Son Set Consultants

PO Box 1536
7679 North 140th East Ave.
Owasso, OK 74055
918-633-0740
E-Mail: Rick@weld-procedure.com, WEB: www.weld-procedure.com

Welding Documents

The majority of the rules of welding codes that's gets confused involves wrong use one of the following three documents:

- Welding Procedure Specification (WPS) = weld recipe
- Procedure Qualification Record (PQR) = proof test of the weld recipe
- Welder Performance Qualification Record (WPQ) = welder test

The biggest source of confusion is the mixing of the rules between these three documents.

Most mistakes are made when one is working with one of the three documents, while applying a requirement from one of the other documents.

The welding industry Code writing committees would do a great service to industry if they would produce three separate Codes:

- The first for the "preparation" of the welding procedure specification (WPS) = weld recipe,
- The second for the "qualification" (proof test) of the WPS (weld recipe) and the documentation of that qualification on a Procedure Qualification Record (PQR),
- The third for the "qualification" of the welder's performance and the documentation of that qualification on a Welders Performance Qualification (WPQ) record.

These three documents, however, are intermixed within welding codes. One must know which of these three documents is being considered. Mixing of the rules for one document with another is the biggest source of confusion.

Another source of confusion is the common use of the word, "procedure."

When someone refers to "the procedure," or "welding procedure," it is not certain if they are referring to the welding procedure specification (WPS) or the procedure qualification record (PQR).

You may avoid this source of confusion if the proper terms are always used.

The scope of all welding codes is the qualification of welders and the welding procedure specifications employed in welding.

- Welding Procedure Specification (WPS) = weld recipe
- Procedure Qualification Record (PQR) = proof test of the weld recipe
- Welder Performance Qualification Record (WPQ) = welder test

The rules that apply to these three documents cover the majority of the requirements of any welding code.

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Welding Documents

Let's take a look at one of these documents in detail.
Print a copy of the Part B page 1 Appendix I to use for reference with the following.

See the major sections of a welding procedure qualification record (PQR) = proof test of a weld recipe. To minimize the amount of data you need to think about at the same time – I have separated out the major sections of the welding procedure qualification record (PQR) = proof test of a weld recipe. This is the same form that will be used on the Practical Exam – out of the Part B Specification Page 1.

APPENDIX I
WELDING PROCEDURE QUALIFICATION RECORD (PQR)

Section #1

PROCEDURE SPECIFICATION

Material specification	[1]
Welding process	[2]
Manual, semiautomatic, automatic:	[3]
Position of welding	[4]
Filler metal specification	[5]
Filler metal classification	[6]
Weld metal analysis	[7]
Shielding gas	[8]
Flow rate	[9]
Single or multiple pass	[10]
Single or multiple arc	[11]
Welding current	[12]
Welding progression	[13]
Preheat temperature	[14]
Welder's ID	[15]
Welder's name	[16]

The blank spaces above are numbered for easy referencing.

The 1st blank (1) is where you would note the material specification (type of material being welded) per your Part B Examination Book of Specifications Appendix XIV Page 17.

The 2nd blank (2) is where you would note the welding process (SMAW or SAW or GMAW or FCAW) per your Part B Examination Book of Specifications Appendix XIV Page 17.

The 3rd blank (3) is where you would note the weld process type (NOTE* SMAW = Manual, SAW = automatic, GMAW & FCAW are both semiautomatic).

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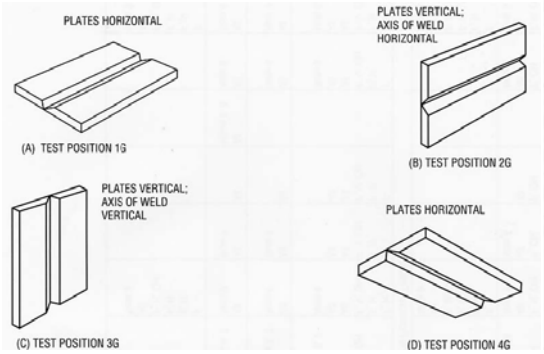
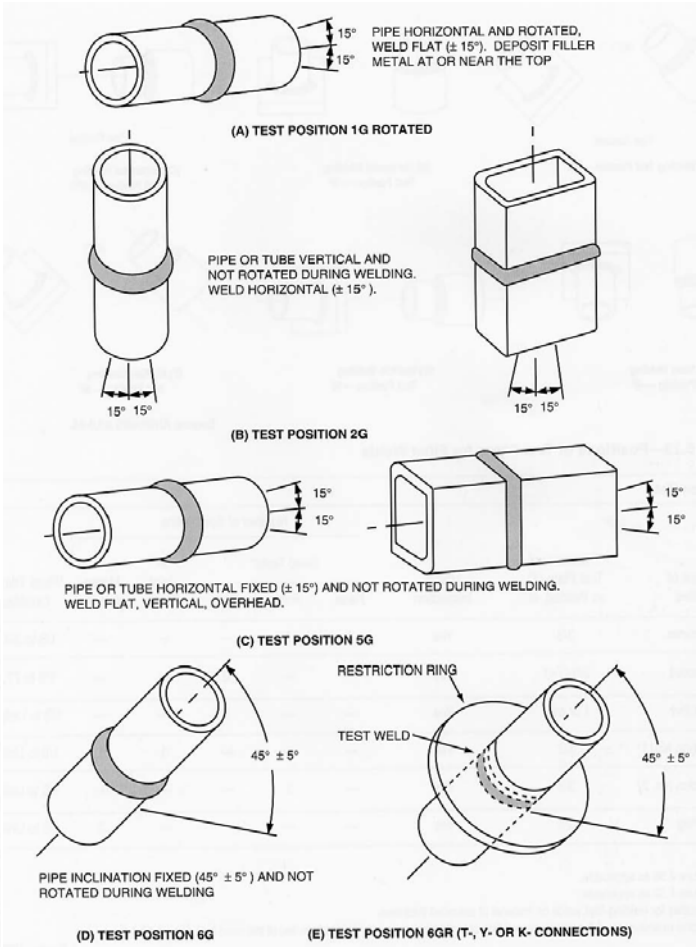
E-Mail: Rick@weld-procedure.com, WEB: www.weld-procedure.com

Welding Documents

The 4th blank (4) is where you would note the position the weld process was performed in





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Welding Documents

The 5th blank (5) is where you would note the weld filler metal specification (see Part B XIV)

Filler Metal Requirements		
Process	AWS Electrode Specification[3]	Electrode Classification[10]
SMAW	A5.1	E60XX, E70XX
	A5.5[6]	E70XX-X
SAW	A5.17	F6XX-EXXX, F6XX-ECXXX, F7XX-EXXX, F7XX-ECXXX
	A5.23[6]	F7XX-EXXX-XX, F7XX-ECXXX-XX
GMAW	A5.18	ER70S-X, E70C-XC, E70C-XM (Electrodes with the -GS suffix are excluded)
	A5.28[6]	ER70S-XXX, E70C-XXX
FCAW	A5.20	E6XT-X, E6XT-XM, E7XT-X, E7XT-XM (Electrodes with the -2, -2M, -3, -10, -13, -14X, and -GS suffix are excluded)
	A5.29[6]	E6XTX-X, E6XT-XM, E7XTX-X, E7XTX-XM

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Welding Documents

The 6th blank (6) is where you would note the weld filler metal classification (see Part B XIV)

Filler Metal Requirements		
Process	AWS Electrode Specification[3]	Electrode Classification[10]
SMAW	A5.1	E60XX, E70XX
	A5.5[6]	E70XX-X
SAW	A5.17	F6XX-EXXX, F6XX-ECXXX, F7XX-EXXX, F7XX-ECXXX
	A5.23[6]	F7XX-EXXX-XX, F7XX-ECXXX-XX
GMAW	A5.18	ER70S-X, E70C-XC, E70C-XM (Electrodes with the -GS suffix are excluded)
	A5.28[6]	ER70S-XXX, E70C-XXX
FCAW	A5.20	E6XT-X, E6XT-XM, E7XT-X, E7XT-XM (Electrodes with the -2, -2M, -3, -10, -13, -14X, and -GS suffix are excluded)
	A5.29[6]	E6XTX-X, E6XT-XM, E7XTX-X, E7XTX-XM

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Welding Documents

The 7th blank (7) is where you would note the weld metal analysis (see Part B Appendix IX)

APPENDIX IX

WELD METAL ANALYSIS

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	0.15	—	—	—	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	25.00–30.00	4.00	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.

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Welding Documents

The 8th blank (8) is where you would note the shielding gas (if any is being used)

Shielding Gas Selection Chart

Process	Thickness	Mild Steel	Stainless	Aluminum	Copper Alloys	Hard Facing	Dissimilar Joining	Gas Blend Recommended
GTAW	< 0.040-0.250	♦	♦	♦	♦	♦	♦	Ar
GTAW	> 0.040-0.250		♦					Ar with < 5% H_2
GTAW	> 0.063-0.250		♦	♦	♦	♦	♦	Ar with up to 50% He
GMAW and Pulse GMAW	> 0.040- 0.250			♦	♦			Ar
GMAW and Pulse GMAW	> 0.250- 0.500			♦	♦			Ar/He
Pulse GMAW	> 0.063- 0.500	♦	♦			♦	♦	Ar with 5% CO_2
GMAW (short-arc, pulse-arc, and spray-arc)	> 0.063- 0.500	♦				♦		Ar with 5-15% CO_2
GMAW (short-arc, pulse-arc, and spray-arc)	> 0.063- 0.500	♦				♦	♦	85% Ar, balance O_2, CO_2
GMAW (short-arc, pulse-arc, and spray-arc)	> 0.063- 0.500	♦				♦		Ar, < 25% He, < 10% CO_2
GMAW (short-arc, pulse-arc, and spray-arc)	> 0.040-0.250		♦				♦	Ar, < 35% He, < 3% CO_2
GMAW (short-arc, pulse-arc, and spray-arc)	> 0.040-0.250		♦					93% Ar, balance N_2, CO_2
GMAW (short-arc, pulse-arc, and spray-arc)	> 0.250- 0.500		♦				♦	95% Ar with < 3% CO_2, < 2% H_2
GMAW (pulse-arc and spray-arc)	> 0.063- 0.250	♦					♦	Ar with < 5% O_2
GMAW (pulse-arc and spray-arc)	> 0.063- 0.250	♦	♦					Ar with < 2% O_2
GMAW (short-arc)	> 0.040- 0.250	♦						Ar with 25% CO_2
GMAW (short-arc)	> 0.063- 0.250		♦					90% He, balance Ar, CO_2
GMAW (globular)	> 0.063- 0.250	♦						Pure CO_2
FCAW	> 0.063- 0.500	♦	♦				♦ with 309SS cored wire	Ar with 25% CO_2
FCAW (globular)	> 0.063- 0.500	♦				♦	♦ with 309SS cored wire	Pure CO_2

Note: The multiple gas recommendations for the same process and material type and thickness indicate that the selection will be based on the specific needs of the application being considered.

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Welding Documents

The 9th blank (9) is where you would note the shielding gas Flow rate (if any gas is being used)

What Is the Optimal Gas Flow?

Shielding gas flow rates are determined by

the process,

welding position,

and operating parameters.

With GTAW, flow rates typically are from 10 to 20 cubic feet per hour (CFH). For GTAW, using a torch with a gas lens will help ensure a laminar flow, which contributes not only to better weld quality, but also to 10 percent or lower gas consumption rates.

With GMAW and FCAW, recommended flow rates vary widely—30 to 45 CFH—depending on the welding position, operating current, and shielding gas composition. For flat-position welding, helium-enhanced mixtures will require slightly higher flow rates than argon-based blends.

Gas flow rates may be reduced if the nozzle-to-work distance is kept as close as possible.

In many instances, production site surveys determine that shielding gas flow rates typically are set in excess of 50 CFH. This can contribute to poor weld quality as atmospheric gases are drawn into the arc zone because of excessive gas turbulence. Optimized flow enhances quality and reduces shielding gas usage.

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Welding Documents

The 10th blank (10) is where you would note if the weld is a single pass (single weld bead) or multiple pass (more than one weld bead)

The 11th blank (11) is where you would note if the weld is a single arc (single weld electrode, torch or head) or multiple arc (more than one weld head – like a dual head SAW process)

The 12th blank (12) is where you would note the welding current:
SMAW = DCEP (reverse)
GTAW = DCEN (straight)
GMAW = DCEN (straight)
FCAW = DCEN (straight)
SAW = DCEN (straight)

The 13th blank (13) is where you would note weld progression if the weld joint is vertical (uphill or downhill)

The 14th blank (14) is where you would note pre-heat temperature. This where the weld joint thickness (typically over ¾" thick) or weld joint material type requires preheat (see Part B Book of Specifications page 20 & 21).

The 15th blank (15) is where you would note the welder's identification stamp that would be placed next to all the welds he or she makes.

The 16th blank (16) is where you would note the welder's name.

The remaining sections are test results / test data.
Section #2

VISUAL INSPECTION RESULTS

Appearance	[17]
Undercut	[18]
Piping porosity	[19]

Section #3

ALL-WELD-METAL TENSION TEST RESULTS

Tensile strength, psi	[20]
Yield point/strength, psi	[21]
Elongation in 2 in., %	[22]
Laboratory Test No:	[23]

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Welding Documents

Section #4

GROOVE WELD TEST RESULTS

Tensile Strength, psi

1. [24]
2. [25]

Section #5

Guided-Bend Tests (2 root-, 2 face-, or 4 side-bends)

Root	Face	Side
1. [26]	1. [28]	1. [30]
2. [27]	2. [29]	2. [31]
		3. [32]
		4. [33]

Section #6

Radiographic-Ultrasonic Examination

RT Report No: [34]
UT Report No: [35]

Section #7

FILLET WELD TEST RESULTS

Minimum size multiple pass Macroetch	Maximum size single pass Macroetch
1. [36]	1. [39]
2. [37]	2. [40]
3. [38]	3. [41]

Section #8

Test Date [42]
Witnessed by [43]

Son Set Consultants

PO Box 1536
7679 North 140th East Ave.
Owasso, OK 74055
918-633-0740
E-Mail: Rick@weld-procedure.com, WEB: www.weld-procedure.com

Welding Documents

Section #9

WELDING PROCEDURE

Pass No.	Electrode Size	Welding Current		Speed of Travel	Joint Detail
		Amperes	Volts		
[44]	[45]	[46]	[47]	[48]	[49]

Section #10

We, the undersigned, certify that the statements in this record are correct.

Procedure No. [50]

Revision No. [52]

Manufacturer or Contractor [51]

Authorized by [53]

Date [54]