

WELD INSPECTION REQUIREMENTS

1 PURPOSE & APPLICATION

- 1.1 The purpose of this procedure is to define the inspection requirements on aerospace welds.
- 1.2 This procedure applies to all employees involved in the quality of aerospace welded components.
- 1.3 This procedure meets at a minimum AWS D17:2001 *Specification for Fusion Welding for Aerospace Structures*.

2 RESPONSIBILITIES

- 2.1 Quality Director
 - 2.1.1 Oversees the personnel certification and audits the process
- 2.2 Inspection Manager
 - 2.2.1 Coordinates inspection personnel and ensures compliance with certifications
- 2.3 Inspection Personnel
 - 2.3.1 Ensure parts submitted meet at a minimum the requirements set forth and the Engineering drawing requirements as they relate to welds.
 - 2.3.2 Maintain the required certifications

3 PROCEDURE

- 3.1 Qualification of Inspection Personnel
 - 3.1.1 PT personnel will be qualified in accordance with MQ-04-17-00-00.
 - 3.1.2 Visual inspectors shall pass an annual eye examination.
 - 3.1.2.1 Eye exam shall be performed by a trained technician using standard methods.
 - 3.1.2.2 Near distance acuity, natural or corrected, shall be one of the following
 - 3.1.2.2.1 Jaeger J1 at 12in.
 - 3.1.2.2.2 Jaeger J2 at 16in.
 - 3.1.2.2.3 Snellen English at 12in
 - 3.1.2.2.4 Other equivalent by a licensed optometrist
 - 3.1.2.3 Far vision shall be 20/30 or better, natural or corrected.
- 3.2 All welds will be visually inspected for conformance to drawing requirements.
- 3.3 Nondestructive Inspection requirements of welds

- 3.3.1 Penetrant Inspection (PT)
 - 3.3.1.1 All Penetrant inspections shall be performed in accordance with MQ-04-16-00-00.
 - 3.3.1.2 All nonferrous Class A and B welds will be penetrant inspected.
 - 3.3.1.3 Ferrous Class A and B welds will be penetrant inspected when required by Engineering drawings.
 - 3.3.1.4 Class C nonferrous and ferrous welds shall be Penetrant inspected when specified on the Engineering Drawing.
- 3.3.2 Magnetic Particle Inspection (MT)
 - 3.3.2.1 All Magnetic Particle Inspections shall be performed in accordance with ASTM E 1444.
 - 3.3.2.2 All ferromagnetic Class A and B welds shall be magnetic particle inspected unless PT is required by the Engineering drawing.
 - 3.3.2.3 Class C ferromagnetic welds shall be magnetic particle inspected when specified on the Engineering drawing.
- 3.3.3 Radiographic Inspection (RT)
 - 3.3.3.1 All Radiographic Inspections shall be performed in accordance with ASTM E 1742.
 - 3.3.3.2 All Class A groove welds shall be radiographically inspected unless UT is required by the Engineering drawing.
 - 3.3.3.3 Class B and C welds shall be radiographically inspected when required by the Engineering drawing.
- 3.3.4 Ultrasonic Inspection (UT)
 - 3.3.4.1 All Ultrasonic Inspections shall be performed in accordance with ASTM E 164.
 - 3.3.4.2 Ultrasonic inspection may be used in lieu of radiographic inspection when specified on the Engineering drawing.
- 3.3.5 Proof Testing (PRT)
 - 3.3.5.1 Proof testing may be used in conjunction with or in lieu of inspection methods listed in 3.3.1, 3.3.2, 3.3.3, or 3.3.4 when required by the Engineering drawing.
- 3.4 Acceptance Criteria
 - 3.4.1 General Requirements
 - 3.4.1.1 The dimension of any discontinuity shall be defined by its largest dimension.

3.4.1.2 Two or more discontinuities shall be treated as one when the spacing between them is less than the dimension of the larger discontinuity.

3.4.1.3 Discontinuities that will be removed in subsequent machining operations shall not cause for rejection.

3.4.1.4 Any weld with unacceptable discontinuities which has gone through a subsequent operation that affects the metallurgical characteristics or that cannot be rewelded without affecting final metallurgical or surface characteristics shall be rejected.

3.4.1.5 Removal of unacceptable weld metal is allowed provided that the minimum weld size is met.

3.4.1.6 In the case of welds with variations in cross section along the joint, the thickness shall be considered to be the minimum thickness at the discontinuity.

3.4.2 Welds shall be acceptable if they satisfy the conditions of Table 1. Welds not meeting these requirements shall be rejected per MQ-05-05-00-00.

4 REVISION HISTORY – Authored by Travis Mcilnay, approved _____.

Approvals

Bruce Maxwell

16 Oct 2013

Document Custodian

Date

Bruce Maxwell

16 Oct 2013

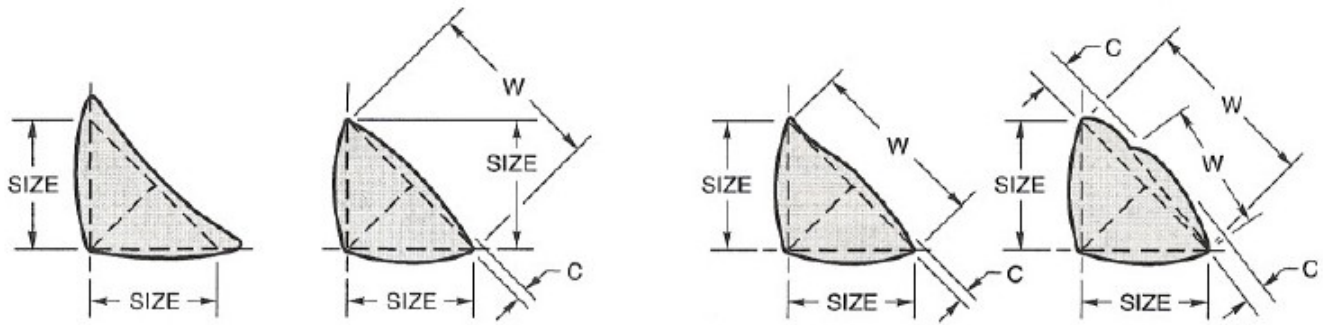
Quality Director

Date

Table 1

Discontinuity	Class A	Class B	Class C
Cracks	None	None	None
Overlap (Cold Lap)	None	None	None
Incomplete Fusion	None	None	None
Incomplete Penetration (groove only)	None	None	None
Porosity – Surface			
Individual Size – Max	.25t or .030”, whichever is less	.33t or .060”, whichever is less	.50t or .090”, whichever is less
Spacing – Min	8x the size of the larger adjacent imperfection	4x the size of the larger adjacent imperfection	2x the size of the larger adjacent imperfection
Accumulated length in any 3” of weld – max	1t or .120”, whichever is less	1.33t or .240”, whichever is less	2t or .360”, whichever is less
Porosity – Subsurface			
Individual Size – Max	.33t or .060”, whichever is less	.50t or .090”, whichever is less	Not applicable
Spacing – Min	4x the size of the larger adjacent imperfection	2x the size of the larger adjacent imperfection	Not applicable
Accumulated length in any 3” of weld – Max	1.33t or .240”, whichever is less	2t or .360”, whichever is less	Not applicable
Inclusions			
Individual size – max	.33t or .060”, whichever is less	.50t or .090”, whichever is less	Not applicable
Spacing – min	4x the size of the larger adjacent imperfection	2x the size of the larger adjacent imperfection	Not applicable
Accumulated length in any 3” of weld – Max	1.33t or .240”, whichever is less	2t or .360”, whichever is less	Not applicable
Undercut			
For the full length of weld – Max depth	.002”	.015t or .002”, whichever is greater	.025t or .002”, whichever is greater
Individual defect – Max depth	.07t or .030”, whichever is less	.10t or .050”, whichever is less	.20t or .070”, whichever is less
Accumulated length in any 3” of weld – Max	.200”	.600”	1.00”
Underfill and/or Concavity			
For the full length of weld – max depth	.005”	.015t or .005”, whichever is greater	.025t or .005”, whichever is greater
Individual defect – max depth	.07t or .030”, whichever is less	.07t or .030”, whichever is less	.07t or .030”, whichever is less
Accumulated length in any 3” of weld – Max	.200”	.600”	1.00”
Craters			
Maximum depth	.20t or .030”, whichever is less	.20t or .050”, whichever is less	.20t or .050”, whichever is less
Maximum length	1t	1t	2t
Weld profiles	See figure 1	See figure 1	See figure 1
Arc Strikes/Gouge Marks	Unacceptable	Unacceptable	No requirement
Fillet Weld Size – when fillet weld size is stated on the drawing			
Minimum size	As shown by symbol	As shown by symbol	As shown by symbol
Fillet Weld Size – minimum size when size is not stated on drawing			
Minimum size – single side fillet	1.5t	1.5t	1.5t
Minimum size – double side fillet	1t	1t	1t

Discontinuity	Class A	Class B	Class C
Fillet Weld Size – max fillet weld size larger than that stated on the drawing			
Material up to .090"	2x the weld callout	2x the weld callout	2x the weld callout
Material .091"-.156"	1.5x the weld callout	1.5x the weld callout	1.5x the weld callout
Material .157"-.750"	1.25x the weld callout	1.25x the weld callout	1.25x the weld callout
Material >.751"	1.1x the weld callout	1.1x the weld callout	1.1x the weld callout
Weld Reinforcement – Manual welds			
Material up to .125"	1t max	No requirement	No requirement
Material .125" - .510"	1/3t or .100", whichever is greater	No requirement	No requirement
Material > .510"	.170" max	No requirement	No requirement
Melt-Through	See Figure 2	See Figure 2	See Figure 2
Discoloration⁽¹⁾ – Titanium			
Bright Silver	Acceptable	Acceptable	Acceptable
Silver	Acceptable ⁽²⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Light Straw	Acceptable ⁽²⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Dark Straw	Acceptable ⁽²⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Bronze	Acceptable ⁽²⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Brown	Acceptable ⁽²⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Violet	Reject ⁽³⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Green	Reject ⁽³⁾	Acceptable ⁽²⁾	Acceptable ⁽²⁾
Blue	Reject ⁽³⁾	Reject ⁽⁴⁾	Reject ⁽⁴⁾
Gray	Reject ⁽⁵⁾	Reject ⁽⁵⁾	Reject ⁽⁵⁾
White	Reject ⁽⁵⁾	Reject ⁽⁵⁾	Reject ⁽⁵⁾
Discoloration – Stainless Steel			
All oxidation colors	Acceptable	Acceptable	Acceptable
Discoloration – Steel			
All Temper film colors	Acceptable	Acceptable	Acceptable
Notes:			
(1) Discoloration comes in various shades, tones and hues.			
(2) Discoloration must be removed prior to additional welding.			
(3) On the weld and in Heat Affected Zone (HAZ) up to .030" beyond the weld.			
(4) Blue discoloration is rejectable if additional welding is to be performed. Blue discoloration is acceptable on finish welds but must be removed prior to subsequent processing.			
(5) Discoloration is rejectable unless it can be proven that embrittlement has not occurred. This proof must be provided through direct testing, such as microhardness.			

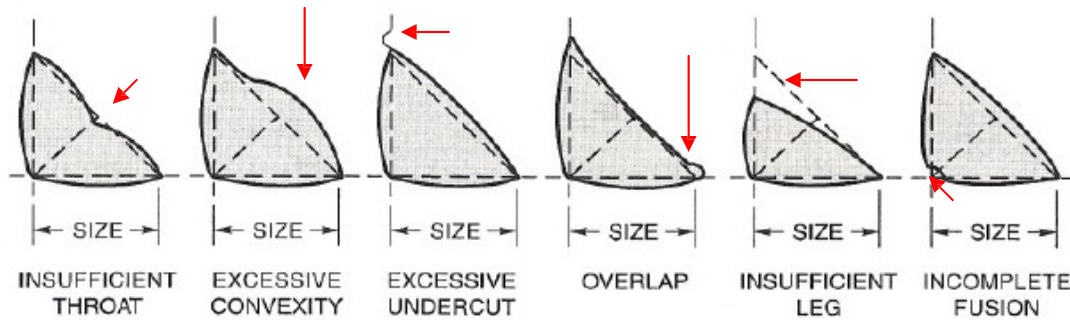


(A) DESIRABLE FILLET WELD PROFILES

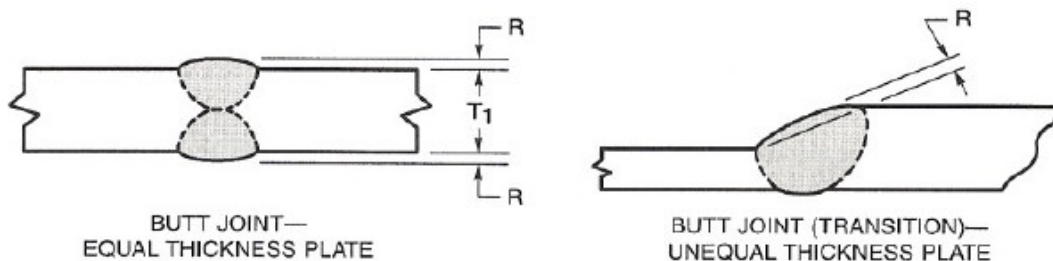
(B) ACCEPTABLE FILLET WELD PROFILES

General Note: Convexity, C, of a weld or individual surface bead with dimension W shall not exceed the value of the following table.

Width of weld face or individual surface bead, W	Max Convexity, C
$W \leq 5/16$ in.	1/16 in.
$W > 5/16$ in.	1/8 in.
$W \geq 1$ in.	3/16 in.

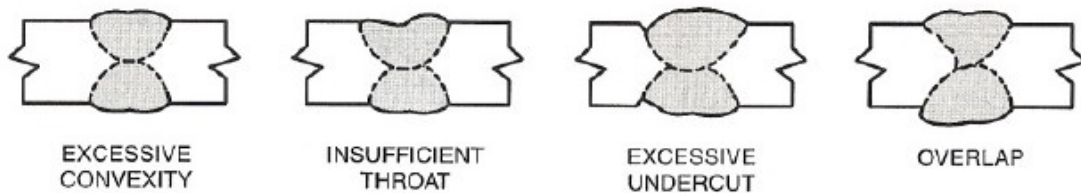


(C) UNACCEPTABLE FILLET WELD PROFILES



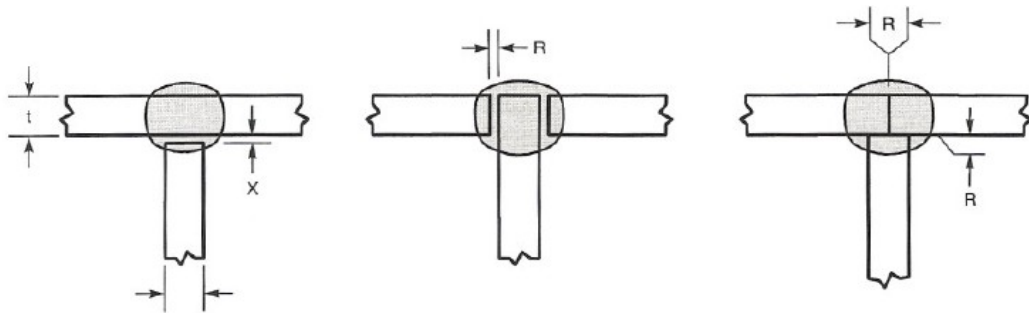
General Note: Reinforcement R shall not exceed 1/8 in. (3 mm).

(D) ACCEPTABLE GROOVE WELD PROFILE IN BUTT JOINT

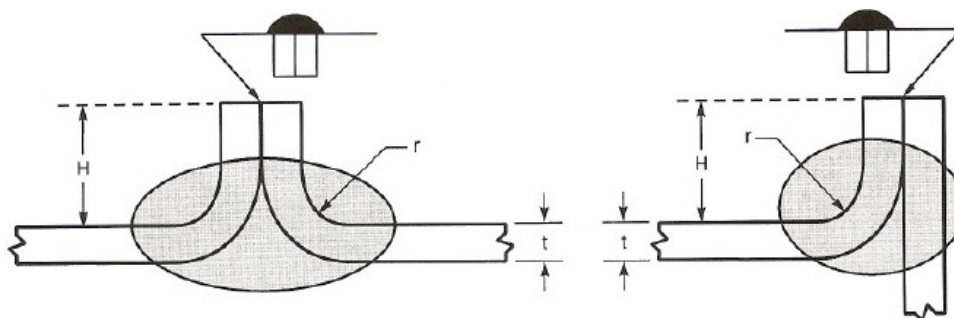


(E) UNACCEPTABLE GROOVE WELD PROFILES IN BUTT JOINTS

Figure 1



Legend:
 t = Thickness of thinner member
 R = Root opening $\leq .010''$ for $t < .100''$, $\leq .030''$ for $t \geq .100''$
 X = Weld penetration Min = $1/2t$ or $.015''$, whichever is greater
 Max = $2-1/2t$ or $.187''$, whichever is less



Thickness (t)	Max Bend Radius (r)	Flange Height (H)
.016"-.032"	.040"	.080"-.120"
.033"-.062"	.060"	.100"-.160"
.063"-.100"	2t	.120"-.200"



Base Metal	Base Metal Thickness (t)	Max Bend Radius (r)	Joggle (J)	Overlap (O)
Titanium	.020"-.040"	.040"	$t + .005''$ $t - .000''$.032"-.060"
CRES	.020"-.063"	.040"	$t + .005''$ $t - .000''$.032"-.090"
Nickel	.020"-.063"	.060"	$t + .005''$ $t - .000''$.032"-.090"

Figure 2