METRIC
MIL-PRF-24176C
14 October 2004
SUPERSEDING
DOD-PRF-24176B (SH)
31 August 1979

PERFORMANCE SPECIFICATION

CEMENT, EPOXY, METAL REPAIR AND HULL SMOOTHING (METRIC)

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

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 covered by this specification are to be furnished ready-to-use for the following types, as specified (see 6.2):

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

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to commandstandards@navsea.navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil

AMSC N/A FSC 8030

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-24441 - Paint, Epoxy-Polyamide, General Specification for.
MIL-PRF-24647 - Paint System, Anticorrosive and Antifouling, Ship Hull.

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

BUREAU OF MEDICINE AND SURGERY (BUMED)

BUMED INST 6270.8 - Procedures for Obtaining Health Hazard Assessments Pertaining to Operational Use of a Hazardous Material.

(Copies of this document are available online at https://bumed.med.navy.mil or from Bureau of Medicine and Surgery, Department of the Navy, 2300 E Street, NW, Washington, DC 20372-5300.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR QUALITY (ASQ)

ASQC Z1.4 - Sampling Procedures and Tables for Inspection by Attributes. (DoD adopted)

(Copies of this document are available from www.asq.org or American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203.)

ASTM INTERNATIONAL

A 109 - Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled. (DoD adopted)
B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate. (DoD adopted)
B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications. (DoD adopted)
C 531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfaces and Polymer Concretes. (DoD adopted)
D 695 - Standard Test Method for Compressive Strength of Carbon and Graphite. (DoD adopted)
D 2240 - Standard Test Method for Rubber Property - Durometer Hardness. (DoD adopted)

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, 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 Qualification. The cement furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.1 and 6.4).

3.1.1 Requalification in case of reformulation. Any changes in the formulation of the product submitted for qualification testing shall be cause for requalification of the product (see 4.2).

3.2 Cement. The cement shall be a two-component (component A-resin and component B-curing agent), chemically reactive, epoxy cement, with suitable additives to produce a material in conformance with the requirements specified herein. The use of any ozone depleting substance (ODS) in the composition of the cement under this specification directly or referenced in any test method is hereto prohibited. Environmentally safe and non-ODS alternative solvents may be substituted for any previously specified ODS such as trichoroethylene (see 6.2). The use of asbestos or asbestos containing ingredients in the cement is prohibited.

3.3 Manufacture. Ingredients for each component shall be processed and mixed to produce a product which is uniform, free from dirt and grit, and in full conformance with the requirements of this specification.

3.4 Quantitative requirements. The cement shall conform to the quantitative requirements shown in Table I, and as herein specified.

TABLE I. Quantitative requirements.

Characteristic	Requirements	
	Minimum	Maximum
Hardness of cured epoxy cement, Type D units	55	---
Pot life, minutes		
21°C ± 1°C (70°F ± 2°F)	15	180
32°C ± 1°C (90°F ± 2°F)	10	120
Curing time, hours	---	24
Compressive strength, pascal (lb/in^2)	3.9×10^7 (5500)	---
Shrinkage, percent	---	0.25

3.5 Qualitative requirements. The cement shall conform to the qualitative requirements specified herein.

3.5.1 Consistency. The two components of the cement shall be of smooth, uniform consistency and sufficiently viscous to allow ready mixing at temperatures between 21°C and 32°C (70°F and 90°F).

3.5.2 Color. The two components of the cement shall be of dissimilar colors and the finished cement shall be a distinctive color different from either component when tested as specified in 4.5.3.

3.5.3 Application characteristics. The cement shall be trowelable and shall produce a smooth surface when tested as specified in 4.5.5.

3.5.4 Resistance to vertical sagging. The cement shall not sag when tested as specified in 4.5.6.

3.5.5 Adhesion and resistance to impact. The cement shall remain firmly adhered to the steel, aluminum, and copper alloy plates when tested after 7-day and 3-month curing periods as specified in 4.5.8.

3.5.6 Compatibility of cement with primers and paint. There shall be no signs of lifting, peeling, softening, blistering, poor intercoat adhesion, or other undesirable properties when tested as specified in 4.5.9.

3.5.7 Alkali resistance (Type I only). The cement shall show no evidence of evolution of gas, loss of adhesion, swelling, softening, marked color change, or other indications of deterioration when tested as specified in 4.5.10.

3.5.8 Storage stability. When stored for 1 year as specified in 4.5.13, the cement shall meet the requirements of 3.4, except that hardness, curing time, and pot life shall vary not more than plus or minus 10 percent of the values specified in Table I.

3.6 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.7 Toxicity. When evaluated in accordance with 4.6, the cement shall have no adverse effect on the health of personnel when used for its intended purpose and shall not cause any environmental problems during waste disposal (see 4.6 and 6.6).

3.8 Asbestos prohibition. Epoxy metal repair and hull smoothing cement provided in accordance with this specification shall contain no asbestos nor any asbestos-containing ingredients.

4. VERIFICATION

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

a. Qualification inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification tests shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command. Qualification tests shall consist of the tests specified in 4.4 and 4.5.

4.3 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 tests. From each lot offered for inspection, a total of 8 liters (two gallons) of the appropriate volume ratio of each component of the cement shall be selected at random and forwarded to an acceptable laboratory for testing as specified in 4.4 and 4.5.

4.3.1.3 Sampling for examination of containers. A random sample of filled containers shall be selected by the inspector in accordance with ASQC Z1.4 at inspection level I to verify compliance with all requirements of this specification regarding fill, closure, marking, and other requirements not involving tests. Any unacceptable containers shall be discarded and be replaced by containers that pass the requirements.

4.3.1.3.1 Examination of containers. Each filled container selected as a sample shall be examined for defects of construction of the container and the closure, for evidence of leakage, and for unsatisfactory markings.

Any container in the sample having defects or under required fill shall be rejected, and if any defective containers in any sample are not replaced for the appropriate sampling plan of ASQC Z1.4, the lot represented by the sample shall be rejected.

4.3.1.4 Lot acceptance. The inspection test samples selected in accordance with 4.3.1.2 shall be subjected to the applicable tests specified in 4.4 and 4.5 except for the adhesion test after the 3-month curing period and for the storage stability test (see 3.5.5 and 3.5.8). The contractor shall not release a lot until a favorable report is received from the laboratory. Nonconformance of a sample shall be basis for rejection of the lot represented by the sample.

4.4 Conformance tests. Conformance tests for each lot shall consist of all the tests specified in 4.5, except for the adhesion test after the 3-month curing period and for the storage stability test (see 3.5.5 and 3.5.8).

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

4.5 Test methods.

4.5.1 Test conditions. Unless otherwise specified, test conditions shall be temperature 25 ± 1°C (70°F ± 2°F) and relative humidity 30 - 80%, using a pre-test conditioning period of 48 hours. The conditioned components of the cement shall be mixed in the proportions recommended by the manufacturer and in a manor to produce a uniform color (see 3.5.2).

4.5.2 Hardness. The hardness test shall be performed in accordance with ASTM D 2240, Type D. Hardness readings shall be determined upon the cemented channel test specimen utilized in 4.5.7. Five random readings shall be made following a 72-hour curing period of the cemented channel. The average of the five readings shall be reported.

4.5.3 Color. Visual examination of the components shall show sufficient contrast in colors so as to produce a new uniform color after combining the two components in the specified proportions and mixing.

4.5.4 Pot life. The pot life of the cement shall be determined at temperatures of 21 ± 1°C to 32 ± 1°C (70 ± 2°F to 90 ± 2°F). The components of the cement prior to mixing shall be conditioned for a period of 4 hours at each specified temperature. The consistency of the components and the mixed cement shall be smooth, uniform, free of lumps and readily mixable by hand. A sufficient amount of cement shall be prepared and immediately introduced into a flat bottom cylindrical metal container approximately 55 millimeters (mm) (2-3/16 inches) in diameter and 35 mm (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 shall be used periodically to probe the surface of the cement to a depth of approximately 3 mm (1/8 inch). The tongue depressor shall be held in a vertical position when probing. The duration of time from the starting time until the cement no longer adheres to the clean end of a probe shall be recorded as the pot life.

4.5.5 Application characteristics. A steel channel approximately 125 mm (5 inches) long by 75 mm (3 inches) wide by 6 mm (1/4 inch) deep shall be constructed. All metal plate surfaces to be utilized for test purposes shall be cleaned and finished with a No. 60 aluminum oxide cloth. The channel, while in a horizontal position, shall be completely filled with freshly-prepared cement and the excess cement removed by drawing a 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.

4.5.6 Resistance to vertical sagging. Upon completion of the test specified in 4.5.5, the mixed but uncured cemented test specimen shall be used to determine the resistance of the cement to vertical sagging. Any excess cement that may extend beyond the open ends of the channel shall be removed with the 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. Sagging below lower end of the channel shall constitute non-compliance with 3.5.4.

4.5.7 Curing time. The cemented channel test specimen utilized in 4.5.6 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.

4.5.8 Adhesion and resistance to impact of cement bonded to metal.

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

Number of plates	Dimensions, Millimeters (inches)	Composition
4	150 by 150 by 6 (6 by 6 by 1/8)	Carbon steel (ASTM A 109)
4	150 by 150 by 6 (6 by 6 by 1/8)	Aluminum alloy (ASTM B209) alloy 5456
6	3 by 75 diameter (1/8 by 3 diameter)	Copper Alloy (ASTM B 584) C 92300

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 1.5 mm (1/16 inch) layer of freshly-prepared cement to the finished surface of the test plates.

4.5.8.2 Procedure. One half the number of specimens prepared with each type alloy shall be cured for 7 days with the remaining specimens cured for 3 months. At the end of the 7-day and 3-month curing periods, the cemented surfaces of the specimens shall be subjected to an impact of a 0.9-kilogram (kg) (2-pound) steel ball dropped from a height of 0.6 meter (m) (2 feet). Four impacts, each approximately 64 mm (2-1/2 inches) from each corner along the diagonal, shall be made upon each aluminum and steel alloy specimen. The copper alloy specimens shall be subjected to two impacts, 25 mm (1 inch) apart along the diameter. Detachment of the cement from the plate or poor adhesion beyond a radius of 6 mm (1/4 inch) from the center of impact shall constitute failure. Each impact area shall be gouged with a 6 mm (1/4 inch) chisel to create a 1 inch long groove that extends into the base metal to verify adhesion of the cement. Visible separation at the interface of the cement and base metal in the walls of the groove shall constitute failure.

4.5.9 Compatibility of cement with primers and paint. Metal plates shall be prepared as specified in 4.5.8.1, except that primer conforming to MIL-DTL-24441, Type IV shall be applied to the finished surfaces to produce a dry film thickness of 65 to 90 µm (2.5 to 3.5 mils). The primer shall be allowed to dry for 24 hours and then shall be covered with a 1.6 mm (1/16-inch) layer of freshly-prepared cement. Upon curing for a period of 48 hours, and without 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". Specimens shall be coated with primer conforming to MIL-DTL-24441, Type IV or primer conforming to MIL-PRF-24647 to produce a dry film thickness of 65 to 90 µm (2.5 to 3.5 mils). Two coats may be required to achieve the specified dry film thickness.

b. Paint system "B". Two coats 115 to 140 µm (4.5 to 5.5 mils) total dry film thickness of anti-fouling paint conforming to MIL-PRF-24647.

After 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 4.5.1 for 1 month. The specimens shall then be subjected to the impact tests specified in 4.5.8.2. 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.

4.5.10 Alkali resistance (Type I only). A 1.6 mm (1/16 inch) layer of the cement shall be applied to the outside surface of a clean glass test tube, approximately 152 mm (6 inches) long by 19 mm (3/4 inch) in diameter. The specimen shall be cured for 48 hours and then immersed to a depth of 102 mm (4 inches) in a 4 percent solution of sodium hydroxide and maintained at the test temperature specified in 4.5.1 for a period of 3 weeks. The alkali solution shall be maintained at 4 percent by addition of water as necessary. The specimen shall be examined periodically and upon completion of the 3-week exposure, for evidence of deterioration.

4.5.11 Compressive strength.

4.5.11.1 Preparation of specimens. A split mold capable of forming a rectangular specimen slightly larger than 13 mm by 13 mm by 76 mm (1/2 by 1/2 by 3 inches) shall be constructed of steel. A hole 1.6 mm (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 13 mm by 13 mm (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 1.6 mm (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 2.27 kg (5 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 1 week at 23 ± 1°C (73 ± 2°F) followed by a cure for 24 hours at 66 ± 1°C (150 ± 2°F). Two test specimens shall be prepared and machined to 13 mm by 13 mm by 25 mm (1/2 by 1/2 by 1 inch) with a tolerance of plus or minus 127 mm (0.005 inch) in each dimension.

4.5.11.2 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.

4.5.12 Shrinkage. Two steel molds, capable of being disassembled to facilitate removal of the test specimens, shall be constructed with cavities 102 mm (4 inches) long by 25 mm (1 inch) wide by 64 mm (1/4 inch) deep. The molds shall be assembled, firmly secured in place and the cavity length of each mold measured to the nearest 25 mm (0.001 inch). A light coating of mold release agent shall be applied to the mold cavities. The mold cavities shall be completely filled with freshly prepared cement and the excess removed by drawing a steel straight edge across the top edges of the mold. The specimens shall be allowed to cure in the molds under the test conditions specified in 4.5.1 for a period of 2 weeks. Upon completion of the 2-week curing period, the molds shall be disassembled and the specimens removed. The length of each specimen shall be measured to the nearest 25 mm (0.001 inch). The percent shrinkage shall be calculated based upon the decrease in length of each specimen from the length of its respective mold. The average percent shrinkage of the two specimens shall be reported. ASTM C 531 may be used as an alternative procedure.

4.5.13 Storage stability. Separate components shall be stowed in original unopened containers for 1 year after date of manufacture at 24°C ± 5°C (75°F ± 9°F), and tested for conformance with 3.5.8. The manufacturer shall certify that his formulas meet this requirement.

4.6 Toxicity. The cement shall be evaluated by the Navy Environmental Health Center (NAVENVIRHLTHCEN) using the administrative Health Hazard Assessment (HHA). A flowchart for this process can be found as enclosure (1) of BUMEDINST 6270.8. The HHA is a review of the cement based on information submitted by the manufacturer, to assess health hazards associated with the handling, application, use and removal of the product. Sufficient data to permit a HHA of the product shall be provided by the manufacturer/distributor to the NAVENVIRHLTHCEN. To obtain current technical information requirements specified by the NAVENVIRHLTHCEN, see 6.6.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The products covered by this specification are to be suitable for use for hull repair and hull smoothness and where air pollution regulations apply (see 6.3).

6.1.1 Type I. Type I cement is resistant to alkali and approved for general use to fair, smooth or fill metallic surfaces that have become worn, pitted, corroded, or misaligned and for application in way of cathodic protection (sacrificial anodes~~,~~ and impressed current systems).

6.1.2 Type II. Type II cement is not alkali resistant, is applicable in the same manner as Type I material and should be used only in areas not affected by cathodic protection (sacrificial anodes~~,~~ and impressed current systems).

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type cement required (see 1.2).
c. Is Material Safety Data Sheet required? (see 6.5).
d. Toxicity conformance (see 3.7 and 6.6).
e. The cement is not to contain any intentionally added ozone depleting substances (ODS) derived form the base stock, the additive package or the finished blend (see 3.2).
f. Packaging requirements (see 5.1) .

6.3 Volatile content. Although the container marking specifically refers to the Air Pollution District of Los Angeles County, the cement may be used anywhere. This includes other air pollution control districts or similar areas controlling the emission of solvents into the atmosphere. Information regarding Los Angeles County Air Pollution Rules 102, 442, and 443 may be obtained from; South Coast Air Quality Management District, Metropolitan Zone, 434 South Pedro Street, Los Angeles, CA 90013.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24176 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160.

6.5 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. In order to obtain the MSDS, FAR clause 52.223-3 must be in the contract.

6.6 Toxicity evaluation. The NAVENVIRHLTHCEN requires sufficient information to permit a HHA of the product. Any questions concerning toxicity, information required to conduct a HHA, and requests for a HHA should be addressed to the Commanding Officer, Navy Environmental Health Center, ATTN: Hazardous Materials Department, Industrial Hygiene Directorate, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. Upon receipt of the HHA, a copy should be provided to Commander, Naval Sea Systems Command, ATTN: SEA 05M3, 1333 Isaac Hull Ave., SE, Stop 5133, Washington Navy Yard, DC 20376-5133.

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

6.8 Subject term (key word) listing.

Bonding material
Hull repair

Custodians:
Army - CR4
Navy - SH

Preparing activity:
Navy - SH
(Project 8030-0824)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at www.dodssp.daps.mil.