

MIL-F-18251C  
 24 October 1967  
 SUPERSEDING  
 MIL-F-18251B  
 20 July 1960  
 (See 6.3)

MILITARY SPECIFICATION

FLUXES, WELDING, SUBMERGED ARC PROCESS

CARBON AND LOW-ALLOY STEEL APPLICATION

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

1. SCOPE

1.1 Scope. This specification covers fluxes for welding carbon and low-alloy steels by the submerged arc process with A1 and B1 types bare coiled electrodes of MIL-E-18193.

1.2 Classification.- Fluxes shall be furnished in the following types, as specified (see 6.2):

Type

MIL-F1  
 MIL-F2  
 MIL-F3

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 the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

UU-S-48 - Sacks, Shipping, Paper  
 PPP-D-723 - Drums, Fiber

MILITARY

MIL-E-18193 - Electrodes, Welding, Carbon Steel and Alloy Steel, Bare, Coiled

STANDARDS

FEDERAL

Federal Test Method Std. No. 151 - Metals, Test Methods

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes  
 MIL-STD-147 - Palletized and Containerized Unit Loads 40"X48" 4-Way  
 (Partial) Pallet Skids, Runners, or Pallet-Type Base  
 MIL-STD-271 - Nondestructive Testing Requirements for Metals

PUBLICATIONS

MILITARY

NAVSHIPS 0900-003-9000 - Radiographic Standards for Production and Repair Welds

(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.)

2.2 Other publications.- The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect, on date of invitation for bids or request for proposal shall apply.

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UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules .

(Applications for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Blvd., Chicago, Ill. 60606.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A212 - Specification for High Tensile Strength Carbon-Silicon Steel Plates for Boilers and Other Pressure Vessels
- A370 - Methods and Definitions for Mechanical Testing of Steel Products

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

AMERICAN WELDING SOCIETY (AWS)

- Z49.1 - Safety in Welding and Cutting--American Standard

(Applications for copies should be addressed to the American Welding Society, Inc., United Engineering Center, 345 East 47th Street, New York, N.Y. 10017.)

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

3. REQUIREMENTS

3.1 Material.- The materials shall be such as to yield fluxes conforming to the requirements of this specification.

3.2 Uniformity.- Basic materials shall be assembled in such a manner that the composition of the finished product, when determined as specified in 4.4.1, shall not vary between different parts of the same lot by more than 10 percent.

3.3 Flux form and particle size.- A flux shall be granular in nature and capable of free flowing through the flux feeding tubes, valves, and nozzles of standard welding equipment, but need not otherwise have a specific particle size or shape.

3.4 Composition.-

3.4.1 Characteristic alloying element.- The different types of flux shall contain the following characteristic alloying elements, or oxides as indicated, within the limits specified.

3.4.1.1 Type MIL-F1.- The flux shall contain a minimum of 17 percent by weight of manganese.

3.4.1.2 Type MIL-F2.- The flux shall contain a minimum of 35 percent by weight of aluminum oxide.

3.4.1.3 Type MIL-F3.- The flux shall contain manganese in an amount 12 percent by weight maximum.

3.4.2 Moisture.- Moisture content of all types of flux shall not exceed 0.3 percent by weight.

3.5 Performance.-

3.5.1 Soundness.- Electrode-flux combinations shall be capable of depositing groove welds free from slag entrapments, weld metal cracking, and porosity in excess of class 1 of NAVSHIPS 0900-003-9000.

3.5.2 Mechanical properties.- All fluxes, when tested as specified in 4.4.3.5, shall result in deposit of weld metal exhibiting the welded mechanical properties specified in table 1.

Table I - Mechanical properties

Type of flux	Type of electrode (MIL-E-18193)	Ultimate tensile strength as-welded	Yield strength (0.2 percent offset) as-welded and stress-relieved	Elongation (as-welded, stress-relieved) percent in 2 inches	Charpy-V notch impact test stress-relieved	
					Energy (ft./lbs.)	Test temperature °F
		P.S.I. minimum	P.S.I. minimum	Minimum	Minimum	Minus
MIL-F1	MIL-A1	60,000	45,000	25	20	20
MIL-F1	MIL-B1	70,000	50,000	22	20	20
MIL-F2	MIL-B1	70,000	50,000	22	20	20
MIL-F3	MIL-B1	70,000	50,000	22	20	20

3.5.3 Slag removal.- The slag deposited during welding shall be capable of being readily removed from weld deposits with hand tools (not air or power operated).

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract or purchase order, the supplier 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 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 Sampling for quality conformance inspection.-

4.2.1 Inspection lot.- For purposes of sampling and quality conformance inspection a lot shall consist of all flux of one type offered for delivery at one time.

4.2.1.1 Lot identification.- Each lot of flux shall be uniquely identified by the manufacturer's control number or other marking which shall appear on each unit and shipping container.

4.2.2 Sampling for examination of filled containers.- A random sample of filled containers shall be selected from each lot in accordance with MIL-STD-105 at inspection level I, acceptable quality level (AQL) = 2.5 percent defective, to verify compliance with this specification regarding fill, closure, marking, and any other requirements not involving tests.

4.2.3 Sampling for tests.- Two containers shall be selected at random from each inspection lot. From each of these containers a 5-pound specimen shall be taken. One of these specimens shall be taken at the time of selection, placed in separate clean, dry, metal or glass container, sealed, and marked for tests, excluding weld test. The other 5-pound specimen may be taken from the second container at the time it is opened for preparation of the required welds. The second 5-pound specimen shall be used to verify test results obtained with the first 5-pound sample in accordance with 4.3.2.

#### 4.3 Quality conformance inspection.-

4.3.1 Examination of filled containers.- Each sample filled container selected in accordance with 4.2.2, shall be examined for defects of the container and closure, for evidence of leakage, and for unsatisfactory markings; each sample filled container shall also be weighed to determine the amount of the contents. Any container in the sample, having one or more defects or under required fill, shall be rejected. If the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected.

4.3.2 Tests, except weld tests.- The two 5-pound specimens selected in accordance with 4.2.3 shall be subjected to the tests specified in 4.4.1 and 4.4.2. If one test fails, the lot shall be rejected.

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4.3.3 Weld tests.- The sample for weld tests selected in accordance with 4.2.3 shall be subjected to the performance tests specified in 4.4.3 to verify compliance with 3.5 except where waiver is permitted as provided in 4.3.4. The lot shall be rejected if the sample fails the performance test.

4.3.4 Conditions governing waiver.- X-ray soundness and mechanical property tests may be waived by the command or agency concerned if the flux type has been previously procured and has passed these tests (see 6.2). A test report of X-ray soundness and mechanical performance shall be furnished.

#### 4.4 Test procedures.-

4.4.1 Uniformity and composition.- A determination of the alumina or manganese content as applicable (see 3.4.1) in each of the sample specimens shall be determined by any standard method yielding results normally accurate within 2 percent. A comparison of the determinations shall not disclose a variability greater than specified as permissible in 3.2 and compliance with 3.4.1.

4.4.2 Moisture.- A determination of the moisture content shall be made by any standard method yielding results normally accurate within 5 percent, for compliance with 3.4.2.

#### 4.4.3 Performance.-

4.4.3.1 Equipment.- The equipment used in the conduct of performance tests shall be a standard commercial make of automatic welding head, designed for use with and capable of a uniform and controlled feed of granular flux and bare electrode wire; a uniform and controlled speed of travel; and of sufficient capacity to conduct the required welding current. The head shall be supplied with direct current from a source of adequate capacity to maintain the conditions specified in 4.4.3.3.

4.4.3.2 Materials.- Assemblies shall be fabricated from ASTM-A-212 steel, using the flux under test in conjunction with 5/32 inch diameter bare electrode of type MIL-A1 or MIL-B1 of MIL-E-18193.

4.4.3.3 Procedure.- Weld metal shall be deposited in the sequence, but not necessarily the number of beads shown in figure 1, at 550 + 25 amperes, d.c.r.p., except that a lower amperage may be used on the first layer, and 28 volts, in a direction away from the point of ground connection at a speed of progression of 16 ± 1 inches per minute. The preheat and interpass temperature shall be 300 ± 25°F.

4.4.3.4 Soundness.- The soundness of the weld shall be determined in accordance with the notes to figure 1 for conformance with the requirements of 3.5.1.

4.4.3.5 Mechanical properties.- Specimens shall be sectioned as shown on figure 1 from assemblies fabricated as specified in 4.4.3.2. Conformance with 3.5.2 shall be determined by testing as specified in the notes to figure 1.

### 5. PREPARATION FOR DELIVERY

5.1 Packing.- Packing shall be level A or C as specified (see 6.2).

5.1.1 Level A.- Welding flux shall be packed in 80- or 100-pound capacity bags or drums as specified (see 6.2).

5.1.1.1 Drums.- Drums shall conform to type II or III, grade A of PPP-D-723.

5.1.1.2 Bags.- Bags shall be of a waterproof type and shall be in accordance with UU-S-48 (extensible heavy duty shipping sack kraft paper).

5.1.2 Palletization.- When specified (see 6.2), bags and drums shall be palletized for shipment in accordance with MIL-STD-147.

5.1.3 Level C.- Welding flux shall be packed in containers in a manner to insure safe delivery and acceptance at destination. Containers shall comply with the Uniform Freight Classification Rules or other carrier regulations applicable to the mode of transportation.

#### 5.1.4 Marking.-

5.1.4.1 Flux containers or the smallest integral unit container.- Shipment marking information shall be provided on all flux containers in accordance with the manufacturer's commercial practice. In addition, the information shall include lot identification (see 4.2.1.1), type, specification number, manufacturer's or distributor's name, date of manufacture (month/year), and manufacturer's or distributor's brand or type designation. In addition, all flux containers shall carry the following warning label, as a minimum, prominently displayed in legible type on the container:

CAUTION  
 WELDING MAY PRODUCE FUMES AND GASES HAZARDOUS TO HEALTH.  
 AVOID BREATHING THESE FUMES AND GASES.  
 USE ADEQUATE VENTILATION.  
 SEE Z49.1 "SAFETY IN WELDING AND CUTTING - AMERICAN STANDARD"  
 PUBLISHED BY THE AMERICAN WELDING SOCIETY.

Significant toxic constituents when present in the flux in greater than trace amounts shall be identified on the warning label so that normal ventilation can be increased accordingly. These constituents include but are not limited to those itemized in Sections 8.5 through 8.11 of Z49.1.

5.1.4.2 Shipping containers and palletized unit loads.- Shipment marking information shall be provided on flux containers when shipped separately and on palletized unit loads in accordance with the manufacturer's commercial practice. In addition to the information required for flux containers specified in 5.1.4.1, the information shall include shipping destination, Federal stock number, customer's order number, customer's item number, and customer's name.

#### 6. NOTES

##### 6.1 Intended use.-

6.1.1 General.- Both the physical properties and the chemical composition of weld metal deposited by the submerged arc process are influenced by each of the following variables:

- (a) Type of flux.
- (b) Electrode wire composition.
- (c) Base metal composition.
- (d) Speed of progression.
- (e) Electric conditions employed.

As a consequence, 6.1.2, 6.1.3, and 6.1.4 should be considered not as specified recommendations, but only as general information..

6.1.1.1 Electrodes.- These flux types are intended to be used with MIL-A1 and MIL-B1 bare coiled electrodes of MIL-E-18193.

6.1.2 Type MIL-F1.- This flux is most suitable for single pass where considerable rust may be encountered. It has the highest tolerance for sulfur in the base metal of all flux types herein.

6.1.3 Type MIL-F2.- This is a general purpose flux for welding 3/8-inch thick and heavier sections. It has a tolerance for rust equal to that of type MIL-F1. It also produces higher strength welds than any of the other fluxes herein.

6.1.4 Type MIL-F3.- This is the preferred type for all multiple-pass work in heavy sections.

##### 6.2 Ordering data.- Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type of flux required (see 1.2).
- (c) If radiographic and mechanical properties tests are not required (see 4.5.4).

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- (d) Selection of applicable levels of packing (see 5.1).
- (e) Whether 80- or 100-pound bags or drums are required (see 5.1.1).
- (f) Whether palletization is required (see 5.1.2).

6.3 CHANGES FROM PREVIOUS ISSUE. THE EXTENT OF CHANGES (DELETIONS, ADDITIONS, ETC.)  
PRECLUDE THE ANNOTATION OF THE INDIVIDUAL CHANGES FROM THE PREVIOUS ISSUE OF THIS DOCUMENT.

Custodians:

Army - WC  
Navy - SH  
Air Force - 11

Preparing activity:

Navy - SH  
(Project 3439-0127)

Review activities:

Army - WC  
Navy - SH, AS  
Air Force - 11

User activities:

Army - EL, ME  
Navy - OS

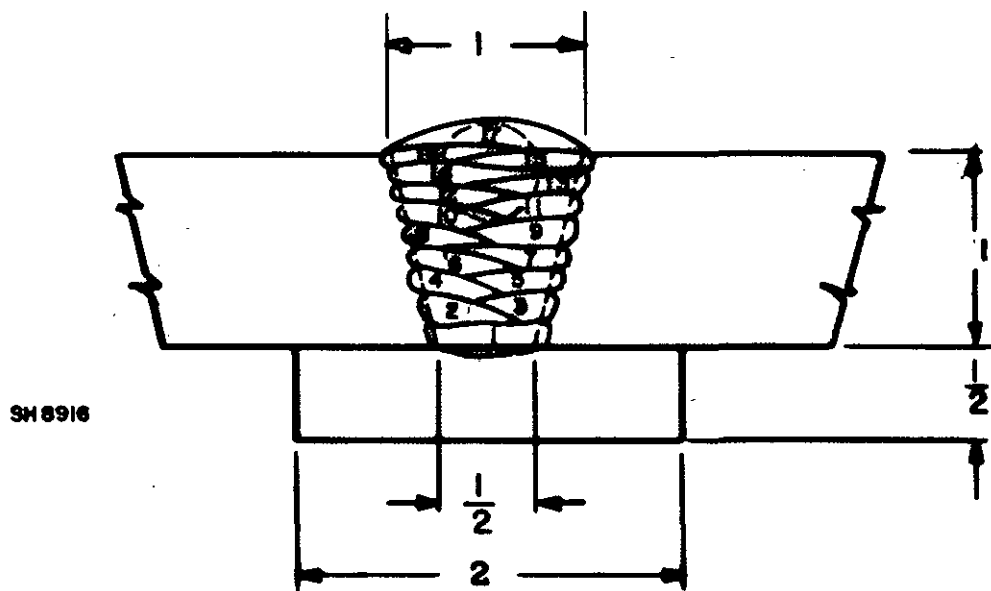
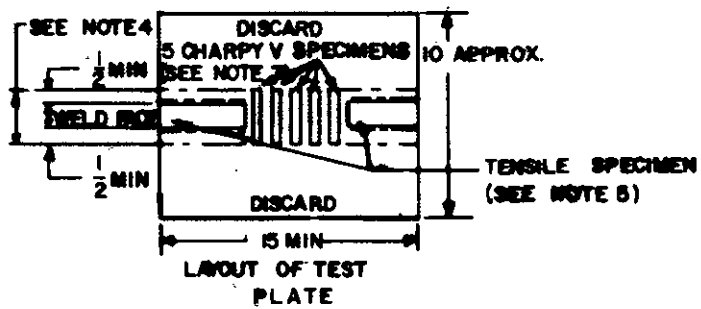


Figure 1 - Groove weld test plate.

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## Notes to figure 1:

1. One joint for X-ray examination and for checking mechanical properties shall be welded in the flat position on base metal as specified in 4.4.32.
2. Welds shall be deposited in layers as shown in figure 1. Layers shall be deposited in sequence shown by figure 1 but not limited to the exact number shown. The final layer shall include reinforcement of standard proportions.
3. After the joint has been tacked, the assembly shall be heated to  $300 \pm 25^\circ\text{F}$ . prior to welding. After completion of each layer the assembly shall be allowed to cool in still air at room temperature and the subsequent layer shall be started when the temperature of the plate has dropped to  $300 \pm 25^\circ\text{F}$ . If it is necessary to interrupt this procedure, the assembly shall be cooled as specified herein. When ready to resume work, the assembly shall be preheated to  $300 \pm 25^\circ\text{F}$ .
4. After completion of the weld, it shall be allowed to cool, the backing strip and the weld reinforcement shall be removed flush with the base plate on both surfaces, and the assembly shall be radiographed in accordance with MIL-STD-271. The radiographs shall meet the radiographic standards specified in 3.5.1. The weld shall be cut as shown resulting in two tensile coupons suitable for 0.505 inch diameter specimens and a center coupon of size sufficient for five charpy V-notch specimens. No base metal shall be removed within 1/2 inch of the edges of the face of the weld by flame cutting. Only sawing or machining shall be used.
5. One tensile coupon, prior to machining shall be stress-relieved using the following procedure: Employing an electric furnace, the all-weld metal coupon shall be heated  $1125 \pm 25^\circ\text{F}$ . held for 2 hours at temperature and allowed to furnace cool at a rate not to exceed  $200^\circ\text{F}$ . per hour maximum to a temperature below  $500^\circ\text{F}$ .
6. Both the stress-relieved and as-welded coupons shall be machined into 0.505 inch tensile specimens and tested. For details see FED-STD-151 or ASTM A-370.
7. The center section of the welded test plate shall be used for the preparation of charpy V-notch impact specimens. Prior to machining specimens, the coupon shall be subjected to the same heat treatment applied to the tensile coupon in note 5 above. Five charpy V-notch specimens shall be machined to dimensions as shown in FED-STD-151 or ASTM A-370. The notch shall be normal to the plate surface.
8. Impact properties for the five specimens shall be obtained at test temperatures specified in table I herein, plus or minus  $3^\circ\text{F}$ . The extreme lowest impact value thus obtained together with the extreme highest value may be disregarded for this test. Two of the three remaining values shall be greater than the specified 20 foot-pound energy level; one of the three may be lower but shall not be less than 15 foot-pounds; the computed average value of these three shall be greater than the specified 20 foot-pound level (see table I herein.).



SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004	
<b>INSTRUCTIONS</b>			
This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).			
SPECIFICATION			
ORGANIZATION (Of submitter)		CITY AND STATE	
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$	
MATERIAL PROCURED UNDER A			
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT		<input type="checkbox"/> SUBCONTRACT	
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.			
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.			
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID			
3. IS THE SPECIFICATION RESTRICTIVE? <input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?			
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)			
SUBMITTED BY (Printed or typed name and activity)			DATE

**FOLD**

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