COMPANY NAME: _____

COMPANY ADDRESS: _____

Welding procedure specification for shielded metal arc welding

SPECIFICATION No. : _____

Scope

This Welding Procedure Specification covers welding and related operations of steel structures which are fabricated in accordance with the terms outlined in CSA W47.1 and CSA W59, latest revisions. The attached Data Sheets form an essential part of this specification.

A change in any of the essential variables contained in succeeding paragraphs or detailed on applicable Welding Procedure Data Sheet(s) shall require a new Welding Procedure Specification and/or a new Welding Procedure Data Sheet(s).

Welding procedure

The welding shall be done manually using the SMAW (Shielded Metal Arc Welding) process.

Joints shall be made following the procedural stipulations indicated in CSA W59, and may consist of single or multiple passes in accordance with the accepted Welding Procedure Data Sheets to which this specification refers.

Base metal

The base metal shall conform to the specifications of steel groups 1, 2, 3 as per Table 11.1 or Table 12.1 of CSA W59. Other groups may be welded providing Welding Procedure Data Sheets are accepted by the Canadian Welding Bureau.

Base metal thickness

Base metal thicknesses from __ mm to __ mm (or all thicknesses) inclusive may be welded under this specification providing the respective Welding Procedure Data Sheets have been supplied and accepted for the appropriate weld size.

CWB Acceptance	**Engineer or Supervisor Acceptance**

Filler metal

The filler metal shall be certified by the Canadian Welding Bureau as conforming to CSA W48.

Storage and conditioning of electrodes

Basic electrodes

The storage and conditioning of electrodes shall be as per CSA W59.

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All basic electrodes shall be delivered in hermetically sealed containers that do not show evidence of damage. However, if such containers show evidence of damage, the electrodes shall be reconditioned in accordance with the requirements of CSA W59.

Immediately after being removed from hermetically sealed containers or from reconditioning ovens, electrodes shall be stored in ovens held at a temperature of at least 120 °C (250°F).

Basic electrodes of E49XX classification that are not used within 4 hours after removal from ovens shall be reconditioned in accordance with the requirements of CSA W59.

Basic electrodes shall be redried no more than once.

Electrodes that have been wet shall be discarded.

Other than basic electrodes

All other than basic electrodes shall be stored in warm and dry conditions and kept free from oil, grease, and other deleterious matter once they have been removed from their containers and packages.

Electrodes that have been wet shall be discarded.

Position

The welding shall be done preferably in the flat position, but other positions such as horizontal, vertical, and overhead are permissible providing the proper Data Sheets are supplied and approved.

Preheat

The minimum preheat before welding will comply with Table 5.3 of CSA W59. Minimum preheat to be maintained or exceeded during welding.

If welding is interrupted for some time so that the temperature of the base metal falls below the minimum preheat temperature, then arrangements will be made to preheat again prior to recommencing welding.

The weldment shall be allowed to cool to the ambient temperature, without external quench media being supplied. In other words, do not cool using water or by immediate placement in frigid conditions which will cause a quick temperature change.

Heat treatment and stress relieving

This will not be applicable to structures welded under this specification, unless a specific Data Sheet showing all the parameters is submitted to the Canadian Welding Bureau and acceptance is obtained.

Electrical characteristics

Welding equipment will be used having a drooping voltage characteristic. The welding current specified will be direct current (straight or reverse polarity) or alternating current. The current range will be as per electrode manufacturer’s instructions and will be shown on the Welding Procedure Data Sheet.

Welding technique

The correct amperage and voltage, speed of travel, thickness of layers, number of passes, position, material electrodes, and any special instructions will be as per Data Sheet.

Arc strikes outside of the area of welds should be avoided on any material.

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Preparation of base material

The edges or surfaces of parts to be joined by welding shall be prepared by oxy-acetylene machine cutting. Where hand cutting is involved the edge will be ground to a smooth surface. All surfaces and edges shall be free from fins, tears, cracks, or any other defects that will adversely affect the quality of the weld.

All loose or thick scale, rust, moisture, grease, or other foreign material that would prevent proper welding or produce objectionable fumes shall be removed.

Quality

Cracks or blow holes that appear on the surface of any pass shall be removed before depositing the next covering pass. The procedure and technique shall be such that undercutting of base metal or adjacent passes is minimized. Fillet and butt welds shall meet the desirable or acceptable fillet weld profiles shown in Figure 5.4 of CSA W59. The reinforcement in groove welds shall not exceed 3 mm (1/8 in) and shall have a gradual transition to the plane of the base metal surface. In general, the weld quality will be such as to meet the requirements of Clause 11.5.4/12.5.4 of CSA W59.

Weld metal cleaning

Slag or flux remaining after a pass shall be removed before applying the next covering pass. Prior to painting, etc., all slag shall be removed and the parts shall be free of loose scale, oil, and dirt.

Treatment of underside of welding groove

Prior to depositing weld metal on the underside of a welding groove, the root shall be gouged, or chipped to sound metal, unless otherwise specified on the applicable Data Sheet.

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Annex E (informative)
Impact tests

Note: *This informative Annex has been written in mandatory language to facilitate adoption by anyone wishing to do so.*

E.1 General

The company shall follow the toughness requirements related to welding specified by the contract or the applicable governing code or standard. Where the applicable governing code or standard (e.g., CSA S6, AWS D1.5) requires different testing requirements, the governing code or standard testing requirements shall be followed.

In the absence of toughness requirements specified by contract or by a governing code or standard, the requirements in Annex E may be used to specify the temperature and minimum average energy values required for the filler metal classification or base metal to be used.

The toughness criteria, including the temperature, for the weld metal, base metal, and/or heat-affected zone (HAZ) shall be specified in the welding procedure data sheet (WPDS) or welding procedure specification (WPS).

When required, impact tests shall be included in the WPDS qualification.

E.2 Test specimens

E.2.1 Butt and T-joint test assemblies

The impact test specimens shall be Charpy V-notch (CVN) type and shall conform to Figure 29. When obtainable, standard-size specimens [10 mm (3/8 in) × 10 mm (3/8 in)] shall be used for nominal material thicknesses of 11 mm (7/16 in) or greater.

The location for individual CVN specimens shall be as shown in Figure 30. Two groups of five specimens should be cut out from the test assembly as shown in Figures 22 and 28.

For material from which standard-size specimens cannot be obtained because of the material shape or thickness, the specimens shall be

a) the largest possible sub-standard-size specimens obtainable; or
b) specimens of full material nominal thickness, which may be machined to remove surface irregularities.

The specimens should be cut extra long to allow for exact positioning of the notch. The longitudinal centreline of the specimens shall be transverse to the weld axis, and the base of the notch shall be perpendicular (normal) to the surface of the test assembly.

The specimens shall be etched with a mild etchant, such as 5% Nital, to reveal the location of the weld fusion zone and HAZ.

For the weld metal samples, five specimens shall be prepared with the centreline of the notch located at the centre of the weld. For the HAZ samples, five specimens shall be prepared so that the notch intersects as much of the HAZ as possible (at least 50% of the notch shall be in the HAZ).

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E.2.2 Testing

The impact specimens shall be tested in accordance with ASTM A370 and ASTM E23.

E.2.3 Qualification range

For a successful CVN test, the following qualification ranges shall apply:

a) The minimum base metal thickness qualified shall be the thickness of the test assembly, T, or 16 mm (5/8 in), whichever is less. However, where T is less than or equal to 6 mm (1/4 in), the minimum thickness qualified shall be 0.5T.
b) Qualification on a 3G (up) test assembly shall qualify all groove and fillet positions.
c) Qualification on a 1G or 2G test assembly shall qualify for 1G, 2G, 1F, and 2F positions.
d) Qualification on a 4G test assembly shall qualify for 1G, 4G, 1F, 2F, and 4F positions.

Note: *Where mechanical and soundness are to be qualified, the maximum thickness, diameter, and/or fillet weld size qualified should be as specified in Tables 13, 14, and 15, but should be considered as independent of impact testing requirements.*

E.2.4 Test results

The specimens with the highest and lowest values shall be discarded, and the arithmetic average of the remaining three specimens shall be calculated.

Two of the three values for the specimens shall equal or exceed the specified minimum average value. One of the three may be lower than the specified minimum average value, but not lower than the specified minimum individual value, and the average of the three shall not be less than the minimum specified average value.

The following acceptance criteria shall apply to standard-size specimens:

a) The average of the three specimens shall not be less than 27 J (20 ft•lb).
b) Two of the three values for the specimens shall equal or exceed 27 J (20 ft•lb).
c) One of the three values may be lower than the specified minimum average value, but not lower than the specified minimum individual value of 20 J (15 ft•lb).

In the case of a failure of the test, a retest of three additional specimens shall be made provided there is sufficient material available from the original welded test assembly. The value of each of the three retested specimens shall equal or exceed 27 J (20 ft•lb).

When sub-standard-size specimens are necessary, the test values shall be as shown in Table E.1.

Impact test values for weld metal specimens from electroslag welds should be obtained at –18 °C (0°F).

E.2.5 Essential variables

The essential variables requiring a requalification shall be as specified in Items a) to c), as follows:

a) The essential variables specified in Table E.2 describe the limits of procedure qualification for impact testing. The essential variables specified in Clauses 11.4.2, 11.4.3, and 11.4.4 apply only when mechanical and soundness testing are specified, but should be considered as independent of impact testing requirements.
b) Impact qualification testing performed on any of the following base metals shall qualify any of the other base metals, either welded to itself or to one of the other listed base metals, within the limits of the essential variables in Table E.2:
   i) CSA G40.21 Grade 350 WT;
   ii) CSA G40.21 Grade 350 AT;
   iii) ASTM A709 Grade 50S, 50, 50W;

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iv) ASTM A588*;
v) ASTM A992*; and
vi) ASTM A572 Grade 50*.

* *With supplemental impact properties specified.*

c) All other specifications and grades of material shall be tested and qualified individually.

Table E.1
Impact test values — Standard- and sub-standard-size specimens
(See Clause E.2.4.)

Specimen size, mm (in)	Minimum average absorbed energy, J (ft•lb)
10 × 10 (0.375 x 0.375)	27 (20)
10 × 7.5 (0.375 x 0.30)	20 (15)
10 × 5.0 (0.375 x 0.20)	14 (10)
10 × 2.5 (0.375 x 0.1)	7 (5)

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Table E.2
Essential variables
(See Clause E.2.5.)

Essential variable	SMAW	GMAW	FCAW	MCAW	SAW	GTAW
Filler metal						
A change in the electrode classification or a change to a weld metal or filler metal classification not covered by CSA W48 or AWS A5.X	X	X	X	X	X	X
A change in the flux/wire classification, a change in either the electrode or flux trade name when not classified by an AWS specification, or a change to a crushed slag					X	
A change in the manufacturer or the manufacturer's brand name or type of electrode	X	X	X	X	X	X
Position						
A change in position other than qualified in Clause E.2.3 b), c), and d)	X	X	X	X		X
Maximum preheat/interpass temperature						
An increase of more than 56 °C (100 °F) in the maximum preheat or interpass temperature qualified	X	X	X	X	X	X
Postweld heat treatment						
A change in the postweld heat treatment temperature and/or time ranges	X	X	X	X	X	X
Electrical characteristics						
An increase over that qualified in heat input or volume of weld metal deposited per unit length of weld for vertical welding position (3G)[1)]	X	X	X	X	X	X

(Continued)

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Table E.2 (Concluded)

Essential variable	SMAW	GMAW	FCAW	MCAW	SAW	GTAW
An increase exceeding 10% over that qualified in heat input or volume of weld metal deposited per unit length of weld for flat (1G), horizontal (2G), or overhead (4G) welding positions, but not exceeding the heat input value recorded for vertical welding position 3G, if tested[1)]	X	X	X	X	X	X
Other						
A change from stringer to weave	X	X	X	X	X	X
A change from multi-pass to single pass[2)]	X	X	X	X	X	X
A change exceeding ±20% in the oscillation variable for mechanized or automatic welding		X	X	X	X	X
A change in joint geometry from bevel, V, J, or U groove to butt square, but not vice versa[3)]	X	X	X	X	X	X
A change in welding from both sides to one side but not vice versa (e.g., changing from welding a double V to a single V)	X	X	X	X	X	X
Base metal						
A change in thickness other than qualified in accordance to Clause E.2.3 a)	X	X	X	X	X	X
A change to base material other than qualified by Clause E.2.5 b)	X	X	X	X	X	X
Test temperature						
A change to a lower test temperature but not vice versa	X	X	X	X	X	X

Notes:

1) *The maximum heat input for multi-pass welds (three layer and more) should be calculated as an average heat input recorded for each welding process. When a single welding process is being tested, the maximum heat input shall be calculated as the average heat input recorded of all passes but not including the heat input recorded for root and cap passes. The maximum heat input for one or two layers should be calculated independently. Alternatively, the weld metal deposited per unit length of weld should be used when the HI formula cannot be used. This should be determined by measurements of deposited weld bead sizes and recording of travel speeds.*
2) *Single-pass PJP or CJP qualifies single-pass and multi-pass welds.*
3) *Testing of a butt square joint with a gap does not qualify a butt square joint with zero gap.*

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Annex F (informative)
CSA G40.21 and ASTM steels for Groups A, B, and C

Note: *This Annex is not a mandatory part of this Standard.*

Table F.1
CSA G40.21 and ASTM steels for Groups A, B, and C
(See Clause 11.5.6 and Table 17.)

Group for soundness tests	Group for mechanical tests	CSA steels	ASTM steels
A	1	260W	A 36
		260WT	A 53 Grade B
		300W	A 106 Grades B, C
		300WT	A 131 Grades A, B, CS, D, DS, E, AH32, DH32, EH32
		350W	A 139 Grade B
		350WT	A 283 Grades A, B, C, D
		350A	A 381 Grade Y35
		350AT	A 500 Grades A, B, C
		380W	A 501
		380WT	A 515 Grades 380, 415
			A 516 Grades 55, 60, 65, 70
			A 516 Grades 380, 415, 450, 485
			A 524 Grades I, II
			A 529 Grades 345, 380
			A 537 Class 1
			A 572 Grades 42, 50
			A 573 Grade 58
			A 588 Grades A, B, C, K
			A 595 Grades A, B, C
			A 606
			A 618 Grades Ib, II, III
			A 633 Grades A, C, D, E
			A 709 Grades 36, 50, 50S, 50W
			A 710 Grade A Class 2 > 50 mm (2 in)

(Continued)

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Table F.1 (Continued)

Group for soundness tests	Group for mechanical tests	CSA steels	ASTM steels
			A 808 (t < 65 mm) A 847 A 913 Grade 50 A 992 A 1008 Grades 30, 33 Type 1, 40 Type 1 A 1008 HSLAS Grade 45 Classes 1 & 2, Grade 50 Classes 1 & 2, Grade 55 Classes 1 & 2 A 1008 HSLAS-F Grade 50 A 1011 SS Grades 30, 33, 50, 55 A 1011M SS Grades 205, 230, 340, 380 A 1011 HSLAS Grade 45 Classes 1 & 2 A 1011 HSLAS Grade 50 Classes 1 & 2 A 1011 HSLAS Grade 55 Classes 1 & 2 A 1011 HSLAS-F Grade 50 A 1011 Grades 30, 33, 36, 40, 45, 50 A 1018 HSLAS Grade 45 Classes 1 & 2 A 1018 HSLAS Grade 50 Classes 1 & 2 A 1018 HSLAS Grade 55 Classes 1 & 2 A 1018 HSLAS Grade 60 Class 2 A 1018 HSLAS-F Grades 50, 60 Class 2 A 1018 SS Grades 30, 33, 36, 40
B	2	400W 400WT 480W 480WT 700Q 700QT	A 514 Grades B, C, J, K, S, T A 572 Grades 60, 65 A 1011 Grades 60, 65, 70, 80
	3	400A 400AT 480A 480AT	A 514 Grades A, E, F, H, M, P, Q, R A 517M A 710 Grade A A 913 Grades 60, 65

(Continued)

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Table F.1 (Concluded)

Group for soundness tests	Group for mechanical tests	CSA steels	ASTM steels
B	4		A 182, A 217, A 335, A 369, A 387, A 389, A 426, A 542, A 543, A 946, A 1017, A 1041
	5		A 203, A 225, A 353, A 533, A 543, A 553, A 645, A 690, A 710, A 736, A 844, A 890, A 946, A 968
	6		A 268
	7		A 217, A 268, A 565, A 815, A 1010, A 1021, A 1053
C	8		A 167, A 213, A 240, A 249, A 276, A 312, A 351, A 376, A 403, A 409, A 430, A 451, A 452, A 473, A 479, A 511, A 554, A 666, A 743, A 744, A 774, A 778, A 813, A 814, A 831, A 851

Notes:

1) *This Table is provided for convenience only. Users should check that the material composition is correct for the applicable required grouping (see Table 17).*
2) *The placement of steels in Groups A1, B2, and B3 is based on published minimum specified values for tensile and yield strengths and chemical analysis based on heat analysis.*

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