

ASME Section IX Overview

What is required?

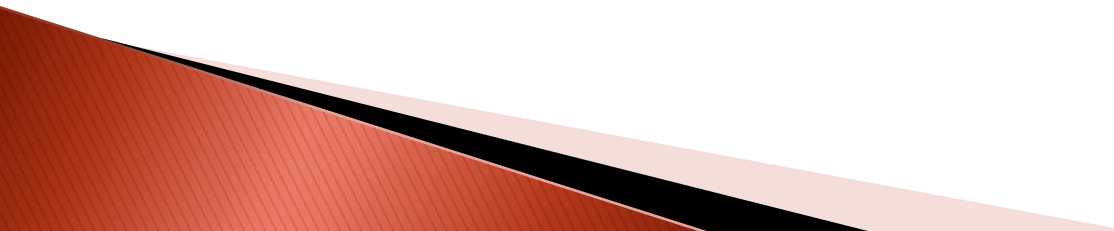
- ▶ Determine if procedure and qualification records are in compliance with applicable ASME Boiler and Pressure Vessel Code
- ▶ The weld procedure review will include:
 - One Weld Procedure Specification (WPS); and
 - One Procedure Qualification Record (PQR).
- ▶ a) Determine if all required essential and nonessential variables have been properly addressed. (Supplemental essential variables will not be a part of the WPS/PQR)
- ▶ b) Determine that the number and type of mechanical tests that are listed on PQR are the proper tests, and whether the results are acceptable.

QW – 141 Mechanical Tests

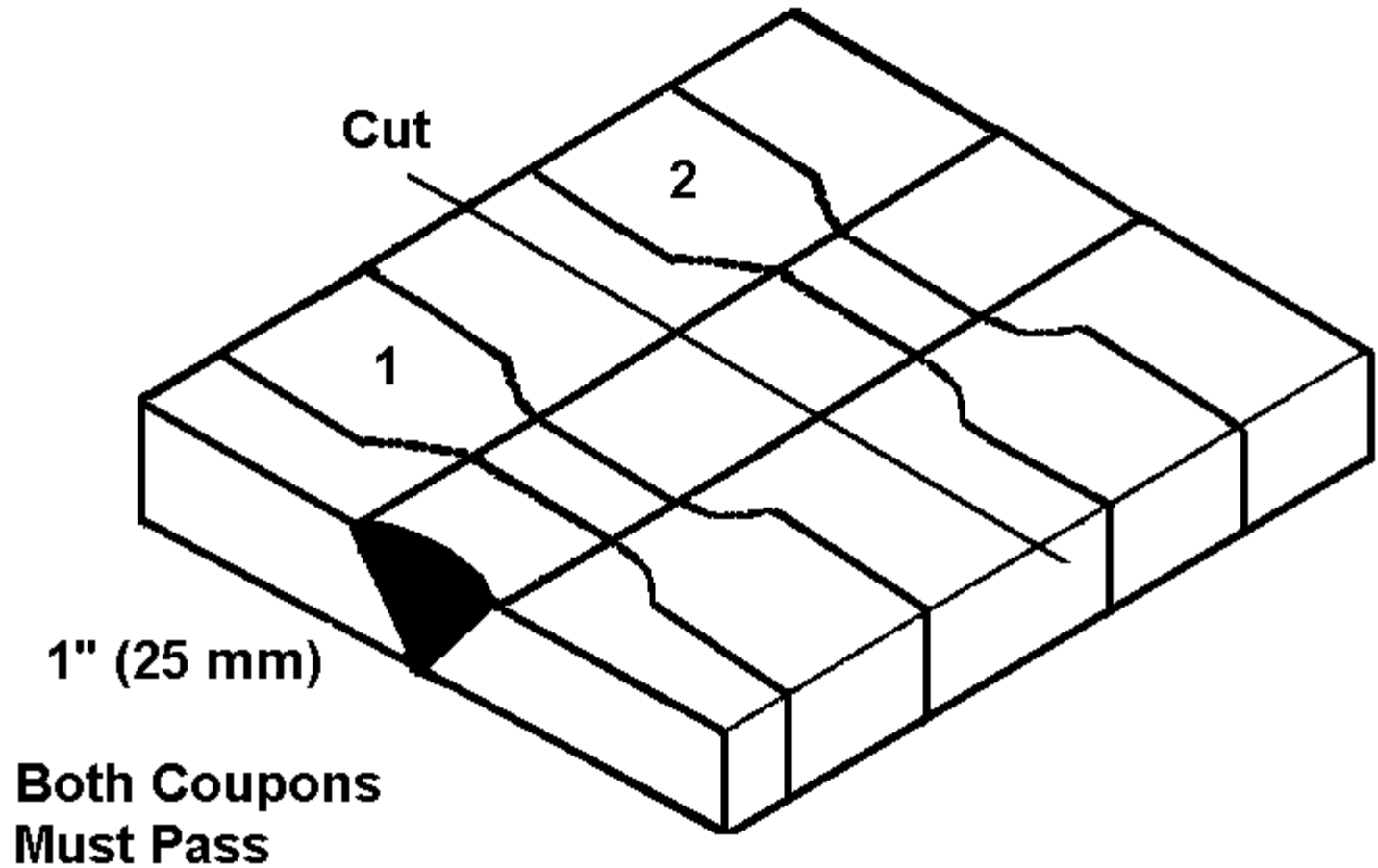
Mechanical tests used in procedure or performance qualification are as follows:

QW – 141.1 Tension Tests ...as described in QW-150 are used to <i>determine the ultimate strength of groove-weld joints.</i>	QW – 141.2 Guided-Bend Tests ...as described in QW-160 are used to <i>determine the degree of soundness and ductility of groove-weld joints.</i>
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QW – 151.1 Reduced Section – Plate

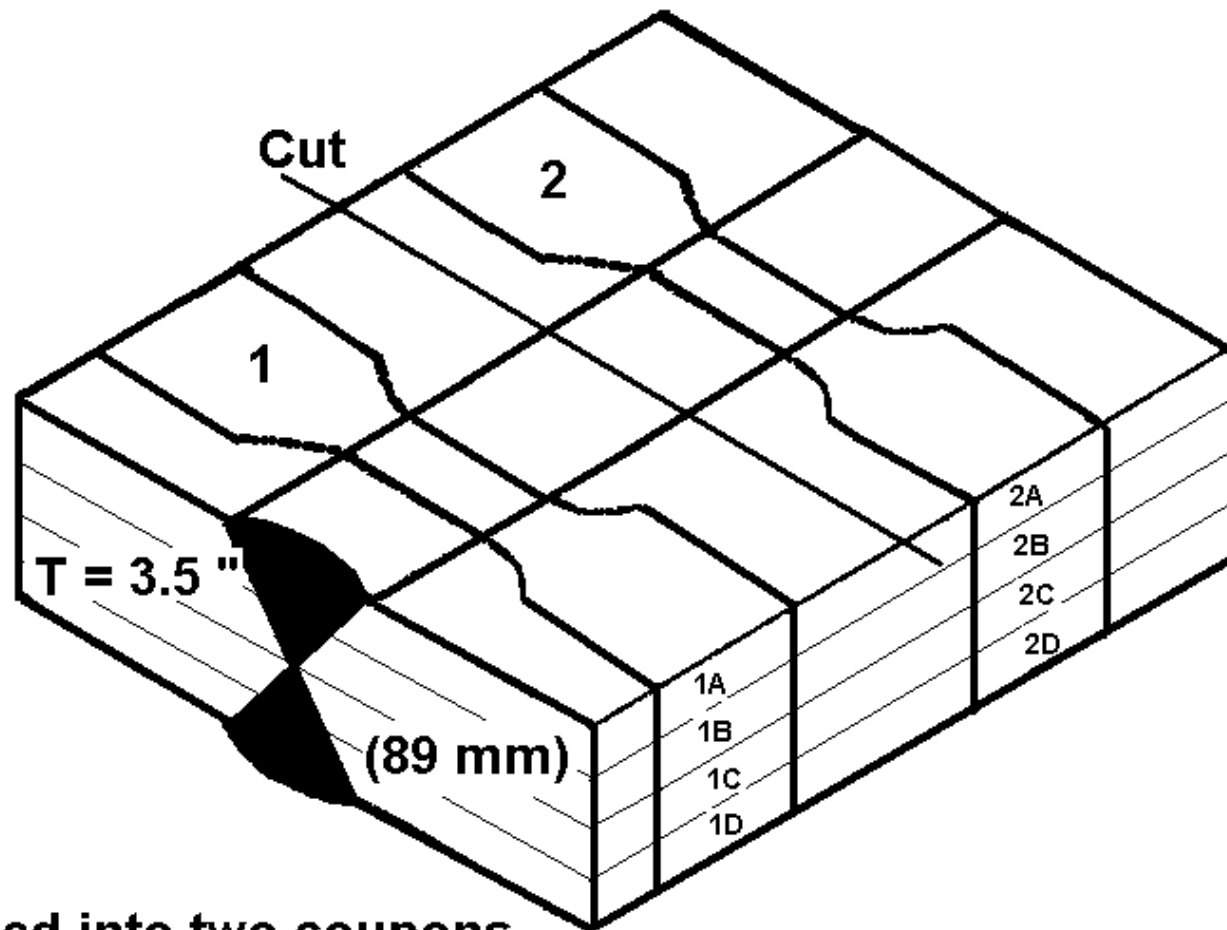
- (a) For thicknesses up to and including 1 in. a *full thickness specimen shall be used for each required tension test.*
- (b) For plate thickness greater than 1 in., *full thickness specimens or multiple specimens may be used, provided QW-151.1(c) and QW-151.1(d) are complied with.*
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QW - 151.1 Reduced Section - Plate



QW - 151.1 Reduced Section - Plate

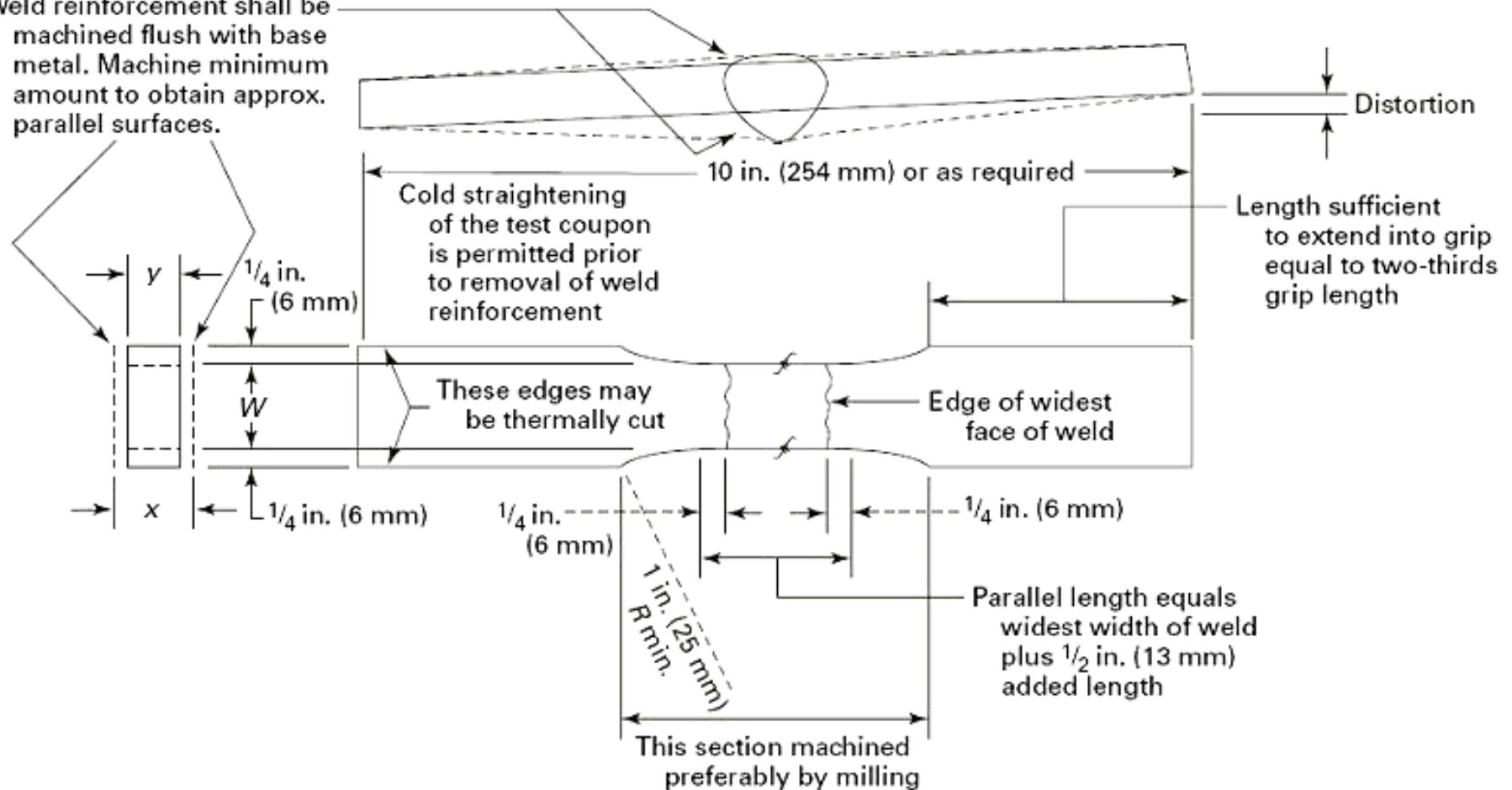
Example: 3.5" (89 mm) in 1" (25 mm) Capacity TS Machine



**Divided into two coupons
each 4 specimens
All eight must pass!**

**Tensile Machine Capacity
1" (25 mm) Maximum**

Weld reinforcement shall be machined flush with base metal. Machine minimum amount to obtain approx. parallel surfaces.



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

Diagram illustrating the dimensions and requirements for a butt joint weld:

- Weld Face:** The top surface of the weld is shown with a smooth, rounded profile. A note indicates: "On ferrous material these edges may be thermally cut".
- Weld Root:** The bottom surface of the weld is shown with a smooth, rounded profile. A note indicates: "Edge of widest face of weld".
- Weld Width:** The width of the weld face is labeled as W .
- Weld Height:** The height of the weld face is labeled as y .
- Weld Depth:** The depth of the weld root is labeled as x .
- Weld Length:** The length of the weld is labeled as $10 \text{ in. (254 mm) or as required}$.
- Weld Bevel:** The bevel angle is labeled as $1 \text{ in. (25 mm) } R \text{ min.}$.
- Weld Preparation:** The section of the weld is labeled as "This section machined preferably by milling".
- Weld Dimensions:** The dimensions of the weld face and root are specified as $\frac{1}{4} \text{ in. (6 mm)}$.

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

QW – 153 Acceptance Criteria

Tension Tests

Minimum values for procedure qualification are provided under the column heading “Minimum Specified Tensile, ksi” of QW/QB- 422. In order to pass the tension test, the specimen shall have a tensile strength that is not less than:

- (a) the *minimum specified tensile strength of the base metal*; or...
- (b) the *minimum specified tensile strength of the weaker of the two*, if base metals of different minimum tensile strengths are used; or...

QW – 153.1 Tensile Strength

- (c) the *minimum specified tensile strength of the weld metal* when the applicable Section provides for the use of weld metal having lower room temperature strength than the base metal; or...
- (d) *if the specimen breaks in the base metal outside of the weld or weld interface, the test shall be accepted as meeting the requirements, provided the strength is not more than 5% below the minimum specified tensile strength of the base metal.* (Note: (d) will be the acceptance paragraph for the majority of welding procedures and used during the WPS/PQR review.)

QW – 163 Acceptance Criteria – Bend Tests

The weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion of the specimen after testing.

The guided-bend specimens *shall have no open discontinuities in the weld or heat-affected zone exceeding 1/8 in. (3.2 mm)*, measured in any direction on the convex surface of the specimen after bending. *Open discontinuities occurring on the corners* of the specimen during testing shall not be considered *unless there is definite evidence that they result from lack of fusion, slag inclusions, or other internal discontinuities.*

QW-191 Radiographic Examination

QW-191.2 Radiographic Acceptance Criteria

(a) Linear Indications

(1) any type of cracks, or zone of incomplete fusion or penetration.

(2) any type of slag inclusion which has a length greater than:

(b) Rounded Indications

(1) the maximum permissible dimension for a rounded indication shall be.....

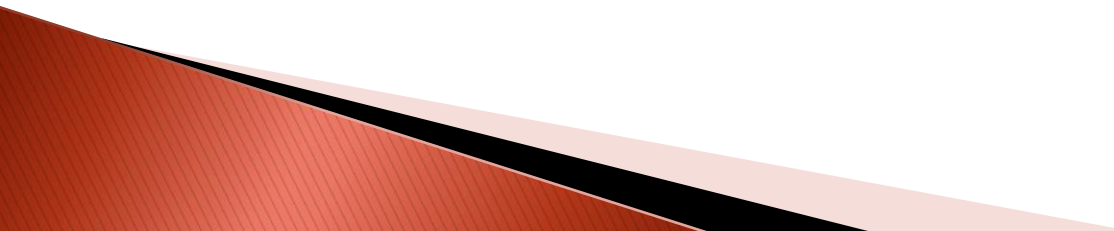
Article II

Welding Procedure Qualifications

QW – 200.2

All changes to a PQR require recertification (including date) by the manufacturer or contractor. (new PQR form and signature) except editorial corrections or adding addenda. An example of an addendum would be a change resulting from a Code change.

Multiple WPS' s With One PQR/Multiple PQR s With One WPS.

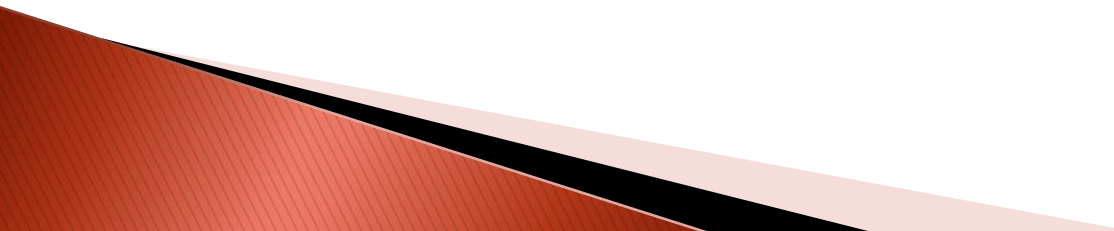


QW-203 Limits of Qualified Positions for Procedures

A welder or welding operator making and passing the WPS qualification test is qualified for the position tested.

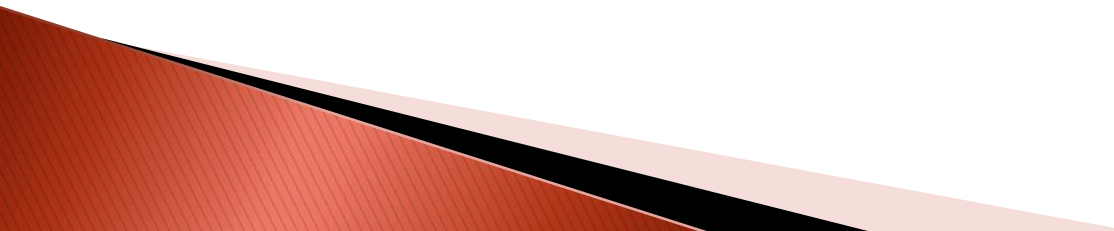
QW-211 Base Metal

The base metals may consist of either plate, pipe, or other product forms. *Qualification in plate also qualifies for pipe welding and vice versa.*

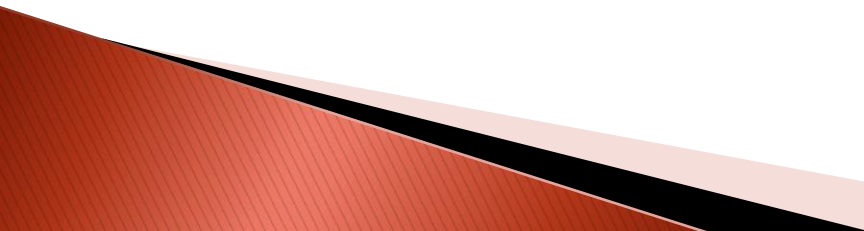


QW – 251 General

Variables (listed for each welding process in QW-252 through QW-265) are subdivided into essential variables, supplementary essential variables, and nonessential variables (QW-401).



QW-250 Welding Processes on the Exam

- **Shielded Metal Arc Welding (SMAW)**
 - **Submerged Arc Welding (SAW)**
 - **Gas Metal and Flux Core Arc Welding (GMAW –FCAW)**
 - **Gas Tungsten Arc Welding (GTAW)**
- 

QW-253 SMAW

Paragraph		Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402 Joints	.1	ϕ Groove design			X
	.4	– Backing			X
	.10	ϕ Root spacing			X
	.11	$\pm$ Retainers			X

Legend:

+ Addition

– Deletion

> Increase/greater than

< Decrease/less than

↑ Uphill

↓ Downhill

← Forehand

→ Backhand

ϕ Change

21

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.

Supplementary Essentials Will Not Be On The WPS/PQR Questions

PROCEDURE QUALIFICATIONS

QW-253

01

QW-253 WELDING VARIABLES PROCEDURE SPECIFICATIONS (WPS) Shielded Metal-Arc (SMAW)

Paragraph	Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402 Joints	.1 ϕ Groove design			X
	.4 - Backing			X
	.10 ϕ Root spacing			X
	.11 $\pm$ Retainers			X
QW-403 Base Metals	.5 ϕ Group Number			
	.6 T Limits impact			
	.7 T/t Limits > 8 in. (203 mm)	X		
	.8 ϕ T Qualified	X		
	.9 t Pass > 1/2 in. (13 mm)	X		
	.11 ϕ P-No. qualified	X		
	.13 ϕ P-No. 5/9/10	X		
QW-404 Filler Metals	.4 ϕ F-Number	X		
	.5 ϕ A-Number	X		
	.6 ϕ Diameter			X
	.7 ϕ Diam. > 1/4 in. (6 mm)			
	.12 ϕ AWS class.			
	.30 ϕ t	X		
	.33 ϕ AWS class.			X
QW-405 Positions	.1 + Position			X
	.2 ϕ Position			
	.3 ϕ $\uparrow\downarrow$ Vertical welding			X
QW-406 Preheat	.1 Decrease > 100°F (56°C)	X		
	.2 ϕ Preheat maint.			X
	.3 Increase > 100°F (56°C) (IP)			
QW-407 PWHT	.1 ϕ PWHT	X		
	.2 ϕ PWHT (T & T range)			
	.4 T Limits	X		
QW-409 Electrical Characteristics	.1 > Heat input			
	.4 ϕ Current or polarity			X
	.8 ϕ I & E range			X
QW-410 Technique	.1 ϕ String/weave			X
	.5 ϕ Method cleaning			X
	.6 ϕ Method back gouge			X
	.9 ϕ Multi to single pass/side			X
	.25 ϕ Manual or automatic			X
	.26 $\pm$ Peening			X

Legend:

+ Addition
- Deletion

> Increase/greater than
< Decrease/less than

$\uparrow$ Uphill
 $\downarrow$ Downhill

$\leftarrow$ Forehand
 $\rightarrow$ Backhand

ϕ Change

The Basic Variables are Identical in most Processes – Joints – Base Metals

QW-254
WELDING VARIABLES PROCEDURE SPECIFICATIONS (WPS)
Submerged-Arc Welding (SAW)

Paragraph		Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402 Joints	.1	ϕ Groove design			X
	.4	– Backing			X
	.10	ϕ Root spacing			X
	.11	$\pm$ Retainers			X
QW-403 Base Metals	.5	ϕ Group Number		X	
	.6	T Limits		X	
	.7	T/t Limits > 8 in. (203 mm)	X		
	.8	ϕ T Qualified	X		
	.9	t Pass > $\frac{1}{2}$ in. (13 mm)	X		
	.11	ϕ P-No. qualified	X		
	.13	ϕ P-No. 5/9/10	X		

Some Variables are shared such as F-Number and some are unique to a Process – Flux Wire Class – Alloy Flux – Supplemental etc...

QW-404 Filler Metals	.4	ϕ F-Number	X		
	.5	ϕ A-Number	X		
	.6	ϕ Diameter			X
	.9	ϕ Flux/wire class.	X		
	.10	ϕ Alloy flux	X		
	.24	$\pm$ Supplemental ϕ	X		
	.27	ϕ Alloy elements	X		
	.29	ϕ Flux designation			X
	.30	ϕ t	X		
	.33	ϕ AWS class.			X
	.34	ϕ Flux type	X		
	.35	ϕ Flux/wire class.		X	X
	.36	Recrushed slag	X		

Shared such as String or Weave Some are Unique to a Process – Oscillation – Tube-Work Distance – Single to multi electrodes etc...

QW-254

WELDING VARIABLES PROCEDURE SPECIFICATIONS (WPS)

Submerged-Arc Welding (SAW) (CONT'D)

Paragraph		Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-410 Technique	.1	ϕ String/weave			X
	.5	ϕ Method cleaning			X
	.6	ϕ Method back gouge			X
	.7	ϕ Oscillation			X
	.8	ϕ Tube-work distance			X
	.9	ϕ Multi to single pass/side		X	X
	.10	ϕ Single to multi electrodes		X	X
	.15	ϕ Electrode spacing			X
	.25	ϕ Manual or automatic			X
	.26	± Peening			X

Article III

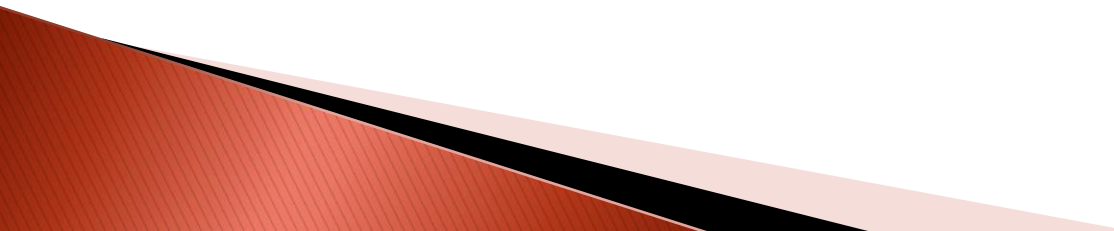
Welding Performance

Qualifications

QW-300.1

This Article lists the welding processes separately, with the essential variables that apply to welder and welding operator performance qualifications.

A welder or welding operator may be qualified by **radiography** of a test coupon, radiography of his initial production welding, or by **bend tests** taken from a test coupon except as stated in QW-304 and QW-305.

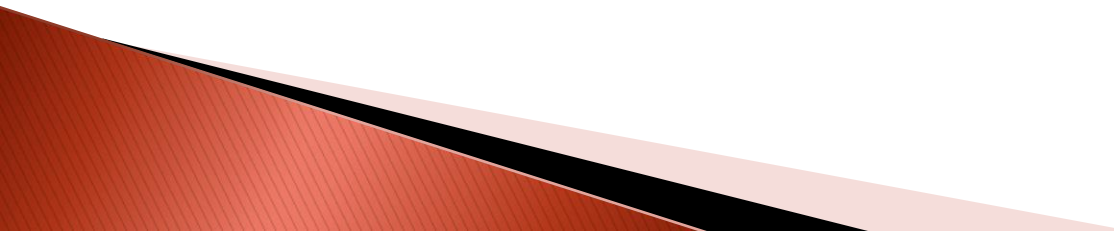


QW-301.2 Qualification Tests

- The performance qualification test shall be welded in accordance with a qualified (WPS), except that when performance qualification is done in accordance with a WPS that requires a **preheat or postweld heat treatment**, these may be omitted.
- The welder or welding operator who prepares the WPS qualification test coupons meeting the requirements of QW-200 is also qualified within the limits of the performance qualifications, listed in QW-304 for welders and in QW-305 for welding operators.
- He is *qualified only within the limits for positions* specified in QW-303.

QW-302.2 Radiographic Examinations

When the welder or welding operator is qualified by radiographic examination,....., the minimum length of coupon (s) to be examined **shall be 6 in.** and shall include the **entire weld circumference** for pipe (s), except that for **small diameter pipe**, multiple coupons may be required, but the number need not exceed **four consecutively** made test coupons.



QW-304 Welders

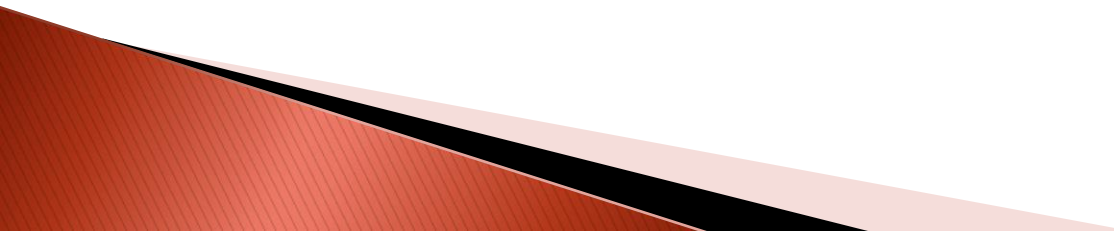
Alternatively, welders making a groove weld using SMAW, SAW, GTAW, PAW, and GMAW (**except short-circuiting mode**) or a combination of these processes, may be qualified by radiographic examination, except for

P-No. 21 through P-No. 25,
P-No. 51 through P-No. 53,
P-No. 61 through P-No. 62 metals.

Welders making groove welds in P-No. 21 through P-No. 25 and P-No. 51 through P-No. 53 metals with the GTAW process may also be qualified by radiographic examination. The radiographic examination shall be in accordance with QW-302.2.

QW-304.1 Examination

Alternatively, a 6 in. length of the first production weld made by a welder using the process (es) and/or mode of arc transfer specified in QW-304 may be qualified by radiography.

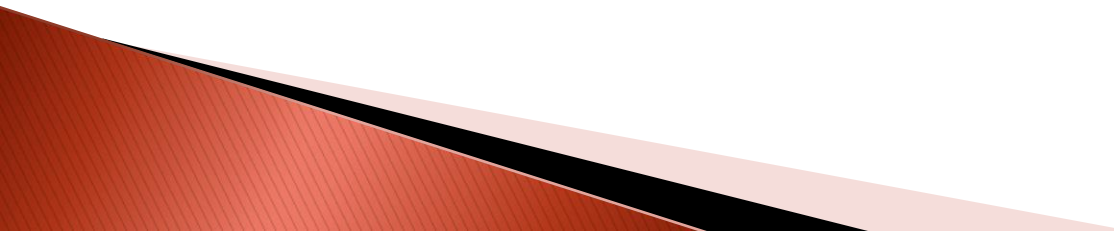


QW-304.2

Failure to Meet Radiographic Standards

If a production weld is selected for welder performance qualification and it does not meet the radiographic standards, the welder has failed the test.

In this event, the *entire production weld* made by this welder *shall be radiographed and repaired by a qualified welder or welding operator*. Alternatively, retests may be made as permitted in QW-320.

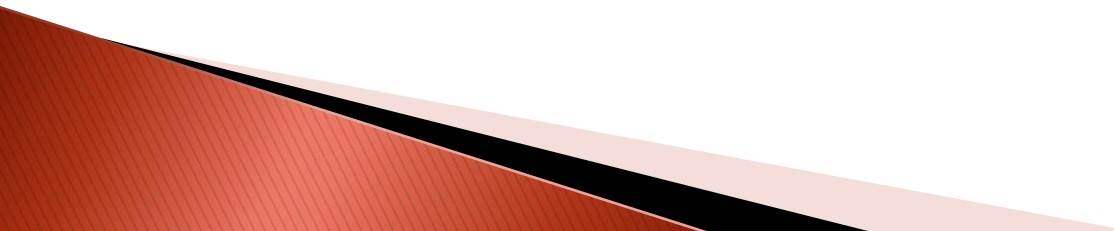


QW-305.1 Examination

Welds made in test coupons may be examined by radiography (QW-302.2) or by visual and mechanical examinations (QW-302.1, QW-302.4). *Alternatively, a 3 ft (0.9 m) length of the first production weld made entirely by the welding operator* in accordance with a qualified WPS may be examined by radiography.

QW-321 Retests

A welder or welding operator who fails one or more of the tests prescribed in QW-304 or QW-305, as applicable, may be retested under the following conditions:



QW-322.1 Expiration of Qualification

The performance qualification of a welder or welding operator shall be affected.....occurs:

(a) When he *has not welded* with a process during a period of 6 months or more, his qualifications for that process shall expire; unless, *within the six month period,*

(1) *a welder has welded* using a manual or semiautomatic welding process which will maintain his qualification ...

(2) *a welding operator has welded* with a machine or automatic welding process which will maintain his.....

(b) *When there is a specific reason to question his ability to make welds that meet the specification, the qualifications*shall be revoked. *All other qualifications not questioned remain in effect.*

QW-322.2 Renewal of Qualification

(a) Renewal of qualification expired under QW-322.1(a) above may be made for any process by welding a single test coupon of either plate or pipe, of any material, thickness or diameter, in any position, and by testing of that coupon as required by QW-301 and QW-302.

(b) Welders and welding operators *whose qualifications have been revoked under QW-322.1(b)* above *shall requalify* Qualification shall utilize a test coupon appropriate to the planned production work. The coupon shall be welded and tested as required by QW-301 and QW-302. Successful test restores the qualification.

Article IV

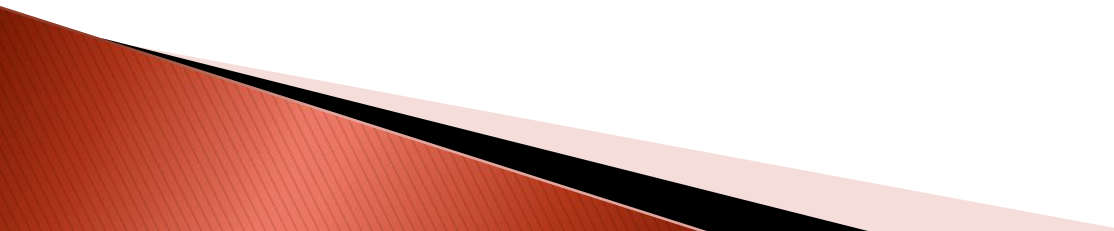
Welding Data

QW – 401 General

A change from one welding process to another welding process is an essential variable and requires requalification.

QW – 401.1 Essential Variables (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.).



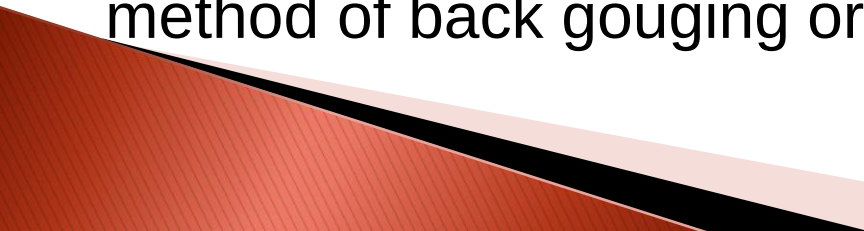
QW – 401.2 Essential Variable Performance

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.).

Supplemental Essential Variables are not on the Exam.

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, etcetera).



P-Numbers will be limited to Welding Only

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-Number:

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

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

F-NUMBERS (NONFERROUS) ← **What a mistake in the Code**
 Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification	UNS No.
<u>Steel and Steel Alloys</u>			
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	...
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	...

QW-433

[illegible]

QW-433

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-451.1

A03

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.		Tension, QW-150	Side Bend, QW-160	Face Bend, QW-160	Root Bend, QW-160
Less than $\frac{1}{16}$ (1.6)	T	$2T$	$2t$	2	...	2	2
$\frac{1}{16}$ to $\frac{3}{8}$ (1.6 to 10), incl.	$\frac{1}{16}$ (1.6)	$2T$	$2t$	2	Note (3)	2	2
Over $\frac{3}{8}$ (10), but less than $\frac{3}{4}$ (19)	$\frac{3}{16}$ (4.8)	$2T$	$2t$	2	Note (3)	2	2
$\frac{3}{4}$ (19) to less than $1\frac{1}{2}$ (38)	$\frac{3}{16}$ (4.8)	$2T$	$2t$ when $t < \frac{3}{4}$ (19)	2 [Note (4)]	4	...	...
$\frac{3}{4}$ (19) to less than $1\frac{1}{2}$ (38)	$\frac{3}{16}$ (4.8)	$2T$	$2T$ when $t \geq \frac{3}{4}$ (19)	2 [Note (4)]	4	...	...
$1\frac{1}{2}$ (38) and over	$\frac{3}{16}$ (4.8)	8 (203) [Note (5)]	$2t$ when $t < \frac{3}{4}$ (19)	2 [Note (4)]	4	...	...
$1\frac{1}{2}$ (38) and over	$\frac{3}{16}$ (4.8)	8 (203) [Note (5)]	8 (203) [Note (5)] when $t \geq \frac{3}{4}$ (19)	2 [Note (4)]	4	...	...

NOTES:

- (1) The following variables further restrict the limits shown in this table when they are referenced in QW-250 for the process under consideration: QW-403.9, QW-403.10, QW-403.32, and QW-407.4. Also, QW-202.2, QW-202.3, and QW-202.4 provide exemptions that supersede the limits of this table.
- (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 $\frac{3}{8}$ in. (10 mm) and over.
- (4) See QW-151.1, QW-151.2, and QW-151.3 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.

WELDING DATA

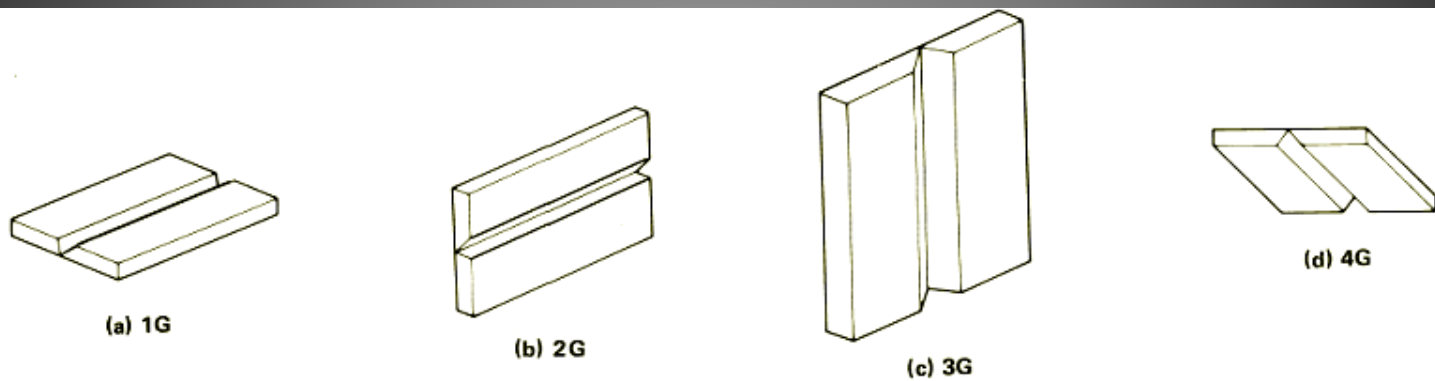
QW-452.3
GROOVE-WELD DIAMETER LIMITS

Outside Diameter of Test Coupon, in. (mm)	Outside Diameter Qualified, in. (mm)	
	Min.	Max.
Less than 1 (25)	Size welded	Unlimited
1 (25) to $2\frac{7}{8}$ (73)	1 (25)	Unlimited
Over $2\frac{7}{8}$ (73)	$2\frac{7}{8}$ (73)	Unlimited

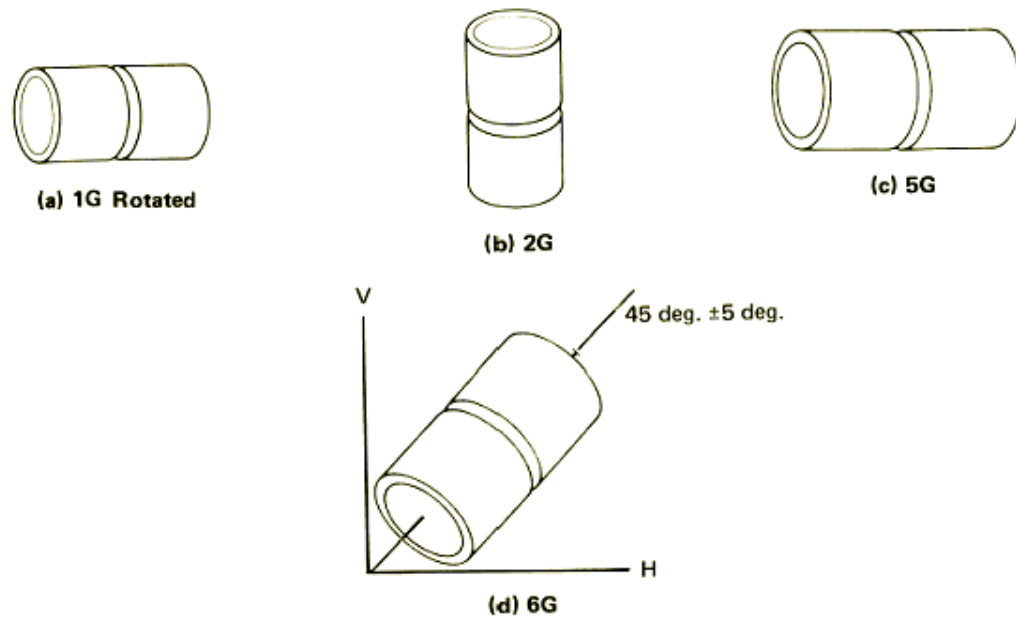
GENERAL NOTES:

- (a) Type and number of tests required shall be in accordance with QW-452.1.
- (b) $2\frac{7}{8}$ in. (73 mm) O.D. is the equivalent of NPS $2\frac{1}{2}$.

QW-461.4



QW-461.3 GROOVE WELDS IN PLATE — TEST POSITIONS



QW-461.4 GROOVE WELDS IN PIPE — TEST POSITIONS

QW-461.9

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
		Plate and Pipe Over 24 In. (610 mm) O.D.	Pipe ≤ 24 In. (610 mm) O.D.	
Weld	Position			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

Welder's Qualification

QW-353

Shielded Metal-Arc Welding (SMAW)

Essential Variables

<u>Paragraph</u>		<u>Brief of Variables</u>
<u>QW 402</u>		
Joints	.4	Deletion of Backing
<u>QW 403</u>		
Base Metals	.16	Change Pipe Diameter
	.18	Change in P Number
<u>QW 404</u>		
Filler Metals	.15	Change in F Number
	.30	Change in weld t deposited
<u>QW 405</u>		
Positions	.1	Addition of a position
	.3	Change from vertical Up to Down or Down to UP progression