MIL-T-5021D
1 FEBRUARY 1969
SUPERSEDING
MIL-T-5021C
17 August 1962

MILITARY SPECIFICATION

TESTS; AIRCRAFT AND MISSILE WELDING OPERATORS' QUALIFICATION

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the procedure for qualification of welders and welding operators engaged in the welding of aircraft, aircraft parts and accessories, missile, and missile parts and accessories, by fusion welding methods (see 6.2). This specification is not applicable to aircraft and missile ground equipment.

1.2 Classification. For the purpose of this specification, welders and welding operators are classified as follows:

Welder, Class A - Class A welders may weld joints in all aircraft, aircraft parts and accessories, missiles, and missile parts and accessories manufactured from the group(s) of alloy (see 3.2) for which they have passed the applicable tests (table I). Permissible welding processes (see 3.3) will include only those used in qualification tests.

Welder, Class B - Class B welders are restricted to the welding of joints in group I alloys (table I) only, when used in the manufacture of noncritical accessories and aircraft and missile parts which are not part of the primary or secondary structure. This includes such parts as fairing brackets, steps, supports for instruments, and miscellaneous equipment.

Welding Operators, Class A - Class A welding operators may machine weld all aircraft, aircraft parts, missile and missile parts and accessories manufactured from the group(s) of alloys (see 3.2) for which they have passed the applicable tests (table II). Equipment that may be used will be limited to that of the processes (see 3.3) used in the qualification tests. Class A welding operators may weld all types of joints for which welding procedures have been established.

FSC 14GP

Welding Operators, Class B - Class B welding operators are restricted to the machine or automatic welding of production joints, using pre-established weld settings, for the alloy group(s) for which they have passed the applicable tests, as specified in table II.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Military

MIL-R-5632	Rods and Wire, Steel, Welding (for Aircraft)
MIL-E-8697	Electrode, Welding, Coated, Low Hydrogen Heat-Treatable Steel

STANDARDS

Military

MIL-STD-00418B(SH)	Mechanical Tests for Welded Joints
MIL-STD-453	Inspection, Radiographic

Federal

Fed Std 66	Steel, Chemical Composition and Hardenability
Fed Test Method Std No. 151	Metals; Test Methods

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS FOR QUALIFICATION

3.1 Demonstration of proficiency. To achieve qualified status, each welder and welding operator shall demonstrate his skill and proficiency by satisfactorily welding the required joints, using the alloy possessing the more difficult weldability characteristics within that group which he is required to weld in production. The welds will be made with the equipment and process (see 3.3) used in production.

3.1.1 Record of proficiency. The facility employing the welder or welding operator shall complete and retain a record form containing the essential information, as suggested in figure 1, as evidence of the welder's or welding operator's qualification.

3.2 Alloys. The welder or welding operator shall satisfactorily weld the required joints for each group of alloys which he is to weld in production. When welding Groups I and Group II precipitation hardening alloys, the filler alloys employed shall be appropriate for the parent metal being joined and shall produce a weld deposit which will respond to the thermal treatment used to develop high strength in the parent metal with 95 percent joint efficiency after heat treatment.

3.2.1 Grouping of alloys. For the purpose of this specification, the metals and alloys commonly welded in production are classified as follows:

Group I	- Hardenable carbon steel and low alloy steel (alloy classification as indicated in Fed Std 66)
Group II	- Corrosion-resistant and heat-resistant ferrous alloys
Group III	- Nickel base and cobalt base alloys
Group IV	- Aluminum alloys
Group V	- Magnesium alloys
Group VI	- Titanium and titanium alloys

3.3 Welding processes. For the purpose of this specification, welding processes are classified as follows:

a. Gas (oxy-acetylene, oxy-hydrogen)
b. Shielded metal arc
c. Submerged arc
d. Gas tungsten arc
e. Gas metal arc
f. Atomic hydrogen
g. Carbon arc
h. Electron beam
i. Plasma-arc

3.3.1 Fusion welding of Group VI. Titanium alloys shall be restricted to welding processes specified in 3.3 (d.), (e.), (h.), and (i.).

3.4 Record of welding variables. Information concerning welding variables shall be observed and recorded while the respective specimen joints are being welded.

3.4.1 Properties of welded joints. The welded joints shall be tested and shall exhibit properties conforming to all the requirements specified herein.

3.5 Eligibility for welding. No welder or welding operator shall be permitted to perform any welding operation in connection with any contract until qualified, except as provided for in 1.1.

3.5.1 A welder or welding operator who has acquired qualified "status" in welding a specific alloy by a specific process is, with the exceptions of Group II precipitation-hardening alloys and all Group III alloys, eligible to weld other alloys in the respective group(s) of a less difficult weldability classification without taking further examination. However, a welder or welding operator shall be permitted to weld alloys in only that group or groups of alloys for which he has been qualified and only with processes used in the qualification tests. A certified welder or welding operator may not weld material less than 25 percent below the minimum thickness indicated on his current certificate.

3.6 Preparation of welded joints.

3.6.1 Materials.

3.6.1.1 Base metal. The material to be used for the welded samples of the qualification tests shall conform to nominal composition and mechanical properties with the material used in production in the manufacturer's plant for the fabrication of aircraft, aircraft parts and accessories, missiles, and missile parts and accessories.

3.6.1.2 Filler metal. The welding rods or electrodes shall conform to those that are regularly used in production welding of the respective materials.

3.6.2 Qualification tests. The qualification tests for welders and welding operators shall consist of the welding and inspection of joints specified in tables I and II.

3.6.3 Specimen joints.

3.6.3.1 Standard joints. Requirements concerning the dimensions, welding, positioning, testing, and properties of standard Joints Nos. 1, 2, 3, and 4 shall be as indicated in figure 2 (sheets 1, 2, 3, and 4) respectively, and as specified herein.

3.6.3.2 Joint No. 4 alternate. Joint No. 4 represents a combination of light and heavy sections quite often found in aircraft fittings. The contractor may substitute for this specimen a fitting having the same general characteristics and requiring at least the skill necessary to weld Joint No. 4. This fitting may, when the welding operator is reexamined, be selected from a batch made during the regular production.

3.6.3.3 Joint No. 5. This sample shall consist of the manufacture of two butt-welded joints in sheets or plates of the nominal chemical composition to be used in production work. One joint shall be made between two sheets of equal thickness, representing the thinnest sheet to be welded in production. The other joint shall be made between sheets or plates of equal thickness, but shall represent the thickest material to be welded in production. The joints shall be approximately 6 to 12 inches in length. For sheet over 1/8 inch in thickness, the metal may be laid on both sides of the joint. On metal 0.090 inch thickness and over, it is permissible to chamfer the butting edges in order to facilitate proper penetration.

3.6.3.4 Joint No. 6. This joint shall consist of one or more "T" fillet welds, approximately 4 to 10 inches in length, using materials of compositions, tempers, and the thinnest to thickest material combination used in production. Material over 1/4 inch in thickness shall be welded on both sides.

3.6.3.5 Joint No. 7. Joints Nos. 5 and 6 shall first be tested as specified. If satisfactory, the applicant shall weld one aircraft or missile part typical of the type which he will weld in production. This part shall be tested and examined in accordance with applicable specifications. Then the part shall be sectioned to determine the quality of the weld. When considerable cost is involved in the manufacture of a part, the applicant may submit test joints which are representative of the assembly most difficult to weld and which are nominally identical to the production parts with respect to items such as materials, heat treatment, welds over rivets, edge welds, and plug welds. When representative joints are used in place of a production part, Joints Nos. 5 and 6 need not be tested prior to welding, Joint No. 7.

3.6.3.6 Special applications. The designs of the specimens for qualification tests may be modified, provided the modified designs are more directly applicable to the intended product and more representative of the production joints the welder will be expected to weld. If the joints in the modified specimen are of such nature as to require less skill in welding than the standard specimens, then the production work of the welder shall be similarly restricted. A description of the specimens, procedures, and test requirements to be used in the modified qualification tests shall be made available in accordance with applicable contractual requirements and so indicated on record of examination (see figure 1).

Part I Date_____

Name of applicant _____ Birthdate _____

Weld Class_____ Machine_____
(1)

Welding process: Manual_____ Machine_____

(2)

Applicant's experience
(Insert time, in years, in proper spaces)

	Manual	Machine
Training (school) (in-plant)		
Plant production		
Aircraft and missile		
Other		
Present employer		
Other qualification carried		

Weld procedure

NOTE: A suitable form indicating the complete weld procedure applied, i.e., machine setting (voltage, amperage, gas flows and types, tip sizes, tungsten sizes, weld speed, etc.), electrodes or filler metal type and size, material preparation, equipment make, etc., shall appear here.

Specimen data

NOTE: A suitable form indicating complete information as to joint geometry, material type and preparation, etc., shall appear here.

NOTE: (1) Welding process: Separate form shall be used for each process.

NOTE: (2) Applicant's experience: List only training or experience pertinent to weld process for which qualification is sought.

NOTE: (3) Re-examination data shall be recorded on similar form. The updating of welder's age, experience or other non-pertinent data will not be required.

Witnessed by:_____
(3)

FIGURE 1. Record of examination of welders and welding operators

Part II

Inspection test report:

Results of non-destructive and destructive tests shall appear here. (See figure 5) (Weld dimensions shall also be recorded.)

Witnessed by:_____

Part III

Qualification status:

Accepted:_____Date:_____
Signature authorized representative

Process:_____Code classification:_____

Metal group:_____

Rejected:_____Date:_____

Reason for rejection:_____

Action:_____

(3)

FIGURE 1. Record of examination of welders and welding operators
(Sheet 2 of 2)

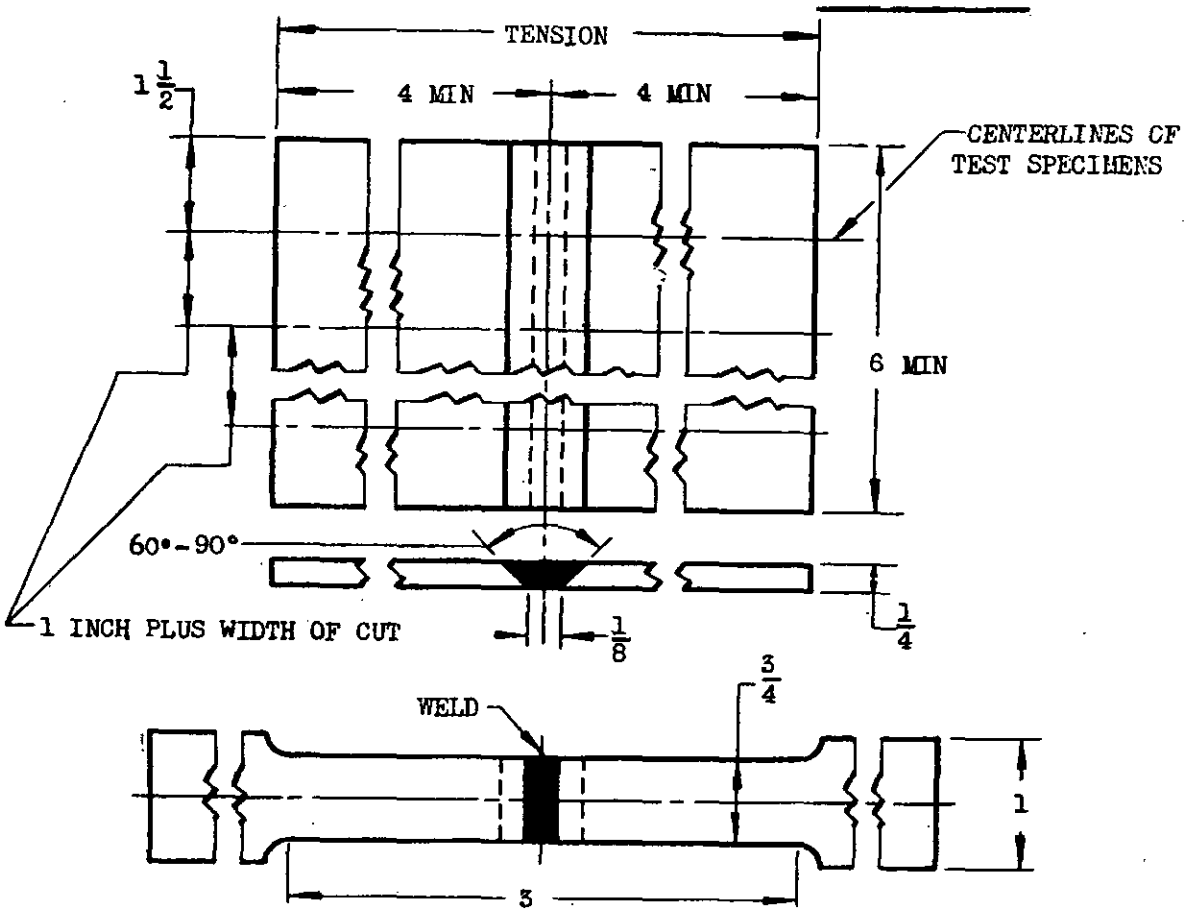
Table I. Designation of joints for welder qualification tests

Group	Class	Qualification joints	Permissible welding after qualification
I. Carbon and low alloy steels	A	(a) Joints 1,2 (overhead only), 3, and 4 of figure 2 (sheets 1,2,3, and 4), respectively, or (b) Joints 1,2 (overhead only), and 3 of figure 2 (sheets 1,2 and 3) plus No. 4 alternate (see 3.6.3.2) or No. 6.	All parts and accessories manufactured from the group of alloys for which tests have been passed.
	B	Joints 1 and 2 of figure 2 (sheets 1 and 2).	Only noncritical accessories and parts, not part of primary or secondary structures, such as steps, fairing brackets, and support for instruments.
II. Corrosion- and heat-resistant alloys	A	Joints 5,6, and 7 (if 5 and 6 are satisfactory).	Same as for group IA.
III. Nickel base and cobalt base alloys	A	Joints 5,6, and 7 (if 5 and 6 are satisfactory).	Same as for group IA.
IV. Aluminum alloys	A	Joints 5,6, and 7 (if 5 and 6 are satisfactory).	Same as for group IA.
V. Magnesium alloys	A	Joints 5,6, and 7 (if 5 and 6 are satisfactory).	Same as for group IA.
VI. Titanium and titanium alloy	A	Joints 5,6, and 7 (if 5 and 6 are satisfactory).	Same as for group IA.

Table II. Designation of joints for welding operators' qualification tests

Alloy Groups	Class	Qualification joints for Welding Operators 1/	Permissible Welding after Qualification
I. Carbon and low alloy steels II. Corrosion-and Heat-Resistant Alloys III. Nickel base and cobalt base alloys	A	Machine Operator Joints 5,6 and 7 (if 6 is not applicable to a specific welding process, see special application 3.6.3.6).	Critical All aircraft, aircraft parts and accessories, missiles and missile parts and accessories manufactured from the group(s) of alloys for which tests have been passed.
IV. Aluminum Alloys V. Magnesium Alloys VI. Titanium and Titanium Alloys	B	Machine Operator Joint No. 7, or alternate special application 3.6.3.6. NOTE: These qualification tests for Class "B" machine operators must be made with established certified weld setting schedules.	Specific joints as described in Figure 1, Record of examination of Welding operator

1/ Welding Operator - One who operates machine or automatic welding equipment



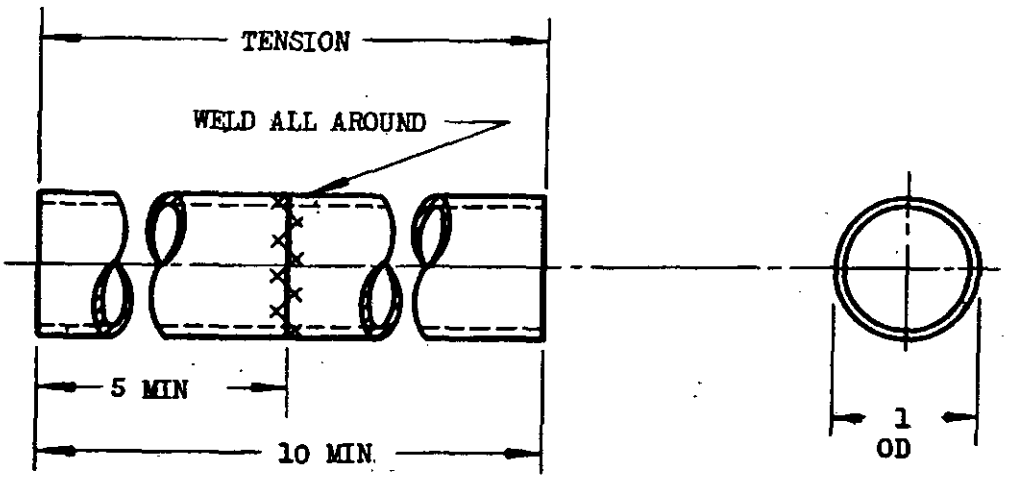
JOINT NO. 1

BUTT JOINT IN PLATE (TENSILE TEST)

EXAMINE FOR FREEDOM FROM WARPING AS AN INDICATION OF THE OPERATOR'S ABILITY. THE REINFORCEMENT SHALL BE MACHINED OFF AND THE SAMPLE CUT INTO TEST SPECIMENS. TENSILE SPECIMENS SHALL BE HEAT TREATED TO THE HIGHEST LEVEL TO WHICH THE RESPECTIVE PRODUCTION PARTS ARE HEAT TREATED OR TO 210 KSI NOMINAL BREAKING STRENGTH. NOT LESS THAN THREE SPECIMENS SHALL BE TESTED. THE TENSILE STRENGTH OF EACH SPECIMEN SHALL BE NOT LESS THAN 90 PERCENT OF THE STRENGTH OF THE PARENT METAL.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS IN INCHES.

FIGURE 2 (sheet 1 of 4). Specimens for qualification tests for welders



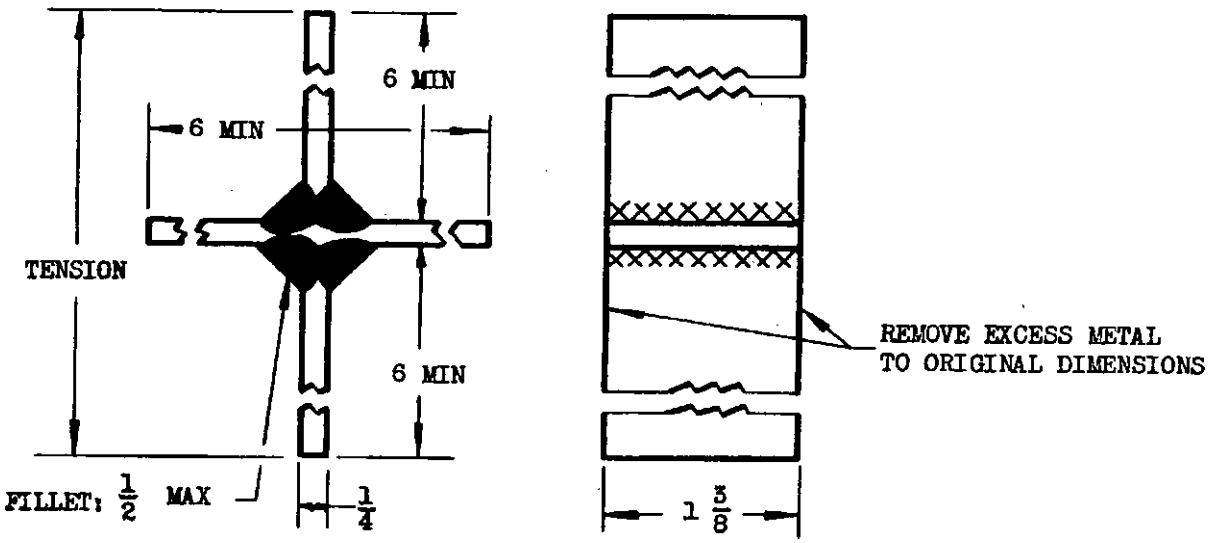
JOINT NO. 2

BUTT JOINT IN TUBING (TENSILE TEST)
NO. OF SPECIMENS - FOUR
THICKNESS OF TUBING: 0.028 to 0.065 INCL

TWO SETS OF JOINTS SHALL BE WELDED, ONE AT BENCH LEVEL AND THE OTHER IN AN OVERHEAD FIXED POSITION NOT LOWER THAN THE OPERATOR'S EYE LEVEL. EACH SET SHALL CONSIST OF A JOINT WELDED WITH THE TUBING IN A HORIZONTAL POSITION AND A JOINT WELDED WITH THE TUBING IN A VERTICAL POSITION. THE JOINTS SHALL BE TESTED AS TENSILE SPECIMENS. THE THICKNESS OF THE BEAD SHALL BE NOT GREATER THAN TWICE THE WALL THICKNESS OF THE TUBING AND SHALL BE MEASURED, BY CROSS SECTIONING IF NECESSARY, AFTER THE SPECIMEN IS TESTED. THE STRENGTH OF THE JOINT SHALL BE NOT LESS THAN 50,000 PSI FOR PLAIN-CARBON STEEL AND 80,000 PSI FOR ALLOY STEEL CALCULATED ON THE AREA OF THE BASE METAL. WELDING POSITIONS SHALL BE IN ACCORDANCE WITH STANDARDS AS PRESCRIBED BY THE AMERICAN WELDING SOCIETY.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS IN INCHES.

FIGURE 2 (sheet 2 of 4). Specimens for qualification tests for welders



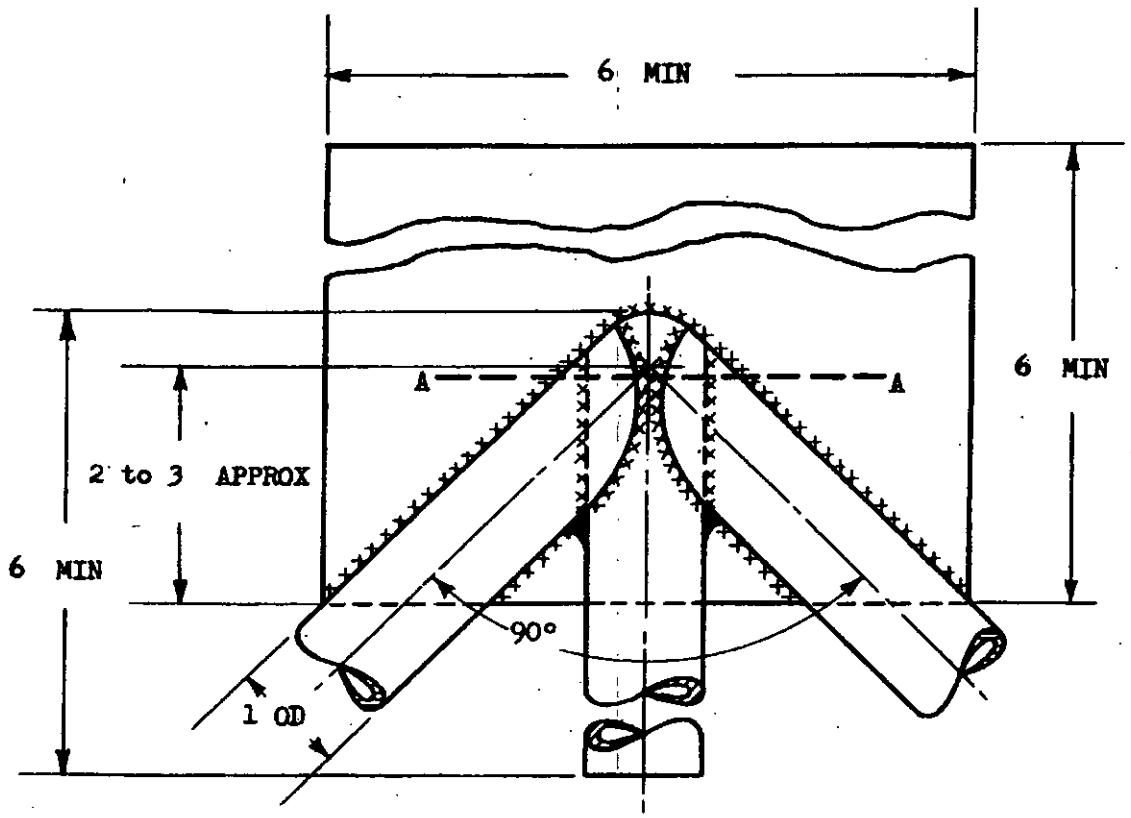
JOINT NO. 3

VERTICAL FILLET WELD (TENSILE TEST)
NO. OF SPECIMENS - TWO

JOINT NO. 3 - VERTICAL FILLET WELD: THIS JOINT SHALL BE MADE WITH THE SHEETS STANDING ON EDGE. THE PIECES SHALL BE SO SUPPORTED THAT THERE IS A CLEARANCE BETWEEN THE LOWER END OF THE SEAM AND THE JIG. THE JOINT SHALL BE TESTED IN TENSION AND SHALL DEVELOP NOT LESS THAN 10,000 POUNDS PER LINEAR INCH IF THE BASE METAL IS PLAIN CARBON STEEL, AND 15,000 POUNDS PER LINEAR INCH IF ALLOY STEEL. (SEE 3.6.1.1). THE BROKEN SPECIMEN SHALL BE EXAMINED TO DETERMINE WHETHER OR NOT THE WELD HAS FUSED INTO THE BASE METAL IN THE ROOT. FAILURE IN THE WELD METAL SHALL BE CONSIDERED SATISFACTORY ONLY WHEN EXAMINATION OF THE FRACTURE INDICATES THAT THE WELD WAS SOUND AND THE MINIMUM TENSILE REQUIREMENTS HAVE BEEN MET.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS IN INCHES.

FIGURE 2 (sheet 3 of 4). Specimens for qualification tests for welders



JOINT NO. 4

CLUSTER JOINT OF SHEET AND TUBING
NO. OF SPECIMENS - TWO
THICKNESS OF TUBING - 0.065
THICKNESS OF SHEET - 1/8 INCH

JOINT NO. 4 - CLUSTER JOINT OF SHEET AND TUBING: THE WELDS SHALL BE EXAMINED BY APPROPRIATE NONDESTRUCTIVE INSPECTION METHODS FOR CRACKING AND SOUNDNESS. AT LEAST ONE SPECIMEN SHALL BE CUT AT SOME SECTION NEAR THE INTERSECTION OF THE TUBING AXES SUCH AS SECTION A-A, POLISHED AND ETCHED. VISUAL EXAMINATION AT A MAGNIFICATION OF AT LEAST 3 DIAMETERS SHALL REVEAL A PENETRATION OF NOT LESS THAN 15 PERCENT IN THE 1/8 INCH PLATE, AND ABSENCE OF BLOWHOLES OR POROSITY IN THE WELD METAL. SATISFACTORY PENETRATION OF WELD INTO BASE METAL IS SHOWN IN FIGURES 3 AND 4.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS IN INCHES.

FIGURE 2 (sheet 4 of 4). Specimens for qualification tests for welders

4. EXAMINATION AND TESTS OF WELDED JOINTS

4.1 Responsibility for inspection. The supplier (employer of the welder or welding operator) is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any other commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Applicable tests.

4.2.1 Visual examination. The exposed surfaces of all welded joints shall be examined visually for evidence of weld quality and welder's and welding operator's proficiency. Welds shall be reasonable smooth and free from irregularities. Welds not reasonably smooth and free from irregularities indicate a lack of experience or skill on the part of the welder or welding operator.

4.2.2 Manual welds, Group I alloys. All joints fabricated by the welder from Group I alloys shall be subjected to tests as specified by Joints Nos. 1, 2, 3, and 4, figure 2 (sheets 1, 2, 3, or 4) as appropriate, and as specified herein.

4.2.2.1 Joint No. 4 alternate. Joints shall be examined visually for indications of the welder's proficiency, and the soundness of the weld deposit determined by metallographic examination of representative sections cut transverse to the direction of welding.

4.2.3 Machine welds, all alloy groups, and manual welds, Groups II through VI. These joints shall be subjected to the tests specified in 4.2.3.1 through 4.2.3.3.

4.2.3.1 Joint No. 5. Not less than two specimens from each welded plate shall be tested in bending (see 4.3.3).

4.2.3.2 Joint No. 6. Two or more macroscopic sections shall be made and examined for soundness, except that when the joint is welded on one side only, the joint may be tested in bending by applying lateral pressure to the stem of the "T" in such a manner that the legs adjacent to the fillet assume an angle not greater than 30 degrees. Root penetration shall be complete and confirmed by three macrosections: one within the first inch of weld length, one in the last inch, and one near the center.

4.2.3.3 Joint No. 7. The welded joint in the production item, or the sample joint representative of a production joint, shall be sectioned to determine weld quality. When representative sample joints are employed, the corresponding joints in a production item shall be examined visually and radiographically or by other non-destructive means.

4.3 Test methods.

4.3.1 Visual. The exposed surfaces of welded joints shall be examined for smoothness of surface of the weld bead, weld contour, and evidence of excessive irregularities, unsoundness, craters, lack of fusion, or surface oxidation.

4.3.2 Tensile.

4.3.2.1 Preparation of specimens. Tensile test specimens from Joint No. 1 shall be prepared in accordance with Method 211, type F2 of Federal Test Method Standard No. 151, with a 3/4-inch width of test section and with the welded joint transverse to the long dimension, and at the approximate center of the test section, as indicated in the sketch of the tensile specimen of Joint No. 1 (figure 2, sheet 1). Tubular specimens from Joint No. 2 shall be tested as full-section specimens in accordance with Method 211 of Federal Test Method Standard No. 151.

4.3.2.2 Method. Tensile tests shall be conducted in accordance with the test methods specified in Federal Test Method Standard No. 151, except that ultimate tensile strength only shall be determined.

4.3.2.3 Acceptance criteria. The weld shall be considered satisfactory when the failure in tension occurs in the base metal. Joints failing at edge of the weld or in the weld metal shall be considered satisfactory only when the fracture is free from defects and the joint conforms to all the requirements specified herein. The surfaces of weld metal fractures shall be examined visually or at low magnification (not more than three diameters) for the presence of excessive porosity, blowholes, inclusions, cracking, or other defects.

4.3.3 Bend.

4.3.3.1 Preparation of specimens. The excess weld metal on either side of the joint shall be ground flush with the surface of the base metal, and the welded plate cut into strip specimens 1 inch in width with the joint at the approximate center of and transverse to the specimens.

4.3.3.2 Method.

4.3.3.2.1 Groups I, II, III, alloys. The specimens shall be bent in the weld, 180 degrees over a diameter not to exceed twice the nominal thickness of the welded sheets, in such manner that the weld is at the center of the bend. For joints welded on one side, the outside of the bend shall be on the side on which the weld was deposited.

4.3.3.2.2 Groups IV, V, and VI alloys. The specimens shall be bent through an angle of 105 degrees over a diameter equal to the bend factor times the nominal thickness of the material. Bending shall be at room temperature, transverse to the weld in any direction relative to the direction of rolling. Bending shall be by continuous pressure and without shock. The bend factor and bend radii to be employed shall be dependent upon the approximate tensile strength of the material to be tested, as listed in table III. Specimens shall be bent in such manner that the weld is at the center of the bend. For joints welded on one side, the outside of the bend shall be the side on which the weld was deposited.

Table III. Bend factor and radii (Group VI alloys)

Approximate tensile strength (psi)	Bend radius
Less than 50,000	2T
Above 50,000-75,000	3T
Above 75,000-120,000	5T
Above 120,000-140,000	8T
Above 140,000-155,000	10T
Above 155,000-170,000	14T

4.3.3.3 Acceptance criteria. The weld shall be considered satisfactory when the total lengths of all cracks in any direction do not exceed 1/16 inch.

4.3.4 Metallographic sections.

4.3.4.1 Preparation of specimens and examination of structure. The welded joint shall be sectioned transverse to the direction of welding, and the surface of the section shall be ground and polished to suitable fineness. The polished section shall be examined visually and at a magnification of from 3 to 10 diameters for fusion characteristics and weld defects. The section shall then be lightly etched to reveal macro-structure and reexamined at low magnification. The sections shall be examined for the following properties or defects and appropriate elements noted on the inspection test report (figure 5).

a. Overall fusion of weld root penetration, burn-through, blowholes.
b. Convexity, concavity, and size of bead of fillet.
c. Undercutting and overlapping.
d. Inclusions.
e. Cracks.
f. Porosity.

4.3.4.2 Acceptable criteria. Welds shall exhibit characteristics of fusion, penetration, and soundness of weld deposit, indicative of satisfactory welding practice. The quality of the welds on Joint No. 4 shall be equal to or better than that exhibited by figure 3. (Also see figure 4).

4.3.5 Radiographic examination. Welds may be examined by radiography provided it has been demonstrated that the technique established for examination will give a positive indication of defects. Such inspection shall be performed in accordance with MIL-STD-453.

4.4 Weld quality requirements.

4.4.1 Weld soundness. Welds shall be free of cracks, incomplete fusion or penetration, overlap, undercut, surface voids, and overlapping folds. Porosity shall not exceed the following limitations:

a. Single porosity. The maximum extent of single cavities shall not exceed 1/3 of the thickness of the thinner material ("t") of the joint or .060, whichever is the lesser. Interconnected porosity shall be considered as a single cavity.

b. Scattered porosity. The sum of the areas in any plane of all the cavities contained in any one inch length of weld must not exceed 5 percent of an area in square inches equal to one times the thickness of the parent metal, or when unequal thicknesses are welded the thickness of the thinner material.

c. Linear porosity. The sum of the areas of the radiographic images, of three or more porosity cavities in alignment shall not exceed 2.5 percent of an area equal to one times the thickness of the thinner material welded. The maximum extent of linear porosity shall not exceed 1/3 the parent material thickness or .060 inch (whichever is less) and the width shall not exceed 10 percent of parent material thickness at any point.

4.4.1.1 Inclusions, either tungsten or nonmetallic, shall be subject to the same dimensional limitations defined for scattered or linear porosity. Where both inclusions and porosity are present, the total of their combined lengths shall be within the limitations for porosity.

4.4.2 Weld dimensions. Weld reinforcements on butt welds and the size of fillet welds shall be established by the contractor. Dimensions or sizes shall be in accordance with standard design practices applied to parts to be welded in production.

4.5 Rejection and retest. When the welder or welding operator fails on one joint, he shall be permitted to submit two other specimens of the same joint. If either of these specimens fails to conform to the requirements specified for that joint, the welder or welding operator shall be disqualified. If reexamination is desired after the above tests, the welder or welding operator shall be required to submit a complete series of qualification tests as specified in 3.6.2. In addition to the above, the welder or welding operator will be required to submit one additional set of specimens of the joint which resulted in the disqualification.

4.6 Report of tests. Upon successful completion of the specified tests, and inspection test report, containing the essential information as suggested by figure 5, shall be completed and signed by a responsible official of the contractor.

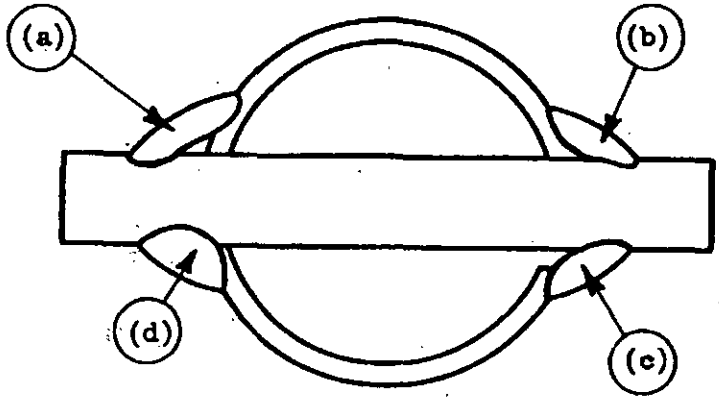
5. MAINTENANCE OF QUALIFICATION

5.1 Maintenance of status for welders. Qualified status of a welder may be maintained by a continuing record of satisfactory workmanship in compliance with 5.2, or by successfully completing reexamination tests every 6 months as specified in 5.1.1. Requalification shall be required of any welder whenever there is evidence of the lack of proficiency.

5.1.1 Reexamination. This reexamination will be required when a continuous record of workmanship is not maintained. Class A welders shall be reexamined every 6 months by welding Joint No. 4 for Group I alloys and Joint No. 5 for Groups II, III, IV, V, and VI alloys, or by welding alternate joints as provided in 3.6.3.2, 3.6.3.5, or 3.6.3.6, as applicable. Class B welders shall be reexamined every 6 months by welding Joint No. 2 (overhead or by welding joints representative of production joints requiring at least as much skill. When the welder fails the above test, he shall be reexamined in accordance with 4.5.

5.1.2 Maintenance of status for welding operators. Qualified status of welding operators may be maintained by a continuing record of satisfactory workmanship in conformance with 5.2, or by successfully completing reexamination every 6 months as required by 5.1.1. Examination or reexamination of a welding operator or equipment will be required whenever there is reason to question the proficiency of the welding operator, operation of the equipment, or the quality of the welds. Periodic reexamination will not be required for welding operators when records indicate that a satisfactory quality level is being maintained in the welds.

FIGURE 3. Satisfactory weld metal penetration in Joint No. 4



(a) INCOMPLETE ROOT PENETRATION
(b) INSUFFICIENT PENETRATION IN THICK PLATE
(c) BAD NOTCH CAUSED BY POOR FIT-UP AND INCOMPLETE ROOT PENETRATION
(d) SATISFACTORY WELD

FIGURE 4. Welding examples

INSPECTION TEST REPORT

Date_____

Name of laboratory_____ Address_____

Supervisor of laboratory_____

Joint No. 1—Butt joint in plate

	1	2	3	4	5
Specimen No.					
Area					
Ultimate load					
Ultimate stress, psi					
Location of fracture					
Fusion [1]					
Soundness [1]					

Joint No. 2—Butt joint in tubing

	1	2	3	4	5
Specimen No.					
Area					
Ultimate load					
Ultimate stress, psi					
Fracture					
Fusion [1]					
Soundness [1]					

Joint No. 3—Vertical fillet weld

	1	2
Specimen No.		
Length		
Ultimate load		
Lb. per linear inch		
Fracture		
Fusion [1]		
Fillet [1]		
Soundness [1]		

[1] See footnote at end of figure 5.

FIGURE 5 (*sheet 1 of 2*). *Inspection test report*

Joint No. 4—Cluster joint of sheet and tubing		
	1	2
Specimen No.		
Fusion [1]		
Fillet [1]		
Soundness [1]		
Penetration [1]		
Undercut—Overlap [1]		

Joint No. 5—Butt welds		
	1	2
Specimen No.		
Area		
Ultimate load		
Ultimate stress, psi		
Fracture		
Fusion [1]		
Soundness [1]		
Bend test		

Joint No. 6—"T" fillet weld		
	1	2
Specimen No.		
Fusion [1]		
Fillet [1]		
Soundness [1]		

Joint No. 7—Production welds					
	1	2	3	4	5
Specimen No.					
Area					
Ultimate load					
Ultimate stress, psi					
Fracture					
Fusion [1]					
Fillet contour [1]					
Soundness [1]					

[1] Indicate whether "satisfactory" or "unsatisfactory."

FIGURE 5 (*sheet 2 of 5*). *Inspection test report*

5.2 Continuing record of workmanship. The determination of a satisfactory record of workmanship shall be based on approved, periodic scheduled inspection of cross sections through typical production welds, by proof testing of production welds to stresses greater than the maximum service stresses, or by nondestructive methods normally conducted by the contractor for inspecting production weldments capable of disclosing the presence of such typical defects as cracks, entrapped slag, porosity, lack of fusion, and insufficient penetration. A continuous recording system of inspection results shall be maintained.

6. NOTES

6.1 Intended use. This specification is intended for use in ascertaining that prospective aircraft and missile welders and welding operators possess a satisfactory level of proficiency.

6.2 Definitions.

6.2.1 Fusion welding. As used in this specification, fusion welding may be defined as a process in which metals are welded together by bringing them to the molten state at the surfaces to be joined, with or without the addition of filler metal and without the application of mechanical pressure or blows.

6.2.2 Welders and welding operators. Welders include personnel who make welds by manual manipulation of the electrode holder or torch held by the hand. Welding operators include personnel who operate equipment that controls the position and relative movement of the torch, arc, electron beam or plasma. The equipment performs the welding operation under the control of the welding operator who makes the initial control and positioning adjustments and other adjustments of the controls, as required, as the weld is made.

6.3 Welder's or welding operator's badge and certificate. At the option of the employer, a qualified welder or welding operator may wear a badge or be issued a certificate furnished by the employer, which indicates the type of welding, class of welding, group of alloys, date of issuance, the welder's or welding operator's name, and facsimile of the welder's or welding operator's stamp.

6.4 Marginal indicia. The margins of this specification are marked to indicate where changes, deletions, or additions to the previous issue have been made. This is done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Figures are not so marked. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - MI
Navy - AS
Air Force - 11

Reviewer activity:
Air Force - 70

User activities:
Army - MU
Navy - OS

Preparing activity:
Air Force - 11

Project No. 14GP-0001