

MIL-C-24176(SHIPS)
4 January 1966

MILITARY SPECIFICATION

CEMENT, EPOXY, METAL REPAIR AND HULL SMOOTHING

1. SCOPE

1.1 Scope. - This specification covers a two component epoxy cement for use in filling rough or pitted metal surfaces.

1.2 Classification. - Epoxy cements shall be of the following types, as specified (see 6.2):

Type I - Alkali resistant.
Type II - Non-alkali resistant.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitations for bids form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

GG-D-226 - Depressor, Tongue, Wood.
QQ-A-250/9 - Aluminum Alloy 5456, Plate and Sheet.

MILITARY

MIL-P-15328 - Primer, Pretreatment (Formula No. 117 for Metals).
MIL-P-15929 - Primer Coating, Shipboard, Vinyl-Red Lead (Formula No. 119 - For Hot Spray).
MIL-P-15930 - Primer Coating, Shipboard, Vinyl-Zinc Chromate (Formula No. 120 - For Hot Spray).
MIL-P-15931 - Paint, Anti-Fouling, Vinyl Red (Formula No. 121).
MIL-B-16541 - Bronze, Valve, Castings.

STANDARDS

FEDERAL

FED-STD-141 - Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing.

MILITARY

~~MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.~~

(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.

OFFICIAL CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York, N. Y., 10016.)

FSC 8030

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AMERICAN SOCIETY FOR TESTING AND MATERIALS
ASTM-D-695 - Compressive Properties of Rigid Plastics

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

(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 Qualification. - The cement furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable qualified products list.

3.2 Material. - The cement shall be a two-component (component A-resin base and component B-curing agent), chemically reactive, epoxy cement, with suitable additives to produce a material in conformance with the requirements specified herein.

3.3 Consistency. - The two components of the cement shall be of smooth, uniform consistency and sufficiently mobile to allow ready mixing at temperatures between 70° and 90° Fahrenheit (F.).

3.4 Mixing ratio. - The volume ratio between components used to produce the required cement shall be a maximum of 1 to 5.

3.5 Volatile matter. - When tested as specified in 4.6.2, the volatile matter of the cement shall not exceed 0.6 percent.

3.6 Color. - When tested as specified in 4.6.3, the two components of the cement shall be of dissimilar colors and the finished cement shall be a distinctive color different from either compound.

3.7 Pot life. - When tested as specified in 4.6.4, the pot life of the mixed cement shall conform to the requirements of Table I.

Table I - Pot life requirements.

Temperature (°F.)	Pot life	
	Minimum	Maximum
70 (+2)	15 minutes	3 hours
90 (+2)	10 minutes	2 hours

3.8 Application characteristics. - When tested as specified in 4.6.5, the cement shall be readily trowelable and shall produce a smooth surface.

3.9 Resistance to vertical sagging. - When tested as specified in 4.6.6, the cement shall not sag.

3.10 Curing time. - When tested as specified in 4.6.7, the cement shall be completely cured or hardened after 24 hours.

3.11 Adhesion and resistance to impact. - When tested after 7 days and 3 months curing periods as specified in 4.6.8, the cement shall remain firmly adhered to the steel, aluminum and bronze plates.

3.12 Compatibility of cement with primers and paint. - When tested as specified in 4.6.9, there shall be no signs of lifting, peeling, softening nor poor adherence of the cement, primers and paint.

3.13 Alkali resistance (type 1 only). - When tested as specified in 4.6.10, the cement shall show no evidence of evolution of gas, loss of adhesion, swelling, softening, marked color change or other indications of deterioration.

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3.14 Compressive strength.- When tested as specified in 4.6.11, the compressive strength of cement shall be a minimum of 5500 pounds per square inch.

3.15 Storage life.- After storage for six months in the original unopened containers, the components of the cement shall not show any separation into phases which cannot be reincorporated readily by moderate hand stirring. When tested as specified in 4.6.4, the components shall still be capable of producing a cement which conforms to the pot life requirement at 70°F.

3.16 Directions for use.- Each container shall be clearly labeled with directions for use, which shall include the following:

- (a) Brand name.
- (b) Designation or code number for the proper hardener to be used with the resin material.
- (c) Mixing ratio of hardener to resin by volume.
- (d) Pot life of cement after mixing.
- (e) Precautionary markings shall be applied as follows:
 - (1) "Caution: Do not mix hardener and resin together until ready for use."
 - (2) "Warning: May cause skin irritation. Avoid contact with the skin. Use protective gloves when handling."
 - (3) Include any other necessary handling precautions, such as flammability or toxic vapors.

3.17 Identification characteristics.- Values for identification characteristics shall be provided by individual suppliers for characteristics as indicated by "X" in table II. The values shall be established for each smoothing cement prior to qualification approval. The purpose of these values is to serve as a basis for determining that the material being offered is essentially the same as that which was approved under qualification testing. Subject to approval by the Bureau of Ships, alternate means of identification (for example, infra-red spectrographic examination, chemical analysis, and so forth) may be substituted for the characteristics in table II provided appropriate data is submitted by the supplier.

Table II - Identification characteristic values.

Characteristic	Cement components		Cement
	Component A (Resin base)	Component B (Curing agent)	
Percent of principal constituents (10 percent or more of total)	X	X	
Percent volatile matter	X	X	
Weight per gallon	X	X	
Consistency	X	X	
Mixing ratio	X	X	
Color	X	X	
Pot life			X
Application characteristics			X
Resistance to vertical sagging			X
Alkali resistance			X
Curing time			X
Compressive strength			X

3.18 Workmanship.- The component ingredients shall be processed as required in accordance with the best commercial practices for producing a high-quality material which will conform to the requirements specified herein.

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

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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 Qualification tests.-^{1/} Qualification tests shall be conducted at a laboratory satisfactory to the Bureau of Ships. Qualification tests shall consist of the tests specified in 4.6. Two one-quart containers of cement shall be submitted for qualification testing.

4.3 Quality conformance inspection.-

4.3.1 Sampling.-

4.3.1.1 Lot.- For purposes of sampling, a lot shall consist of all cement from one production batch offered for delivery at one time.

4.3.1.2 Sampling for examination of filled containers.- A random sample of filled containers shall be selected in accordance with Table III for the examination specified in 4.4.1.

Table III - Sampling for examination of filled containers.

Lot size Number of containers	Sample size Number to be examined	Number of containers containing defects	
		Acceptance number	Rejection number
Up to 5	All	--	--
6 to 25	5	0	1
26 to 62	8	0	1
63 to 160	13	1	2
161 to 410	20	1	2
411 to 1000	32	2	3
1001 to 2560	50	3	4
2561 to 6250	80	5	6
6251 to 16000	125	7	8

4.3.1.3 Sampling for tests.- From each lot offered for inspection, a total of two gallons of the appropriate volume ratio of each component of the cement shall be selected at random for the tests specified in 4.5.

4.4 Examination.-

4.4.1 Examination of filled containers.- Each filled container selected in accordance with 4.3.1.2 shall be examined for significant defects in addition to those specified in table IV.

^{1/} Application for Qualification Tests shall be made in accordance with "Provisions Governing Qualification" (see 6.3 and 6.4).

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Table IV - Classification of defects.

Examine	
Packaging	Container not type specified. Closure not type specified. Size not as specified. Evidence of rust or corrosion. Bail or handle missing or damaged. Bail grip damaged.
Packing	Not as specified. Container not as specified. Arrangement of containers not as specified. Closing and strapping not as specified.
Marking	Interior or exterior markings (as applicable), omitted, illegible, incorrect, incomplete, and not as specified.
Fill	Container below the required or indicated fill.

4.4.1.1 Rejection.- If the number of defective filled containers exceeds the acceptance number specified in table III, this shall be cause for rejection of the entire lot represented by the sample filled containers.

4.5 Quality conformance tests.- Quality conformance tests for each lot shall consist of all the tests specified in 4.6 except for the adhesion test after the 3-month curing period and for the storage life test (see 3.11 and 3.15).

4.5.1 Rejection.- If any sample is found not to be in conformance with the requirements of this specification, this shall be cause for the rejection of the lot represented by the sample.

4.6 Test methods.-

4.6.1 Test conditions.- Unless otherwise specified herein, the atmospheric conditions surrounding all materials used in preparation of test specimens, prior to and during test, shall be $23^{\circ} \pm 1^{\circ}\text{C}$. ($73.4^{\circ} \pm 2^{\circ}\text{F}$.) and 50 plus or minus 2 percent relative humidity; the conditioning period prior to test shall be a minimum of 48 hours. The conditioned components of the cement to be used for test purposes shall be mixed in the proportion recommended by the manufacturer and in a manner so as to produce, as rapidly as possible, a homogeneous color (see 4.6.3).

4.6.2 Volatile matter.- A tared metal container, approximately 3 inches in diameter and 1/16 inch deep, shall be completely filled with freshly prepared cement. The container and contents shall be weighed immediately and then placed in a circulating oven at $100^{\circ} - 105^{\circ}\text{C}$. ($212^{\circ} - 221^{\circ}\text{F}$.) for 24 hours. At the end of this period the container and contents shall be cooled, weighed, and the percent weight loss of the cement calculated and recorded.

4.6.3 Color.- Visual examination of the components shall show sufficient contrast in colors so as to produce a new homogeneous color after combining the two components in the specified proportion and mixing.

4.6.4 Pot life.- The pot life of the cement shall be determined at temperatures of $70^{\circ} (+2^{\circ})\text{F}$. and $90^{\circ} (+2^{\circ})\text{F}$. The components of the cement prior to mixing, shall be conditioned for a period of four hours at each specified temperature. A sufficient amount of cement shall be prepared and immediately introduced into a flat bottom cylindrical metal container approximately 55 millimeter (mm) (2-3/16 inches) in diameter and 35mm (1-3/8 inches) in depth (e.g., tin ointment box). The time at which the container is completely filled with cement shall be noted as the "starting time." A clean wooden tongue depressor conforming to GG-D-226, shall be used periodically to probe the surface of the cement to a depth of approximately 1/8 inch. The tongue depressor shall be held in a vertical position when probing. The duration of time from

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the "starting time" until the cement no longer adheres to the clean end of a probe, shall be recorded as the pot life.

4.6.5 Application characteristics.- A steel channel 5 inches long by 3 inches wide by 1/4 inch deep shall be constructed. The channel, while in a horizontal position, shall be completely filled with freshly prepared cement and the excess cement removed by drawing a steel straight edge across the top edges of the channel. Dragging or clinging of the cement to the straight edge resulting in incomplete fill of the channel or production of a rough cement surface shall be cause for rejection.

4.6.6 Resistance to vertical sagging.- Upon completion of the test specified in 4.6.5, the cemented channel test specimen shall be used to determine the resistance of the cement to vertical sagging. The excess cement which may extend beyond the open ends of the channel shall be removed with the steel straight edge and the channel positioned so that its long dimension is in a vertical position. Any sagging of the cement below the lower end of the channel during a 24-hour period shall be noted and recorded.

4.6.7 Curing time.- The cemented channel test specimen utilized in 4.6.6 shall be used to determine the curing time of the cement. Upon completion of the 24 hour vertical sag test, the cemented area of the channel shall be sanded immediately with No. 60 aluminum oxide cloth and any gumming or roll-up of the cement on the abrasive cloth shall be indicative of incomplete curing or hardening and shall be cause for rejection.

4.6.8 Adhesion and resistance to impact of cement bonded to metal.-

4.6.8.1 Preparation of specimens.- Metal plates of the following compositions and dimensions shall be prepared:

Number of plates	Dimensions (Inches)	Composition
4	6 x 6 x 1/8	Carbon steel
4	6 x 6 x 1/8	Aluminum alloy 5456
6	1/8 x 3 diameter	Temper H321(QQ-A-250 /9) Bronze (MIL-B-16541)

All metal plate surfaces to be utilized for test purposes shall be cleaned and finished with a No. 60 aluminum oxide cloth. Specimens shall be prepared by applying a 1/16-inch layer of freshly prepared cement to the finished surface of the test plates.

4.6.8.2 Procedure.- One half the number of specimens prepared with each type alloy shall be cured for seven days with the remaining specimens cured for three months. At the end of the seven day and three month curing periods, the cemented surfaces of the specimens shall be subjected to an impact of a two-pound steel ball dropped from a height of two feet. Four impacts, each approximately 2-1/2 inches from each corner along the diagonal, shall be made upon each aluminum and steel alloy specimen. The bronze alloy specimens shall be subjected to two impacts, one inch apart along the diameter. Detachment of the cement from the plate or poor adhesion beyond a radius of 1/4-inch from the center of impact shall constitute failure. Gouging at the impact area with a 1/4-inch chisel shall be conducted as an aid in determining adhesion.

4.6.9 Compatibility of cement with primers and paint.- Metal plates shall be prepared as specified in 4.6.8.1, except that primer pretreatment (formula 117) conforming to MIL-P-15328, shall be applied to the finished surfaces to produce a dry film thickness of 0.3 to 0.5 mils. The pretreatment primer shall be allowed to dry for 24 hours and then shall be covered with a 1/16-inch of freshly prepared cement. Upon curing for a period of 48 hours, and without prior sanding one half the number of specimens shall be over-coated with paint system "A" and the remaining specimens with paint system "B", defined as follows:

- (a) **Paint system "A".-** One coat (0.3 to 0.5 mils, dry film thickness) of primer pretreatment (formular 117) conforming to MIL-P-15328. Allow to dry for 1 hour. Apply 2 coats (2.5 to

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3.5 mils total dry film thickness) of vinyl primer (formula 119) conforming to MIL-P-15929. Allow a drying time of at least 2 hours between coats.

- (b) Paint system "B". - Two coats (3.5 to 4.5 mils total dry film thickness) of vinyl red anti-fouling paint (formula 121) conforming to MIL-P-15931. Allow a drying time of at least 2 hours between coats. Upon drying, the coated specimens shall be examined for any signs of incompatibility between the paint systems and cement. After conditioning for a period of 4 days, the specimens shall be completely immersed in a 4-percent sodium chloride solution and maintained at the test temperature specified in 4.6.1 for one month. The specimens shall then be subjected to the tests specified in 4.6.8.2. Causes for rejection shall be as specified therein. Poor adherence of the paint system to the cement, as evidenced by lifting shall also constitute a cause for rejection.

4.6.10 Alkali resistance (type 1 only). - A 1/16-inch layer of the cement shall be applied to the outside surface of a glass test tube, approximately 6 inches long by 3/4 inch in diameter. The specimen shall be cured for 48 hours and then immersed to a depth of 4 inches in a 4 percent solution of sodium hydroxide and maintained at the test temperature specified in 4.6.1 for a period of 3 weeks. Freshly prepared alkali solution shall be maintained at 4 percent by addition of water as necessary. The specimen shall be examined for evidence of deterioration periodically and upon completion of the 3-week exposure.

4.6.11 Compressive strength. -

4.6.11.1 Preparation of specimens. - A split mold capable of forming a rectangular specimen slightly larger than 1/2 by 1/2 by 3 inches, shall be constructed of steel. A hole 1/16 inch in diameter shall be placed at the lower end of the mold to allow for the escape of entrapped air. The upper end of the mold shall be fitted with a steel plunger whose cross-sectional dimensions shall be slightly less than 1/2 inch by 1/2 inch. A light coating of a mold release agent shall be applied to the mold cavity. Freshly prepared cement shall be introduced into the mold cavity prior to assembly. After assembling and clamping the mold in place, the plunger shall be depressed slightly to permit cement to exude from the 1/16 inch orifice and expel any entrapped air. The mold shall then be firmly secured to a flat surface so as to prevent further exudation of the cement through the orifice. A weight of five pounds shall be applied to the plunger and the cement specimen allowed to cure for 24 hours while under pressure. The cement specimen shall be removed from the mold and aged for one week at $73^{\circ} \pm 2^{\circ}\text{F}$ followed by a cure for 24 hours at $150^{\circ} \pm 2^{\circ}\text{F}$. Two test specimens shall be prepared and machined to 1/2 by 1/2 by 1 inch with a tolerance of plus or minus 0.005 inch in each dimension.

4.6.11.2 Procedure. - The 0.2 percent offset yield stress of the cement in compression shall be determined in accordance with ASTM D-695 and the average value obtained from two tests noted and recorded.

4.6.12 Weight per gallon. - Weight per gallon for identification purposes (see table II) shall be determined in accordance with method 4184 of FED-STD-141.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early use. -

5.1.1 Preservation and packaging. - Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early usage and may conform to the supplier's commercial practice when such meets these requirements.

5.1.2 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier, at lowest rate, and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early usage. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules and Regulations or other carrier regulations as applicable to the mode of transportation and may conform to the supplier's commercial practice when such meets these requirements.

5.1.3 Marking. - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. In addition to the labeling

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(see 3.16), shipment marking information shall include nomenclature, Federal stock number, contract or order number, contractor's name and destination, date of manufacture, and lot number.

5.2 Domestic shipment and storage or overseas shipment.- The requirements, and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.2).

(5.2.1 The following provides various levels for protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made (see 6.2).

5.2.1.1 Preservation and packaging.-

5.2.1.1.1 Level A.- The cement shall be furnished in pint, quart or gallon multiple friction top cans conforming to type V, class 2, round, of PPP-C-96 in the quantity specified (see 6.2). Activator or hardener shall be packaged in the above specified cans in the quantity required for mixing with the packaged unit of base resin. If seams of cans are soldered, they shall be coated with a suitable coating which is nonreactive to the base resin and the activator or hardener.

5.2.1.1.2 Level C.- Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity for early usage. This level may conform to the supplier's commercial practice when such meets the requirements of this level.

5.2.1.2 Packing.-

5.2.1.2.1 Level A.- The pint, quart and gallon multiple friction top cans shall be arranged and packed in accordance with the overseas equipment requirements of the appendix to PPP-C-96.

5.2.1.2.2 Level B.- The pint, quart and gallon multiple friction top cans shall be arranged and packed in accordance with the domestic shipment requirements of the appendix to PPP-C-96.

5.2.1.3 Marking.- In addition to the labelling (see 3.16), interior and exterior shipping containers shall be marked in accordance with MIL-STD-129.)

6. NOTES

6.1 Intended use.-

6.1.1 Type I.- Cement procured under this type is resistant to alkali and approved for general use, and for application in way of cathodic protection (sacrificial anodes, and impressed current systems).

6.2.1 Type II.- Cement procured under this type is not alkali resistant, and shall be used only in areas not affected by cathodic protection (magnesium anodes and impressed current).

6.2 Ordering data.- Procurement documents shall specify the following:

- (a) Title, number, and date of this specification.
- (b) Type cement required (see 1.2).
- (c) Capacity of container and quantity required (see 5.2.1.1.1).
- (d) Packaging, packing, and marking requirements other than required by 5.1 (see 5.2).

6.3 With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List QPL 24176, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Bureau of Ships, Department of the Navy, Washington, D.C. 20360 and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.4).

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6.4 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

**Preparing activity:
Navy - SH
(Project 8030-N050Sh)**

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
<p style="text-align: center;"><u>INSTRUCTIONS</u></p> <p>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).</p>		
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

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