DE HAVILLAND AIRCRAFT OF CANADA LIMITED

BOMBARDIER
Toronto Site

PPS 37.06 - TESTING AND CERTIFICATION OF AIRCRAFT FUSION WELDERS

Issue 32 - This Production Process Standard (PPS) supersedes PPS 37.06, Issue 31.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to christie.chung@dehavilland.com.
- This PPS is effective as of the distribution date.

THIS PPS IS CO-OWNED BY DE HAVILLAND AIRCRAFT OF CANADA LIMITED AND BOMBARDIER INC.

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Signed original on file. Validation of paper prints is the responsibility of the user.

Issue 32 - Summary of Changes (over the previous issue)

The following summaries are not detailed and are intended only to assist in alerting PPS users to changes which may affect them; refer to the applicable sections of this PPS for detailed procedure and requirements.

- Specified this is a jointly owned PPS by both De Havilland Aircraft of Canada Limited and Bombardier Inc.
- Specified that aircraft welders certified according to BAERD GEN-010 is considered certified to this PPS for Lear 45 program only.
- Specified for DASH 8 program, laboratories should be accredited according to DAGER-006.
- Added additional requirements regarding certification (see paragraph 5.1.3, paragraph 5.1.4.1, paragraph 5.1.4.2).
- Deleted allowance of using BCAR A8-10 as equivalent test joints to LAB 057 or LAB 058.
- Removed tube requirement from base metal form when certifying welders (see item e in paragraph 5.1.8).
- Where a welder is being certified to weld “non-standard” parts, added the requirement that all modification must be subject to the approval of the Welding Specialist.
- Revised maximum limit for visual examination defect limits for butt weld mis-match defect from 0.15T to 0.15" + 10% T or 0.040" maximum, whichever is less. See Table IV.
- Specified the base metal thickness of weld test specimens is controlled by lab drawings LAB 057 (butt welds) and LAB 058 (fillet welds) for all facilities and not just DHC/BA site.
- Revised Base Metal Thickness (section 5.4.3) section as follows: For both butt welds and fillet welds, an acceptable test weld in a base metal of thickness “T” (sheet wall thickness) certifies welders to weld the base metal in the thicknesses range of 0.67T to 4T. Where the base metal thickness (T) for an acceptable test weld is greater than 1 inch, certify welder to weld material in the thicknesses range 0.67T to unlimited.
- Added additional requirements for tensile testing (see paragraph 6.4.3 and paragraph 6.4.4).
- Specified the value in Table VII for the acceptance limits for metallographic examination for incomplete root penetration applies to aluminum alloys only. For all other materials, complete fusion to the root of the weld is required.
- Revised Safety Precautions section.

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1 SCOPE

1.1 This Production Process Standard (PPS) specifies the procedure and requirements for the practical testing toward certification of welders engaged in the fusion welding of aircraft parts, assemblies and engine material.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.1.3 For Lear 45 program only, aircraft welders certified according to BAERD GEN-010 may be considered certified to this PPS.

1.2 This PPS is co-owned by De Havilland Aircraft of Canada Limited (DHC) and Bombardier Inc. (BA) due to its applicability for both the DHC DASH 8 and BA Lear 45 programs. Frozen revisions of Bombardier documents (e.g., BAPS, BAERD GEN, BAMS, etc.) specified herein apply only to the DASH 8 program.

2 HAZARDOUS MATERIALS

2.1 Before receipt at DHC or BA, all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the DHC/BA Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact DHC/BA Environment, Health and Safety Department.

3 REFERENCES

3.1 AMS 2694 - Fusion Welding - Weld Repair of Casting.

3.2 ASTM E8 - Standard Test Methods for Tension Testing of Metallic Materials.

3.3 BAERD GEN-010 - Qualification of Aircraft Fusion Welders.

3.4 BAERD GEN-018 - Engineering Requirements for Laboratories.

3.5 DAGER-006 - Engineering Requirements for Laboratories.

3.6 DHC Laboratory Drawings - LAB 057 and LAB 058.

3.7 BCAR A8-10 - Approval of Welders, British Civil Airworthiness Requirements (BCAR), Sub-Section A8, Chapter A8-10.

3.8 PPS 13.26 - General Subcontractor Provisions.

3.9 PPS 13.39 - DASH 8 & Lear 45 Critical and Special Processes PPS Index.

3.10 PPS 20.10 - Radiographic Inspection.

3.11 PPS 30.01 - Heat Treatment of Aluminum and Aluminum Alloys.

3.12 PPS 30.04 - Steel Heat Treatment - Carbon and Low Alloy Steels.

3.13 PPS 30.06 - Heat Treatment of Precipitation Hardenable (PH) Stainless Steels.

3.14 PPS 30.08 - Heat Treatment of Martensitic Stainless Steels.

3.15 PPS 30.10 - Heat Treatment of Austenitic (Strain Hardenable) Stainless Steel.

3.16 PPS 30.13 - Heat Treatment of Nickel and Nickel Alloys.

3.17 PPS 30.14 - Heat Treatment of Titanium and Titanium Alloys.

3.18 PPS 37.03 - Fusion Welding of Aluminum and Aluminum Alloys.

3.19 PPS 37.04 - Fusion Welding of Ferrous and Nickel Alloys.

3.20 PPS 37.05 - Fusion Welding of Titanium.

3.21 PPS 37.09 - Special Welding Procedure.

3.22 PPS 37.10 - Requirements for Fusion Welds.

4 MATERIALS, EQUIPMENT AND FACILITIES

4.1 Materials

4.1.1 Weld test detail parts must meet the requirements of LAB 057 or LAB 058. Base metals and alloys are divided into 10 groups according to base metal composition, as listed in Table I. Weld test materials must be ordered, stored and made available for practising and testing according to in-house or subcontract procedures which ensure traceability and control.

4.2 Equipment

4.2.1 Equipment employed in the welding processes. Refer to Figure 1 for a listing of fusion welding processes.

4.3 Facilities

4.3.1 Facilities performing fusion welding of aluminum, ferrous, nickel or titanium alloys must meet the facility requirements specified in PPS 37.03, PPS 37.04, PPS 37.05 or PPS 37.09, as applicable.

4.3.2 This PPS has been categorized as a Controlled Special Process according to PPS 13.39 and as such only facilities specifically approved according to PPS 13.39 are authorized to perform testing and certification of aircraft fusion welders according to this PPS.

4.3.3 Subcontractors must direct requests for approval to DHC or BA Quality.

4.3.4 All testing and evaluation specified herein must only be performed by DHC/BA Toronto Materials Laboratory or by laboratories accredited according to DAGER-006 (DASH 8) or BAERD GEN-018 (Lear 45), as applicable.

5 PROCEDURE

5.1 General

5.1.1 Fusion welding is defined as a process by which metals are bonded together by bringing the metals to the molten state at the surfaces to be joined, with or without the addition of filler metal, without the application of mechanical pressure.

5.1.2 To be certified or re-certified, fusion welders must produce certification weld test assemblies which meet the requirements of this standard **after** the training requirements specified in PPS 37.03, PPS 37.04, PPS 37.05 or PPS 37.09, as applicable, have been met.

5.1.3 Consider welders certified in any base metal group only after successful completion of the above training requirements and successful completion of the 4 weld test joints representing fillet and butt welds in the thinnest and thickest sections of the applicable base metal encountered in production.

5.1.4 One weld test consists of welding 2 sets of detail parts and submitting the better test assembly for examination according to section 6. Practice assemblies may be welded before attempting the weld test. Deform and scrap all weld test assemblies made for practice and also the weld test assembly that is not chosen for examination.

5.1.4.1 Before attempting initial certification tests only, personnel who have never been certified to fusion weld according to PPS 37.03, PPS 37.04, PPS 37.05 or PPS 37.09, as applicable, must be subject to a training period of not more than 2 weeks (80 hours), as conducted by the Welding Specialist or other qualified instructor.

5.1.4.2 Before initial certification only, certified personnel attempting certification in a different base metal group may be subject to a training period of not more than 3 days (24 hours), if necessary, as conducted by the Welding Specialist or other qualified instructor.

5.1.4.2.1 The Welding Specialist must maintain a sufficient quantity of detail parts, similar to those required for test joints and stored in a secure area, for personnel to weld during training periods.

5.1.5 Welders may be certified in any combination of the conditions specified in paragraph 5.1.8. A separate certification (and acceptable weld test) is required for each combination of welding conditions. For each combination in which certified, the welder must be issued an approval code, specifying the conditions listed in paragraph 5.1.8. Refer to Figure 1 for a breakdown of the approval code.

5.1.6 Except for instances where a welder is being certified to weld “non-standard” parts, LAB 057 or LAB 058 test joints must be used in the weld test. Refer to Figure 2 for a general description of standard weld test joints.

5.1.7 In instances where a welder is being certified to weld “non-standard” parts (e.g., repair welding of castings, welding of tubing to castings, etc.), the test joint design must be modified to better reflect the parts in question. Except as noted below, approval to weld “non-standard” parts is given for a specific part number only. Successful welding of a Weld Capability Test Slab as specified in AMS 2694 will certify the welder for all repair welding of castings. Modification must be subject to the approval of the Welding Specialist.

5.1.8 Set-up and conduct weld tests to certify welders based on the following variable welding conditions:

(a) Welding Process (see section 5.4.1)
(b) Base Metal Composition (see section 5.4.2)
(c) Base Metal Thickness (see section 5.4.3)
(d) Welding Position (see section 5.4.5)
(e) Base Metal Form: Sheet (see section 5.4.4)
(f) Type of Weld: Butt or Fillet (see section 5.4.4)
(g) Additional Welding Conditions (see section 5.4.6)

5.1.8.1 If applicable, the welding conditions specified must be representative of those involved during production welding.

5.1.8.2 Certification as a welder must be based on all of the conditions specified in paragraph 5.1.8.

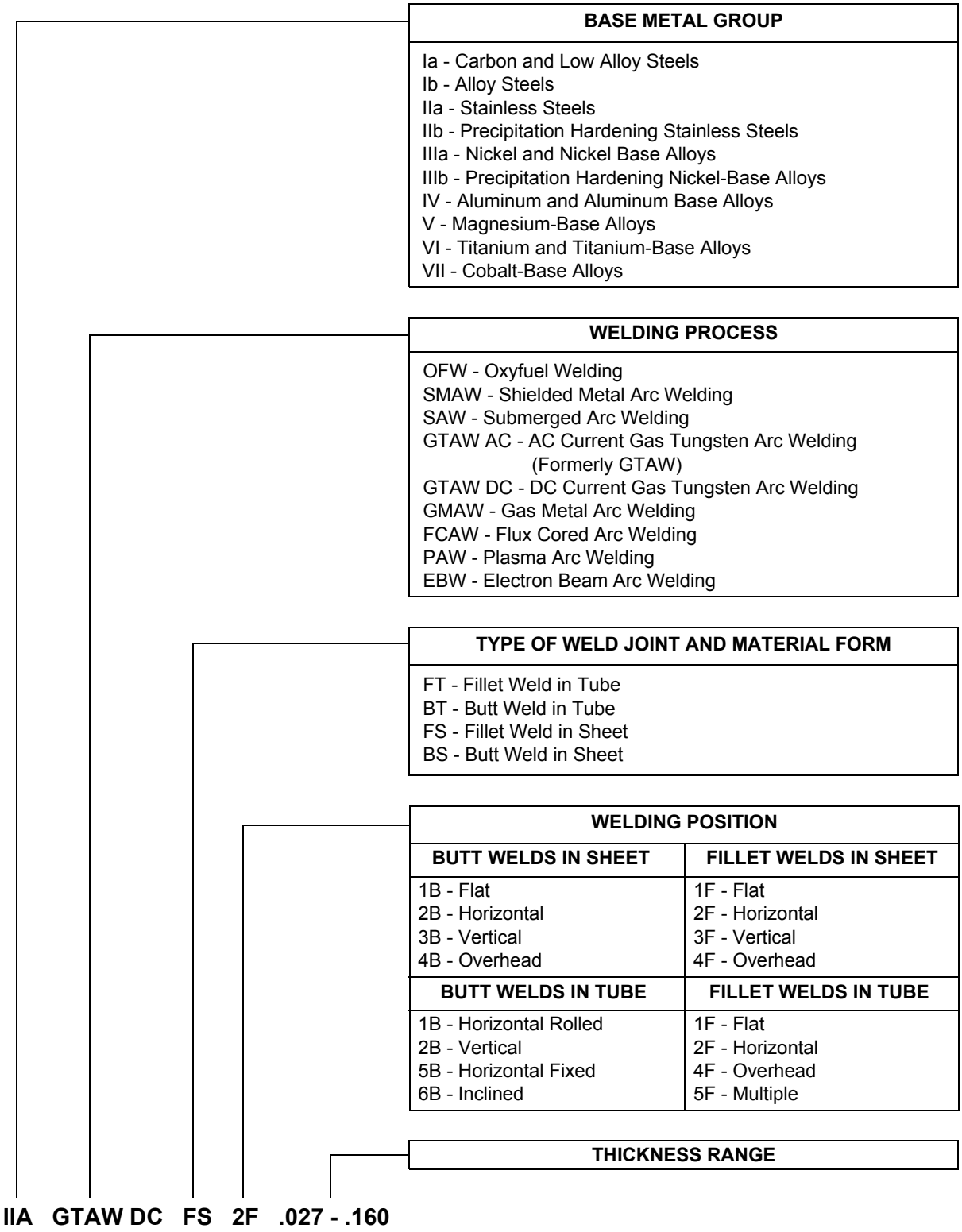


FIGURE 1 - BREAKDOWN OF APPROVAL CODE

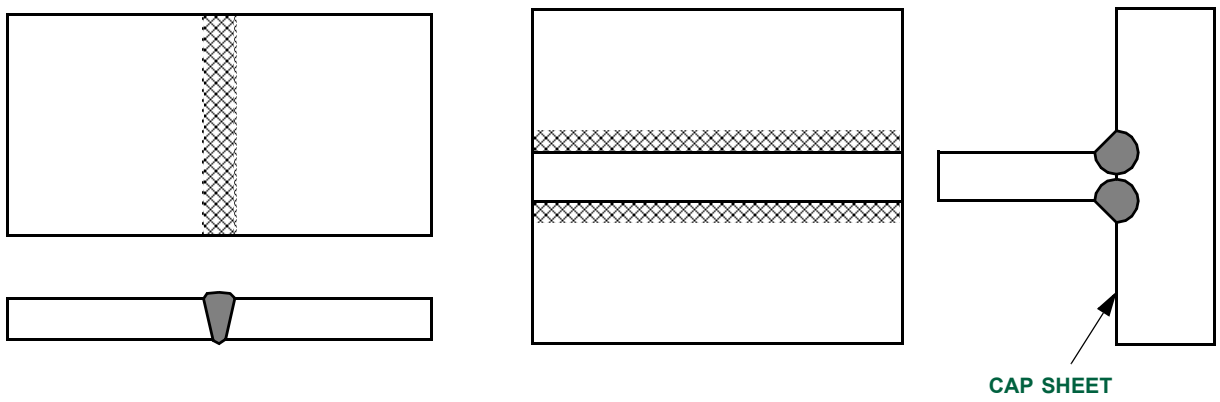


FIGURE 2 - GENERAL DESCRIPTION OF WELD TEST JOINTS

5.2 Welding Terminology

5.2.1 Refer to PPS 37.10 for illustrations of welding terminology.

5.3 Weld Test Joints

5.3.1 Detail parts for butt weld test joints must be according to LAB 057 and those for fillet weld test joints must be according to LAB 058.

5.3.2 Do not hammer or roll welded test joints or work them in any way which would remove material from the joints.

5.4 Weld Test Conditions

5.4.1 Welding Process

5.4.1.1 An acceptable weld test joint made using a given welding process certifies the trainee to weld using that welding process only. Refer to Figure 1 for a listing of fusion welding processes.

5.4.2 Base Metal

5.4.2.1 Except as noted in paragraph 5.4.2.1.1, an acceptable test weld performed on an alloy included in one of the 10 base metal groups listed in Table I certifies the welder for that base metal group only.

5.4.2.1.1 Certification to weld in a base metal group with a “b” designator also certifies the welder to weld any alloy in the base metal group with the same number and an “a” designator (see Table I).

TABLE I - SPECIFIC ALLOYS OF BASE METAL GROUPS

GROUP	GENERAL DESCRIPTION OF BASE METAL	SPECIFIC ALLOYS IN BASE METAL GROUP
Ia	Carbon and Low Alloy Steels	1005, 1008, 1010, 1012, 1015, 1018, 1020, 1025, 1118, 1315, 1320, 1322, 4015, 4020, 4120, 8620, AMS 6418 (Hy-Tuf)
Ib (Note 1)	Alloy Steels	1137, 4130, 4135, 4335, 4340, 4340V, 8635, 8640, 8735, 8740
IIa	Stainless Steels	201, 202, 301, 302, 304, 310, 316, 321, 347, 348, 17-4 PH, 410, 420, 21-6-9, 19-9 DL, 19-9 DX, Custom 455, 15-5 PH
IIb (Note 1)	Precipitation Hardening Stainless Steels	A286, 17-7 PH, PH 13-8 Mo, PH 15-7
IIIa	Nickel and Nickel-Base Alloys	Nickel 200 and 201, Monel 400, Hasteloy X, G, C4, G2, B, C, B2, N and 276, Inconel 600 and 625, Carpenter Cb3, Haynes 20 Mod, Incoloy 800, 800H and 825
IIIb (Note 1)	Precipitation Hardening Nickel-Base Alloys	Monel K500, Udimet 700, Incoloy 901, Rene 41, 77 and 80, Inconel 601, 718, X750 and 706
IV	Aluminum and Aluminum-Base Alloys	356, 1060, 1100, 2014, 2219, 3003, 3004, 5052, 5083, 5086, 5154, 5254, 5454, 5456, 5652, 6061, 6063
V	Magnesium-Base Alloys	AZ80, AZ61, M1, AZ31
VI	Titanium and Titanium-Base Alloys	Ti-5Al-2.5Sn, Commercially Pure Titanium
VII	Cobalt-Base Alloys	Stellite 6, 21, 23, 27, 30 and 31, HS188, L605, S816

Note 1. Certification in a base metal group with a “b” designator certifies the welder in the base metal group with the same number and an “a” designator.
Note 2. Perform welding operations according to the PPS specified herein.

5.4.2.2 Except for 5052-O (AMS4015 or QQ-A-250/8), if a specific alloy from a base metal group is specified by LAB 057 or LAB 058, then the test welds for that base metal group must be performed using the specified alloy. In place of 5052-O (AMS4015 or QQ-A-250/8), it is acceptable to substitute 6061-O (AMS4025 or QQ-A-250/11).

5.4.3 Base Metal Thickness

5.4.3.1 Except as specified in paragraph 5.4.3.2, for both butt welds and fillet welds, an acceptable test weld in a base metal of thickness “T” (sheet wall thickness) certifies welders to weld the base metal in the thicknesses range of 0.67T to 4T.

5.4.3.2 Where the base metal thickness (T) for an acceptable test weld is greater than 1 inch, certify welder to weld material in the thicknesses range 0.67T to unlimited.

5.4.3.3 For fillet test welds, the cap sheet (see Figure 2) may be no more than twice as thick as the other member (i.e., 2T maximum).

5.4.3.4 The base metal thickness of weld test specimens is controlled by lab drawings LAB 057 (butt welds) and LAB 058 (fillet welds).

5.4.4 Base Metal Form and Weld Type

5.4.4.1 Except as noted in paragraph 5.4.4.1.1, an acceptable test weld of a particular type (butt or fillet) in a particular form (tube or sheet), as indicated in Table II, certifies welders to weld the corresponding types and forms specified in the Table.

5.4.4.1.1 An acceptable butt test weld does not certify welders to perform fillet welds in base metals less than or equal to 0.063" (1.6 mm) thick. Certification to perform fillet welds in this thickness range requires an acceptable fillet test weld.

5.4.5 Welding Position

5.4.5.1 The completion of an acceptable test weld using a particular welding position, as indicated in Table II, certifies welders to weld in the corresponding welding positions specified in the table. Welding positions are shown in Figure 3 through Figure 6.

TABLE II - POSITIONS, METAL FORM & WELD TYPE CERTIFIED BY SPECIFIC TEST WELD

TEST WELD			BASE METAL-FORM, WELD TYPE AND POSITION CERTIFIED															
BASE METAL-FORM	WELD TYPE	WELDING POSITION	SHEET								TUBE							
			BUTT				FILLET (Note 1)				BUTT (Note 2)				FILLET (Note 1)			
			1B	2B	3B	4B	1F	2F	3F	4F	1B	2B	5B	6B	1F	2F	4F	5F
SHEET	BUTT	1B	X				X	X			X				X			
		2B	X	X			X	X			X	X			X			
		3B	X		X		X	X	X		X				X			
		4B	X			X	X	X		X	X				X			
SHEET	FILLET	1F					X								X			
		2F					X	X							X	X		
		3F					X	X	X						X			
		4F					X	X		X					X	X	X	
TUBE	BUTT	1B	X				X	X			X				X	X		
		2B	X	X			X	X			X	X			X	X		
		5B	X		X	X	X		X	X	X		X		X		X	X
		6B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TUBE	FILLET	1F					X								X			
		2F					X	X							X	X		
		4F					X	X		X					X	X	X	
		5F					X	X	X	X					X	X	X	X

Note 1. Butt test weld does not certify a welder to perform fillet welds in base material with thickness less than or equal to 0.063" (1.6 mm).
Note 2. A sheet test weld qualifies for tube welds 1 inch (25.4 mm) in O.D. or greater.
Note 3. 'X' denotes base metal form, weld type, and welding position certified by the corresponding test weld.

5.4.6 Additional Welding Conditions

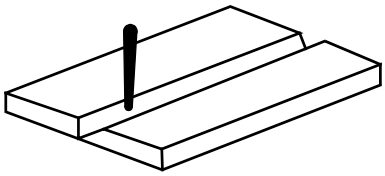
5.4.6.1 Other conditions requiring acceptable test welds for certification are as follows:

5.4.6.1.1 An acceptable test weld without backing certifies a welder to weld with or without backing, but the reverse does not apply.

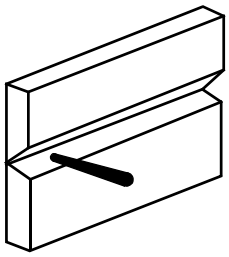
5.4.6.1.2 An acceptable single welded butt test weld certifies a welder to weld single and double butt welds, but the reverse does not apply.

5.4.6.1.3 An acceptable complete penetration butt test weld certifies a welder to weld complete and partial penetration butt welds, but the reverse does not apply.

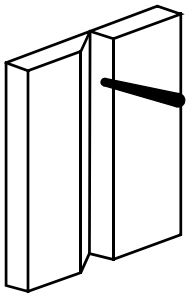
5.4.6.1.4 For the GTAW (TIG) process only, separate weld tests are required to certify welders to perform AC current and DC current welding.



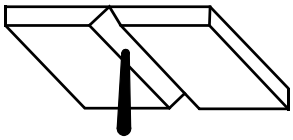
1B FLAT: Welding is from upper side of joint and sheet is horizontal.



2B HORIZONTAL: Axis of the weld is horizontal and sheet is in vertical plane.

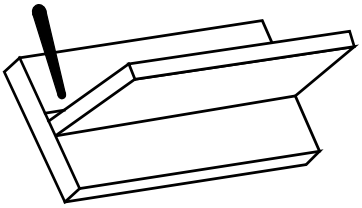


3B VERTICAL: Axis of weld is vertical.

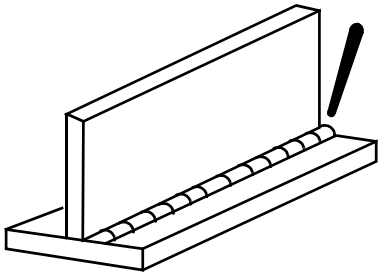


4B OVERHEAD: Welding is from underside of joint.

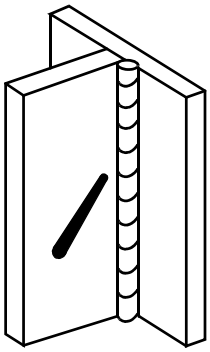
FIGURE 3 - WELDING POSITIONS FOR BUTT WELDS IN SHEET



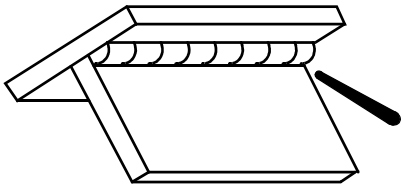
1F FLAT: Welding is from upper side of joint and weld face is horizontal.



2F HORIZONTAL: Welding is on upper side of horizontal surface against vertical surface.

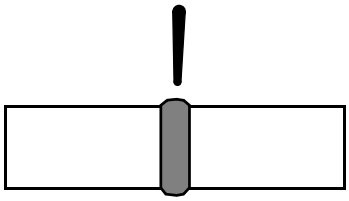


3F VERTICAL: Axis of weld is vertical.

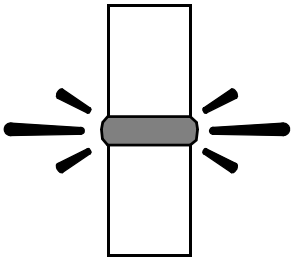


4F OVERHEAD: Welding is from underside of joint.

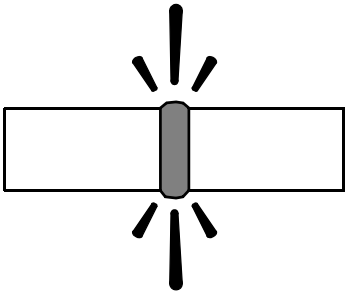
FIGURE 4 - WELDING POSITIONS FOR FILLET WELDS IN SHEET



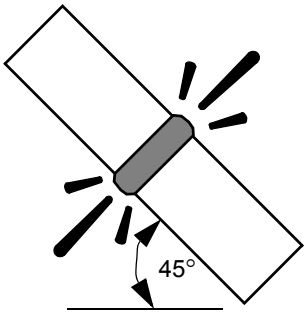
1B HORIZONTAL ROLLED: Axis of tube is horizontal and welding is performed in flat position by rolling the tube.



2B VERTICAL: Axis of tube is vertical and tube is not rotated during welding.

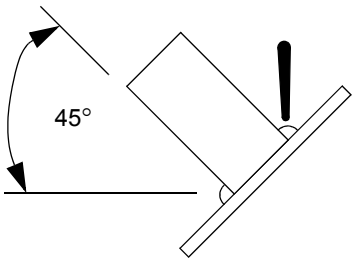


5B HORIZONTAL FIXED: Axis of tube is horizontal and tube is not rotated during welding.

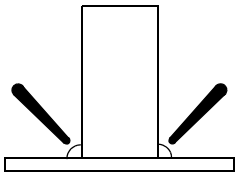


6B INCLINED: Axis of tube is at a 45° angle to the horizonta and tube is not rotated during welding.

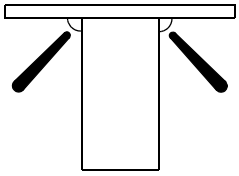
FIGURE 5 - WELDING POSITIONS FOR BUTT WELDS IN TUBES



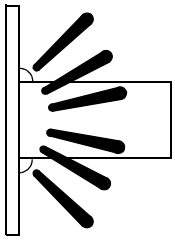
1F FLAT: **Welding is from upper side of joint and tube is rotated during welding.**



2F HORIZONTAL: **Welding is on upper side of horizonta surface against vertical surface and tube is not rotated during welding.**



4F OVERHEAD: **Welding is performed from the underside of joint and tube is not rotated during welding.**



5F MULTIPLE: **Axis of tube is horizontal and tube is not rotated during welding.**

FIGURE 6 - WELDING POSITIONS FOR FILLET WELDS IN TUBES

6 REQUIREMENTS

6.1 General

6.1.1 Welders must meet the vision requirements specified in paragraph 8.3.

6.1.2 Welding of weld test joints must be witnessed by an impartial observer.

6.1.3 If the weld test joints fail to meet any of the requirements specified in this section, the welder must be considered to have failed the weld test. In the event of failure of the weld test, the welder must undergo training and/or performance evaluation before re-testing.

6.1.4 In instances where a welder is being certified to weld “non-standard” parts, the welder’s records must specify the specific part number and appropriate wall thickness range the welder is approved to weld.

6.1.5 Certified welders may weld all joints within the limitations of their certifications as specified herein, by manual and semi-automatic processes.

6.1.6 Deform and scrap unexamined weld test assemblies (e.g., practice assemblies).

6.2 Visual Examination

6.2.1 Visually examine the submitted test weld in the as-welded condition at 3X - 10X magnification. Test welds must be free from cracks, overlap and underfill and other defects must be within the limits specified in Table III and Table IV.

6.2.2 If it is difficult to determine whether or not a defect is within acceptable limits through visual examination, verify the measurements during metallographic examination.

TABLE III - MAXIMUM ALLOWABLE WELD REINFORCEMENT IN BUTT WELDS

BASE METAL THICKNESS (T)	MAXIMUM ALLOWABLE REINFORCEMENT			
	WELD FACE		WELD ROOT	
	BASE METAL GROUP	LIMIT AT ANY LOCATION	BASE METAL GROUP	LIMIT AT ANY LOCATION
0.063" (1.6 mm) and under	All	T + 0.020" (0.5 mm) or 0.050" (1.3 mm), whichever is less	IV and V	T + 0.030" (0.8 mm) or 0.070" (1.8 mm), whichever is less
			Ia, Ib, IIa, IIb, IIIa, IIIb, VI, and VII	T + 0.020" (0.5 mm) or 0.050" (1.3 mm), whichever is less
over 0.063" (1.6 mm)	All	0.8T or 0.25" (6.4 mm), whichever is less	IV and V	T or 0.25" (6.4 mm), whichever is less
			Ia, Ib, IIa, IIb, IIIa, IIIb, VI, and VII	0.8T or 0.25" (6.4 mm), whichever is less

TABLE IV - VISUAL EXAMINATION DEFECT LIMITS

DEFECT		MAXIMUM LIMIT
Undercut		0.05T (Note 1)
Mis-match (Butt Welds Only)		0.15" + 10% T or 0.040" maximum, whichever is less (Note 1)
Warping		5°
Melt Through (Fillet Welds Only) (Note 2)	> T	None Allowed
	Between 0.25T and T	1/2" (12.7 mm) per 3" (76.2 mm)
	< 0.25T	Allowed
Suck Back (Fillet Welds Only) (Note 2)	> 0.1T	None Allowed
	< 0.1T	1/2" (12.7 mm) per 3" (76.2 mm)

Note 1. "T" refers to the thickness of test weld members. If the members of the test weld differ in thickness, "T" is the thickness of the thinner member.
Note 2. If the depth of melt through or suck back is in question, verify it during metallographic examination.

6.3 Radiographic Examination

6.3.1 Perform radiographic inspection according to PPS 20.10.

6.3.2 A linear indication is defined as one with a maximum dimension more than 3 times its minimum dimension. Refer to Table V for the acceptability of linear indications.

TABLE V - MAXIMUM ALLOWABLE LINEAR AND NON-LINEAR INDICATIONS (RADIOGRAPHIC EXAMINATION)

INDICATIONS (Note 1)	**BASE METAL THICKNESS (T)** (Note 2)	**MAXIMUM INDICATION LENGTH (INCHES)**
Length of any indication (linear or non-linear)	0.063" (1.6 mm) or less	2T
	greater than 0.063" (1.6 mm)	T or 0.38" (9.7 mm), whichever is less
Accumulated length of linear and non-linear indications in any 1" (25.4 mm) length of weld	0.063" (1.6 mm) or less	2T
	greater than 0.063" (1.6 mm)	T or 0.38" (9.7 mm), whichever is less
Average length of all indications (linear and non-linear)	0.063" (1.6 mm) or less	2T
	greater than 0.063" (1.6 mm)	0.5T or 0.18" (4.6 mm), whichever is less

Note 1. For non-linear indications, estimate an equivalent average circle combining its major and minor dimensions and then use the estimated diameter and area of that circle to determine the acceptability of the indication.
Note 2. Use the thickness (T) of the thicker member when thicknesses of test weld members differ.

6.3.3 Consider indications where the maximum dimension is **less** than 3 times its minimum dimension as non-linear indications. For non-linear indications, estimate an equivalent average circle combining its major and minor dimensions and then use the estimated diameter and area of that circle to determine the acceptability of the indication as specified in Table V.

6.3.4 In test welds with a base metal thickness of 0.063" (1.6 mm) or less, disregard indications with a major dimension of less than 0.002" (0.05 mm). In test welds with a base metal thickness of more than 0.063" (1.6 mm), disregard indications with a major dimension of less than 0.005" (0.13 mm) or 0.02T, whichever is greater.

6.3.5 Test welds with any of the following indications are unacceptable:

- Cracks.
- Incomplete joint penetration and other linear indications exceeding the limits specified in Table V.
- Porosity exceeding the limits specified in Table VI (treat tungsten inclusions as porosity).

TABLE VI - MAXIMUM ALLOWABLE POROSITY (RADIOGRAPHIC EXAMINATION)

POROSITY	BASE METAL THICKNESS (T) (NOTE 1)	MAXIMUM ACCEPTABLE POROSITY (SIZE, AREA, OR AMOUNT)
Any pore	0.063" (1.6 mm) or less	0.6T
	greater than 0.063" (1.6 mm)	0.4T or 0.18" (4.6 mm), whichever is less
Pores larger than 0.3T	0.063" (1.6 mm) or less	8 pores in any 4" (101.6 mm) length of weld
	greater than 0.063" (1.6 mm)	not applicable
Pores larger than 0.2T or larger than 0.12" (3.0 mm), whichever is less	0.063" (1.6 mm) or less	not applicable
	greater than 0.063" (1.6 mm)	12 pores in any 6" (152.4 mm) length of weld
Total porosity area	0.063" (1.6 mm) or less	0.10T inch^2 (2.5T mm^2) in any 4" (101.6 mm) length of weld
	greater than 0.063" (1.6 mm)	0.10T inch^2 (2.5T mm^2) in any 6" (152.4 mm) length of weld
Cluster porosity area in any 1/2" (12.7 mm) length of weld	0.063" (1.6 mm) or less	0.04T inch^2 (1.0T mm^2)
	greater than 0.063" (1.6 mm)	0.025T inch^2 (0.63T mm^2)
Aligned porosity area - defined as the combined area of a group of 3 or more pores within a 1/2" (12.7 mm) length of weld that can be intersected by a straight line	0.063" (1.6 mm) or less	0.02T inch^2 (0.5T mm^2)
	greater than 0.063" (1.6 mm)	0.015T inch^2 (0.38T mm^2)
Note 1. Use the thickness (T) of the thicker member when thickness of test weld members differs.		

6.4 Tensile Testing

6.4.1 Perform tensile testing according to ASTM E8 on all butt welds and on fillet welds if the nominal thickness of the thinnest member is 0.125" (3.2 mm) or greater.

6.4.2 Tensile test specimens must conform to the dimensions specified on LAB 057 or LAB 058, as applicable.

6.4.3 Ultimate tensile strengths for weld test joints that are heat treated subsequent to welding must be as specified in PPS 30.01, PPS 30.04, PPS 30.06, PPS 30.08, PPS 30.10, PPS 30.13 and PPS 30.14, as applicable.

6.4.4 Ultimate tensile strengths for material tested in the as-welded condition must be the same as for the base metal in the annealed condition specified in PPS 30.01, PPS 30.04, PPS 30.06, PPS 30.08, PPS 30.10, PPS 30.13 and PPS 30.14, as applicable.

6.4.5 Consider the weld satisfactory when failure occurs in the base metal, weld metal or heat affected zone (HAZ) at greater than 85% of the minimum ultimate tensile strength of the base metal, as specified in the applicable material specification.

6.5 Metallographic Examination

6.5.1 From the test weld, prepare 2 cross section samples for metallographic examination. If radiographic examination according to section 6.3 has indicated a suspect area in the test weld, cut the cross section samples from 2 separate locations in the suspect area. If no suspect area was determined, cut the cross section samples from 2 separate locations at the same distance from each end of the test weld. Etch and examine sections at 10 - 20X magnification.

6.5.2 In test welds with a base metal thickness of 0.063" (1.6 mm) and less, disregard defects with a major dimension of less than 0.002" (0.05 mm). In test welds with a base metal thickness of more than 0.063" (1.6 mm), disregard defects with a major dimension of less than 0.005" (0.13 mm) or 0.02T, whichever is greater.

6.5.3 Welds which do not meet the limits of Table VII are unacceptable.

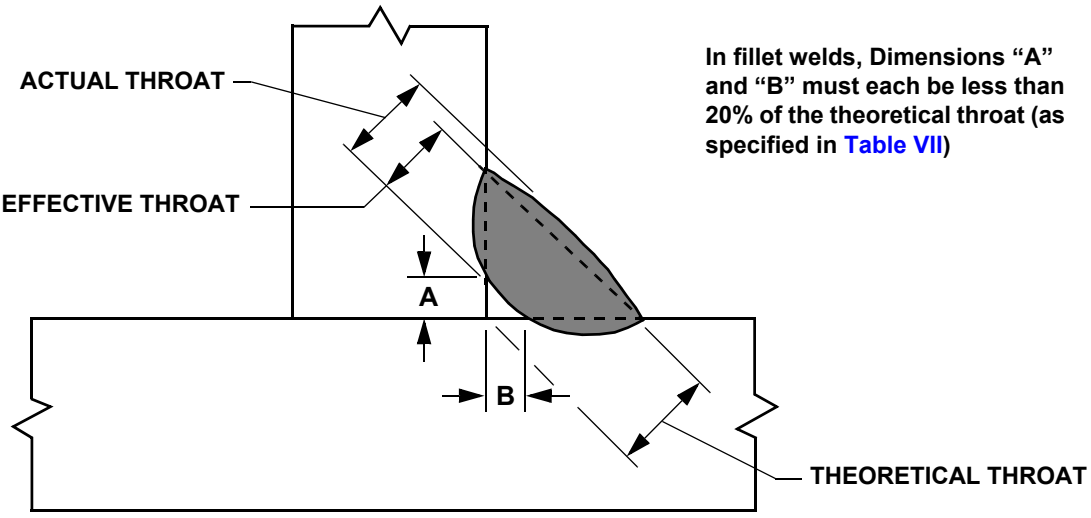


FIGURE 7 - FILLET WELD WITH INCOMPLETE PENETRATION TO THE ROOT

TABLE VII - ACCEPTANCE LIMITS (METALLOGRAPHIC EXAMINATION)

WELD CHARACTERISTIC	ACCEPTANCE LIMIT FOR BASE METAL THICKNESS (T) (Note 1)	
	0.063" (1.6 mm) OR LESS	**OVER 0.063" (1.6 mm)**
Leg size (Fillet welds only)	Maximum 6T or T + 0.18" (4.6 mm), whichever is less	Maximum 3T or T + 0.25" (6.4 mm), whichever is less
Leg size ratio (Fillet welds only)	The ratio of leg of larger size to leg of smaller size must be less than 1.5 at any cross section	
Undercut	0.05T maximum	
Porosity	Maximum acceptable pore size is 0.6T	Maximum acceptable pore size is 0.4T or 0.18" (4.6 mm), whichever is less
Actual Throat (Fillet welds only)	0.75T minimum	
Depth of Fusion (Fillet welds only)	0.10T minimum (Note 2)	
Linear Defects (Note 3)	Maximum of 0.30 times the actual throat or 0.12" (3.0 mm), whichever is less	
Incomplete Root Penetration (Fillet welds only) (Note 4)	Dimensions “A” and “B” as shown in Figure 7 must be less than 20% of the theoretical throat (Note 5)	Complete fusion to the root of the weld is required
Melt Through (Fillet Welds Only)	(Note 6)	
Suck Back (Fillet Welds Only)	(Note 6)	
Cracks	Not Allowed	

Note 1. If the members of the test weld differ in thickness, “T” is the thickness of the thinner member.
Note 2. This minimum depth of fusion must be maintained along the entire length of the weld leg (excluding the “ramp-up” at the start of the weld and the “ramp-down” at the end of the weld).
Note 3. A linear defect is defined as one with a maximum dimension more than 3 times its minimum dimension.
Note 4. For butt welds, there must be complete joint penetration, indications of melt through, and a convex root surface.
Note 5. This requirement applies to aluminum alloys only. For all other materials, complete fusion to the root of the weld is required.
Note 6. Melt through and suck back limits are checked during visual examination (see Table IV). If the depth of the defect is in question, verify it during metallographic examination.

6.6 Record of Certification

6.6.1 For each test joint, a record indicating “PASS” or “FAIL” of the weld test joint must be prepared and kept on file.

6.6.2 For each welder, keep a record of the following:

- Due dates and last results of welders’ annual eye examinations
- A list of approval codes for each welder
- Due dates for recertification in each approval code for each welder
- A list of suspended approvals for each welder
- Results of certification training courses specified in the relevant welding PPS’s.

7 DHC/BA SAFETY PRECAUTIONS

7.1 The safety precautions specified herein are specific to DHC/BA to meet Canadian Federal and Provincial government environmental, health and safety regulations. It is strongly recommended that other facilities consider these safety precautions; however, suppliers, subcontractors and partners are responsible for ensuring that their own environmental, health and safety precautions satisfy the appropriate local government regulations.

7.2 Observe standard plant safety precautions when performing the procedure specified herein.

7.3 When fusion welding, observe the safety precautions specified in the applicable welding PPS.

8 PERSONNEL REQUIREMENTS

8.1 This PPS has been categorized as a Controlled Special Process according to PPS 13.39. Refer to PPS 13.39 for personnel requirements.

8.2 Only personnel certified according to this standard and PPS 37.03, PPS 37.04, PPS 37.05 or PPS 37.09, as applicable, may perform fusion welding.

8.3 At least once a year every welder must be tested and meet the following minimum acceptance standards for visual acuity:

- Distant vision of 20/30 in at least one eye, either corrected or uncorrected.
- Near vision in at least one eye, either corrected or uncorrected, of Jaeger #2 or Snellen 14/18 at a distance of 16" (406.4 mm).

8.4 Except as noted in paragraph 8.4.1, the maximum re-certification period for each given approval code is 12 months (i.e., in order to maintain their certification, welders must be re-certified according to this PPS for each approval code at no more than every 12 months). If objective evidence exists (i.e., poor production weld joints) to cause doubt as to the ability of a welder to meet the welding requirements, the welder must be re-certified according to this PPS before being allowed to continue to weld according to that approval code. If the results of a re-certification weld test performed before the re-certification due date are unavailable until after the due date, a single 4 week certification extension may be issued, enabling the welder to weld within the applicable code pending results of the re-certification weld test.

8.4.1 For any 3 month period, if a welder certified in a particular alloy and thickness combination has not produced at least one satisfactory production weld in that alloy and thickness combination, his certification in that alloy and thickness combination must be considered to have lapsed and re-certification will be required before further production welding of parts in that alloy and thickness combination.