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MILITARY STANDARD

WELDING, FLASH, STANDARD LOW CARBON STEEL

AMSC N/A
AREA THJM

DEPARTMENT OF DEFENSE
Washington, DC 20301

Welding, Flash, Standard Low Carbon Steel

1. This Military Standard is approved 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: US Army Tank-Automotive Command, ATTN: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

This document contains information on a welding process where fusion is achieved over the entire abutting surfaces of two plates, bars or tubes without utilization of filler metal in one welding operation. This fusion is achieved by the heat generated by the resistance to the flow of electric current between the faying surfaces followed by the application of pressure when the required heating is completed.

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1. SCOPE

1.1 Scope. This standard covers procedures for the flash welding of standard low carbon steels with a carbon content not greater than 0.23.

2. REFERENCED DOCUMENT

2.1 Government document.

2.1.1 Specifications. Unless otherwise specified, the following specification of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation forms a part of this standard to the extent specified herein.

SPECIFICATION
MILITARY

MIL-W-6873 - Welding; Flash, Carbon and Alloy Steel

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document (s) form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernmental documents which is current on the date of the solicitation

AMERICAN SOCIETY FOR TESTINC AND MATERIALS

ASTM A370 - Mechanical Testing of Steel Products.
ASTM E8 - Tension Testing of Metallic Materials.

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

AMERICAN WELDING SOCIETY

ANSI/AWS A3.0 - Standard Welding Terms and Definitions.

(Applications for copies should be addressed to American Welding Society, Inc., 550 N.W. LeJeune Road, P.O. Box 351040, Miami, Florida 33135.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Definitions. The definitions of the terms used in this standard, except where noted, are in accordance with ANSI/AWS A3.0, Standard Welding Terms and Definitions.

3.1.1 Faying surface. The mating surface of a member that is in contact with or in close proximity to another member to which it is to be joined.

3.1.2 Flash. Material that is expelled from a flash weld prior to the upset portion of the welding cycle.

3.1.3 Flash welding. A resistance welding process that produces coalescence at the faying surface of a butt joint by a flashing action and by application of pressure after heating is substantially completed. The flashing action, caused by very high current densities at small contacts between parts, forcibly expels the material from the joint as the parts are slowly moved together. The weld is completed by a rapid upsetting of the work pieces.

3.1.4 Production run. As defined in MIL-W-6873, a production run is the production flash welding of identical parts without a change in machine setup for 4 hours of continuous operation or for a period of time acceptable to the inspector.

3.1.5 Upset. Bulk deformation resulting from the application of pressure in welding. The upset may be measured as a percent (%) increase in interface area, or a reduction in length.

3.1.6 Upset distance. The total loss of axial length of the work pieces from the initial contact to the completion of the weld. In flash welding, the upset distance is equal to the platen movement from the end of flash time to the end of upset.

3.1.7 Weld failure. As defined in MIL-W-6873, a weld failure is a failure either partially or wholly in the weld plane except for partial weld-plane failures in heat-treated whole specimens. Partial weld-plane failures in heat-treated whole specimens are not considered weld failures where a fracture in the weld plane does not exceed 25% of the weld area and is accompanied by visual necking down of the parent metal.

4. GENERAL REQUIREMENTS.

4.1 Requirements. The equipment shall be capable of bringing the two sections to be welded into contact, initiating the flow of welding current and causing a "flashing" action between the faying surfaces of the adjacent pieces of metal. As the metal on the surfaces is burned or flashed away, the movable platen shall advance and maintain the gap within appropriate limits such that flashing is maintained until the mating surfaces and adjacent areas have attained a degree of plasticity suitable for welding. The surfaces shall be rapidly brought together with sufficient force to close all craters formed during flashing, expel molten metal and substantially all oxides and impurities from the weld proper, upset the adjacent metal, and produce welds of acceptable quality.

4.1.1 Equipment. The welding equipment shall be of sufficient capacity and shall be supplied with adequate utilities to produce good quality flash welds. Means shall be provided for automatically controlling the feed of the joint during flashing, the rates and distance of travel of the sections to be welded, and for controlling the secondary voltage and current magnitudes and timing, and the time of current cutoff.

4.1.2 Operation. Once the process has been initiated by the operator, the equipment shall follow the sequence of operations automatically and complete the weld. The equipment shall consistently produce welds which meet the quality standards specified herein.

4.1.3 Electrodes. The electrodes shall be of adequate size, and shall be so fitted to the surfaces of the parts to be welded so that the necessary current will be uniformly distributed about the contact zone, and shall be conducted from the electrode to the work without damage owing to localized overheating.

4.1.4 Control of machine variables. The equipment shall be set up by experienced operators under the supervision of a welding engineer or other authorized personnel.

4.1.5 Welding schedules. Complete flash welding procedure schedules shall be established as specified herein for the joints to be welded in production and approved by the Government inspector before a machine may be used in the welding of items to be furnished on Government contract.

4.1.6 Flash removal. A sufficient amount of the extruded or upset metal shall be removed from all weld areas in order that no defective or unsound material remains. A weld shall be rejected if it is necessary to machine below the level of the surface of the parent metal to remove surface defects. Unless otherwise specified, the removal of the internal flash from joints in hollow shapes will not be required.

4.2 Materials. Standard low carbon steels of not greater than 0.23 carbon content may be welded provided that all requirements of this standard are met.

4.2.1 Cleaning. The surfaces of the parts contacting the electrodes, and the surfaces at the fusion zones, shall be clean and free from oxides, paint, grease, dirt or foreign matter which would interfere with the flow of current or fusion of the metal. Chemical cleaning or grit blasting are preferred. Sand blasting may be employed provided the surfaces are treated to remove imbedded sand particles prior to welding.

4.3 Inspection requirements. Flash welded joints shall be sound and free from injurious defects such as cracks, inclusions, die burns and porosity which affect the strength or serviceability of the part.

5. DETAILED REQUIREMENTS

5.1 Joint preparation. Joints shall be designed and prepared such that mating parts be aligned in a manner that the heat generated by the flow of current will be uniformily distributed over the section. The details of joint preparation shall be determined by the contractor and shall become a part of the welding schedule. Recommended practices are shown in figure 1.

5.1.1 Joint alignment tolerances.

5.1.1.1 Sheet and tubular joints. For sheet thickness or wall thickness of tubing 0.080 inch and less, the misalignment of thickness shall not exceed 0.008 inch. For sheet or wall thickness greater than 0.080 inch, the misalignment of thickness shall not exceed 10% of the nominal section thickness up to a maximum of 0.030 inch, except for the following two higher ratios where a smaller misalignment is required.

O.D. Wall Ratio (maximum)	Misalignment Tolerance Percent Maximum
35:1	6
40:1	4

Misalignment shall be measured at, or near, the plane of the weld before the flash is removed.

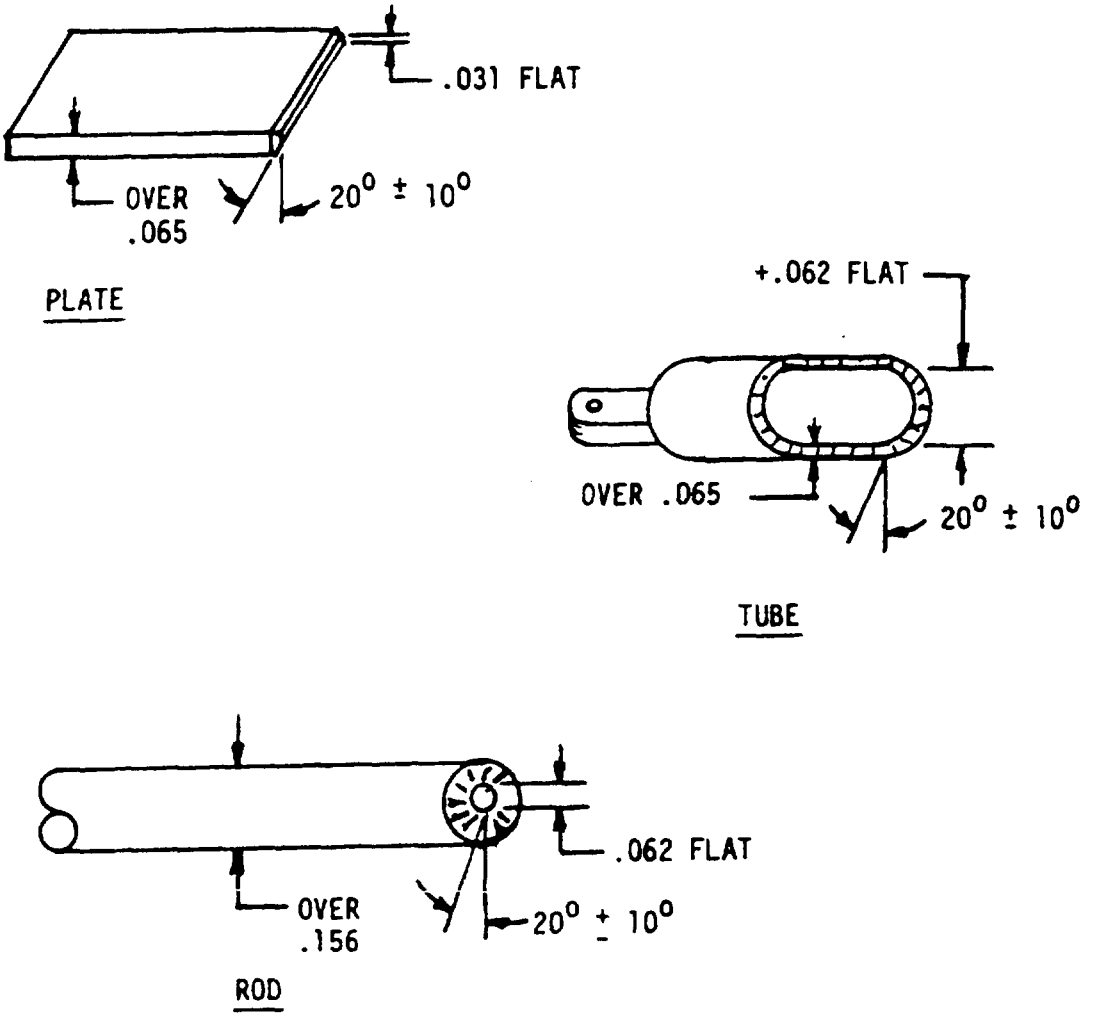
5.1.1.2 Bars. The misalignment of the surfaces in joints between bars and rods shall not exceed 5% of the diameter or thickness when measured at, or near, the plane of the weld, before the flash is removed.

5.1.1.3 Angular misalignment. The angular misalignment of the welded joints shall not exceed 0.005 inch per inch of length.

5.1.1.4 Limitation on tubing. Tubing possessing a ratio of outside diameter to wall thickness of greater than 30:1 shall not be flash-welded unless the equipment is capable of meeting the more rigid alignment tolerances for 35:1 and 40:1 ratios specified in 5.1.1.1.

5.2 Certification of welding schedules.

5.2.1 Flash welding schedules. Welding schedules shall be established by the contractor for each joint differing in material, area or contour from joints previously welded in accordance with approved schedules, or for each welding machine over an appropriate range of cross-sectional area, or wall thickness or both.



NOTE: a. THE ENDS OF PARTS TO BE WELDED SHALL BE CUT SQUARE WITHIN PLUS OR MINUS 1/2 A DEGREE.

b. WHEN THE NOMINAL STOCK THICKNESS EXCEEDS THE VALUES GIVEN IN THIS FIGURE, CHAMFER ONE OF THE PARTS AS SHOWN. IN THE EVENT IDENTICAL PARTS ARE TO BE WELDED TO EACH OTHER RESULTING IN EACH BEING CHAMFERED, CHANGE THE ANGLE TO 10°.

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.

FIGURE 1. Recommended end preparation for flash butt welding of tubing, flat sheets, and bar.

5.2.2 Weld schedule content. A complete welding schedule shall include the preparation of the parts to be welded, choice of electrodes and fittings, and appropriate machine control devices and settings to provide the proper sequence of events. A typical flesh welding schedule is shown in figure 2.

Manufacturer of machine _____
Type and serial number _____
Capacity of machine _____
Transformer tap setting _____
Transformer turns ratio _____
Secondary voltage (Approx) _____
Flashing time (seconds) _____
Beginning of upset to current cutoff _____
Burnoff (inches) _____
Upset travel (inches) _____
Platen travel control cam (when used) _____
Area of electrode contact areas _____
Work locaters employed _____
Material and surface condition _____
Details of joint preparation: (Show sketch and dimensions.)

_____
* Signature (Welding Engr)

_____
* Signature (Govt Inspector)

*Note: The supervisory welding engineer or authorized alternates and the authorized Government Inspector shall sign schedule form.

FIGURE 2. Typical welding schedule.

5.2.3 Establishing welding schedules.

5.2.3.1 General. The three initial welding schedules established by the contractor for a given machine shall represent joints of the greatest and least cross-sectional areas to be welded in production plus one joint of intermediate area. To determine the acceptability of the settings and the consistency of the resulting welds, 15 or more specimens shall be welded at each of the 3 points, the welds tested to destruction in tension or bending, and the test data submitted to the authorized inspector with a request for approval of the welding schedules represented. Assemblies welded with the respective machine shall not be acceptable as items furnished on a Government contract until approval of the welding schedules has been obtained. Weld schedules shall not be changed during a production run, except as provided in 5.2.3.2.

5.2.3.2 Additional schedules or modification of existing schedules. To weld parts with cross-sectional areas other than those specifically checked above, or to accomplish minor modification of existing schedules as may be necessary, the contractor shall demonstrate that the settings for these secondary points are acceptable on five sample parts or control specimens. If unsatisfactory results are obtained for a secondary point, a sample of 15 shall be run to check the point, after suitable adjustments in settings have been made. Specific approval of each additional schedule will not be required, but complete records shall be made readily available to operating personnel and authorized inspection personnel for reference at any time.

5.2.4 Production run. Unless otherwise specified, one setting of the machine shall satisfactorily weld the maximum and minimum cross-sectional areas scheduled during a production run. No change in setting shall be made during a run without the approval of the authorized inspector.

5.2.5 Individual part certification. When one, or a limited number of joint types are to be welded in production and complete qualification of the machine is not considered necessary or desirable, the contractor may establish individual schedules on the basis of 15 test specimens, subject to approval by the authorized inspector.

5.3 Certification test specimens. Either production parts or simulated parts may be used in welding certification test specimens. The parts shall be prepared under production conditions. The mating surfaces to be joined and the electrode contact areas shall be indentical with the production part in cross-sectional area, contour, and finish. The joints shall be welded in accordance with the proposed welding procedure and with the requirments specified herein.

5.3.1 Type of specimens. Specimens shall be tested in full section whenever practicable. Where test specimens are too large to be tested in full section, tensile coupons conforming to an appropriate type, as defined under ASTM E8 may be cut from locations, such that the weld zone is included in the test section. The aggregate weld area of the coupons shall be approximately 50% of the area of the weld joint represented.

5.4 Test procedures.

5.4.1 Contractor inspection. Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements as specified herein. The Government reserves the right to perform or witness any of the inspections set forth in this standard.

5.4.2 Production control. All specimens required herein for checking production flash welding shall be welded in accordance with the established schedule.

5.4.3 Sample testing. Unless otherwise specified on the drawing, in the contract, or order, the amount and type of testing other than visual, shall be performed at the discretion of the Government inspector.

5.4.4 Visual examination. Each flash-welded joint shall be examined for cracks, die burns, telescoping, and other indications of unsound welding before and after the flash is removed.

5.4.5 Destructive tensile test. A destructive tensile test shall be performed in accordance with the requirements specified in 5.3. Other methods of destructive tests such as bend tests, impact tests or short-time fatigue tests, which are sensitive to variation in weld quality may be used when approved by the procuring activity.

5.4.6 Tensile tests. The whole weld test specimen shall be subjected to tensile tests in accordance with ASTM A370. Where test specimens are too large to be tested in whole, they may be cut into tensile coupons prior to testing in accordance with ASTM E8, except that reduction in size of the test section of the specimens will not be required. The entire test specimen, except that part removed by machining, shall be tested when cut into coupons. The ultimate strength of the parent metal will be determined from the average of not less than three tensile tests. Specimens of welded joints having failures completely outside of the weld may be substitutued for tensile specimens of the parent metal.

5.5 Test requirements.

5.5.1 Whole specimens. The results of the tests on whole specimens shall conform to the following:

a. No specimen tested in the "as welded" condition shall fail in the weld.
b. For other specimens and conditions, failure in the weld shall be acceptable provided the stress at failure is not less than 95% of the ultimate strength of the base metal or 95% of the average ultimate strength of those specimens (if two or more in number) in which base metal failures occurred. The strength of the base metal shall be determined by retesting a part of the original specimen or by testing a standard tensile coupon machined therefrom.

5.5.2 Strip test coupons. Provided that no defects associated with faulty welding conditions are present, the results of tests on coupons shall be acceptable when:

a. The average strength of all the coupons from each specimen is not less than 95% of the average strength of the parent material.
b. The minimum test value shall be not less than 80% of the average strength of all the coupons, except that one coupon may have a test value below 80% but above 60% provided the previous history of the tests for the particular setting shows that the frequency of occurrence of the lower test values is not greater than 1%

5.6 Machine maintenance. The contractor shall satisfy the inspector that all resistance welding equipment receives adequated maintenance attention, that the operation of all component parts is checked periodically, and that any defective parts are replaced before operation is resumed.

5.6.1 Retests. If the results of tests for a particular machine setup are not satisfactory, the machine setup shall be checked and any unsatisfactory condition corrected. The machine setup shall then be recertified using five specimens in accordance with the requirements of 5.3.

5.7 Certification of equipment. Inspection of the contractor's records shall provide proof that the equipment and welding schedules produce flash welded assemblies that meet the requirements of this standard.

6. NOTES

6.1 Intended use. The procedures covered by this specification are intended for Military tracked and wheeled vehicle applications and other applications where control procedures are desired.

6.2 Protective atmosphere welding. For greater assurance of weld quality, tubing with a wall thickness over 0.149 inch should be welded in a protective atmosphere.

6.3 Subject term (key word) listing.

Flash welding, low carbon steel
Low carbon steel, flash welding
Steel, welding of
Welding
Welding, low carbon steel

Custodian:
Army - AT

Review activity:
Navy - SH

User activity:
Army - AR
Navy - OS

Preparing activity:
Army - AT

(Project THJM-A252)

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MIL-STD-336, WELDING, FLASH, STANDARD LOW CARBON STEEL

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