

**INCH-POUND**

MIL-S-24149C(SH)

27 March 1989~~SUPERSEDING~~

MIL-S-24149B

1 June 1981

(See 6.8)

## MILITARY SPECIFICATION

STUDS, WELDING, AND ARC SHIELDS (FERRULES),  
GENERAL SPECIFICATION FOR

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers studs for welding with stud welding equipment and arc shields (ferrules) for shielding studs where applicable.

1.2 Classification. Studs and arc shields (ferrules) shall be of the following types, as specified (see 6.2). Classes and styles shall be as specified on the applicable specification sheet.

- Type I - Carbon steel studs, fluxless weld-end.
- Type II - Carbon steel studs, solid flux or aluminum flux coated weld-end.
- Type III - Aluminum alloy studs, bulb weld-end.
- Type IV - Aluminum alloy studs, cone protection weld-end.
- Type V - Corrosion-resistant steel studs, solid flux weld-end.
- Type VI - Carbon steel studs, tipped or pointed weld-end.
- Type VII - Aluminum alloy studs, tipped or pointed weld-end.
- Type VIII - Corrosion-resistant steel studs, tipped or pointed weld-end.

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 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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## SPECIFICATIONS

## FEDERAL

- QQ-P-35 - Passivation Treatments for Corrosion-Resisting Steel.
- PPP-F-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.
- PPP-H-1581 - Hardware (Fasteners and Related Items), Packaging of.

## MILITARY

- MIL-C-14550 - Copper Plating (Electrodeposited).
- MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
- MIL-C-87115 - Coating, Immersion Zinc Flake/Chromate Dispersion.

(See supplement 1 for list of associated specification sheets.)

## STANDARDS

## MILITARY

- MIL-STD-248 - Welding and Brazing Procedure and Performance Qualification.
- MIL-STD-1318 - Fastener Test Methods Method 8, Tensile Strength.

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099).

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A 380 - Standard Practice for Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems. (DoD adopted)
- A 751 - Standard Methods, Practices, and Definitions for Chemical Analysis of Steel Products.
- B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel. (DoD adopted)
- B 695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel. (DoD adopted)
- E 34 - Standard Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys. (DoD adopted)
- E 353 - Standard Methods for Chemical Analysis of Stainless Heat-Resisting, Maraging and Other Similar Chromium - Nickel-Iron Alloys.

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

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## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

## B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017 or the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.3.

3.3 Materials.3.3.1 Studs.

3.3.1.1 Studs (types I, II, and VI). Studs shall be manufactured from carbon steel of chemical composition indicated in the appropriate specification sheet.

3.3.1.2 Studs (types III, IV, and VII). Studs shall be manufactured from aluminum alloy of chemical composition indicated in the appropriate specification sheet.

3.3.1.3 Studs (types V and VIII). Studs shall be manufactured from corrosion-resistant steel (CRES) of chemical composition indicated in the appropriate specification sheet. Studs shall be fabricated from annealed bar stock (90 Rockwell B maximum hardness).

3.3.2 Arc shields (ferrules). Arc shields (ferrules), as applicable, shall be formed of heat-resistant ceramic material capable of maintaining their designed shape when subjected to the heat of the metallic arc. The number of vents is optional.

3.3.3 Welding flux. Solid flux for use on solid flux studs and aluminum flux for use on aluminum flux coated weld-ends shall be commercially pure aluminum of suitable size and shape to assure satisfactory welding characteristics.

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3.3.4 Recovered materials. Unless otherwise specified herein, all material and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.4 Design and construction.

3.4.1 Threads. All threads shall be in accordance with ANSI B1.1 as specified on individual specification sheet.

3.4.2 Grooves (annular rings). The grooves (annular rings) of the stud shall be made by rolling or machining.

3.4.3 Concentricity. The concentricity of the stud diameter of the threaded parts, shank, collar, shoulders and weld-ends to each other and to the inserted flux or slag points shall not vary more than 0.050 inch.

3.4.4 Flux components. Flux components, as applicable, shall be tightly fitted and secured to the stud.

3.4.5 Arc shields. Arc shields shall be supplied with studs as applicable. The arc shield dimensions shall be compatible with standard stud-welding equipment.

3.5 Performance characteristics. The studs shall meet the following performance requirements, when subjected to the applicable tests specified in 4.5 and 4.6.

3.5.1 Chemical analysis. The chemical composition of the studs shall be in accordance with that specified on the applicable specification sheet (see 4.5.2).

3.5.2 Bend. The studs shall withstand the bend tests with no visual evidence of cracking in the weld zone (see 4.6.1).

3.5.3 Tensile strength. The studs shall meet the tensile strength requirements specified on the applicable specification sheet (see 4.6.2).

3.5.4 Torque. If the torque test of 4.6.3 is conducted in lieu of tensile testing, stud threads shall be free of any lubricant and shall meet the minimum torque value specified in table I.

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TABLE I. Minimum torque requirements (ft-lb).

Stud thread size	Aluminum	Carbon steel or CRES
No. 10	---	2.6
1/4	5	6.5
5/16	9.6	12.5
3/8	16	23
7/16	24	37
1/2	36	57
5/8	---	115
3/4	---	207

3.6 Protective coating or treatment. Unless otherwise specified in the contract (see 6.2), all studs shall be furnished without protective coating or treatment.

3.6.1 Zinc coating. When specified (see 6.2), carbon steel studs shall be zinc coated in accordance with ASTM B 633, type II, class Fe/Zn 13, ASTM B 695, class 12, or MIL-C-87115, class 3.

3.6.2 Copper coating. When specified (see 6.2), carbon steel studs shall be copper coated in accordance with MIL-C-14550.

3.6.3 Passivation. When specified (see 6.2), corrosion-resistant steel studs shall be cleaned and descaled in accordance with ASTM A 380, and passivated in accordance with QQ-P-35.

3.7 Workmanship. The workmanship shall be uniform in quality and the surface shall not contain any foreign matter, corrosion, or detrimental defects, such as perforations, sharp edges or corners, seams, cracks, laps, dents, raised metal, nicks, scratches, burrs, or other irregularities which might adversely affect performance, reliability, maintainability, or safety.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies

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submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) First article inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of the examinations and tests specified in 4.5 and 4.6 (see 6.3 and 6.6).

4.3.1 First article unit. Forty studs of each type and class having the same weld-end geometry, flux, and arc shield for which first article approval is required shall be subjected to first article inspection. The 40 studs shall be subjected to the visual and dimensional examinations specified in 4.5. Twenty welded stud samples shall be bend tested in accordance with 4.6.1 and 20 welded stud samples shall be tensile tested in accordance with 4.6.2.

4.3.2 Retest. If failure occurs in the weld zone for any bend test or at less than specified minimum tensile strength of the stud in any of the tensile tests, a new first article unit shall be prepared and tested. Repetition of such failures shall be cause for refusal to grant first article approval.

4.3.3 Acceptance. For a stud and arc shield to be first article approved, each stud of each group of 40 studs shall, by test or retest, meet all first article inspection requirements.

4.3.4 Duration of first article approval. A type and class of stud with arc shield, once first article inspected, is considered first article approved until the stud manufacturer makes any change in the weld-end geometry, material, flux, or arc shield which affects the welding characteristics (see 6.3).

4.4 Quality conformance inspections.

4.4.1 Lot. A lot shall consist of all studs and arc shields of one heat of stud material (same type and class covered by a single specification sheet) and produced under essentially the same conditions (see 6.3).

4.4.2 Inspection conditions. Unless otherwise specified in the contract (see 6.2), all inspections shall be performed in accordance with the test conditions specified in the applicable test method paragraph.

4.4.3 Sampling.

4.4.3.1 Samples for visual and dimensional inspection. Samples shall be selected for visual and dimensional inspection as shown in table II. The following discrepancies shall be considered defectives for rejection purposes:

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- (a) Material failing to meet specified requirements.
- (b) Dimensions not within specified tolerances.
- (c) Protective coatings or treatment failing to meet specified requirements.
- (d) Flux inserts (as applicable), nonconforming, missing, or not tightly fitted.
- (e) Arc shields, improper size, chipped or cracked.

TABLE II. Sampling for visual and dimensional examination.

Number of studs in inspection lot	Number of studs in sample
2 - 15	2
16 - 25	3
26 - 90	5
91 - 150	8
151 - 280	13
281 - 500	20
501 - 1200	32
1201 - 3200	50
3201 - 10000	80
10001 - 35000	125
35001 - 150000	200
150001 - 500000	315
500001 & over	500

4.4.3.2 Samples for chemical analysis. One sample shall be selected from each heat or lot (see 6.3).

4.4.3.3 Samples for bend and tensile tests. Sample size shall be as specified in table III.

TABLE III. Sampling for bend and tensile tests.

Number of studs in inspection lot	Number of studs in sample
2 - 50	2
51 - 500	3
501 - 35000	5
35001 and over	8

4.4.3.4 Samples for coating or surface treatment tests. Samples for stud coating or surface treatment tests shall be taken as specified in the applicable coating specification (see 6.3).

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4.4.4 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using a tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.4.5 Test requirements and methods. Test requirements and examinations and tests shall be in accordance with table II.

TABLE IV. Test requirements and methods.

Test	Requirement	Examination or test
Chemical analysis	3.5.1	4.5.2
Bend test	3.5.2	4.6.1
Tensile strength test	3.5.3	4.6.2

4.5 Examinations. Examinations shall be performed as follows:

4.5.1 Visual and dimensional inspection. Studs and arc shields (ferrules) shall be examined to determine conformance to this specification and applicable specification sheet with respect to all requirements.

4.5.2 Chemical analysis. Samples selected in accordance with 4.4.3.2 shall be analyzed in accordance with ASTM A 751 for steel, ASTM E 34 for aluminum, and ASTM E 353 for corrosion-resistant steel.

4.6 Tests. Tests shall be performed as follows:

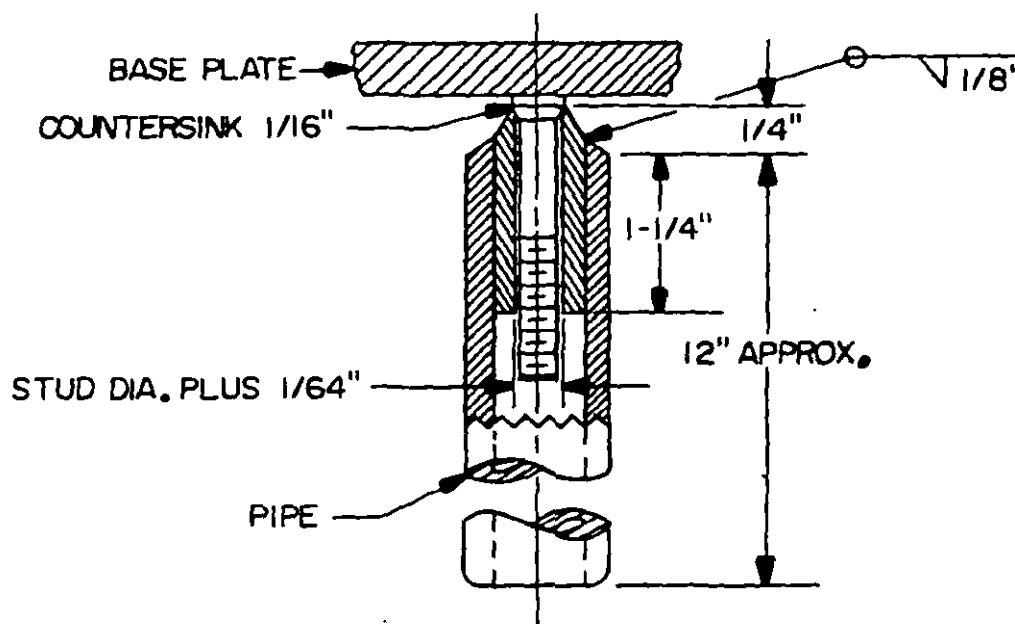
4.6.1 Bend test.

4.6.1.1 Steel. Carbon steel and corrosion-resistant steel studs shall be welded in accordance with MIL-STD-248 in a perpendicular position to suitable base plates and bent 90 degrees, or until stud fails with no evidence of cracking in the weld zone.



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4.6.1.2 Aluminum. Aluminum alloy studs shall be welded in accordance with MIL-STD-248 in a perpendicular position to suitable base plates and bent 15 degrees as shown on figure 1 with no evidence of cracking in the weld zone.



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FIGURE 1. Suggested test setup for bending aluminum alloy welded studs.

4.6.2 Tensile strength test. Welded studs shall be subjected to a minimum tensile stress in accordance with MIL-STD-1318. The stud shall be tested to failure and shall meet the minimum tensile load requirement. The tensile load is based on the cross-sectional area of the minor diameter or shank diameter, whichever is less, times the minimum required tensile strength.

4.6.3 Torque test. At the option of the contractor, threaded studs may be torque tested in accordance with MIL-STD-248, in lieu of the tensile strength test.

4.7 Inspection of packaging. Sample packs, and the inspection of the preservation, packing and marking for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

## 5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Preservation, packing and marking. Studs and arc shields shall be preserved level A, B or commercial (level C), packed level A, B or commercial (level C) as specified (see 6.2), and marked including bar coding and other ordering data options in accordance with PPP-H-1581. In addition, for Navy acquisitions, the following applies:

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(a) Navy shipboard stowage fire-retardant requirements.

- (1) Treated lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.  
Category 1 - general use.

Level C - Type I - non-weather resistant.  
Category 1 - general use.

- (2) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes shall meet the flamespread index and the specific optic density requirement of PPP-F-320.

5.2 Level A preservation and levels A and B packing. Use of all types of loose-fill materials for packaging applications such as cushioning, filler, or dunnage is prohibited for items destined for shipboard installation/stowage.

5.3 Commercial (level C) preservation and packing. When loose-fill type materials are used for packaging applications such as cushioning, filler, and dunnage, all containers (unit, intermediate, and shipping) shall be marked or labeled with the following information:

## "CAUTION

Contents cushioned with loose-fill material shall not be taken on board ship. Remove and discard loose-fill material. If required, recushion with cellulosic material, bound fiber, fiberboard, or transparent flexible cellular material."

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

6.1.1 Types I, II, and VI. Types, I, II, and VI studs, applied to steel surfaces by automatic stud-welding equipment, are used as a means of attaching sheathing, insulation, electric cables and equipment, piping, and other parts.

6.1.2 Types III, IV, and VII. Types III, IV, and VII studs, applied to aluminum alloy surfaces by automatic stud-welding equipment, are used as a means of attaching insulation and sheathing to aluminum alloy decks, bulkheads, and other attachments where permitted under the applicable specification.

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6.1.3 Types V and VIII. Types V and VIII studs, applied to corrosion-resistant steel surfaces by automatic stud-welding equipment, are used as a means of attaching electric cables and equipment, piping, and other parts in highly corrosive atmospheres.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification and applicable specification sheet.
- (b) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (c) Type of stud and arc shield (see 1.2).
- (d) Applicable Military Specification Sheet part numbers.
- (e) First article inspection, whether required (see 3.2).
- (f) Type of protective coating or treatment (see 3.6).
- (g) If inspection conditions are other than specified (see 4.4.2).
- (h) Level of preservation and packing requirements (see 5.1).
- (i) When fire-retardant requirements are not required (see 5.1(a)(1)(2)).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
4.3	DI-T-4901	First article inspection report	-----
4.3.4	DI-E-2037	Engineering change proposals (ECP's) and requests for deviations and waivers (long form)	-----
4.3.4	DI-E-2038	Engineering change proposals (ECP's) and requests for deviations and waivers (short form)	-----
4.4.1, 4.4.3.2, and 4.4.3.4	DI-E-2121	Certificate of compliance	-----

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

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6.4 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.2), and the number of items to be tested as specified in 4.3. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.5 Acceptable quality levels (AQL). Recommended AQL for visual and dimensional examination is 4.0, and for bend and tensile tests is 1.5.

6.6 First article inspection report. The first article inspection report should include results of all tests and a complete description, including dimensions and tolerances, of the studs, weld-ends, arc shields, and flux.

6.7 Subject term (key word) listing.

Bend test  
Copper coating  
Grooves  
Threads  
Tensile strength  
Torque

6.8 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:  
Navy - SH  
(Project 5307-N024)

**STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL***(See Instructions - Reverse Side)***1. DOCUMENT NUMBER**

MIL-S-24149C(SH)

**2. DOCUMENT TITLE STUDS, WELDING, AND ARC SHIELDS (FERRULES),**

GENERAL SPECIFICATION FOR

**3a. NAME OF SUBMITTING ORGANIZATION****4. TYPE OF ORGANIZATION (Mark one)**☐

VENDOR

☐

USER

☐

MANUFACTURER

☐

OTHER (Specify): \_\_\_\_\_

**b. ADDRESS (Street, City, State, ZIP Code)****5. PROBLEM AREAS****a. Paragraph Number and Wording:****b. Recommended Wording:****c. Reason/Rationale for Recommendation:****6. REMARKS****7a. NAME OF SUBMITTER (Last, First, MI) - Optional****7b. WORK TELEPHONE NUMBER (Include Area Code) - Optional****c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional****8. DATE OF SUBMISSION (YYMMDD)**

TO DETACH THIS FORM, CUT ALONG THIS LINE.