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MIL-STD-1947(MR)

15 May 1985

MILITARY STANDARD

ULTRASONIC WELDING OF ALUMINUM AND ALUMINUM ALLOY MATERIALS

AMSC NO. A3558

AREA THJM

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DEPARTMENT OF DEFENSE
Washington, DC 20360

Ultrasonic Welding of Aluminum And Aluminum Alloy Materials

MIL-STD-1947(MR)

1. This Military Standard is approved for use by the Army Materials and Mechanics Research Center, Watertown, MA, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: AMXMR-SMS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FOREWARD

This standard prescribes the procedures for ultrasonic spot welding and establishes the requirements for joining aluminum and aluminum alloy sheet, electrical, automotive and aircraft components and assemblies.

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1. SCOPE

1.0 Scope. This standard established the requirements and procedures for joining assemblies by the ultrasonic welding process for the following types of aluminum sheets and classes of weld joint classification:

1.1 Types. Two types of aluminum sheet shall be covered:

Type I - Alclad Sheet
Type II - Non-Clad or Bare Sheet

1.2 Classification. Three classes of welded joints will be treated:

Class A - A welded joint, whose failure during any operating condition would cause loss of the equipment or system or one of its major components, loss of control, unintentional release or inability to release any armament store, failure of gun installation components; or which may cause significant injury to occupants of manned systems.

Class B - A welded joint whose failure would reduce the overall strength of the equipment or system or preclude the intended functioning or use of equipment.

Class C - A welded joint which is considered non-critical and for which no stress analysis is considered.

The class of joint used in a welded assembly will be called out on engineering drawings.

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2. REFERENCE DOCUMENTS

2.1 Specifications.

DOD-D-1000 Drawing, Engineering and Associated List.
Metal Cleaning Methods.
Vapor Degreasing of Materials.
MIL-S-5002 Surfaces Treatments and Inorganic Coatings For Metal Surfaces of Weapons.

STANDARDS

MIL-STD-100 Engineering Drawing Practices.
MIL-STD-171 Finishing of Metal and Wood Surfaces.

2.2 Other publications.

AMERICAN WELDING SOCIETY (AWS) STANDARDS

AWS A2.4 - Symbols for Welding and Nondestructive Testing.
AWS A3.0 - Welding Terms and Definitions.

(Application for copies should be addressed to the American Welding Society, 550 Northwest LeJeune Road, P.O.Box 351040, Miami, FL 33126).

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies).

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3. DEFINITIONS

3.1 Contractor and manufacturer. The term "contractor" as used in this specification is defined as the organization having a direct contact with one Government activity. The term "manufacturer" is defined as the organization actually performing the operations covered by this specification. The contractor may or may not be the manufacturer.

3.2 Welding symbols. Symbols for welding shall be as specified in AWS A2.4.

3.3 Welding terms and definitions. Welding terms and definitions shall be as specified in AWS A3.0.

3.4 Ultrasonic welding. Ultrasonic welding is a solid state welding process in which coalescence is produced at the faying surface by local application of high frequency vibratory energy while the workpieces are held together.

3.5 Production witness specimen. Weld specimens made in production setups and destructively tested to provide data on the qualities of production welds which cannot be tested.

3.6 Spot size. The bonded areas joining the parts in ultrasonic welding.

3.7 Sheet. Sheets below 0.18 inches may be ultrasonically welded to itself, although spot strength will tend toward lower strengths at greater thicknesses. Sheets may also be welded to thick members such as plates, extrusions, forgings and castings.

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4. GENERAL REQUIREMENTS

4.1 Welding equipment The equipment used in ultrasonic welding shall consist of a wedge-reed assembly, an ultrasonic transducer with a minimum capability of 4000 watts RMS, a power supply for the transducer, a control system for the power, a control system for tip pressure, an anvil assembly, a recording system for power and pressure outputs, a supporting frame and a system for clamping workpieces near or around the power tip.

4.1.1 Recording device. A multi-channel recording device shall be attached and shall record at a minimum the forward power, the load power and the pressure during a weld cycle for Class A and B joints.

4.1.2 Welding tip. The radius of the welding tip shall be greater than 10 inches. The anvil shall be flat or have a radius in excess of 10 inches.

4.1.3 Mechanical power. All elements of the mechanical power transmission system shall be dimensionally controlled. Welding records shall include a list of the elements employed including the reed, the transducer, the tip, the anvil, the anvil base and the workpiece clamp components.

4.1.4 Power and pressure system. The power and pressure control systems employed will be recorded on welding records. The control setting used in welding will be recorded. Any large permanent changes in these systems or modifications of the dials that lead to significant (i.e $>$20%) changes in the power and pressure output traces, that are being recorded, will be cause to require recertification in accordance with 5.3.6. Minor changes to the requirements of 5.5.1 will be monitored in production in accordance with 5.5.3.2.2.

4.1.5 Welding with interlayer material. When welding with interlayers between the sheets, workpiece clamps around the power tip shall leave sufficient unclamped area so that the interlayer material may freely move away from the power tip pressure zone. Inadequate freedom to flow can lead to high internal pressures in the interface area and balooning of the sheet around the tip.

4.2 Welding plan. The manufacture shall establish a welding plan for ultrasonic welding of assemblies, detailing the schedule, the weld spot sequence and tooling arrangements to insure repeatable production of uniformly shaped, acceptable parts. The welding plan shall include an engineering drawing defining the spot locations as well as a document defining the spot sequence as well as other factors which may be considered critical. Jigs or other means of locating spots will be defined in the plan.

4.3 Quality control. The manufacturer's quality control department shall insure that all certification, workmanship, property, sequence, and production monitoring provisions are enforced.

4.3.1 Schedules. The welding schedule shall be available at the machine for continual reference and for examination by the inspection group. Qualified personnel shall be responsible for operating the machines in accordance with the welding schedule.

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5. DETAILED REQUIREMENTS

5.1 Design requirements. The manufacturer designs using ultrasonic welds shall be justified by the Design Allowable Certification Method. This method establishes the requirement that the shear strengths of the welds developed by a particular schedule shall meet or exceed a given shear strength value that has been specified upon the applicable drawings. Drawing values and spot patterns shall be based upon load analysis and available spot strength data that has been shown to be predictable. The manufacturer shall assure that minimum strength spots are achieved in production.

5.1.1 When conditions are encountered which cause any of the requirements of this specification to be inapplicable, the contractor shall submit alternate procedures and requirements for approval by the procuring activity. The request for approval shall include a description of the conditions which render the requirements inapplicable, such as reduced flange widths and space limitations; and shall include data to indicate that the alternate procedures and requirements are adequate for the given application.

5.1.2 Granted approvals of alternate procedures shall remain in effect as complying with this specification until the contractor is notified otherwise by the procuring activity.

5.2 Materials and Preparation-to-Weld Requirements

5.2.1 Materials. Aluminum alloys joined or assembled in accordance with this specification shall be as specified on applicable drawings. Surfaces shall have standard mill finishes and be essentially free of surface disturbances such as scratches. No more that one scratch is permitted over the smallest of the pitch distances between spot centers.

5.2.1.1 Interlayer materials. Interlayer materials that may be applied for adhesion, sealing or faying surface protection shall be controlled by specification or by manufacturer's data sheets.

5.2.1.2 Additional materials. Materials used to facilitate welding such as scab sheets or coupling agents shall have known characteristics and shall be from known sources and such sources shall be recorded on welding records.

5.2.2 Preparation for Welding

5.2.2.1 Cleaning. Parts to be welded shall be cleaned in a consistent manner. Unless otherwise specified in the contract or purchase order, the parts shall be cleaned and deoxidized in accordance with MIL-STD-171. A maximum time interval of 30 days is permitted between cleaning and welding provided parts are kept dry and free of dust and other contamination. All metal identification marks of an organic material nature must be removed. Mechanical cleaning is not permitted prior to welding. The ability of a cleaning procedure to effectively prepare materials for welding shall be demonstrated by the ability of materials cleaned by the process to be welded in compliance with the Certification Requirements of this specification. The cleaning procedure is a necessary component of the Certification Weld Schedule. If the approved cleaning procedure is changed, recertification or certification checks shall be made to assure that that change is satisfactory.

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5.2.2.2 Treated parts. Parts which are to be surface treated by anodizing or by chemical treatments, such as Alodine, shall be so treated after cleaning. A maximum time interval of 30 days is permitted between surface treatment and welding, provided parts are kept dry and free of dust and other contamination.

5.2.2.3 Assemblies. Assemblies that are to be welded together with interlayers such as sealants, primers or adhesives shall not have these materials applied until immediately before welding application. It must be determined and established that a build-up of panel temperature will not cause curing before the welding is completed. Early curing can inhibit the attainment of proper welds. Convenient cooling systems may be employed to control assembly temperature.

5.2.3 Welding of assemblies

5.2.3.1 Welding of multispot assemblies. Welding of multispot assemblies shall be done in accordance with a prepared plan that shall include certified weld schedule(s), weld spot locations, weld spot sequences, an established arrangement(s) of mechanical power transmission components, and an established minimum shear strength for witness tests.

5.2.3.2 Interlayer material. Welding of assemblies which include interlayer between sheet pairs shall be accomplished in one continuous time period without interruptions, such as lunch time or overnight breaks, to avoid curing of the interlayer before completion. When welding with interlayers that contain solids, spots shall not be made in areas that have been compressed by the action of a clamp on any preceding weld. Special certification of weld properties are required for exceptions to this rule.

5.2.3.3 Faying surfaces. Faying surfaces of parts being joined must be free of foreign particulate matter. Fit-up before welding shall also be done in an area free of airborne particulates from filing, wire brushing, sanding, etc. Foreign particles are evident if a finger traced on the surface reveals them by coloration pickup, by a gritty sensation or by leaving a contrasting streak on the surface.

5.2.3.4 Part alignment. Part alignment shall be established with tooling holes. Alignment pins may be discarded after the second weld in an assembly of two parts.

5.2.3.5 Treated surfaces. Where ultrasonic welds have disrupted existing surface films such as anodic flims, chemical films (Alodine) or primers; these areas shall be given touch-up treatments in accordance with MIL-S-5002.

5.2.3.6 Assembly support. During welding, assemblies shall be so supported that no gravity loads or bending loads are transmitted into the welding zone. Such loads can result in permanent local deformations due to the combination of strain and ultrasonic energy.

5.3 Weld schedule certification.

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5.3.1 Certification. Four certification tests shall be performed to demonstrate that a particular machine arrangement and schedule will produce ultrasonic welds on a given combination of alloys, tempers, thicknesses, and interlayers which meet the requirements of this standard and applicable drawing spot strength minimums.

5.3.2 Certification test reports. For any given machine, the certification report shall list the machine settings, and the arrangement of the power transmission components that are to be certified for production usage. Also the machine certification data shall include profiles of pressure and power as a function of time during the weld cycle. No conditions of the test shall depart sufficiently from the production usage. Figure 2, 2A, 2B, are typical of sheets making up a certification test report.

5.3.2.1 Examination data. Part of a completed certification test report shall be the shear strength data on each weld, the average, the numbers of specimens with shear values outside of the set limits, and the spot diameters of each metallographic specimen. The examination page will have a formal indication of the success or failure to meet the certification criteria applicable to the subject material combination.

5.3.3 Shear Test

5.3.3.1 Shear test specimens. Shear test specimens of ultrasonic spotwelds, whatever the sheet thickness, must be of such dimension as to meet the following two criteria:

(1) The specimen width and the overlap of the two sheets must be such that both sheets uniformly fit within the workpiece clamps.

(2) The specimen must fail by shear or nuggeting and not by sheet tear outside the weld. If sheet tear occurs, the specimen should be made wider.

5.3.3.2 Dimensions of specimens. For most alloys and thicknesses, a specimen 2.5 inches wide and with a 2.5 inches overlap and with the weld centered within will be satisfactory. Such specimens may be prepared as single pairs or they may be saw cut from spot welded sheets whose width is some multiple of 2.5 inches" wide and which contain spotwelds in a 2.5 inches spacing.

5.3.3.2.1 Lengths. The lengths of components of joint specimens shall be a minimum of three times the width.

Shear test. The specimens shall be pulled in calibrated testing machines with the grips aligned through the center weld spot. The specimens shall be lightly clamped between teflon coated restrictor blocks during pulling with two clamps applied on either end of blocks (Figure 1). Clamps of 2 to 3 inch mouth with an 0.25 inch thread and a 1 inch wide grip faces are satisfactory when hand tightened. The blocks shall be 2X the length of the overlap. These blocks and clamps are to minimize moment rotations without adding to the test load.

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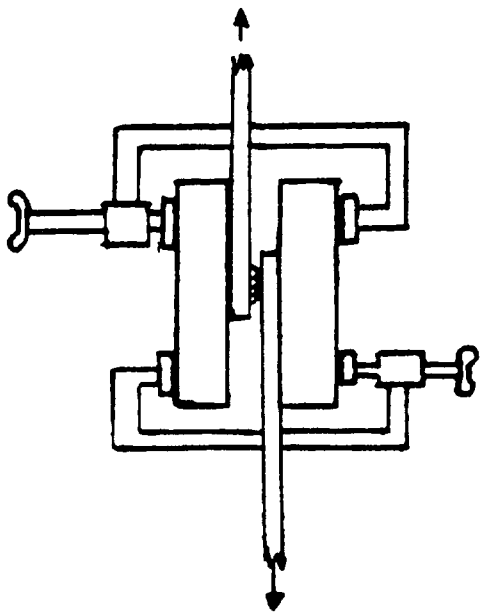

Figure 1. Shear Strength Tests

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(date coded)

Schedule _____

ULTRASONIC SPOT WELD CERTIFICATION DATA
FOR
SHEET ALLOY MATERIAL _____

Serial _____

Date Completed _____

SHEET ALLOY THICKNESS _____

Base Machine _____ Power Controller _____ Pressure Controller _____

Power Control Settings	Total Cycle Time ____ sec.	Pressure Control Settings
Scrub power _____	Frequency _____	Scrub pressure _____
Scrub time _____ sec.		Pressure slope _____
Power slope _____		Peak pressure _____
Peak power _____		Pre Squeeze _____

Power Transmission Components and Dimensions				Special Notes
1. Transducer	_____	7. Sonotrode Radius	____	
2. Wedge Reed	_____	8. Clamp Support System	____	
3. Anvil Support	_____	9. Upper Clamp Jaw	____	
4. Anvil Post	_____	10 Lower Clamp Jaw	____	
5. Anv. Post Radius	_____	11. Special Supports	____	
6. Sonotrode	_____	12. Clamp Pressure	____	

Interlayers: Thickness: Surface preparation per:

Welding Aids: Shim
Stock

Operator: _____ Engineer: _____
Signature Signature

Append Power and Pressure Traces of _____th specimen.

Figure 2

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Ultrasonic Weld Certification

Schedule Serial_____

Visible Criteria Acceptable _____ Comments:

Nonacceptable _____ per:

Fractographic character

Acceptable _____ Comments:

specimens _____ Nonacceptable _____ per:

Mechanical Criteria: (Refer to attached data sheets)

1. Lowest value _____

2. Average value _____

3. Consistency

_____% percent of the number tested have values greater .875 times the test lot average.

Design allowables:

This certificate justifies for the system tested a design shear value of:

_____lbs. at an m.s. of 0 for class ____
_____lbs. at an m.s. of 0.2 for class ____
_____lbs. at an m.s. of 0.5 for class ____
_____lbs. at an m.s. of 1.0 for class ____

Reduced testing -

This certificate has reduced testing based upon a safety margin of _____ on the drawing requirements (No lower m.s. may be applied to these data!).

Spot Size -

Weld spots in production shall not fall below _____sq. in. area.

Quality Control Inspector_____ Approved_____

Signature Date Signature Date

Figure 2A

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Ultrasonic Weld Certification

Schedule Serial _____
Data Sheet (1 of)
Lowest Value

Load	Area	Load	Area	Load	Area	Load	Area
1		26		51		76	
2		27		52		77	
3		28		53		78	
4		29		54		79	
5		30		55		80	
6		31		56		81	
7		32		57		82	
8		33		58		83	
9		34		59		84	
10		35		60		85	
11		36		61		86	
12		37		62		87	
13		38		63		88	
14		39		64		89	
15		40		65		90	
16		41		66		91	
17		42		67		92	
18		43		68		93	
19		44		69		94	
20		45		70		95	
21		46		71		96	
22		47		72		97	
23		48		73		98	
24		49		74		99	
25		50		75		100	

Highest Value

Figure 2B

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5.3.4 Design Allowable Certification - A process weld schedule will be certified to produce a shear strength requirement specified on a drawing by conforming to the design allowable certification requirements. Examination results from 5.4 shall be entered on the test report. The following number of samples shall be shear tested:

Class A - 200
Class B - 100
Class C - 50

The following number of random welds shall be peeled open for qualitative fractography:

Class A - 8
Class B - 5
Class C - 3

The design allowable certificate shall clearly state "this certificate justifies a design shear value of _____ pounds or lower, at a margin of safety of____".

5.3.5 Reduced testing with positive safety margins. To the extent that significant gaps may exist between the drawing requirement and the lowest value experienced in a test lot, a relaxation of testing requirements may be obtained in accordance with the Table I. The proper category is automatically identified as testing data accumulates. The design allowable certificate shall then state "this certificate has reduced testing based upon a safety margin of _____ over the drawing requirement".

Table I Reduced Testing Requirements

Safety Margin 1/	0	0.2	0.5	1.0
Class A	200	100	50	25
Class B	100	50	25	15
Class C	50	25	15	15

Note: 1/ (where the safety margin is: $\frac{\text{lowest test value - lbs.}}{\text{drawing requirement - lbs.}} - 1 = \text{m.s.}$)

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5.3.6 Recertification. Recertification (i.e., a repeat of the certification testing) may be required when component changes are made in the mechanical power transmission system or when important changes occur in the pressure/power output traces. Recertification may also be required if Quality Assurance Monitoring of production output indicates that spot quality has been reduced.

5.3.7 Certification checks. When a power transmission system has been disassembled/reassembled, been out of service for more than 30 days, or when a new operator assumes control, a certification check will be made. A certification check shall consist of one-half the testing required in Table 1. This check will be satisfactory if no data is outside the limits of the existing certification. Failure of the certification check will require a complete recertification. Certification checks will be appended to the existing certification.

5.4 Weld Property Requirements

5.4.1 Dimensional and visual requirements. The following requirements shall be the basis for visual examination and acceptance:

a. Assemblies made by ultrasonic welding shall be free of distortions of contour that prevent the end use fit or function. Minor local flattening of a curved shape due to clamps and the weld spot itself will be permitted.

b. Areas contacted in ultrasonic welding, including the tip, anvil and clamp contacts, shall be free of surface damage as evidenced by cracks, pits, local roughness, or step-like indentations exceeding .001 inch. Minor abrasion is acceptable.

c. No visible dimensional changes in the plane of the sheets shall be produced as a result of ultrasonic welding.

d. No extruded ribbons shall remain on the periphery of surface welds after brushing with a nonmetallic fiber brush or after stripping with a pressure sensitive tape. Minor peripheral rims are acceptable.

e. No non-aluminum, galvanically active, base metals shall be left adhering to the spot surfaces as a result of the welding operation or of the welding aids used.

f. Spot depths from the surface plane shall not exceed 10% of the sheet thicknesses at the center of the spot. Since spot strength is not significantly affected by spot depth, deviations from this rule may be taken where required and justified. Insofar as aerodynamic smoothness or appearance establish special indentation limits, these may be requested on prints and met by special welding techniques.

g. On Type I materials there shall be no disruption of the continuity of the alclad layer such that areas with long dimensions greater than .05 inch are exposed in a non-clad condition. Thinning of the alclad layer in the spot is permitted.

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h. In the normal case, spot shapes shall lie between round and oval. Any sharp deviation from normal such as triangular, semicircular, or rectangular are unacceptable when made with a round spherical tip. If tips and anvil are intentionally shaped then the spots shall reflect those shapes.

5.4.4 Fractrographic requirement. Weld spots shall be fractrographically examined for weld soundness. Fractrographic examination provides qualitative information on weld completeness and on contamination in ultrasonic welds.

5.4.2.1 Fractographic procedure. Weld spots to be examined will be peeled open by forcing the bonded sheets apart. This can be normally accomplished on Type I materials with wedges or by peeling with sufficiently long cantilever arms. Type II materials are more prone to pulling a nugget or to sheet rupture when peel is attempted. When this occurs, it can be taken as a sufficiently positive quality, in itself, to satisfy fractographic requirements. Satisfactory fractographic quality shall be evidenced by a uniform, matte metallic sheen on the peeled surface for welds without interlayers and by a uniform, matte, metallic to soft gray appearance when interlayers are present. Fractographic examination shall not show more than one visual tone in the weld spot. Two tones are evidence of either incomplete bonding or of excessive entrapped contaminant. Such welds are unacceptable unless specifically noted in the schedule certification.

5.4.3 Shear Strength Requirement

5.4.3.1 Design allowable certification. The shear strength value of the lowest specimen in the test must exceed the specified design minimun on the drawing. The test lot average shall be recorded on certification report (see Figure 2B). Ninety percent (90%) of the number of specimens tested must have values greater than .875 times the test lot average. Test data points shall be rounded off to the nearest whole number. "Where safety margins (see 5.3.5) of 0.5 or greater exist the consistency requirement shall be based on the following: 50% of the number of specimens tested must have values greater than .875 times the test lot average.

5.4.3.2 Production witness specimens for design allowable certification. The average strength of the production test lot shall be not less than 0.90 times the test lot average for Class A welds and not less than 0.875 for Class B and C welds. No specimen in a group of three consecutive test lots (see 5.3.4) (9 specimens) for Class A welds or two consecutive test lots (6 specimens) for Class B and C welds may be less that 0.84 times the test lot average for Class A welds, .80 times the test lot average for Class B welds and 0.77 times the test lot average for Class C welds.

5.5 Production Welding Quality Control

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5.5.1 Welding machine controls and adjustments. While control values shall be defined in a certification exercise it is necessary to provide a less than rigid requirement that these be tightly controlled in production. Tuning variables and temperature variables can introduce the need to periodically adjust controls during welding operations. The effects of such adjustments will be observable in the recorded power traces and in the size of the weld spot as well as its strength. The recognized relationship of size to strength permits the skilled operator to observe size and to adjust the length of the power cycle to control weld size and strength. Tuning or detuning can affect power delivery and hence spot characteristics. The degree of tuning must be monitored and adjusted by the operator. Achievement of the target spot size shall be the prime criteria in allowing control values to deviate from the certified schedule.

5.5.2 Test specimens for production monitoring. Production monitoring test specimens shall conform to the production parts they represent with respect to type, alloy, thickness combination, surface preparation and interlayer, if present. Specimens will also be of sufficient size to fully address the clamping practice used in production and otherwise satisfy the requirements of 5.5.3. When used for process monitoring, witness specimens shall employ the production weld conditions that are in use.

5.5.3 Production Witness Welds

5.5.3.1 Test lot. Independent of the class (see 1.2), a production test lot shall consist of five (5) test specimens. Three of the test specimens shall be tested in accordance with 5.3.3 and two test specimens shall be peeled for fractographic inspection in accordance with 5.4.2.1.

5.5.3.2 Test Points

5.5.3.2.1 Preproduction. One test lot will be conducted at the beginning of each shift or after a machine shutdown exceeding 2 hours.

5.5.3.2.2 Routine. Single test lots will be conducted at regular intervals or whenever changes or adjustments are made in the equipment setup. Intervals by class will be as follows:

Class A	-	before each assembly is welded when the assembly contains between 25 and 75 welds; otherwise after every 75 welds.
Class B and C	-	after every 150 welds

5.5.4 Records. Records should be made available for review by the Government representative and contractor inspection personnel, for their use at any time. Unless otherwise specified in the contract all records shall be retained by the manufacturer for 2 years after the completion of the contract.

5.5.5 Inspection of Production Parts.

5.5.5.1 Visual examination. Unless otherwise specified on the drawing or detailed specification the exterior quality of the spots shall be inspected per paragraph 5.4.1 as follows:

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Class A - All spot welds

Class B and C - Sampling as a m minimum to MIL-STD-105, AQLI.0, herd II.

5.5.5.2 Weld integrity. The internal bond below a surface spot shall be assured by the use of an ultrasonic thickness gauge which will read the combined thickness of both bonded sheets in the bond area but only the top sheet thickness when no bond exists. (A Krautkramer CL204 or equivalent is a suitable unit). Inspect as follows:

Class A - Every 4th spotweld on flat assemblies;
Every weld on curved assemblies

Class B and C - Sampling as a minimum, every 16th spot weld on flat assemblies; Every 4th weld on curved assemblies.

5.5.5.3 Spot size (area). Spot size is an important indicator of spot strength. On Class A and B joints, the spots will be scanned to determine whether all have a consistent size and that the sizes are consitent with the sizes on certification or witness welds. Major deviations in size (1/2 or less of normal) shall be cause for rejection. (see Note 2).

Monitor as follows:

Class A - Check every 5th spot and all small appearing spots

Class B and C - Check smallest spots

5.5.6 Acceptance of production parts. Unless otherwise specified in the contract conformance of production parts to paragraphs 5.5.5.1, 5.5.5.2 and 5.5.5.3 as well as 5.5.3 shall have primary weight in accepting production parts. Nonconformance of production machine parameters to the certification parameters will be of secondary importance and shall be carefully considered before being a basis for rejection of production parts.

5.5.7 Correction of sub-size spots. When limited numbers of spots (less than 2%) are found to be below the required area size, such spots may be rewelded directly over the old weld or a reinforcing weld may be made immediately adjacent to the sub-par weld.

5.5.8 The reduction of spot quality. The occurrence of significant numbers of sub-size spots (i.e., more than 2%) or other quality problems shall be reason for a suspension of production and for requiring a recertification of the weld schedule(s) being used.

Notes

1. Radiographic inspection. Radiographic criteria are not applicable to ultrasonic welding since no bulk melting occurs in the spots and there are no propensities for the development of shrinkage cracks or porosity.

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2. Spot size. Improper schedules can produce surface fatigue cracks, however, these are both visible and apparent from low shear test values. Spot sizes should be consistent under properly controlled welding conditions; obvious deviations (1/2 or less of normal size) from a consistent size is a basis for evaluation of controls and recertification.

3. Metallographic examination. Metallographic (i.e., cross section examination of the weld plane) examination is not a useful or satisfactory procedure for monitoring the quality of ultrasonic welds. The quality of ultrasonic welds depends largely upon the dispersion of minute entrapped oxides and other contaminants. Metallographic examination is not required.

Custodian:
Army - MR

Review activities:
Army - AV

Preparing activity:
Army - MR

Project No. THJM-A225

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APPENDIX A

When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DAR 7-104.9 (n) (2) or the applicable FAR DoD supplement are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.

Paragraph No.	Data Requirement Title	Applicable DID No.
4.1.4	Ultrasonic Welding Certification Test Report	DI-T-1928
5.3.2		
5.4.3.1		

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