	1

NOTES:
(1) When using one, two, or more welders, the thickness *t* of the deposited weld metal for each welder with each process shall be determined and used individually in the Thickness column.
(2) Thickness of test coupon of $^3/_4$ in. (19 mm) or over shall be used for qualifying a combination of three or more welders, each of which may use the same or a different welding process.
(3) Face- and root-bend tests may be used to qualify a combination test of:
(a) one welder using two welding processes; or
(b) two welders using the same or a different welding process.

QW-452.3
GROOVE-WELD DIAMETER LIMITS

Outside Diameter of Test Coupon, in. (mm)	Outside Diameter Qualified, in. (mm)	
	Min.	Max.
Less than 1 (25)	Size welded	Unlimited
1 (25) to less than $2^7/_8$ (73)	1 (25)	Unlimited
$2^7/_8$ (73) and over	$2^7/_8$ (73)	Unlimited

GENERAL NOTES:
(a) Type and number of tests required shall be in accordance with QW-452.1.
(b) $2^7/_8$ in. (73 mm) O.D. is the equivalent of NPS $2^1/_2$.

QW-452.4
SMALL DIAMETER FILLET-WELD TEST

Outside Diameter of Test Coupon, in. (mm)	Minimum Outside Diameter Qualified, in. (mm)	Thickness Qualified
Less than 1 (25)	Size welded	All
1 (25) to less than $2\frac{7}{8}$ (73)	1 (25)	All
$2\frac{7}{8}$ (73) and over	$2\frac{7}{8}$ (73)	All

GENERAL NOTES:
(a) Type and number of tests required shall be in accordance with QW-452.5.
(b) $2\frac{7}{8}$ in. (73 mm) O.D. is considered the equivalent of NPS $2\frac{1}{2}$.

QW-452.5
FILLET-WELD TEST

Type of Joint	Thickness of Test Coupon as Welded, in. (mm)	Range Qualified	Type and Number of Tests Required [QW-462.4(b) or QW-462.4(c)]	
			Macro	Fracture
Tee fillet	$\frac{3}{16}$–$\frac{3}{8}$ (4.8–10)	All base material thicknesses, fillet sizes, and diameters $2\frac{7}{8}$ (73) O.D. and over [Note (1)]	1	1
	Less than $\frac{3}{16}$ (4.8)	*T* to 2 *T* base material thickness, *T* maximum fillet size, and all diameters $2\frac{7}{8}$ (73) O.D. and over [Note (1)]	1	1

GENERAL NOTE: Production assembly mockups may be substituted in accordance with QW-181.2.1. When production assembly mockups are used, range qualified shall be limited to the fillet sizes, base metal thicknesses, and configuration of the mockup.
NOTE:
(1) $2\frac{7}{8}$ in. (73 mm) O.D. is considered the equivalent of NPS $2\frac{1}{2}$. For smaller diameter qualifications, refer to QW-452.4 or QW-452.6.

QW-452.6
FILLET QUALIFICATION BY GROOVE-WELD TESTS

Type of Joint	Thickness of Test Coupon as Welded, in. (mm)	Range Qualified	Type and Number of Tests Required
Any groove	All thicknesses	All base material thicknesses, fillet sizes, and diameters	Fillet welds are qualified when a welder/welding operator qualifies on a groove weld test

QW-453
PROCEDURE/PERFORMANCE QUALIFICATION THICKNESS LIMITS AND TEST SPECIMENS FOR HARD-FACING (WEAR-RESISTANT) AND CORROSION-RESISTANT OVERLAYS

Thickness of Test Coupon (T)	Corrosion-Resistant [Note (1)] Overlay		Hard-facing Overlay (Wear-Resistant) [Note (2)]	
	Nominal Base Metal Thickness Qualified (T)	Type and Number of Tests Required	Nominal Base Metal Thickness Qualified (T)	Type and Number of Tests Required
Procedure Qualification Testing				
Less than 1 in. (25 mm) T	T qualified to unlimited	Notes (4), (5), and (9)	T qualified up to 1 in. (25 mm)	Notes (3), (7), (8), and (9)
1 in. (25 mm) and over T	1 in. (25 mm) to unlimited		1 in. (25 mm) to unlimited	
Performance Qualification Testing				
Less than 1 in. (25 mm) T	T qualified to unlimited	Note (6)	T qualified to unlimited	Notes (8) and (10)
1 in. (25 mm) and over T	1 in. (25 mm) to unlimited		1 in. (25 mm) to unlimited	

NOTES:

(1) The qualification test coupon shall consist of base metal not less than 6 in. (152 mm) × 6 in. (152 mm). The weld overlay cladding shall be a minimum of $1^1/_2$ in. (38 mm) wide by approximately 6 in. (152 mm) long. For qualification on pipe, the pipe length shall be a minimum of 6 in. (152 mm), and a minimum diameter to allow the required number of test specimens. The weld overlay shall be continuous around the circumference of the test coupon. For processes (performance qualification only) depositing a weld bead width greater than $^1/_2$ in. (13 mm) wide, the weld overlay shall consist of a minimum of three weld beads in the first layer.

(2) The test base metal coupon shall have minimum dimensions of 6 in. (152 mm) wide × approximately 6 in. (152 mm) long with a hard-faced layer a minimum of $1^1/_2$ in. (38 mm) wide × 6 in. (152 mm) long. The minimum hard-faced thickness shall be as specified in the Welding Procedure Specification. Alternatively, the qualification may be performed on a test base metal coupon that represents the size of the production part. For qualification on pipe, the pipe length shall be 6 in. (152 mm) minimum, and of a minimum diameter to allow the required number of test specimens. The weld overlay shall be continuous around the circumference of the test coupon.

(3) The hard-facing surface shall be examined by the liquid penetrant method and shall meet the acceptance standards in QW-195.2 or as specified in the WPS. Surface conditioning prior to liquid penetrant examination is permitted.

(4) The corrosion-resistant surface shall be examined by the liquid penetrant method and shall meet the acceptance standards as specified in QW-195.

(5) Following the liquid penetrant examination, four guided side-bend tests shall be made from the test coupon in accordance with QW-161. The test specimens shall be cut so that there are either two specimens parallel and two specimens perpendicular to the direction of the welding, or four specimens perpendicular to the direction of the welding. For coupons that are less than $^3/_8$ in. (10 mm) thick, the width of the side-bend specimens may be reduced to the thickness of the test coupon. The side-bend specimens shall be removed from locations specified in QW-462.5(c) or QW-462.5(d).

(6) The test coupon shall be sectioned to make side-bend test specimens perpendicular to the direction of the welding in accordance with QW-161. Test specimens shall be removed at locations specified in QW-462.5(c) or QW-462.5(d).

(7) After surface conditioning to the minimum thickness specified in the WPS, a minimum of three hardness readings shall be made on each of the specimens from the locations shown in QW-462.5(b) or QW-462.5(e). All readings shall meet the requirements of the WPS.

(8) The base metal shall be sectioned transversely to the direction of the hard-facing overlay. The two faces of the hard-facing exposed by sectioning shall be polished and etched with a suitable etchant and shall be visually examined with ×5 magnification for cracks in the base metal or the heat-affected zone, lack of fusion, or other linear defects. The overlay and the base metal shall meet the requirements specified in the WPS. All exposed faces shall be examined. See QW-462.5(b) for pipe and QW-462.5(e) for plate.

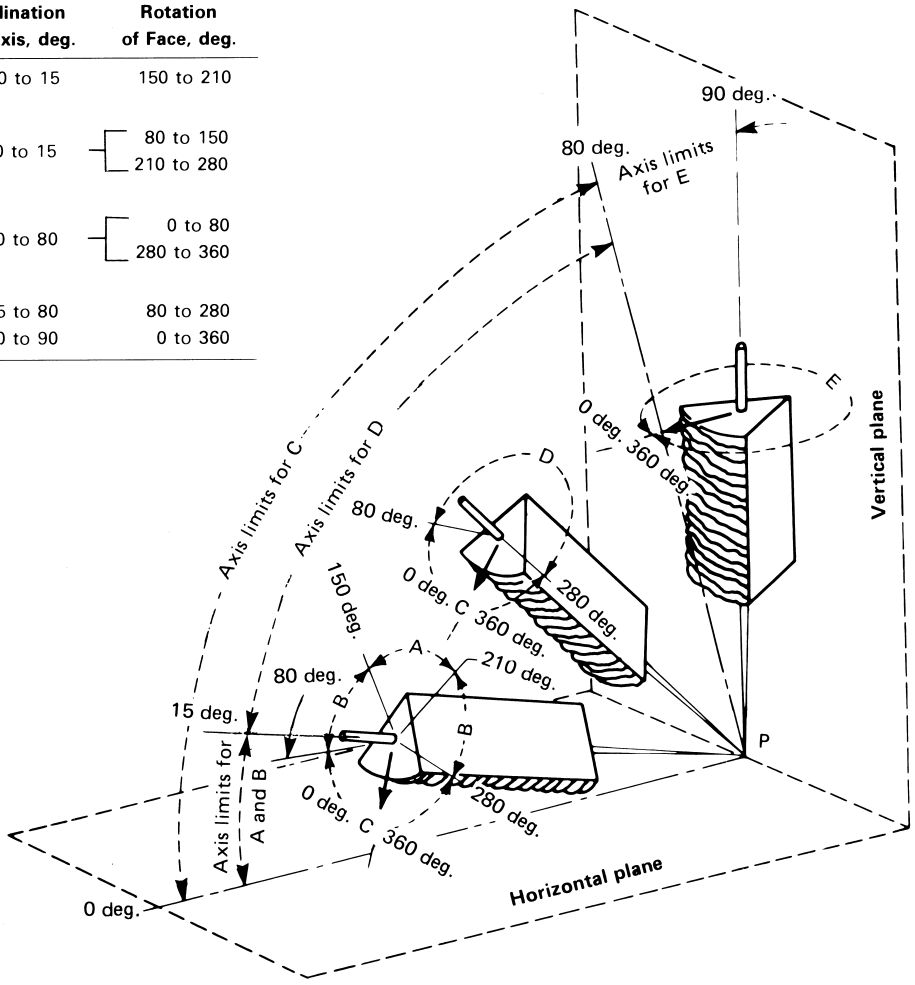
(9) When a chemical composition is specified in the WPS, chemical analysis specimens shall be removed at locations specified in QW-462.5(b) or QW-462.5(e). The chemical analysis shall be performed in accordance with QW-462.5(a) and shall be within the range specified in the WPS. This chemical analysis is not required when a chemical composition is not specified on the WPS.

(10) At a thickness greater than or equal to the minimum thickness specified in the WPS, the weld surface shall be examined by the liquid penetrant method and shall meet the acceptance standards in QW-195.2 or as specified in the WPS. Surface conditioning prior to liquid penetrant examination is permitted.

QW-460 GRAPHICS

QW-461 Positions

Tabulation of Positions of Welds			
Position	Diagram Reference	Inclination of Axis, deg.	Rotation of Face, deg.
Flat	A	0 to 15	150 to 210
Horizontal	B	0 to 15	80 to 150 210 to 280
Overhead	C	0 to 80	0 to 80 280 to 360
Vertical	D	15 to 80	80 to 280
	E	80 to 90	0 to 360



GENERAL NOTE:

The horizontal reference plane is taken to lie always below the weld under consideration.

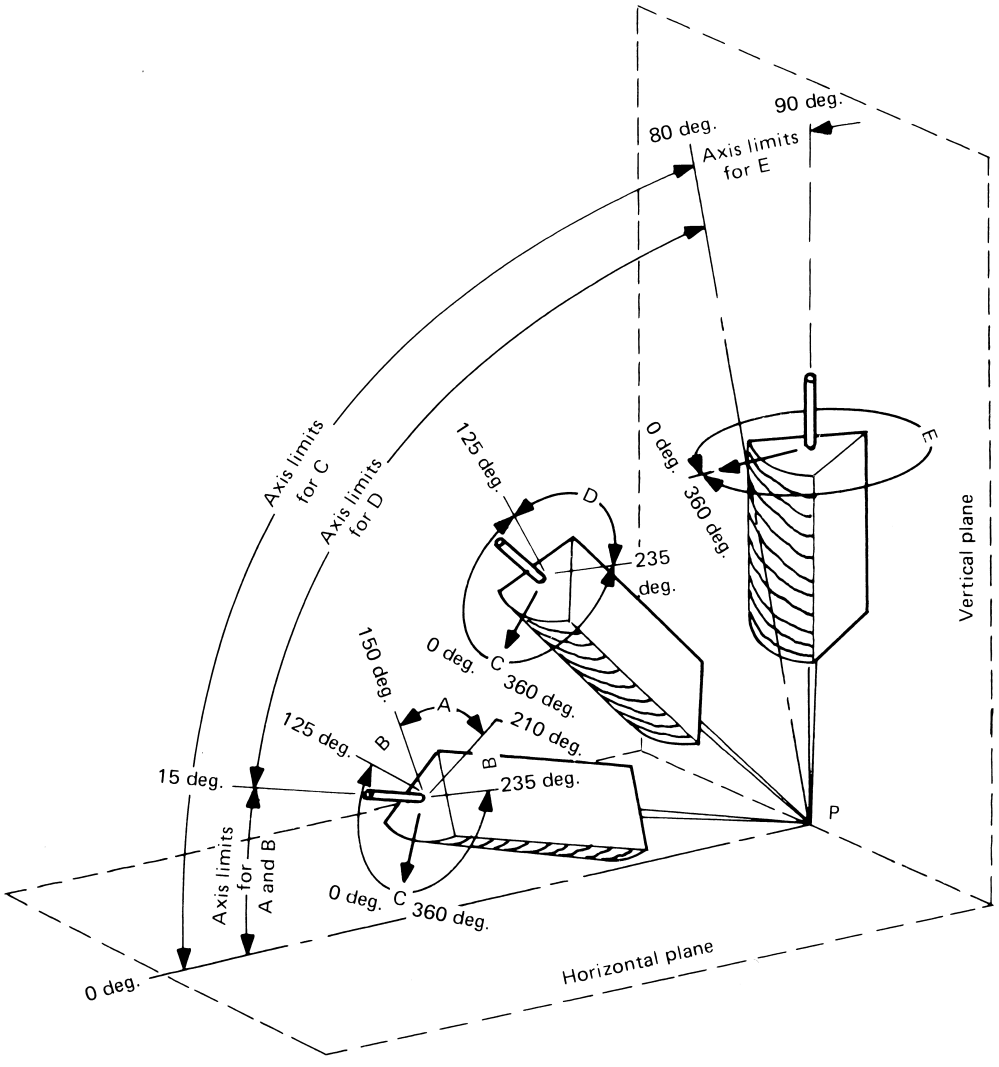
Inclination of axis is measured from the horizontal reference plane toward the vertical.

Angle of rotation of face is measured from a line perpendicular to the axis of the weld and lying in a vertical plane containing this axis. The reference position (0 deg.) of rotation of the face invariably points in the direction opposite to that in which the axis angle increases. The angle of rotation of the face of weld is measured in a clockwise direction from this reference position (0 deg.) when looking at point *P*.

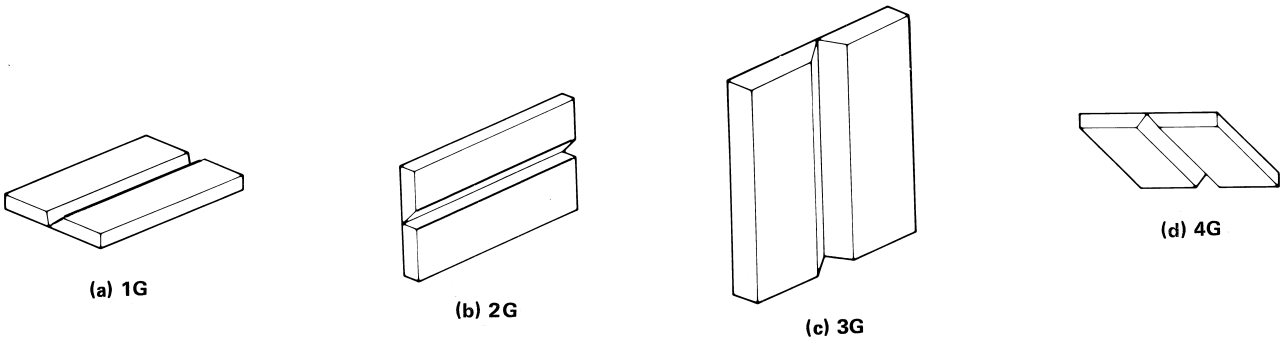
QW-461.1 POSITIONS OF WELDS — GROOVE WELDS

Tabulation of Positions of Fillet Welds

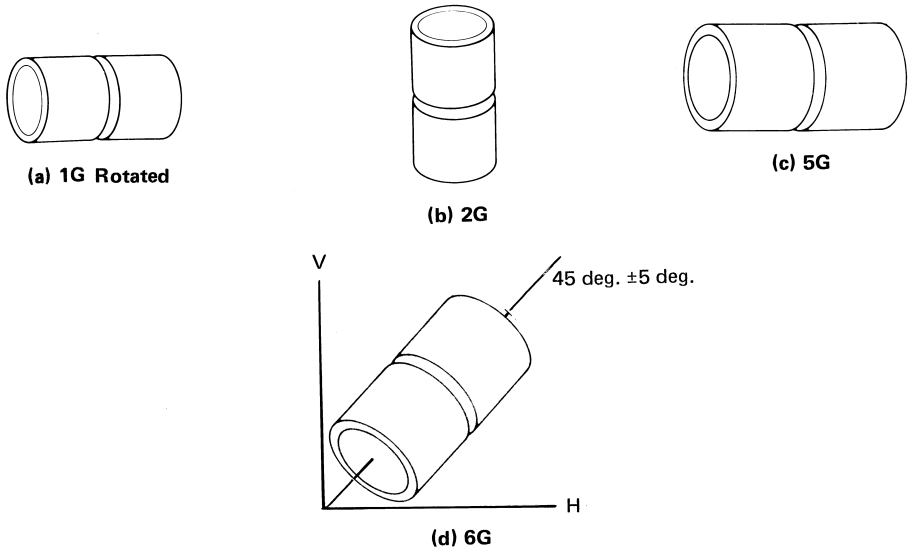
Position	Diagram Reference	Inclination of Axis, deg.	Rotation of Face, deg.
Flat	A	0 to 15	150 to 210
Horizontal	B	0 to 15	125 to 150 210 to 235
Overhead	C	0 to 80	0 to 125 235 to 360
Vertical	D	15 to 80	125 to 235
	E	80 to 90	0 to 360



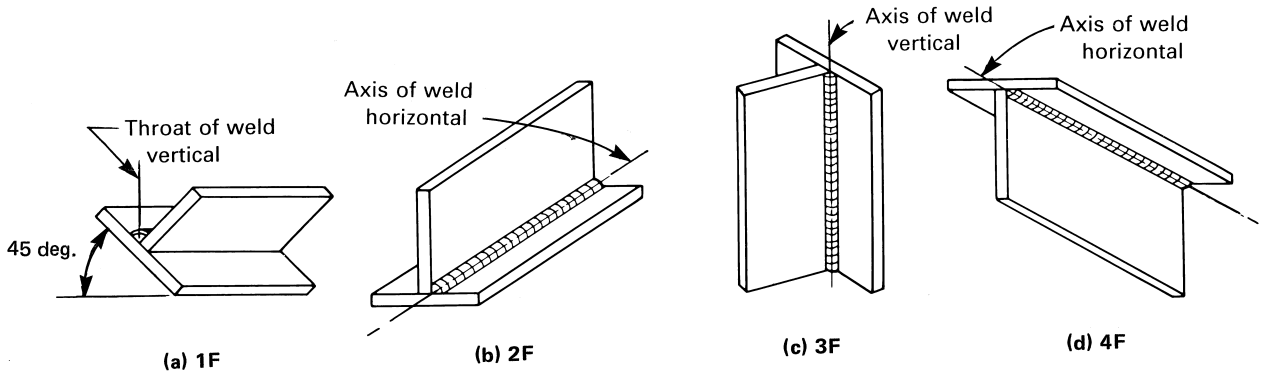
QW-461.2 POSITIONS OF WELDS — FILLET WELDS



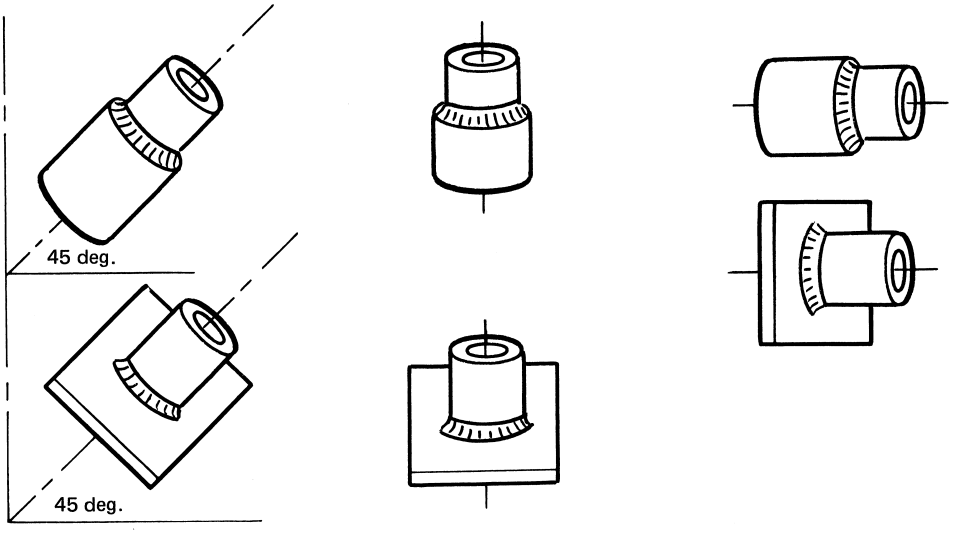
QW-461.3 GROOVE WELDS IN PLATE — TEST POSITIONS



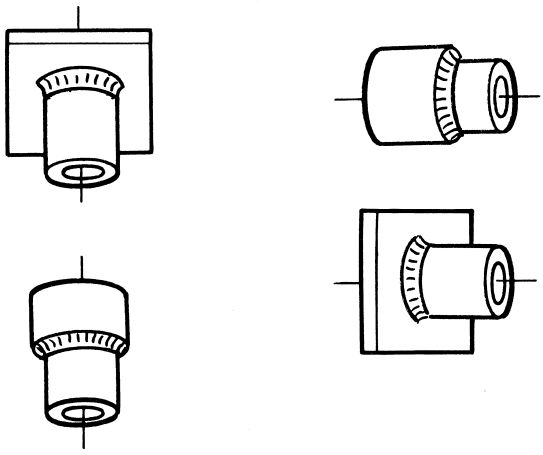
QW-461.4 GROOVE WELDS IN PIPE — TEST POSITIONS



QW-461.5 FILLET WELDS IN PLATE — TEST POSITIONS

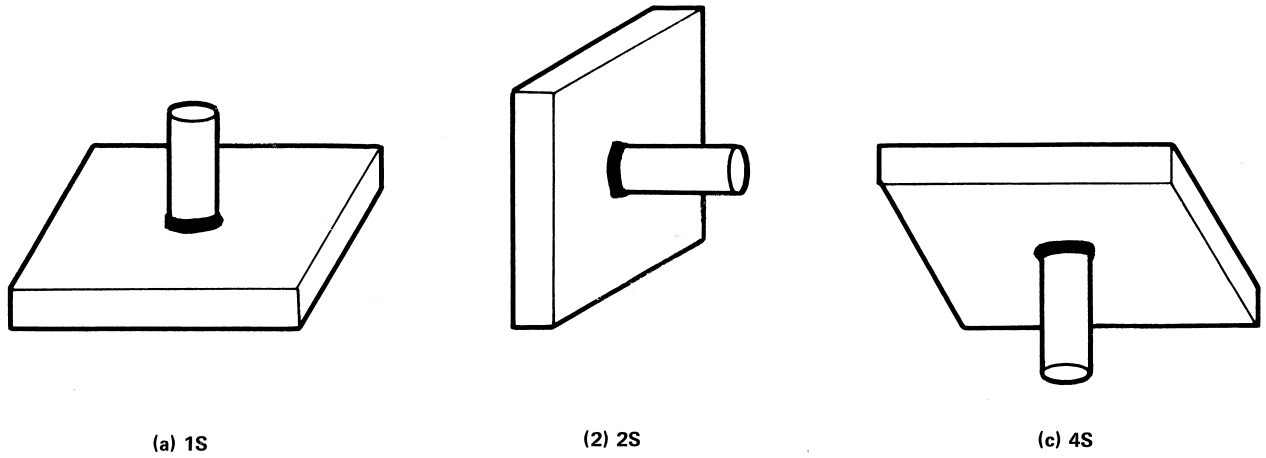


(a) 1F (Rotated) (b) 2F (c) 2FR (Rotated)

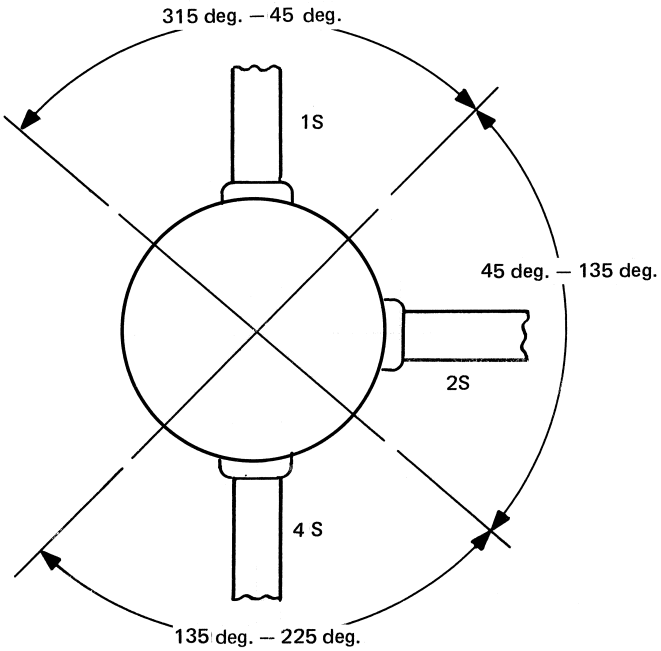


(d) 4F (e) 5F

QW-461.6 FILLET WELDS IN PIPE — TEST POSITIONS



QW-461.7 STUD WELDS — TEST POSITIONS



QW-461.8 STUD WELDS — WELDING POSITIONS

QW-461.9
PERFORMANCE QUALIFICATION — POSITION AND DIAMETER LIMITATIONS
(Within the Other Limitations of QW-303)

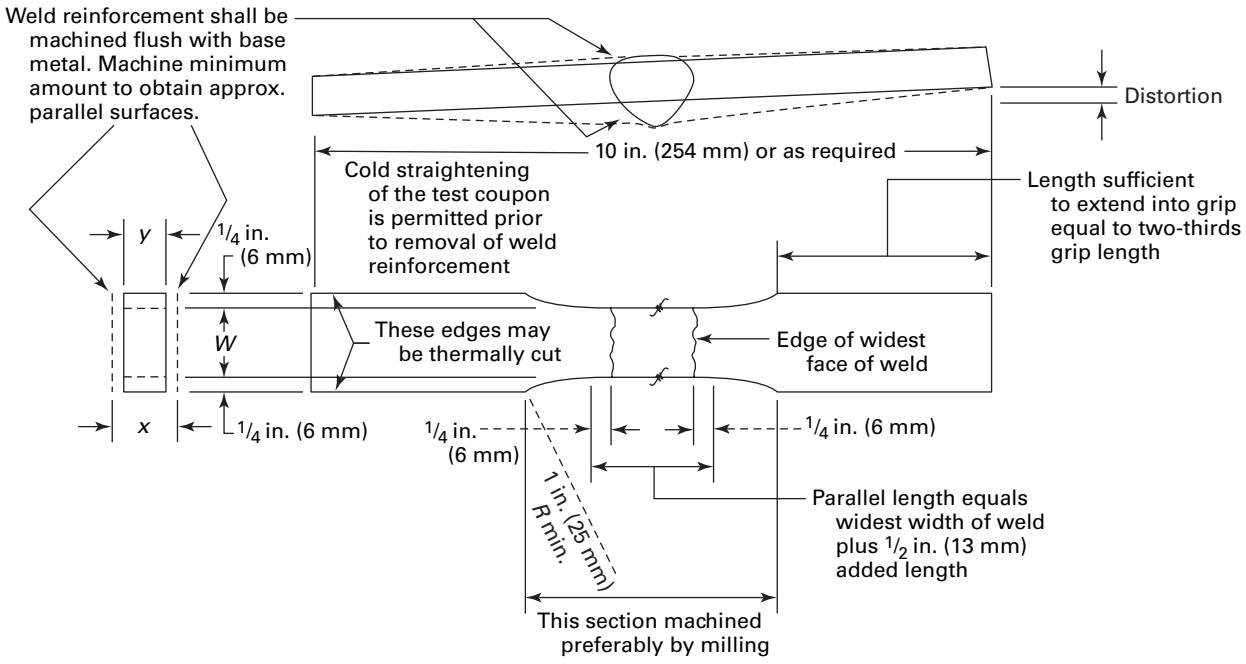
Qualification Test		Position and Type Weld Qualified [Note (1)]		
		Groove		Fillet
Weld	Position	Plate and Pipe Over 24 in. (610 mm) O.D.	Pipe ≤ 24 in. (610 mm) O.D.	Plate and Pipe
Plate — Groove	1G	F	F [Note (2)]	F
	2G	F,H	F,H [Note (2)]	F,H
	3G	F,V	F [Note (2)]	F,H,V
	4G	F,O	F [Note (2)]	F,H,O
	3G and 4G	F,V,O	F [Note (2)]	All
	2G, 3G, and 4G	All	F,H [Note (2)]	All
	Special Positions (SP)	SP,F	SP,F	SP,F
Plate — Fillet	1F	. . .	. . .	F [Note (2)]
	2F	. . .	. . .	F,H [Note (2)]
	3F	. . .	. . .	F,H,V [Note (2)]
	4F	. . .	. . .	F,H,O [Note (2)]
	3F and 4F	. . .	. . .	All [Note (2)]
	Special Positions (SP)	. . .	. . .	SP,F [Note (2)]
Pipe — Groove [Note (3)]	1G	F	F	F
	2G	F,H	F,H	F,H
	5G	F,V,O	F,V,O	All
	6G	All	All	All
	2G and 5G	All	All	All
	Special Positions (SP)	SP,F	SP,F	SP,F
Pipe — Fillet [Note (3)]	1F	. . .	. . .	F
	2F	. . .	. . .	F,H
	2FR	. . .	. . .	F,H
	4F	. . .	. . .	F,H,O
	5F	. . .	. . .	All
	Special Positions (SP)	. . .	. . .	SP,F

NOTES:
(1) Positions of welding as shown in QW-461.1 and QW-461.2.
F = Flat
H = Horizontal
V = Vertical
O = Overhead
(2) Pipe $2^{7}/_{8}$ in. O.D. and over.
(3) See diameter restrictions in QW-452.3, QW-452.4, and QW-452.6.

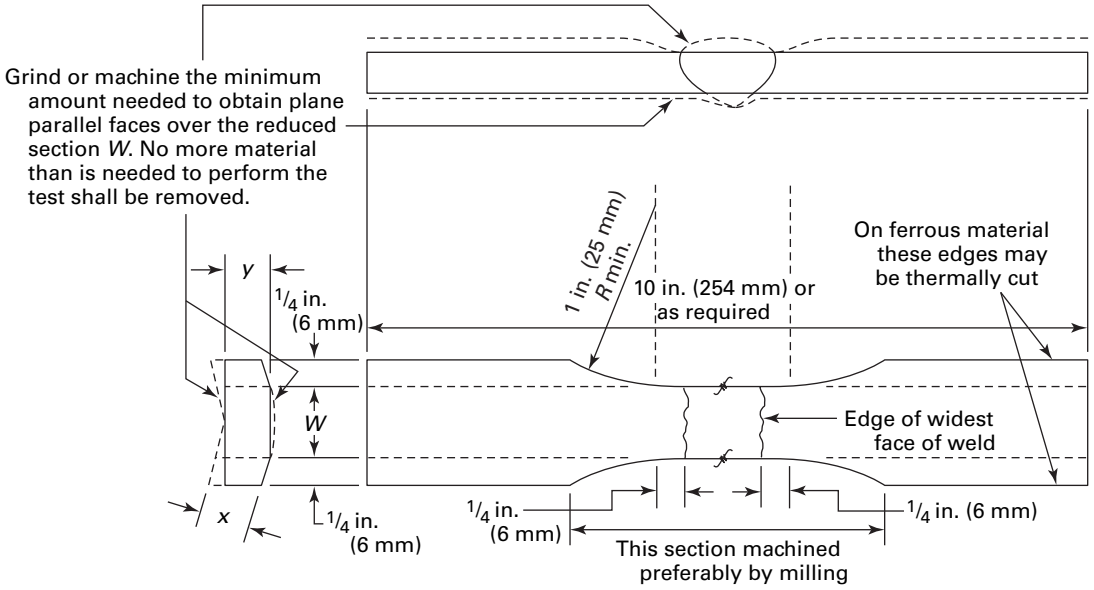
QW-462 Test Specimens

The purpose of the QW-462 figures is to give the manufacturer or contractor guidance in dimensioning test specimens for tests required for procedure and performance qualifications. Unless a minimum, maximum, or tolerance is given in the figures (or as QW-150, QW-160, or QW-180 requires), the dimensions are to be considered approximate. All welding processes and filler material to be qualified must be included in the test specimen.

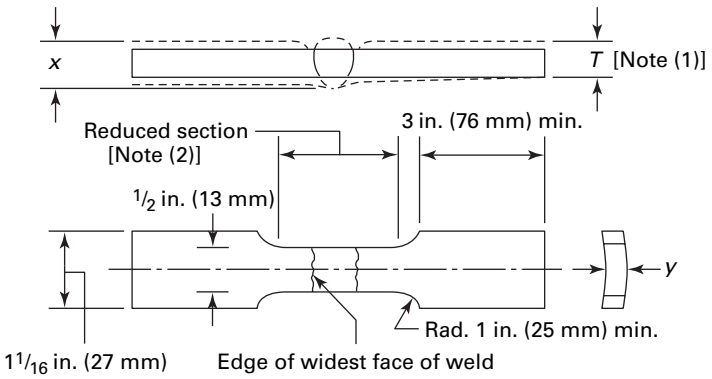
x = coupon thickness including reinforcement
y = specimen thickness
T = coupon thickness excluding reinforcement
W = specimen width, $^3/_4$ in. (19 mm)



QW-462.1(a) TENSION — REDUCED SECTION — PLATE

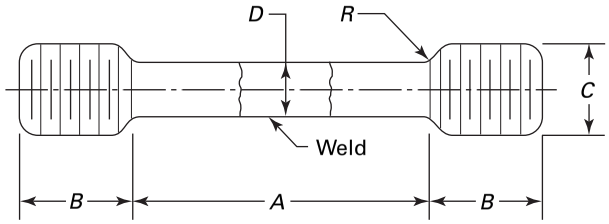


QW-462.1(b) TENSION — REDUCED SECTION — PIPE



NOTES:
(1) The weld reinforcement shall be ground or machined so that the weld thickness does not exceed the base metal thickness *T*. Machine minimum amount to obtain approximately parallel surfaces.
(2) The reduced section shall not be less than the width of the weld plus 2*y*.

QW-462.1(c) TENSION — REDUCED SECTION ALTERNATE FOR PIPE

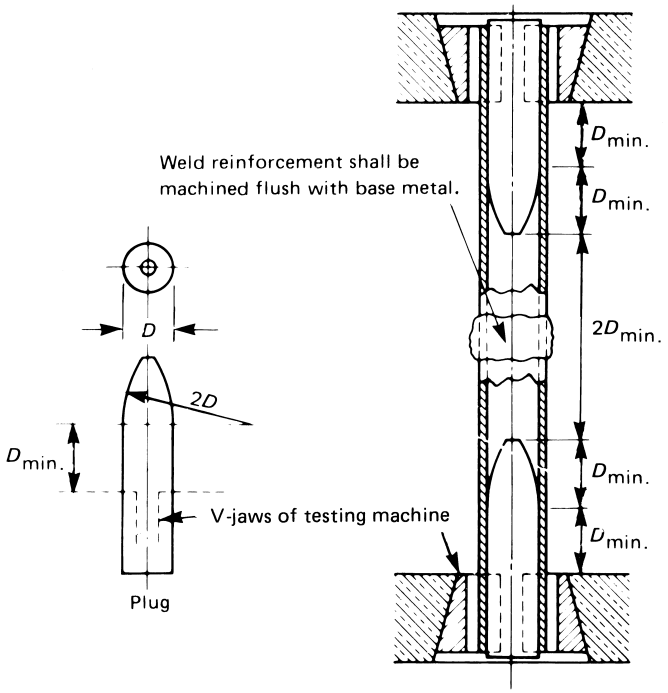


	Standard Dimensions, in. (mm)			
	(a) 0.505 Specimen	(b) 0.353 Specimen	(c) 0.252 Specimen	(d) 0.188 Specimen
A—Length of reduced section	Note (1)	Note (1)	Note (1)	Note (1)
D—Diameter	0.500 ± 0.010 (12.7 ± 0.25)	0.350 ± 0.007 (8.89 ± 0.18)	0.250 ± 0.005 (6.35 ± 0.13)	0.188 ± 0.003 (4.78 ± 0.08)
R—Radius of fillet	3/8 (9.6) min.	1/4 (6.4) min.	3/16 (4.8) min.	1/8 (3.2) min.
B—Length of end section	1 3/8 (35) approx.	1 1/8 (29) approx.	7/8 (22) approx.	1/2 (13) approx.
C—Diameter of end section	3/4 (19)	1/2 (13)	3/8 (10)	1/4 (6)

GENERAL NOTES:
(a) Use maximum diameter specimen (a), (b), (c), or (d) that can be cut from the section.
(b) Weld should be in center of reduced section.
(c) Where only a single coupon is required, the center of the specimen should be midway between the surfaces.
(d) The ends may be of any shape to fit the holders of the testing machine in such a way that the load is applied axially.

NOTE:
(1) Reduced section *A* should not be less than width of weld plus 2*D*.

QW-462.1(d) TENSION — REDUCED SECTION — TURNED SPECIMENS

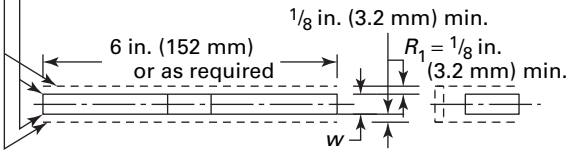


QW-462.1(e) TENSION — FULL SECTION — SMALL DIAMETER PIPE

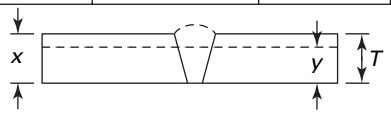
(1a) For procedure qualification of materials other than P-No. 1 in QW-422, if the surfaces of the side bend test specimens are gas cut, removal by machining or grinding of not less than 1/8 in. (3.2 mm) from the surface shall be required.

(1b) Such removal is not required for P-No. 1 materials, but any resulting roughness shall be dressed by machining or grinding.

(2) For performance qualification of all materials in QW-422, if the surfaces of side bend tests are gas cut, any resulting roughness shall be dressed by machining or grinding.



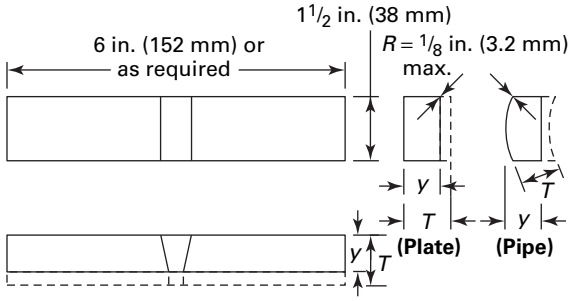
T, in. (mm)	y, in. (mm)	w, in. (mm)	
		P-No. 23, F-No. 23, or P-No. 35	All other metals
3/8 to 1 1/2 (10 to 38), incl.	T	1/8 (3.2)	3/8 (10)
>1 1/2 (38)	Note (1)	1/8 (3.2)	3/8 (10)



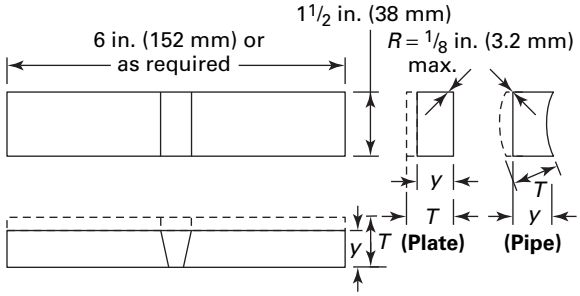
GENERAL NOTE: Weld reinforcement and backing strip or backing ring, if any, may be removed flush with the surface of the specimen. Thermal cutting, machining, or grinding may be employed. Cold straightening is permitted prior to removal of the reinforcement.

NOTE:
(1) When specimen thickness T exceeds 1 1/2 in. (38 mm), use one of the following.
  (a) Cut specimen into multiple test specimens y of approximately equal dimensions [3/4 in. (19 mm) to 1 1/2 in. (38 mm)]. y = tested specimen thickness when multiple specimens are taken from one coupon.
  (b) The specimen may be bent at full width. See requirements on jig width in QW-466.1.

QW-462.2 SIDE BEND



Face-Bend Specimen — Plate and Pipe



Root-Bend Specimen — Plate and Pipe

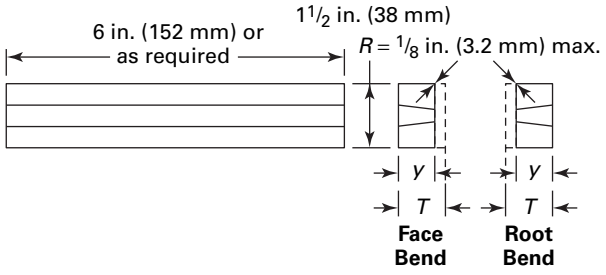
T, in. (mm)	*Y*, in. (mm) P-No. 23, F-No. 23, or P-No. 35	*Y*, in. (mm) All Other Metals
1/16 < 1/8 (1.6 < 3.2)	*T*	*T*
1/8–3/8 (3.2–10)	1/8 (3.2)	*T*
>3/8 (10)	1/8 (3.2)	3/8 (10)

GENERAL NOTES:

(a) Weld reinforcement and backing strip or backing ring, if any, shall be removed flush with the surface of the specimen. If a recessed ring is used, this surface of the specimen may be machined to a depth not exceeding the depth of the recess to remove the ring, except that in such cases the thickness of the finished specimen shall be that specified above. Do not flame-cut nonferrous material.

(b) If the pipe being tested is 4 in. (102 mm) nominal diameter or less, the width of the bend specimen may be 3/4 in. (19 mm) for pipe diameters 2 in. (DN50) to and including 4 in. (DN 100). The bend specimen width may be 3/8 in. (10 mm) for pipe diameters less than 2 in. (DN50) down to and including 3/8 in. (10 mm) and as an alternative, if the pipe being tested is equal to or less than 1 in. (25 mm) nominal pipe size (1.315 in. O. D.) (DN25), the width of the bend specimens may be that obtained by cutting the pipe into quarter sections, less an allowance for saw cuts or machine cutting. These specimens cut into quarter sections are not required to have one surface machined flat as shown in QW-462.3(a). Bend specimens taken from tubing of comparable sizes may be handled in a similar manner.

QW-462.3(a) FACE AND ROOT BENDS — TRANSVERSE

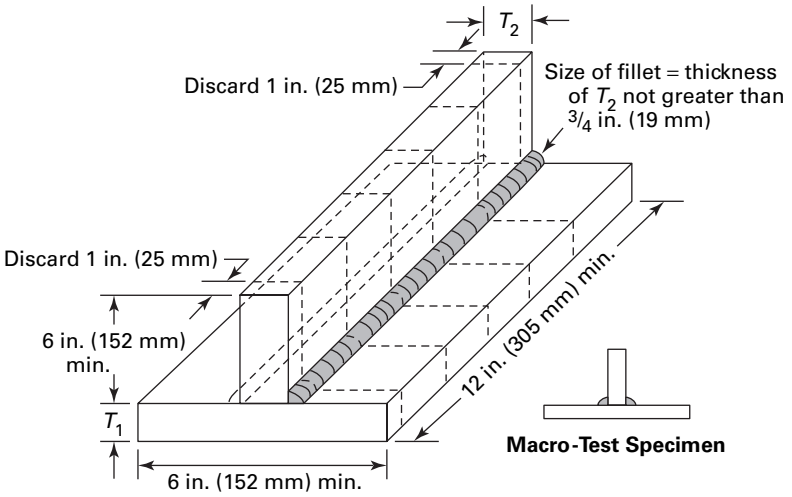


T, in. (mm)	*Y*, in. (mm) P-No. 23, F-No. 23, or P-No. 35	*Y*, in. (mm) All Other Metals
1/16 < 1/8 (1.6 < 3.2)	*T*	*T*
1/8–3/8 (3.2–10)	1/8 (3.2)	*T*
>3/8 (10)	1/8 (3.2)	3/8 (10)

GENERAL NOTE: Weld reinforcements and backing strip or backing ring, if any, shall be removed essentially flush with the undisturbed surface of the base material. If a recessed strip is used, this surface of the specimen may be machined to a depth not exceeding the depth of the recess to remove the strip, except that in such cases the thickness of the finished specimen shall be that specified above.

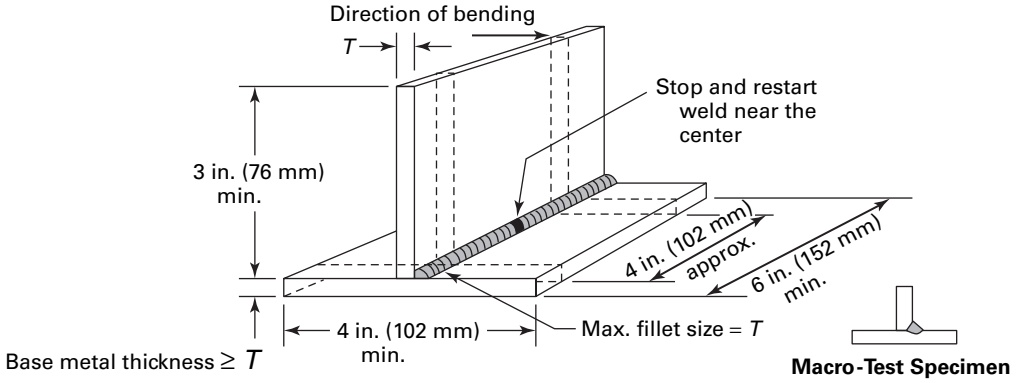
QW-462.3(b) FACE AND ROOT BENDS — LONGITUDINAL

T_1	T_2
$^1/_8$ in. (3.2 mm) and less	T_1
Over $^1/_8$ in. (3.2 mm)	Equal to or less than T_1, but not less than $^1/_8$ in. (3.2 mm)



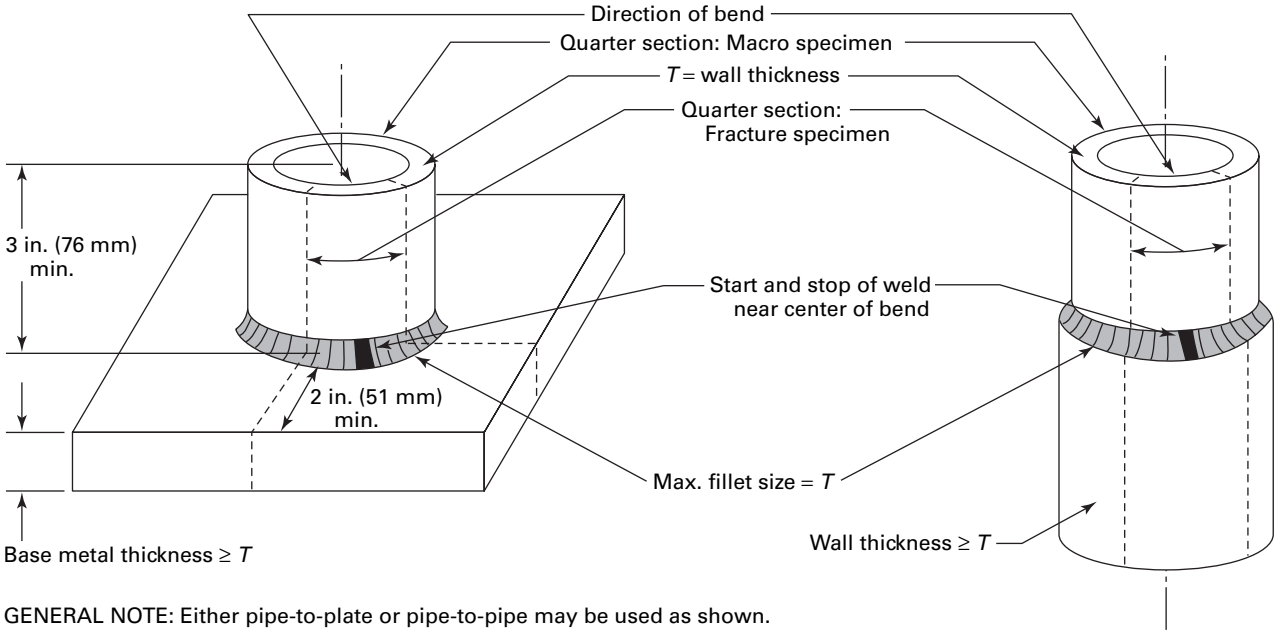
GENERAL NOTE: Macro-test — the fillet shall show fusion at the root of the weld but not necessarily beyond the root. The weld metal and heat-affected zone shall be free of cracks.

QW-462.4(a) FILLET WELDS — PROCEDURE



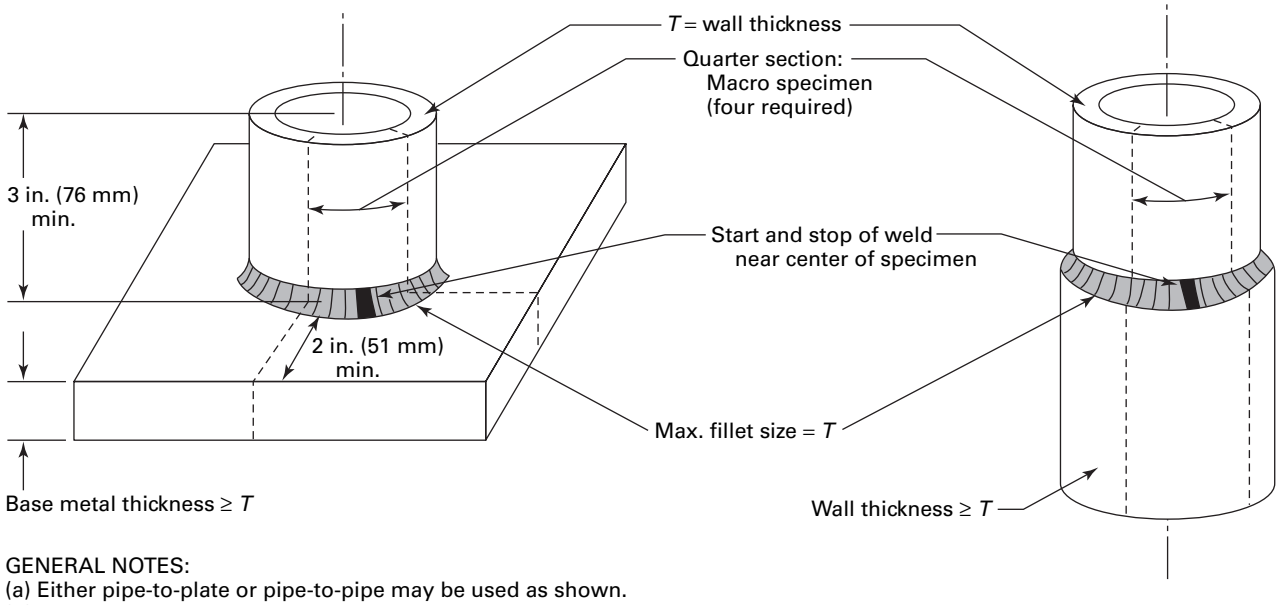
GENERAL NOTE: Refer to QW-452.5 for T thickness/qualification ranges.

QW-462.4(b) FILLET WELDS — PERFORMANCE



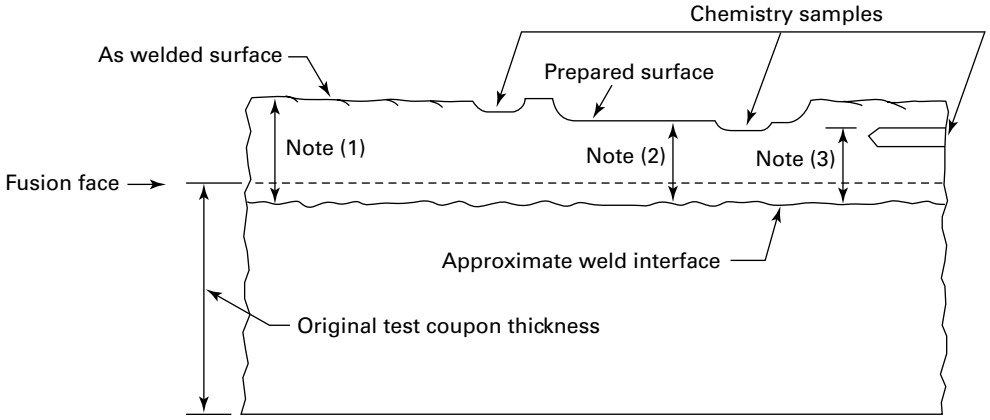
GENERAL NOTE: Either pipe-to-plate or pipe-to-pipe may be used as shown.

QW-462.4(c) FILLET WELDS IN PIPE — PERFORMANCE



GENERAL NOTES:
(a) Either pipe-to-plate or pipe-to-pipe may be used as shown.
(b) Macro test:
(1) The fillet shall show fusion at the root of the weld but not necessarily beyond the root.
(2) The weld metal and the heat-affected zone shall be free of cracks.

QW-462.4(d) FILLET WELDS IN PIPE — PROCEDURE



NOTES:

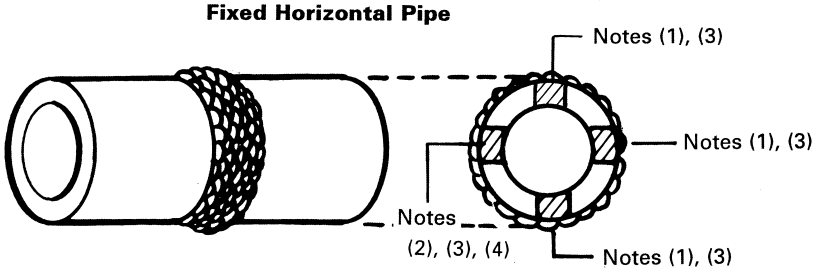
(1) When a chemical analysis or hardness test is conducted on the as welded surface, the distance from the approximate weld interface to the final as welded surface shall become the minimum qualified overlay thickness. The chemical analysis may be performed directly on the as welded surface or on chips of material taken from the as welded surface.

(2) When a chemical analysis or hardness test is conducted after material has been removed from the as welded surface, the distance from the approximate weld interface to the prepared surface shall become the minimum qualified overlay thickness. The chemical analysis may be made directly on the prepared surface or from chips removed from the prepared surface.

(3) When a chemical analysis test is conducted on material removed by a horizontal drilled sample, the distance from the approximate weld interface to the uppermost side of the drilled cavity shall become the minimum qualified overlay thickness. The chemical analysis shall be performed on chips of material removed from the drilled cavity.

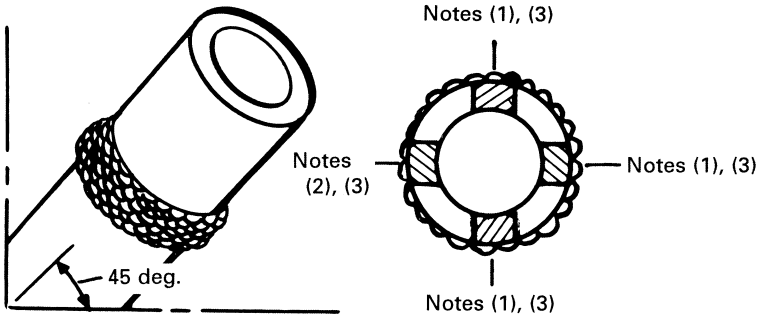
QW-462.5(a) CHEMICAL ANALYSIS AND HARDNESS SPECIMEN CORROSION-RESISTANT AND HARD-FACING WELD METAL OVERLAY

Fixed Horizontal Pipe



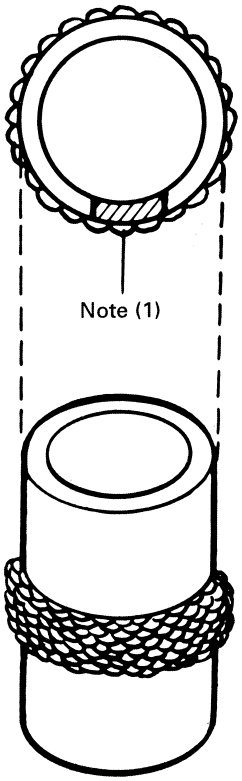
Test Specimen Location for 5G Overlay Qualification
(Specimens Required From a Minimum of Three Locations)

Fixed Pipe on 45 deg. Angle



Test Specimen Location for 6G Overlay Qualification
(Specimens Required From a Minimum of Three Locations)

Fixed Vertical and Flat Rolled Pipe

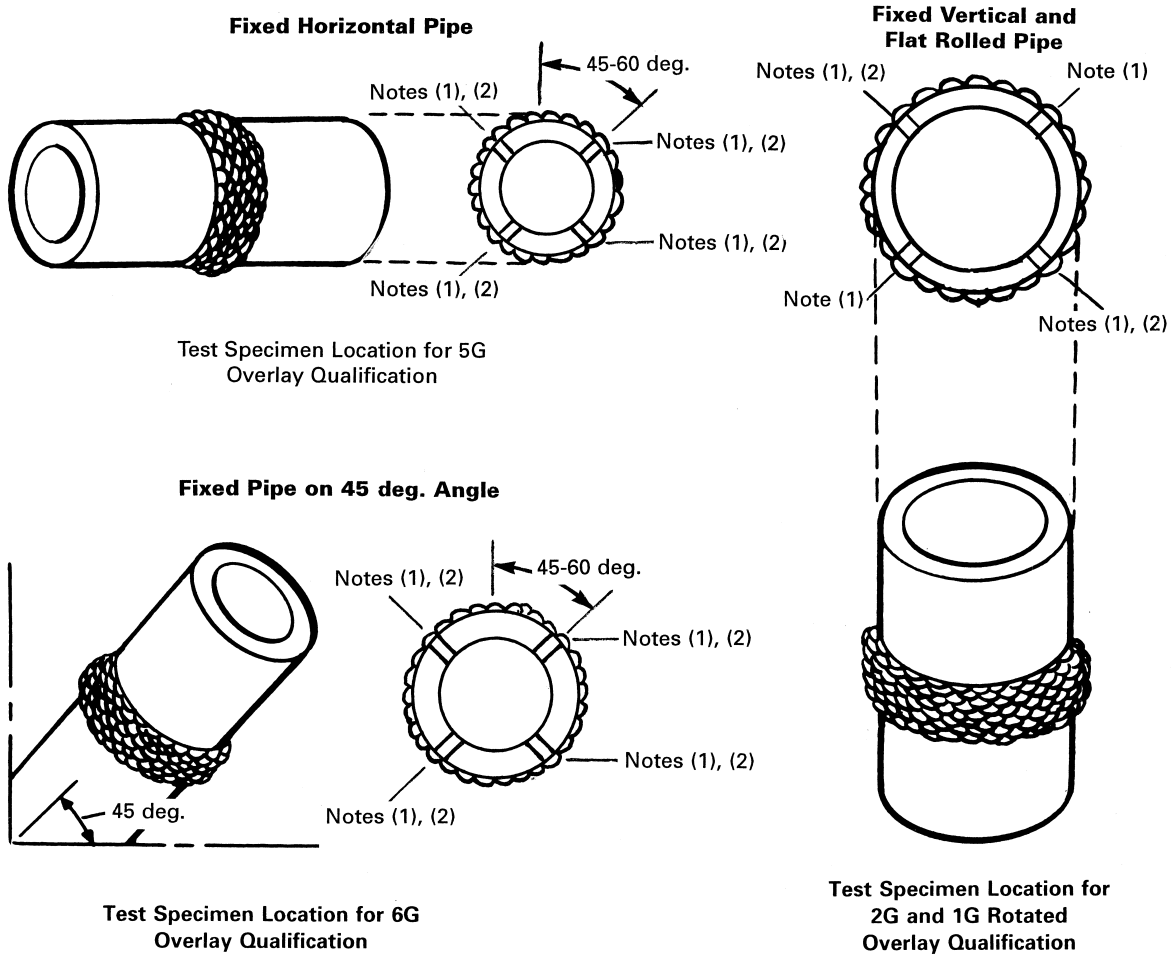


Test Specimen Location for
2G and 1G Rotated Overlay Qualification
(Specimens Required From One Location)

GENERAL NOTE: Overlay may be on the inside or outside of pipe.

NOTES:
(1) Location for required test specimen removal (QW-453.).
(2) Testing of circumferential hardfacing weld metal on pipe procedure qualification coupons may be limited to a single segment (completed utilizing the vertical, up-hill progression) for the chemical analysis, hardness, and macro-etch tests required in QW-453. Removal is required for a change from vertical down to vertical up-hill progression (but not vice-versa).
(3) Location of test specimens shall be in accordance with the angular position limitations of QW-120.
(4) When overlay welding is performed using machine or automatic welding and the vertical travel direction of adjacent weld beads is reversed on alternate passes, only one chemical analysis or hardness specimen is required to represent the vertical portion. Qualification is then restricted in production to require alternate pass reversal of rotation direction method.

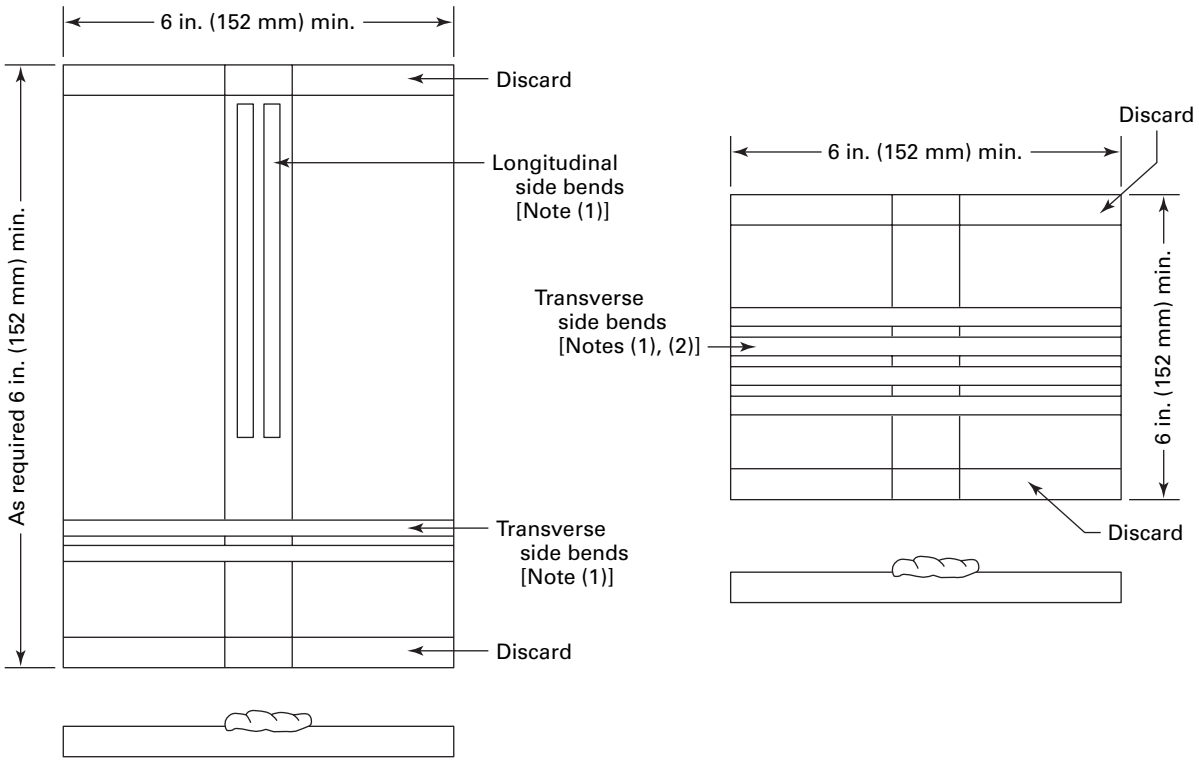
QW-462.5(b) CHEMICAL ANALYSIS SPECIMEN, HARD-FACING OVERLAY HARDNESS, AND MACRO TEST LOCATION(S) FOR CORROSION-RESISTANT AND HARD-FACING WELD METAL OVERLAY



GENERAL NOTE: Overlay may be on the inside or outside of pipe.

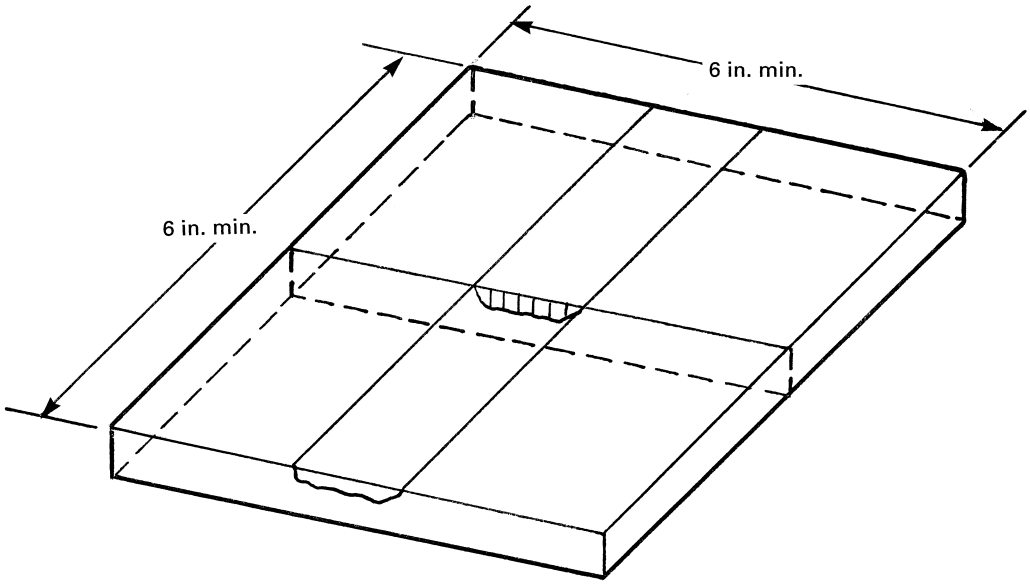
NOTES:
(1) Location for required test specimen removal — Procedure (QW-453).
(2) Location for required test specimen removal — Performance (QW-453).

QW-462.5(c) PIPE BEND SPECIMEN — CORROSION-RESISTANT WELD METAL OVERLAY



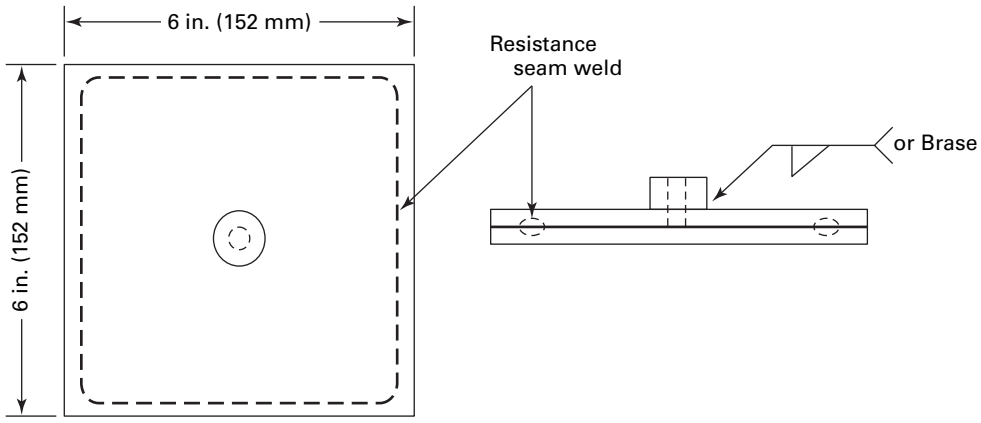
NOTES:
(1) Location for required test specimen removal — Procedure (QW-453). Four-side-bend test specimens are required for each position.
(2) Location for required test specimen removal — Performance (QW-453). Two-side-bend test specimens are required for each position.

QW-462.5(d) PLATE BEND SPECIMENS — CORROSION-RESISTANT WELD METAL OVERLAY

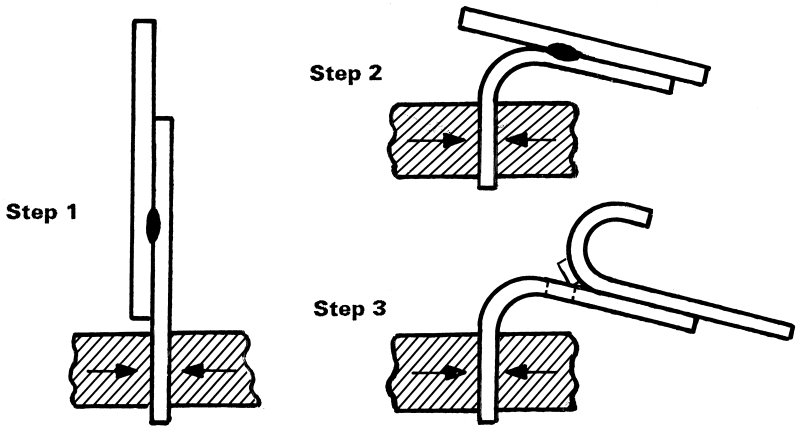


GENERAL NOTES:
(a) Location for required test specimen removal. One required for each position.
(b) Removal required for a change from vertical up to vertical down and vice versa.

QW-462.5(e) PLATE MACRO, HARDNESS, AND CHEMICAL ANALYSIS SPECIMENS — CORROSION-RESISTANT AND HARD-FACING WELD METAL OVERLAY



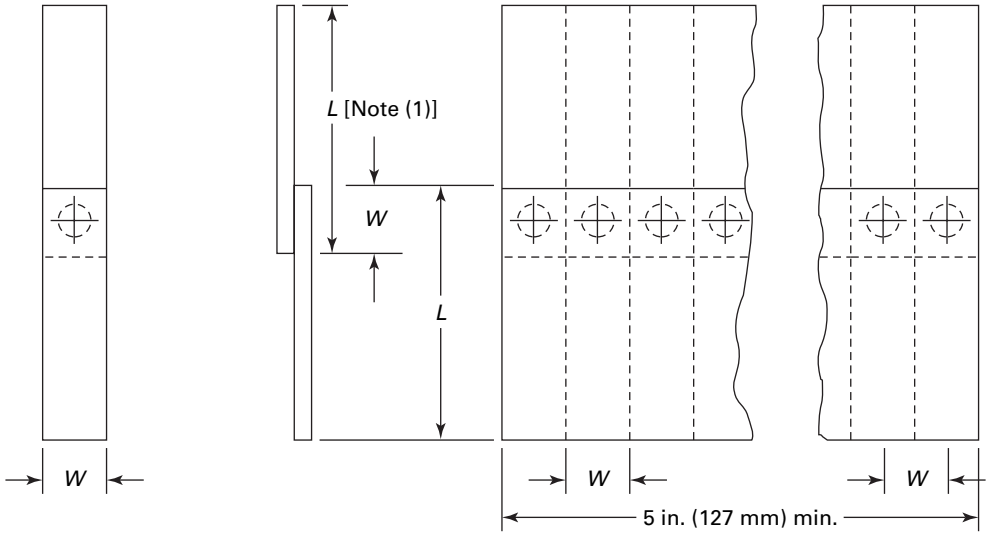
QW-462.7 RESISTANCE SEAM WELD



Peel Test

Step 1 - Grip in vise or other suitable device.
Step 2 - Bend specimen.
Step 3 - Peel pieces apart with pincers or other suitable tool.

QW-462.8 SPOT WELDS IN SHEETS



(a) Single Spot Shear Specimen

(b) Multiple Spot Shear Specimen [Note (2)]

Nominal Thickness of Thinner Sheet, in. (mm)	*W*, in. (mm) Min.
Over 0.008 to 0.030 (0.20 to 0.76)	0.68 (17.3)
Over 0.030 to 0.100 (0.76 to 2.54)	1.00 (25.4)
Over 0.100 to 0.130 (2.54 to 3.30)	1.25 (31.8)
Over 0.130 (3.30)	1.50 (38.1)

NOTES:
(1) *L* shall be not less than 4*W*.
(2) Sketch (b) shall be made of 5 specimens or more.

QW-462.9 SPOT WELDS IN SHEET

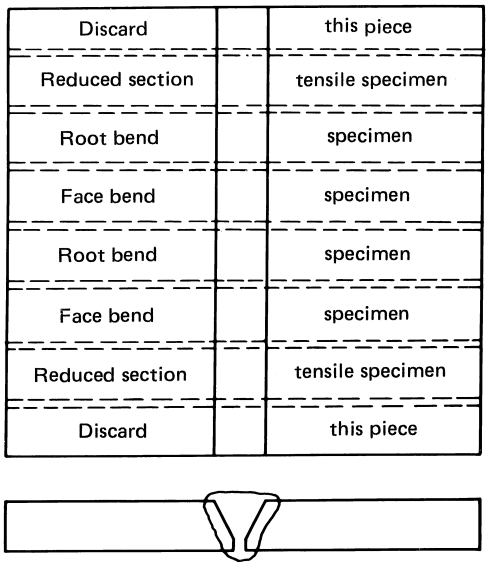
QW-462.10
SHEAR STRENGTH REQUIREMENTS FOR SPOT OR PROJECTION WELD SPECIMENS

Customary Units					SI Units				
P-No. 1 Through P-No. 11 and P-No. 41 Through P-No. 47 Metals					P-1 Through P-11 and P-4X Metals				
Nominal Thickness of Thinner Sheet, in.	Ultimate Strength 90,000 to 149,000 psi, lb per Spot, Min.	Ultimate Strength 90,000 to 149,000 psi, lb per Spot, Min. Avg.	Ultimate Strength Below 90,000 psi, lb per Spot, Min.	Ultimate Strength Below 90,000 psi, lb per Spot, Min. Avg.	Nominal Thickness of Thinner Sheet, mm	Ultimate Strength 620 MPa to 1 027 MPa, kg per Spot, Min.	Ultimate Strength 620 MPa to 1 027 MPa, kg per Spot, Min. Avg.	Ultimate Strength Below 620 MPa, kg per Spot, Min.	Ultimate Strength Below 620 MPa, kg per Spot, Min. Avg.
0.009	130	160	100	125	0.23	59	73	45	57
0.010	160	195	115	140	0.25	73	88	52	64
0.012	200	245	150	185	0.30	91	111	68	84
0.016	295	365	215	260	0.41	134	166	98	118
0.018	340	415	250	305	0.46	154	188	113	138
0.020	390	480	280	345	0.51	177	218	127	156
0.022	450	550	330	405	0.56	204	249	150	184
0.025	530	655	400	495	0.64	240	297	181	225
0.028	635	785	465	575	0.71	288	356	211	261
0.032	775	955	565	695	0.81	352	433	256	315
0.036	920	1,140	690	860	0.91	417	517	313	390
0.040	1,065	1,310	815	1,000	1.02	483	594	370	454
0.045	1,285	1,585	1,005	1,240	1.14	583	719	456	562
0.050	1,505	1,855	1,195	1,475	1.27	683	841	542	669
0.056	1,770	2,185	1,460	1,800	1.42	803	991	662	816
0.063	2,110	2,595	1,760	2,170	1.60	957	1 177	798	984
0.071	2,535	3,125	2,080	2,560	1.80	1 150	1 418	943	1 161
0.080	3,005	3,705	2,455	3,025	2.03	1 363	1 681	1 114	1 372
0.090	3,515	4,335	2,885	3,560	2.29	1 594	1 966	1 309	1 615
0.100	4,000	4,935	3,300	4,070	2.54	1 814	2 239	1 497	1 846
0.112	4,545	5,610	3,795	4,675	2.84	2 062	2 545	1 721	2 121
0.125	5,065	6,250	4,300	5,310	3.18	2 297	2 835	1 950	2 409

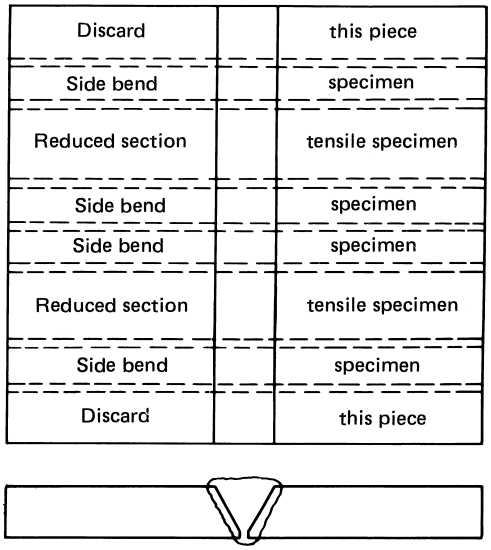
QW-462.11
SHEAR STRENGTH REQUIREMENTS FOR SPOT OR PROJECTION WELD SPECIMENS

Customary Units							SI Units						
P-No. 21 Through P-No. 25 Aluminum Alloys							P-2X Aluminum Alloys						
Nominal Thickness of Thinner Sheet, in.	Ultimate Strength 35,000 to 55,999 psi		Ultimate Strength 19,500 to 34,999 psi		Ultimate Strength Below 19,500 psi		Nominal Thickness of Thinner Sheet, mm	Ultimate Strength 241 MPa to 386 MPa		Ultimate Strength 134 MPa to 241 MPa		Ultimate Strength Below 134 MPa	
	lb per Spot		lb per Spot		lb per Spot			kg per Spot		kg per Spot		kg per Spot	
	Min.	Min. Avg.	Min.	Min. Avg.	Min.	Min. Avg.		Min.	Min. Avg.	Min.	Min. Avg.	Min.	Min. Avg.
0.010	50	65	...	...	...	...	0.25	23	29	...	...	...	...
0.012	65	85	30	40	20	25	0.30	29	39	14	18	9	11
0.016	100	125	70	90	50	65	0.41	45	57	32	41	23	29
0.018	115	145	85	110	65	85	0.46	52	66	39	50	29	39
0.020	135	170	100	125	80	100	0.51	61	77	45	57	36	45
0.022	155	195	120	150	95	120	0.56	70	88	54	68	43	54
0.025	175	200	145	185	110	140	0.64	79	91	66	84	50	64
0.028	205	260	175	220	135	170	0.71	93	118	79	100	61	77
0.032	235	295	210	265	165	210	0.81	107	134	95	120	75	95
0.036	275	345	255	320	195	245	0.91	125	156	116	145	88	111
0.040	310	390	300	375	225	285	1.02	141	177	136	170	102	129
0.045	370	465	350	440	260	325	1.14	168	211	159	200	118	147
0.050	430	540	400	500	295	370	1.27	195	245	181	227	134	168
0.050	515	645	475	595	340	425	1.27	234	293	215	270	154	193
0.063	610	765	570	715	395	495	1.60	277	347	259	324	179	225
0.071	720	900	645	810	450	565	1.80	327	408	293	367	204	256
0.080	855	1,070	765	960	525	660	2.03	388	485	347	435	238	299
0.090	1,000	1,250	870	1,090	595	745	2.29	454	567	395	494	270	338
0.100	1,170	1,465	940	1,175	675	845	2.54	531	665	426	533	306	383
0.112	1,340	1,675	1,000	1,255	735	920	2.84	608	760	454	569	333	417
0.125	1,625	2,035	1,050	1,315	785	985	3.18	737	923	476	596	356	447
0.140	1,920	2,400	...	...	...	...	3.56	871	1 089	...	...	...	...
0.160	2,440	3,050	...	...	...	...	4.06	1 107	1 383	...	...	...	...
0.180	3,000	3,750	...	...	...	...	4.57	1 361	1 701	...	...	...	...
0.190	3,240	4,050	...	...	...	...	4.83	1 470	1 837	...	...	...	...
0.250	6,400	8,000	...	...	...	...	6.35	2 903	3 629	...	...	...	...

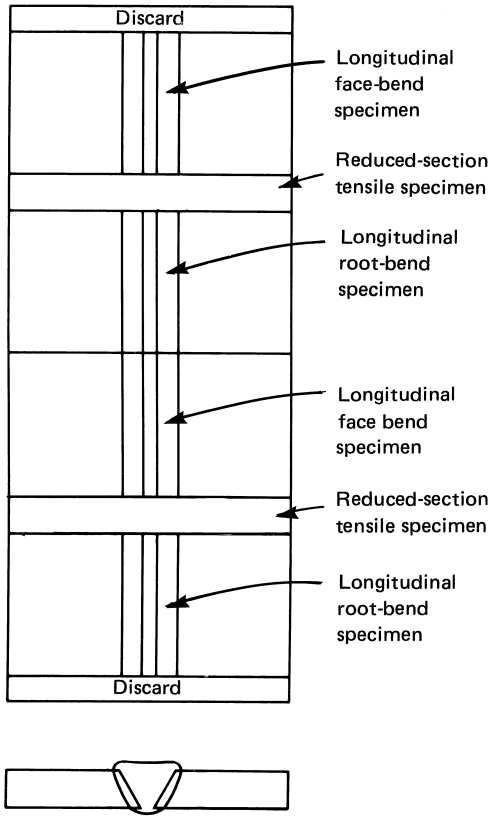
QW-463 Order of Removal



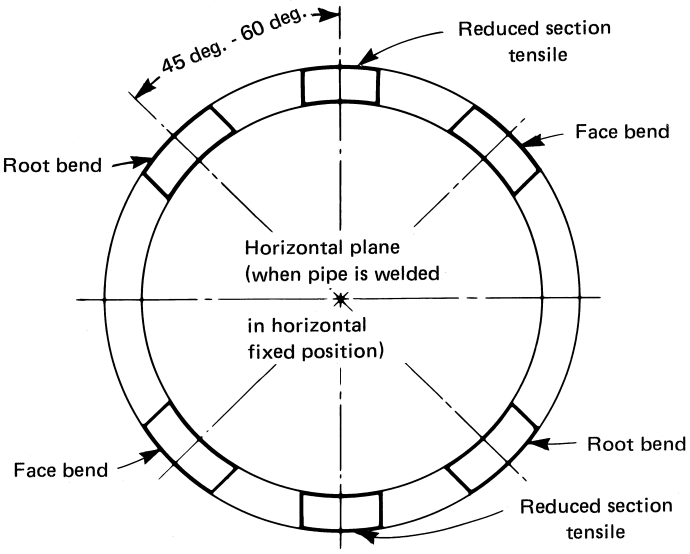
QW-463.1(a) PLATES — LESS THAN 3/4 in. (19 mm) THICKNESS PROCEDURE QUALIFICATION



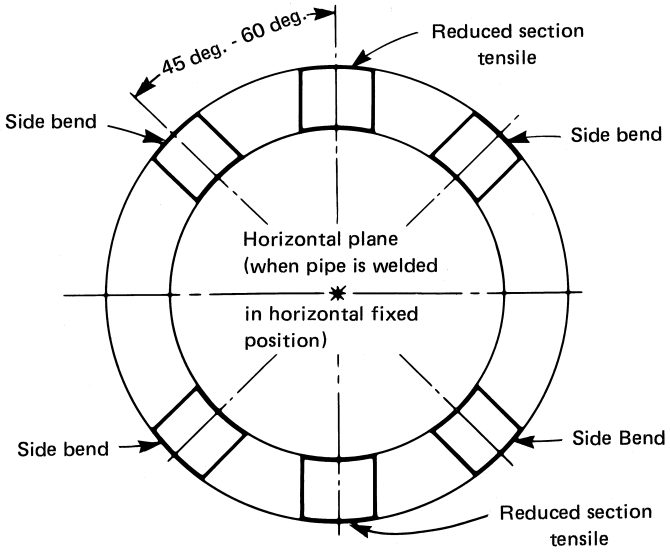
QW-463.1(b) PLATES — 3/4 in. (19 mm) AND OVER THICKNESS AND ALTERNATE FROM 3/8 in. (10 mm) BUT LESS THAN 3/4 in. (19 mm) THICKNESS PROCEDURE QUALIFICATION



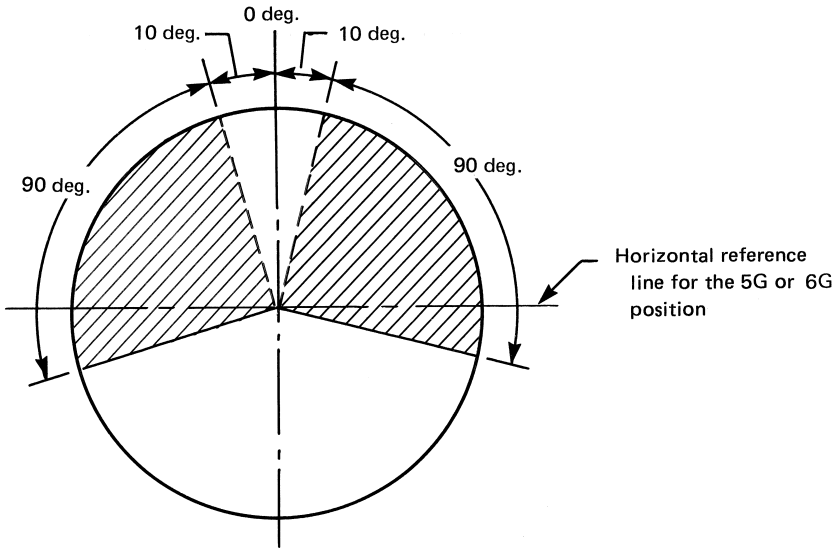
QW-463.1(c) PLATES — LONGITUDINAL PROCEDURE QUALIFICATION



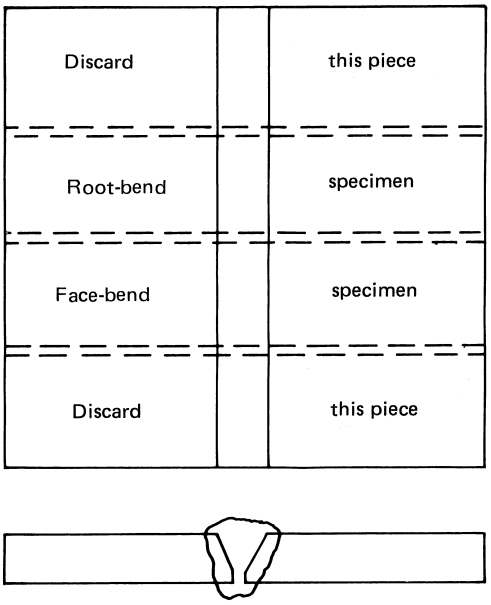
QW-463.1(d) PROCEDURE QUALIFICATION



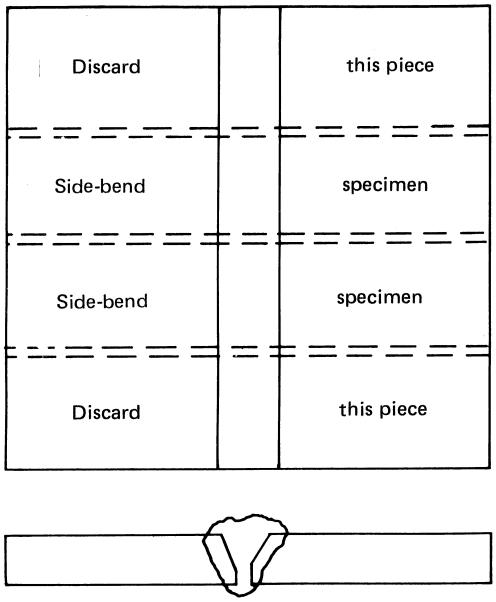
QW-463.1(e) PROCEDURE QUALIFICATION



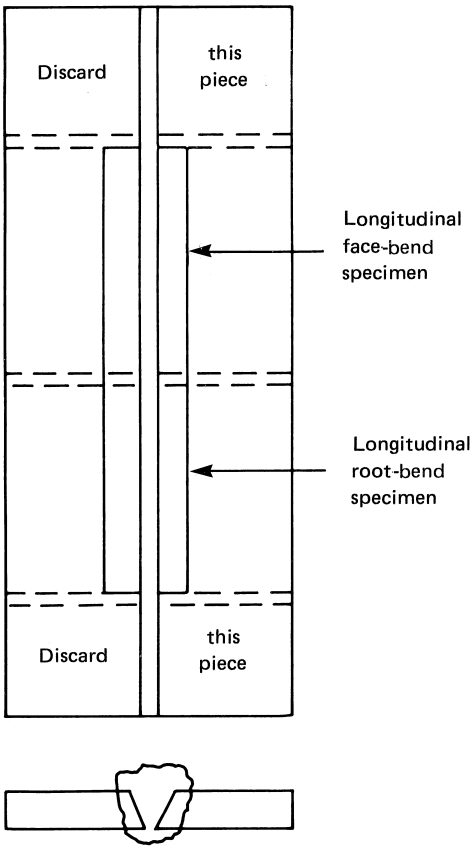
QW-463.1(f) NOTCH-TOUGHNESS TEST SPECIMEN LOCATION



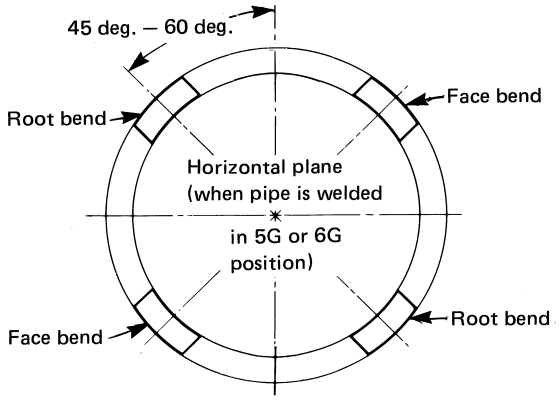
QW-463.2(a) PLATES — LESS THAN 3/4 in. (19 mm) THICKNESS PERFORMANCE QUALIFICATION



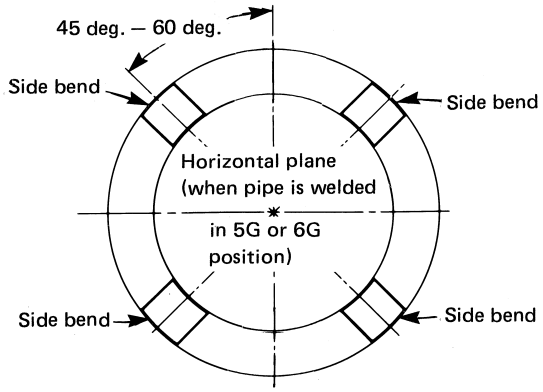
QW-463.2(b) PLATES — 3/4 in. (19 mm) AND OVER THICKNESS AND ALTERNATE FROM 3/8 in. (10 mm) BUT LESS THAN 3/4 in. (19 mm) THICKNESS PERFORMANCE QUALIFICATION



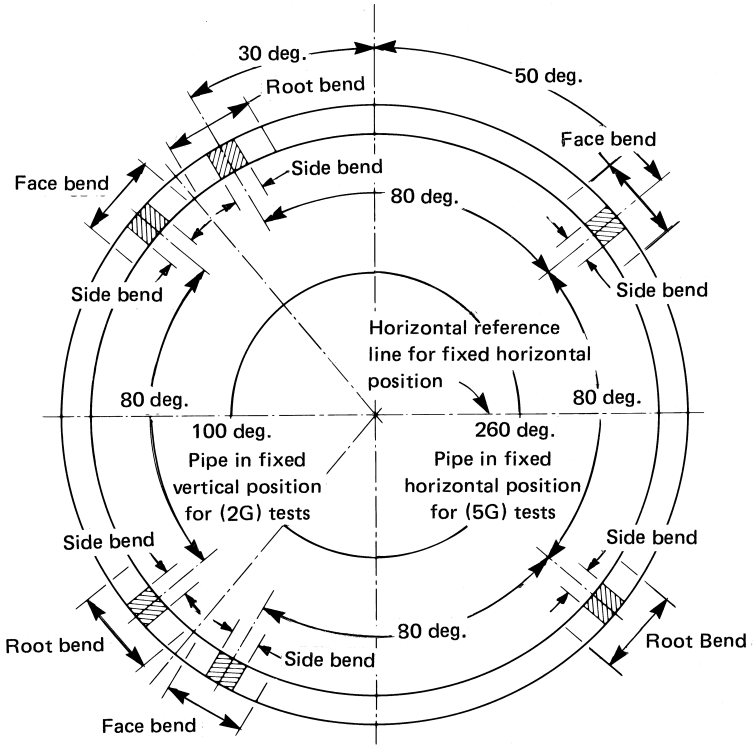
QW-463.2(c) PLATES — LONGITUDINAL PERFORMANCE QUALIFICATION



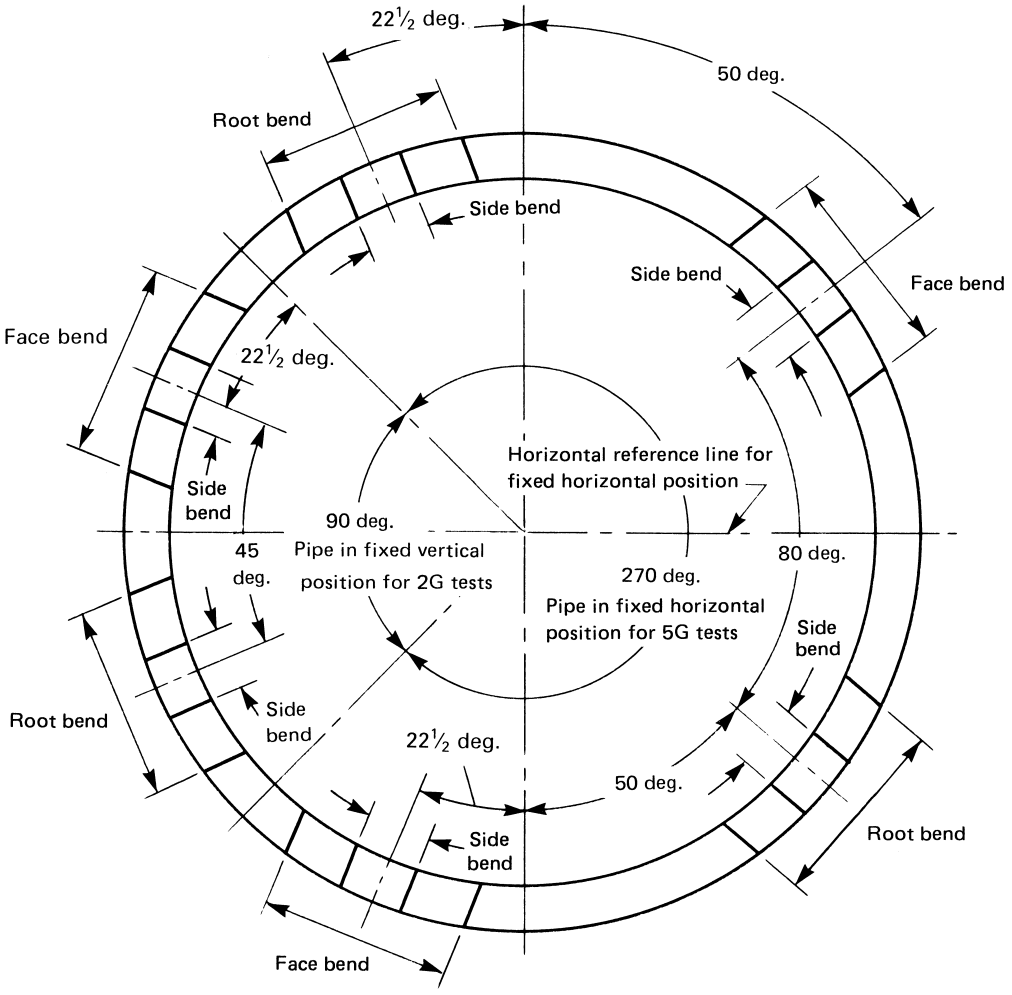
QW-463.2(d) PERFORMANCE QUALIFICATION



QW-463.2(e) PERFORMANCE QUALIFICATION

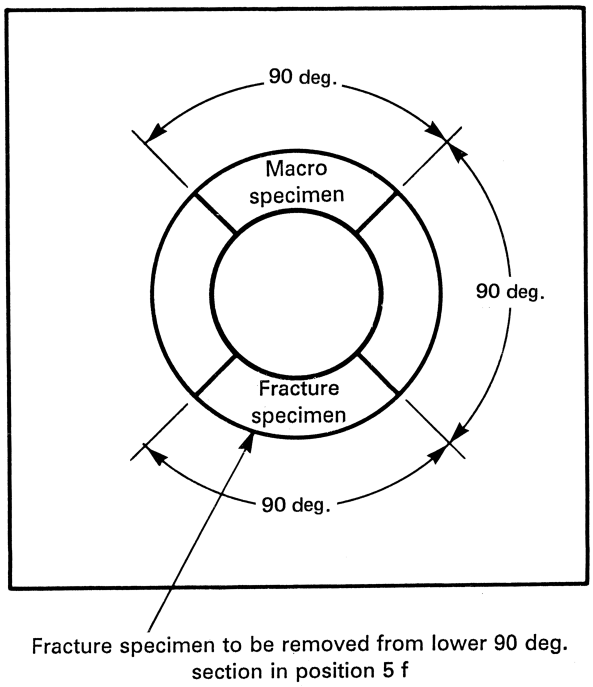


QW-463.2(f) PIPE — 10 in. (254 mm) ASSEMBLY PERFORMANCE QUALIFICATION

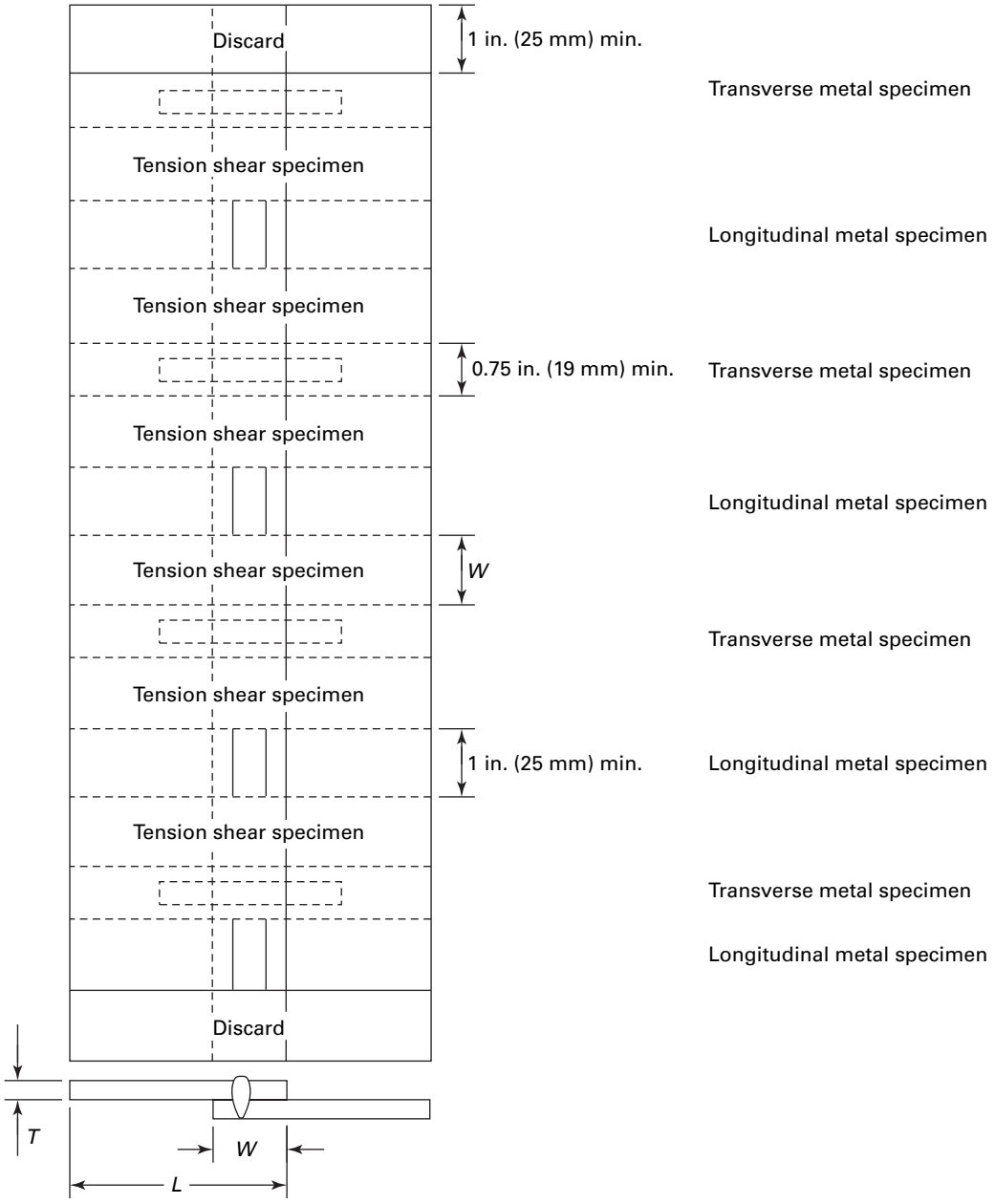


GENERAL NOTE: When side bend tests are made in accordance with QW-452.1 and QW-452.3, they shall be removed as shown in QW-463.2(g) in place of the face and root bends.

QW-463.2(g) 6 in. (152 mm) OR 8 in. (203 mm) ASSEMBLY PERFORMANCE QUALIFICATION

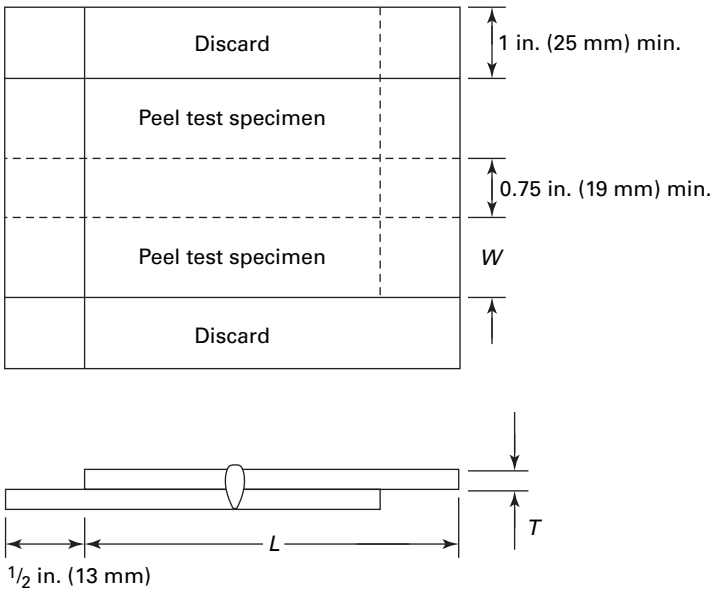


QW-463.2(h) PERFORMANCE QUALIFICATION



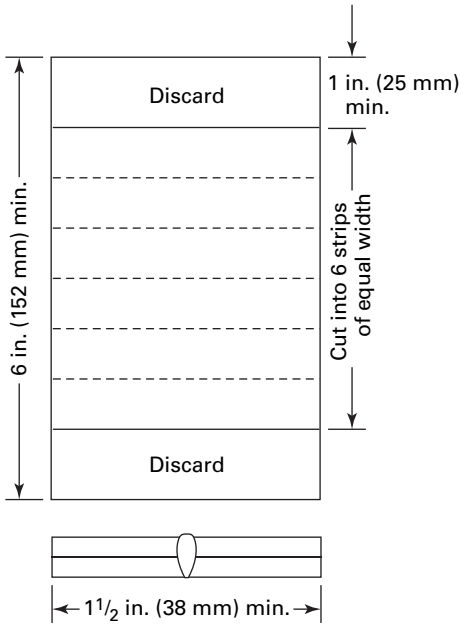
Thickness of Thinner, Sheet, *T*, in. (mm)	Specimen Width, *W*, in. (mm)	Recommended Length, *L*, in. (mm)
Up to 0.029 (0.74)	5/8 (16)	3 (76)
0.031 to 0.050 (0.79 to 1.27)	3/4 (19)	3 (76)
0.051 to 0.100 (1.29 to 2.54)	1 (25)	4 (102)
0.101 to 0.130 (2.57 to 3.30)	1 1/4 (32)	5 (127)
0.131 to 0.190 (3.33 to 4.83)	1 1/2 (38)	5 (127)
0.191 (4.85) and over	2 (51)	6 (152)

QW-464.1 PROCEDURE QUALIFICATION TEST COUPON AND TEST SPECIMENS



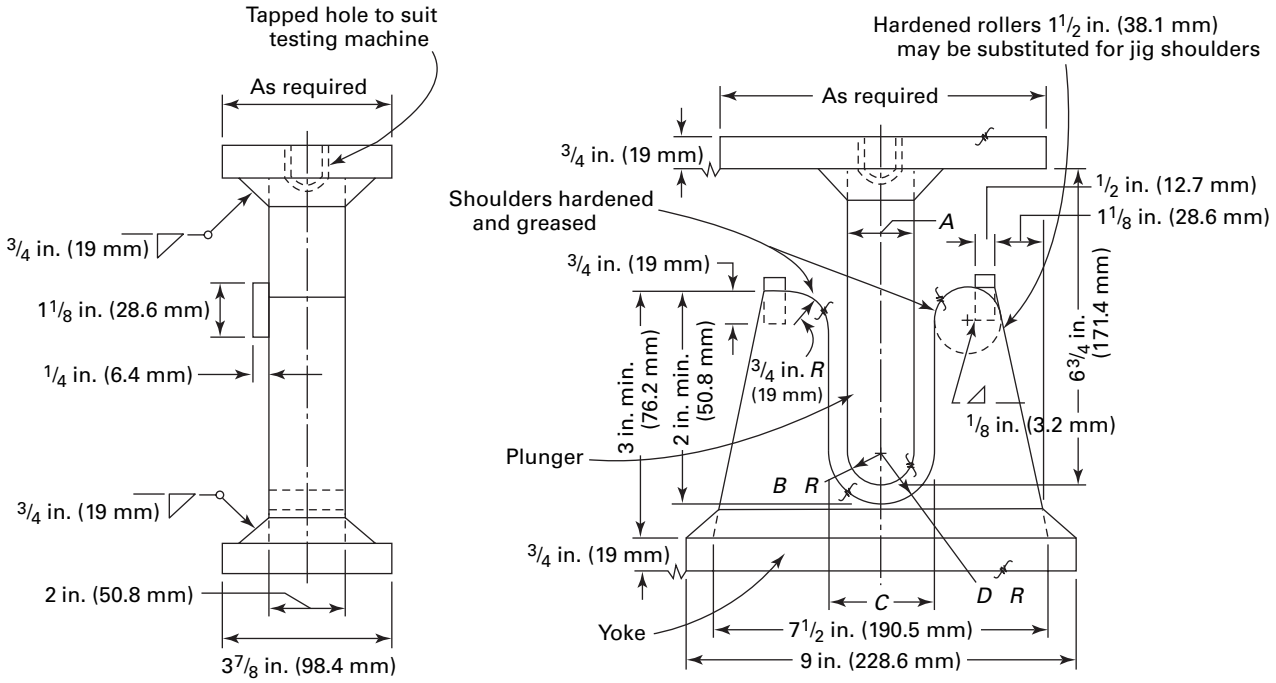
Thickness of Thinner Sheet, *T*, in. (mm)	Specimen Width, *W*, in. (mm)	Recommended Length, *L*, in. (mm)
Up to 0.029 (0.74)	5/8 (16)	2 (51)
0.030 to 0.058 (0.76 to 1.47)	1 (25)	3 (76)
0.059 to 0.125 (1.50 to 3.2)	1 1/2 (38)	4 (102)

(a) Peel Test Coupon and Specimens



(b) Metallurgical Examination Coupon and Transverse Specimens

QW-464.2 PERFORMANCE QUALIFICATION TEST COUPONS AND TEST SPECIMENS



Customary Units

Material	Thickness of Specimen, in.	*A*, in.	*B*, in.	*C*, in.	*D*, in.
P-No. 23 to P-No. 21 through P-No 25; P-No. 21 through P-No. 25 with F-No. 23; P-No. 35; any P-No. metal with F-No. 33, 36, or 37	1/8 t = 1/8 or less	2 1/16 16 1/2 t	1 1/32 8 1/4 t	2 3/8 18 1/2 t + 1/16	1 3/16 9 1/4 t + 1/32
P-No. 11; P-No. 25 to P-No. 21 or P-No. 22 or P-No. 25	3/8 t = 3/8 or less	2 1/2 6 2/3 t	1 1/4 3 1/3 t	3 3/8 8 2/3 t + 1/8	1 11/16 4 1/3 t + 1/16
P-No. 51	3/8 t = 3/8 or less	3 8t	1 1/2 4t	3 7/8 10t + 1/8	1 15/16 5t + 1/16
P-No. 52, P-No. 53, P-No. 61, P-No. 62	3/8 t = 3/8 or less	3 3/4 10t	1 7/8 5t	4 5/8 12t + 1/8	2 5/16 6t + 1/16
All others with greater than or equal to 20% elongation	3/8 t = 3/8 or less	1 1/2 4t	3/4 2t	2 3/8 6t + 1/8	1 3/16 3t + 1/16
All others with less than 20% elongation	t = (see Note b)	32 7/8 t, max.	16 7/16 t, max.	34 7/8 t + 1/16, max.	17 7/16 t + 1/32, max.

(continued)

QW-466.1 TEST JIG DIMENSIONS

SI Units					
Material	Thickness of Specimen, mm	*A*	*B*	*C*	*D*
P-No. 23 to P-No. 21 through P-No. 25; P-No. 21 through P-No. 25 with F-No. 23; P-No. 35; any P-No. metal with F-No. 33, 36, or 37	3.2 t = 3.2 or less	52.4 $16\frac{1}{2}t$	26.2 $8\frac{1}{4}t$	60.4 $18\frac{1}{2}t + 1.6$	30.2 $9\frac{1}{4}t + 0.8$
P-No. 11; P-No.25 to P-No. 21 or P-No. 22 or P-No. 25	9.5 t = 9.5 or less	63.5 $6\frac{2}{3}t$	31.8 $3\frac{1}{3}t$	85.8 $8\frac{2}{3}t + 3.2$	42.9 $4\frac{1}{3}t + 1.6$
P-No. 51	9.5 t = 9.5 or less	76.2 $8t$	38.1 $4t$	98.4 $10t + 3.2$	49.2 $5t + 1.6$
P-No. 52; P-No. 53; P-No. 61; P-No. 62	9.5 t = 9.5 or less	95.2 $10t$	47.6 $5t$	117.5 $12t + 3.2$	58.7 $6t + 1.6$
All others with greater than or equal to 20% elongation	9.5 t = 9.5 or less	38.1 $4t$	19.0 $2t$	60.4 $6t + 3.2$	30.2 $3t + 1.6$
All others with less than 20% elongation	t = (see Note b)	$32\frac{7}{8}t$, max.	$16\frac{7}{16}t$, max.	$34\frac{7}{8}t + 1.6$ max.	$17\frac{7}{16}t + 0.8$ max.

GENERAL NOTES:

(a) For P-Numbers, see QW-422; for F-Numbers, see QW-432.

(b) The dimensions of the test jig shall be such as to give the bend test specimen a calculated percent outer fiber elongation equal to at least that of the base material with the lower minimum elongation as specified in the base material specification.

$$\text{percent outer fiber elongation} = \frac{100t}{A + t}$$

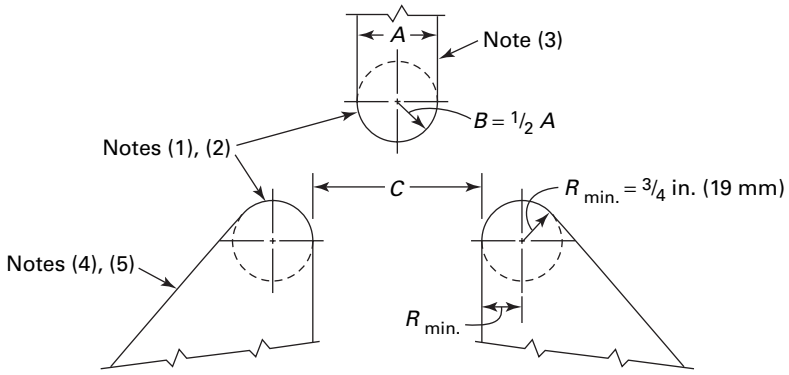
The following formula is provided for convenience in calculating the bend specimen thickness:

$$\text{thickness of specimen } (t) = \frac{A \times \text{percent elongation}}{[100 - (\text{percent elongation})]}$$

(c) For guided-bend jig configuration, see QW-466.2, QW-466.3, and QW-466.4.

(d) The weld and heat-affected zone, in the case of a transverse weld bend specimen, shall be completely within the bend portion of the specimen after testing.

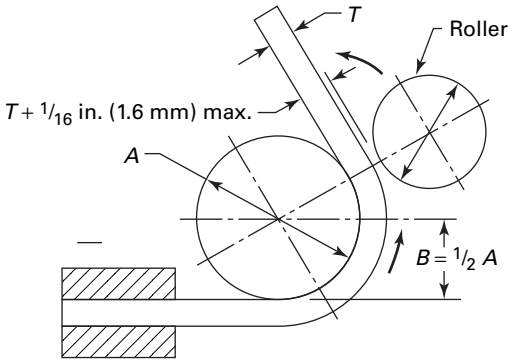
QW-466.1 TEST JIG DIMENSIONS (CONT'D)



GENERAL NOTE: See QW-466.1 for jig dimensions and general notes.

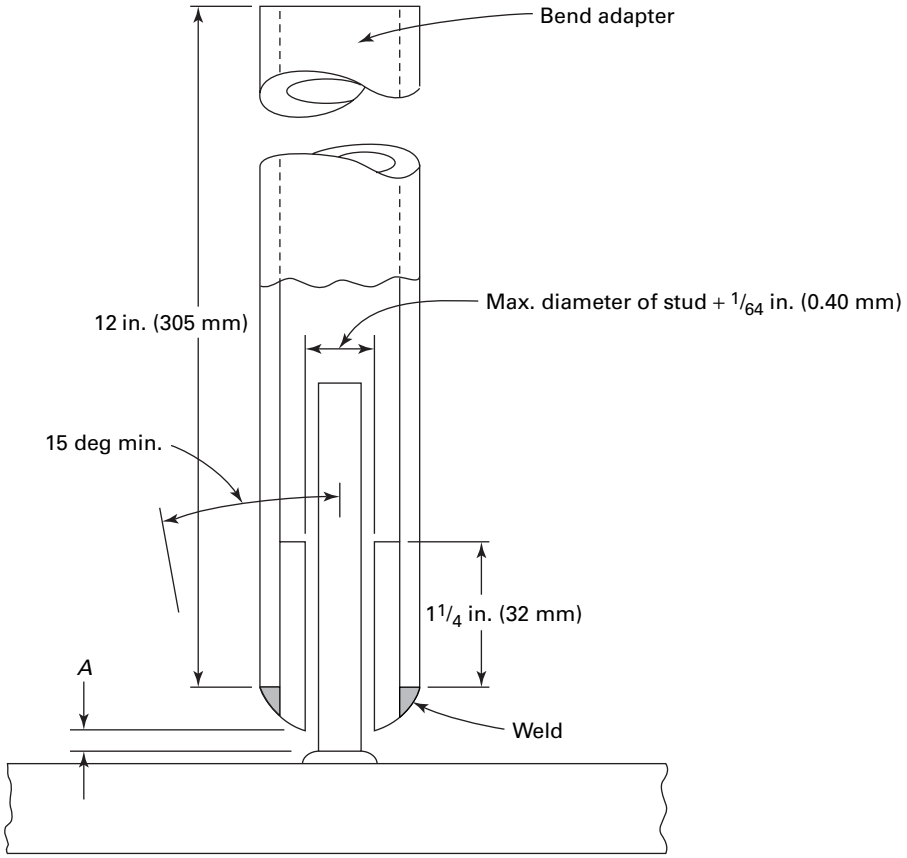
NOTES:
(1) Either hardened and greased shoulders or hardened rollers free to rotate shall be used.
(2) The shoulders or rollers shall have a minimum bearing surface of 2 in. (51 mm) for placement of the specimen. The rollers shall be high enough above the bottom of the jig so that the specimens will clear the rollers when the ram is in the low position.
(3) The ram shall be fitted with an appropriate base and provision made for attachment to the testing machine, and shall be of a sufficiently rigid design to prevent deflection and misalignment while making the bend test. The body of the ram may be less than the dimensions shown in column A of QW-466.1.
(4) If desired, either the rollers or the roller supports may be made adjustable in the horizontal direction so that specimens of *t* thickness may be tested on the same jig.
(5) The roller supports shall be fitted with an appropriate base designed to safeguard against deflection and misalignment and equipped with means for maintaining the rollers centered midpoint and aligned with respect to the ram.

QW-466.2 GUIDED-BEND ROLLER JIG



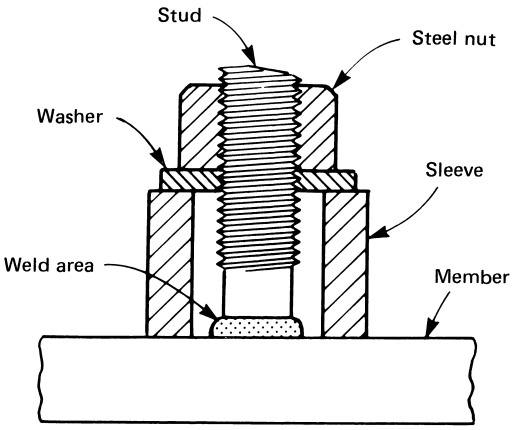
GENERAL NOTES:
(a) See QW-466.1 for jig dimensions and other general notes.
(b) Dimensions not shown are the option of the designer. The essential consideration is to have adequate rigidity so that the jig parts will not spring.
(c) The specimen shall be firmly clamped on one end so that there is no sliding of the specimen during the bending operation.
(d) Test specimens shall be removed from the jig when the outer roll has been removed 180 deg from the starting point.

QW-466.3 GUIDED-BEND WRAP AROUND JIG



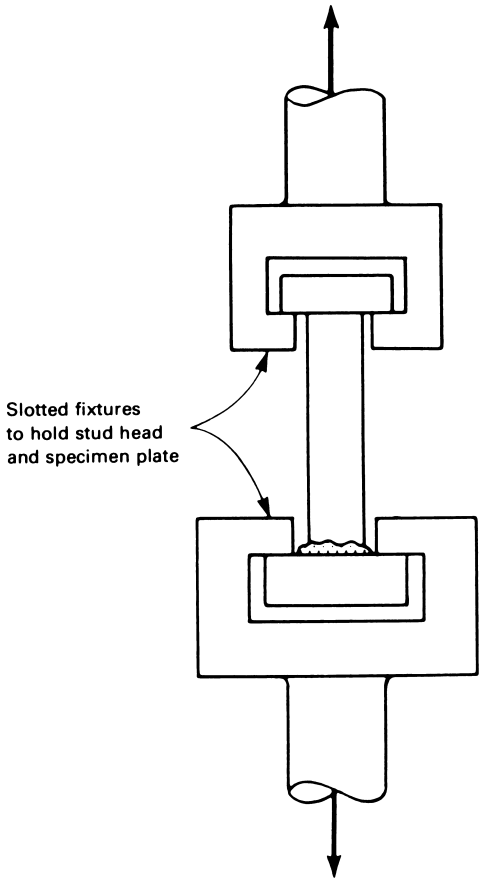
For Stud Diameter, in. (mm)	Use Adapter Gap, *A*, in. (mm)
1/8 (3.2)	1/8 (3.2)
3/16 (4.8)	1/8 (3.2)
1/4 (6)	3/16 (4.8)
3/8 (10)	7/32 (5.6)
1/2 (13)	5/16 (8)
5/8 (16)	11/32 (9)
3/4 (19)	15/32 (12)
7/8 (22)	15/32 (12)
1 (25)	19/32 (15)

QW-466.4 STUD-WELD BEND JIG

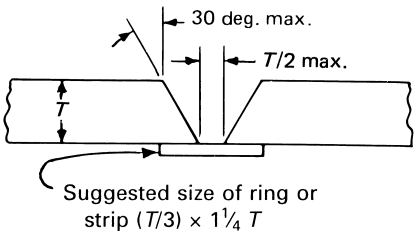


GENERAL NOTES:
(a) Dimensions are appropriate to the size of the stud.
(b) Threads of the stud shall be clean and free of lubricant other than residual cutting oil.

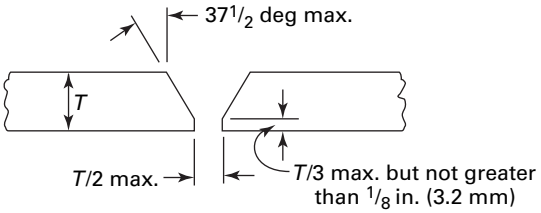
QW-466.5 TORQUE TESTING ARRANGEMENT FOR STUD WELDS



QW-466.6 SUGGESTED TYPE TENSILE TEST FIGURE FOR STUD WELDS



QW-469.1 BUTT JOINT



QW-469.2 ALTERNATIVE BUTT JOINT

QW-470 ETCHING — PROCESSES AND REAGENTS

QW-471 General

The surfaces to be etched should be smoothed by filing, machining, or grinding on metallographic papers. With different alloys and tempers, the etching period will vary from a few seconds to several minutes, and should be continued until the desired contrast is obtained. As a protection from the fumes liberated during the etching process, this work should be done under a hood. After etching, the specimens should be thoroughly rinsed and then dried with a blast of warm air. Coating the surface with a thin clear lacquer will preserve the appearance.

QW-472 For Ferrous Metals

Etching solutions suitable for carbon and low alloy steels, together with directions for their use, are suggested as follows.

QW-472.1 Hydrochloric Acid. Hydrochloric (muriatic) acid and water, equal parts, by volume. The solution should be kept at or near the boiling temperature during the etching process. The specimens are to be immersed in the solution for a sufficient period of time to reveal all lack of soundness that might exist at their cross-sectional surfaces.

QW-472.2 Ammonium Persulfate. One part of ammonium persulfate to nine parts of water, by weight. The solution should be used at room temperature, and should be applied by vigorously rubbing the surface to be etched with a piece of cotton saturated with the solution. The etching process should be continued until there is a clear definition of the structure in the weld.

QW-472.3 Iodine and Potassium Iodide. One part of powdered iodine (solid form), two parts of powdered potassium iodide, and ten parts of water, all by weight. The solution should be used at room temperature, and brushed on the surface to be etched until there is a clear definition or outline of the weld.

QW-472.4 Nitric Acid. One part of nitric acid and three parts of water, by volume.

CAUTION: Always pour the acid into the water. Nitric acid causes bad stains and severe burns.

The solution may be used at room temperature and applied to the surface to be etched with a glass stirring rod. The specimens may also be placed in a boiling solution of the acid, but the work should be done in a well-ventilated room. The etching process should be continued for a sufficient period of time to reveal all lack of soundness that might exist at the cross-sectional surfaces of the weld.

QW-473 For Nonferrous Metals

The following etching reagents and directions for their use are suggested for revealing the macrostructure.

QW-473.1 Aluminum and Aluminum-Base Alloys

Hydrochloric acid (concentrated)	15 ml
Hydrofluoric acid (48%)	10 ml
Water	85 ml

This solution is to be used at room temperature, and etching is accomplished by either swabbing or immersing the specimen.

QW-473.2 For Copper and Copper-Base Alloys: Cold Concentrated Nitric Acid. Etching is accomplished by either flooding or immersing the specimen for several seconds under a hood. After rinsing with a flood of water, the process is repeated with a 50-50 solution of concentrated nitric acid and water.

In the case of the silicon bronze alloys, it may be necessary to swab the surface to remove a white (SiO_2) deposit.

QW-473.3 For Nickel and Nickel-Base Alloys

Material	Formula
Nickel	Nitric Acid or Lepito's Etch
Low Carbon Nickel	Nitric Acid or Lepito's Etch
Nickel–Copper (400)	Nitric Acid or Lepito's Etch
Nickel–Chromium–Iron (600 and 800)	Aqua Regia or Lepito's Etch

MAKEUP OF FORMULAS FOR AQUA REGIA AND LEPITO'S ETCH

	Aqua Regia [(1), (3)]	Lepito's Etch [(2), (3)]
Nitric Acid, Concentrated — HNO_3	1 part	3 ml
Hydrochloric Acid, Concentrated — HCL	2 parts	10 ml
Ammonium Sulfate — $(NH_4)_2(SO_4)$	. . .	1.5 g
Ferric Chloride — $FeCl_3$	. . .	2.5 g
Water	. . .	7.5 ml

NOTES:
(1) Warm the parts for faster action.
(2) Mix solution as follows:
(a) Dissolve $(NH_4)_2(SO_4)$ in H_2O.
(b) Dissolve powdered $FeCl_3$ in warm HCl.
(c) Mix (a) and (b) above and add HNO_3.
(3) Etching is accomplished by either swabbing or immersing the specimen.

QW-473.4 For Titanium

	Kroll's Etch	Keller's Etch
Hydrofluoric acid (48%)	1 to 3 ml	½ ml
Nitric acid (concentrated)	2 to 6 ml	2½ ml
Hydrochloric Acid (concentrated)	...	1½ ml
Water	To make 100 ml	To make 100 ml

QW-473.5 For Zirconium

Hydrofluoric acid	3 ml
Nitric acid (concentrated)	22 ml
Water	22 ml

Apply by swab and rinse in cold water.

These are general purpose etchants which are applied at room temperature by swabbing or immersion of the specimen.

QW-490 DEFINITIONS

QW/QB-491 General

Definitions of the more common terms relating to welding/brazing are defined in QW/QB-492. These are identical to, or substantially in agreement with the definitions of the American Welding Society document, AWS A3.0, Standard Welding Terms and Definitions. There are terms listed that are specific to ASME Section IX and are not presently defined in AWS A3.0. Several definitions have been modified slightly from A3.0 so as to better define the context/intent as used in ASME Section IX.

QW/QB-492 Definitions

arc seam weld — a seam weld made by an arc welding process

arc spot weld — a spot weld made by an arc welding process

arc strike — any inadvertent discontinuity resulting from an arc, consisting of any localized remelted metal, heat-affected metal, or change in the surface profile of any metal object. The arc may be caused by arc welding electrodes, magnetic inspection prods, or frayed electrical cable.

arc welding — a group of welding processes wherein coalescence is produced by heating with an arc or arcs, with or without the application of pressure, and with or without the use of filler metal

as-brazed — adj. pertaining to the condition of brazements after brazing, prior to any subsequent thermal, mechanical, or chemical treatments

as-welded — adj. pertaining to the condition of weld metal, welded joints, and weldments after welding but prior to any subsequent thermal, mechanical, or chemical treatments

backgouging — the removal of weld metal and base metal from the weld root side of a welded joint to facilitate complete fusion and complete joint penetration upon subsequent welding from that side

backhand welding — a welding technique in which the welding torch or gun is directed opposite to the progress of welding

backing — a material placed at the root of a weld joint for the purpose of supporting molten weld metal so as to facilitate complete joint penetration. The material may or may not fuse into the joint. See *retainer*.

backing gas — a gas, such as argon, helium, nitrogen, or reactive gas, which is employed to exclude oxygen from the root side (opposite from the welding side) of weld joints

base metal — the metal or alloy that is welded, brazed, or cut

bond line (brazing and thermal spraying) — the cross section of the interface between a braze or thermal spray deposit and the substrate

braze — a joint produced by heating an assembly to suitable temperatures and by using a filler metal having a liquidus above 840°F and below the solidus of the base materials. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.

brazer — one who performs a manual or semiautomatic brazing operation

brazing — a group of metal joining processes which produces coalescence of materials by heating them to a suitable temperature, and by using a filler metal having a liquidus above 840°F and below the solidus of the base materials. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.

brazing, automatic — brazing with equipment which performs the brazing operation without constant observation and adjustment by a brazing operator. The equipment may or may not perform the loading and unloading of the work.

brazing, block (BB) — a brazing process that uses heat from heated blocks applied to the joint. This is an obsolete or seldom used process.

brazing, dip (DB) — a brazing process in which the heat required is furnished by a molten chemical or metal bath. When a molten chemical bath is used, the bath may act as a flux; when a molten metal bath is used, the bath provides the filler metal.

brazing, furnace (FB) — a brazing process in which the workpieces are placed in a furnace and heated to the brazing temperature

brazing, induction (IB) — a brazing process that uses heat from the resistance of the workpieces to induced electric current

brazing, machine — brazing with equipment which performs the brazing operation under the constant observation and control of a brazing operator. The equipment may or may not perform the loading and unloading of the work.

brazing, manual — a brazing operation performed and controlled completely by hand. See *automatic brazing* and *machine brazing*.

brazing, resistance (RB) — a brazing process that uses heat from the resistance to electric current flow in a circuit of which the workpieces are a part

brazing, semiautomatic — brazing with equipment which controls only the brazing filler metal feed. The advance of the brazing is manually controlled.

01 *brazing, torch (TB)* — a brazing process that uses heat from a fuel gas flame

brazing operator — one who operates machine or automatic brazing equipment

brazing temperature — the temperature to which the base metal(s) is heated to enable the filler metal to wet the base metal(s) and form a brazed joint

brazing temperature range — the temperature range within which brazing can be conducted

build-up of base metal/restoration of base metal thickness — this is the application of a weld material to a base metal so as to restore the design thickness and/or structural integrity. This build-up may be with a chemistry different from the base metal chemistry which has been qualified via a standard butt welded test coupon. Also, may be called base metal repair or buildup.

butt joint — a joint between two members aligned approximately in the same plane

buttering — the addition of material, by welding, on one or both faces of a joint, prior to the preparation of the joint for final welding, for the purpose of providing a suitable transition weld deposit for the subsequent completion of the joint

clad brazing sheet — a metal sheet on which one or both sides are clad with brazing filler metal

coalescence — the growing together or growth into one body of the materials being joined

complete fusion — fusion which has occurred over the entire base material surfaces intended for welding, and between all layers and beads

composite — a material consisting of two or more discrete materials with each material retaining its physical identity

consumable insert — filler metal that is placed at the joint root before welding, and is intended to be completely fused into the root to become part of the weld

contact tube — a device which transfers current to a continuous electrode

corner joint — a joint between two members located approximately at right angles to each other in the form of an L

coupon — see *test coupon*

crack — a fracture-type discontinuity characterized by a sharp tip and high ratio of length and width to opening displacement

defect — a discontinuity or discontinuities that by nature or accumulated effect (for example, total crack length) render a part or product unable to meet minimum applicable acceptance standards or specifications. This term designates rejectability. See also *discontinuity* and *flaw*.

direct current electrode negative (DCEN) — the arrangement of direct current arc welding leads in which the electrode is the negative pole and the workpiece is the positive pole of the welding arc

direct current electrode positive (DCEP) — the arrangement of direct current arc welding leads in which the electrode is the positive pole and the workpiece is the negative pole of the welding arc

discontinuity — an interruption of the typical structure of a material, such as a lack of homogeneity in its mechanical, metallurgical, or physical characteristics. A discontinuity is not necessarily a defect. See also *defect* and *flaw*.

double-welded joint — a joint that is welded from both sides

double-welded lap joint — a lap joint in which the overlapped edges of the members to be joined are welded along the edges of both members

dwell — the time during which the energy source pauses at any point in each oscillation

electrode, arc welding — a component of the welding circuit through which current is conducted

electrode, bare — a filler metal electrode that has been produced as a wire, strip, or bar with no coating or covering other than that incidental to its manufacture or preservation

electrode, carbon — a nonfiller material electrode used in arc welding and cutting, consisting of a carbon or graphite rod, which may be coated with copper or other materials

electrode, composite — a generic term of multicomponent filler metal electrodes in various physical forms, such as stranded wires, tubes, and covered electrodes

electrode, covered — a composite filler metal electrode consisting of a core of a bare electrode or metal-cored electrode to which a covering sufficient to provide a slag layer on the weld metal has been applied. The covering may contain materials providing such functions as shielding from the atmosphere, deoxidation, and arc stabilization, and can serve as a source of metallic additions to the weld.

electrode, electroslag welding — a filler metal component of the welding circuit through which current is conducted between the electrode guiding member and the molten slag

NOTE: Bare electrodes and composite electrodes as defined under arc welding electrode are used for electroslag welding. A consumable guide may also be used as part of the electroslag welding electrode system.

electrode, emissive — a filler metal electrode consisting of a core of a bare electrode or a composite electrode to which a very light coating has been applied to produce a stable arc

electrode, flux-cored — a composite filler metal electrode consisting of a metal tube or other hollow configuration containing ingredients to provide such functions as shielding atmosphere, deoxidation, arc stabilization, and slag formation. Alloying materials may be included in the core. External shielding may or may not be used.

electrode, lightly coated — a filler metal electrode consisting of a metal wire with a light coating applied subsequent to the drawing operation, primarily for stabilizing the arc

electrode, metal — a filler or nonfiller metal electrode used in arc welding and cutting that consists of a metal wire or rod that has been manufactured by any method and that is either bare or covered

electrode, metal-cored — a composite filler metal electrode consisting of a metal tube or other hollow configuration containing alloying ingredients. Minor amounts of ingredients providing such functions as arc stabilization and fluxing of oxides may be included. External shielding gas may or may not be used.

electrode, resistance welding — the part of a resistance welding machine through which the welding current and, in most cases, force are applied directly to the workpiece. The electrode may be in the form of a rotating wheel, rotating roll, bar, cylinder, plate, clamp, chuck, or modification thereof.

electrode, stranded — a composite filler metal electrode consisting of stranded wires which may mechanically enclose materials to improve properties, stabilize the arc, or provide shielding

electrode, tungsten — a nonfiller metal electrode used in arc welding, arc cutting, and plasma spraying, made principally of tungsten

face feed — the application of filler metal to the face side of a joint

ferrite number — an arbitrary, standardized value designating the ferrite content of an austenitic stainless steel weld metal. It should be used in place of percent ferrite or volume percent ferrite on a direct one-to-one replacement basis. See the latest edition of AWS A4.2, Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic Stainless Steel Weld Metal.

filler metal — the metal or alloy to be added in making a welded, brazed, or soldered joint

filler metal, brazing — the metal or alloy used as a filler metal in brazing, which has a liquidus above 450°C (840°F) and below the solidus of the base metal

filler metal, powder — filler metal in particle form

filler metal, supplemental — in electroslag welding or in a welding process in which there is an arc between one or more consumable electrodes and the workpiece, a powder, solid, or composite material that is introduced into the weld other than the consumable electrode(s)

fillet weld — a weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, tee joint, or corner joint

flaw — an undesirable discontinuity. See also *defect*.

flux (welding/brazing) — a material used to dissolve, prevent, or facilitate the removal of oxides or other undesirable surface substances. It may act to stabilize the arc, shield the molten pool, and may or may not evolve shielding gas by decomposition.

flux, active (SAW) — a flux from which the amount of elements deposited in the weld metal is dependent upon the welding conditions, primarily arc voltage

flux, alloy (SAW) — a flux which provides alloying elements in the weld metal deposit

flux, neutral (SAW) — a flux which will not cause a significant change in the weld metal composition when there is a large change in the arc voltage

flux cover — metal bath dip brazing and dip soldering. A layer of molten flux over the molten filler metal bath.

forehand welding — a welding technique in which the welding torch or gun is directed toward the progress of welding

frequency — the completed number of cycles which the oscillating head makes in 1 min or other specified time increment

fuel gas — a gas such as acetylene, natural gas, hydrogen, propane, stabilized methylacetylene propadiene, and other fuels normally used with oxygen in one of the oxyfuel processes and for heating

fused spray deposit (thermal spraying) — a self-fluxing thermal spray deposit which is subsequently heated to coalescence within itself and with the substrate

fusion (fusion welding) — the melting together of filler metal and base metal, or of base metal only, to produce a weld

fusion face — a surface of the base metal that will be melted during welding

fusion line — a non-standard term for weld interface

gas backing — see backing gas

globular transfer (arc welding) — a type of metal transfer in which molten filler metal is transferred across the arc in large droplets

groove weld — a weld made in a groove formed within a single member or in the groove between two members to be joined. The standard types of groove weld are as follows:

square groove weld
single-Vee groove weld
single-bevel groove weld
single-U groove weld
single-J groove weld
single-flare-bevel groove weld
single-flare-Vee groove weld
double-Vee groove weld
double-bevel groove weld
double-U groove weld
double-J groove weld
double-flare-bevel groove weld
double-flare-Vee groove weld

heat-affected zone — that portion of the base metal which has not been melted, but whose mechanical properties or microstructures have been altered by the heat of welding or cutting

interpass temperature — the highest temperature in the weld joint immediately prior to welding, or in the case of multiple pass welds, the highest temperature in the section of the previously deposited weld metal, immediately before the next pass is started

joint — the junction of members or the edges of members which are to be joined or have been joined

joint penetration — the distance the weld metal extends from the weld face into a joint, exclusive of weld reinforcement

keyhole welding — a technique in which a concentrated heat source penetrates partially or completely through a workpiece, forming a hole (keyhole) at the leading edge of the weld pool. As the heat source progresses, the molten metal fills in behind the hole to form the weld bead.

lap or overlap — the distance measured between the edges of two plates when overlapping to form the joint

lap joint — a joint between two overlapping members in parallel planes

lower transformation temperature — the temperature at which austenite begins to form during heating

melt-in — a technique of welding in which the intensity of a concentrated heat source is so adjusted that a weld pass can be produced from filler metal added to the leading edge of the molten weld metal

oscillation — for a machine or automatic process, an alternating motion relative to the direction of travel of welding, brazing, or thermal spray device. See also *weave bead*. 01

overlay — a non-standard term, used in Section IX, for surfacing. See *hard-facing* and *corrosion-resistant overlay*.

overlay, corrosion-resistant weld metal — deposition of one or more layers of weld metal to the surface of a base material in an effort to improve the corrosion resistance properties of the surface. This would be

applied at a level above the minimum design thickness as a nonstructural component of the overall wall thickness.

overlay, hard-facing weld metal — deposition of one or more layers of weld metal to the surface of a material in an effort to improve the wear resistance properties of the surface. This would be applied at a level above the minimum design thickness as a nonstructural component of the overall wall thickness.

pass — a single progression of a welding or surfacing operation along a joint, weld deposit, or substrate. The result of a pass is a weld bead or layer.

pass, cover — a final or cap pass(es) on the face of a weld

pass, wash — pass to correct minor surface aberrations and/or prepare the surface for nondestructive testing

peel test — a destructive method of testing that mechanically separates a lap joint by peeling

peening — the mechanical working of metals using impact blows

performance qualification — the demonstration of a welder's or welding operator's ability to produce welds meeting prescribed standards

plug weld — a weld made in a circular, or other geometrically shaped hole (like a slot weld) in one member of a lap or tee joint, joining that member to the other. The walls of the hole may or may not be parallel, and the hole may be partially or completely filled with weld metal. (A fillet-welded hole or spot weld should not be construed as conforming to this definition.)

polarity, reverse — the arrangement of direct current arc welding leads with the work as the negative pole and the electrode as the positive pole of the welding arc; a synonym for direct current electrode positive

polarity, straight — the arrangement of direct current arc welding leads in which the work is the positive pole and the electrode is the negative pole of the welding arc; a synonym for direct current electrode negative

postbraze heat treatment — any heat treatment subsequent to brazing

postheating — the application of heat to an assembly after welding, brazing, soldering, thermal spraying, or thermal cutting

postweld heat treatment — any heat treatment subsequent to welding

powder — see *filler metal, powder*

preheat maintenance — practice of maintaining the minimum specified preheat temperature, or some specified higher temperature for some required time interval after welding or thermal spraying is finished or until post weld heat treatment is initiated

preheat temperature — the minimum temperature in the weld joint preparation immediately prior to the welding; or in the case of multiple pass welds, the minimum temperature in the section of the previously deposited weld metal, immediately prior to welding

preheating — the application of heat to the base metal immediately before a welding or cutting operation to achieve a specified minimum preheat temperature

pulsed power welding — any arc welding method in which the power is cyclically programmed to pulse so that effective but short duration values of a parameter can be utilized. Such short duration values are significantly different from the average value of the parameter. Equivalent terms are pulsed voltage or pulsed current welding. See also *pulsed spray welding*.

pulsed spray welding — an arc welding process variation in which the current is pulsed to utilize the advantages of the spray mode of metal transfer at average currents equal to or less than the globular to spray transition current

rabbet joint — typical design is indicated in QB-462.1(c), QB-462.4, QB-463.1(c), and QB-463.2(a)

retainer — nonconsumable material, metallic or nonmetallic, which is used to contain or shape molten weld metal. See *backing*.

seal weld — any weld designed primarily to provide a specific degree of tightness against leakage

seam weld — a continuous weld made between or upon overlapping members in which coalescence may start and occur on the faying surfaces, or may have proceeded from the surface of one member. The continuous weld may consist of a single weld bead or a series of overlapping spot welds. See *resistance welding.*

short-circuiting transfer (gas metal-arc welding) — metal transfer in which molten metal from a consumable electrode is deposited during repeated short circuits. See also *globular transfer* and *spray transfer*.

single-welded joint — a joint welded from one side only

single-welded lap joint — a lap joint in which the overlapped edges of the members to be joined are welded along the edge of one member only

slag inclusion — nonmetallic solid material entrapped in weld metal or between weld metal and base metal

specimen — refer to test specimen

spot weld — a weld made between or upon overlapping members in which coalescence may start and occur on the faying surfaces or may proceed from the outer surface of one member. The weld cross section (plan view) is approximately circular.

spray-fuse — a thermal spraying technique in which the deposit is reheated to fuse the particles and form a metallurgical bond with the substrate

spray transfer (arc welding) — metal transfer in which molten metal from a consumable electrode is propelled axially across the arc in small droplets

stringer bead — a weld bead formed without appreciable weaving

surfacing — the application by welding, brazing, or thermal spraying of a layer(s) of material to a surface to obtain desired properties or dimensions, as opposed to making a joint

tee joint (T) — a joint between two members located approximately at right angles to each other in the form of a T

test coupon — a weld or braze assembly for procedure or performance qualification testing. The coupon may be any product from plate, pipe, tube, etc., and may be a fillet weld, overlay, deposited weld metal, etc.

test specimen — a sample of a test coupon for specific test. The specimen may be a bend test, tension test, impact test, chemical analysis, macrotest, etc. A specimen may be a complete test coupon, for example, in radiographic testing or small diameter pipe tension testing.

thermal cutting (TC) — a group of cutting processes that severs or removes metal by localized melting, burning, or vaporizing of the workpieces

throat, actual (of fillet) — the shortest distance from the root of a fillet weld to its face

throat, effective (of fillet) — the minimum distance from the fillet face, minus any convexity, to the weld root. In the case of fillet welds combined with a groove weld, the weld root of the groove weld shall be used.

throat, theoretical (of fillet) — the distance from the beginning of the joint root perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross-section of a fillet weld. This dimension is based on the assumption that the root opening is equal to zero.

undercut — a groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal

upper transformation temperature — the temperature at which transformation of the ferrite to austenite is completed during heating

usability — a measure of the relative ease of application of a filler metal to make a sound weld or braze joint

weave bead — for a manual or semiautomatic process, a weld bead formed using weaving. See also *oscillation*. 01

weaving — a welding technique in which the energy source is oscillated transversely as it progresses along the weld path

weld — a localized coalescence of metals or nonmetals produced either by heating the materials to the welding temperature, with or without the application of pressure, or by the application of pressure alone and with or without the use of filler material

weld, autogenous — a fusion weld made without filler metal

weld bead — a weld deposit resulting from a pass. See *stringer bead* and *weave bead*.

weld face — the exposed surface of a weld on the side from which welding was done

weld interface — the interface between the weld metal and base metal in a fusion weld

weld metal — metal in a fusion weld consisting of that portion of the base metal and filler metal melted during welding

weld reinforcement — weld metal on the face or root of a groove weld in excess of the metal necessary for the specified weld size

weld size: groove welds — the depth of chamfering plus any penetration beyond the chamfering, resulting in the strength carrying dimension of the weld

weld size: for equal leg fillet welds — the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section

weld size: for unequal leg fillet welds — the leg lengths of the largest right triangle which can be inscribed within the fillet weld cross section

welder — one who performs manual or semiautomatic welding

welding, arc stud (SW) — an arc welding process that uses an arc between a metal stud, or similar part, and the other workpiece. The process is used without filler metal, with or without shielding gas or flux, with or

without partial shielding from a ceramic or graphite ferrule surrounding the stud, and with the application of pressure after the faying surfaces are sufficiently heated.

welding, automatic — welding with equipment which performs the welding operation without adjustment of the controls by a welding operator. The equipment may or may not perform the loading and unloading of the work. See *machine welding*.

welding, consumable guide electroslag — an electroslag welding process variation in which filler metal is supplied by an electrode and its guiding member

welding, electrogas (EGW) — an arc welding process that uses an arc between a continuous filler metal electrode and the weld pool, employing approximately vertical welding progression with retainers to confine the weld metal. The process is used with or without an externally supplied shielding gas and without the application of pressure. Shielding for use with solid or metal-cored electrodes is obtained from a gas or gas mixture. Shielding for use with flux-cored electrodes may or may not be obtained from an externally supplied gas or gas mixture.

welding, electron beam (EBW) — a welding process that produces coalescence with a concentrated beam composed primarily of high velocity electrons, impinging on the joint. The process is used without shielding gas and without the application of pressure.

welding, electroslag (ESW) — a welding process producing coalescence of metals with molten slag which melts the filler metal and the surfaces of the work to be welded. The molten weld pool is shielded by this slag which moves along the full cross section of the joint as welding progresses. The process is initiated by an arc which heats the slag. The arc is then extinguished and the conductive slag is maintained in a molten condition by its resistance to electric current passing between the electrode and the work. See electroslag welding electrode and consumable guide electroslag welding.

welding, flux-cored arc (FCAW) — a gas metal-arc welding process that uses an arc between a continuous filler metal electrode and the weld pool. The process is used with shielding gas from a flux contained within the tubular electrode, with or without additional shielding from an externally supplied gas, and without the application of pressure.

welding, friction (FRW) — a solid state welding process that produces a weld under compressive force contact of workpieces rotating or moving relative to one another to produce heat and plastically displace material from the faying surfaces

welding, friction, inertia and continuous drive — processes and types of friction welding (solid state welding process) wherein coalescence is produced after heating is obtained from mechanically induced sliding motion between rubbing surfaces held together under pressure. Inertia welding utilizes all of the kinetic energy stored in a revolving flywheel spindle system. Continuous drive friction welding utilizes the energy provided by a continuous drive source such as an electric or hydraulic motor.

welding, gas metal-arc (GMAW) — an arc welding process that uses an arc between a continuous filler metal electrode and the weld pool. The process is used with shielding from an externally supplied gas and without the application of pressure.

welding, gas metal-arc, pulsed arc (GMAW-P) — a variation of the gas metal-arc welding process in which the current is pulsed. See also *pulsed power welding*.

welding, gas metal-arc, short-circuiting arc (GMAW-S) — a variation of the gas metal-arc welding process in which the consumable electrode is deposited during repeated short circuits. See also *short-circuiting transfer*.

welding, gas tungsten-arc (GTAW) — an arc welding process which produces coalescence of metals by heating them with an arc between a tungsten (nonconsumable) electrode and the work. Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (This process has sometimes been called TIG welding, a nonpreferred term.)

welding, gas tungsten-arc, pulsed arc (GTAW-P) — a variation of the gas tungsten-arc welding process in which the current is pulsed. See also *pulsed power welding*.

welding, induction (IW) — a welding process that produces coalescence of metals by the heat obtained from resistance of the workpieces to the flow of induced high frequency welding current with or without the application of pressure. The effect of the high-frequency welding current is to concentrate the welding heat at the desired location.

welding, laser beam (LBW) — a welding process which produces coalescence of materials with the heat obtained from the application of a concentrated coherent light beam impinging upon the members to be joined

welding, machine — welding with equipment which performs the welding operation under the constant observation and control of a welding operator. The

equipment may or may not perform the loading and unloading of the work. See *automatic welding*.

welding, manual — welding wherein the entire welding operation is performed and controlled by hand

welding, operator — one who operates machine or automatic welding equipment

welding, oxyfuel gas (OFW) — a group of welding processes which produces coalescence by heating materials with an oxyfuel gas flame or flames, with or without the application of pressure, and with or without the use of filler metal

welding, plasma-arc (PAW) — an arc welding process which produces coalescence of metals by heating them with a constricted arc between an electrode and the workpiece (transferred arc), or the electrode and the constricting nozzle (nontransferred arc). Shielding is obtained from the hot, ionized gas issuing from the torch orifice which may be supplemented by an auxiliary source of shielding gas. Shielding gas may be an inert gas or a mixture of gases. Pressure may or may not be used, and filler metal may or may not be supplied.

welding, projection (PW) — a resistance welding process that produces coalescence by the heat obtained from the resistance of the flow of welding current. The resulting welds are localized at predetermined points by projections, embossments, or intersections. The metals to be joined lap over each other.

welding, resistance (RW) — a group of welding processes that produces coalescence of the faying surfaces with the heat obtained from resistance of the workpieces to the flow of the welding current in a circuit of which the workpieces are a part, and by the application of pressure

welding, resistance seam (RSEW) — a resistance welding process that produces a weld at the faying surfaces of overlapped parts progressively along a length of a joint. The weld may be made with overlapping weld nuggets, a continuous weld nugget, or by forging the joint as it is heated to the welding temperature by resistance to the flow of the welding current.

welding, resistance spot (RSW) — a resistance welding process that produces a weld at the faying surfaces of a joint by the heat obtained from resistance to the flow of welding current through the workpieces from electrodes that serve to concentrate the welding current and pressure at the weld area

welding, resistance stud — a resistance welding process wherein coalescence is produced by the heat obtained from resistance to electric current at the interface between the stud and the workpiece, until the surfaces to be joined are properly heated, when they are brought together under pressure

welding, semiautomatic arc — arc welding with equipment which controls only the filler metal feed. The advance of the welding is manually controlled.

welding, shielded metal-arc (SMAW) — an arc welding process with an arc between a covered electrode and the weld pool. The process is used with shielding from the decomposition of the electrode covering, without the application of pressure, and with filler metal from the electrode

welding, stud — a general term for the joining of a metal stud or similar part to a workpiece. Welding may be accomplished by arc, resistance, friction, or other suitable process with or without external gas shielding.

welding, submerged-arc (SAW) — an arc welding process that uses an arc or arcs between a bare metal electrode or electrodes and the weld pool. The arc and molten metal are shielded by a blanket of granular flux on the workpieces. The process is used without pressure and with filler metal from the electrode and sometimes from a supplemental source (welding rod, flux, or metal granules).

weldment — an assembly whose constituent parts are joined by welding, or parts which contain weld metal overlay