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DEPARTMENT OF DEFENSE  
DESIGN CRITERIA  
  
IMPREGNATION OF POROUS  
METAL CASTINGS AND POWERED METAL  
COMPONENTS



AMSC N/A

FSC 9540

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MIL-STD-276A

FOREWORD

1. This military standard 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.

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 05Q4, 2531 National Center Bldg 3, Washington, DC 20362-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

## MIL-STD-276A

## CONTENTS

Paragraph	1.	SCOPE .....	1
	1.1	Scope .....	1
	1.2	Applicability.....	1
	1.2.1	Authorization .....	1
	1.2.2	Restrictions on use of filled sodium silicate impregnants.....	1
	1.2.3	Prohibitions on impregnating.....	1
	2.	APPLICABLE DOCUMENTS.....	2
	2.1	Government documents.....	2
	2.1.1	Specifications, standards, and handbooks.....	2
	2.2	Order of precedence.....	2
	3.	DEFINITIONS.....	2
	4.	GENERAL REQUIREMENTS.....	2
	4.1	Preliminary test for pressure tightness.....	2
	4.2	Materials.....	3
	4.3	Preparation of castings for impregnation.....	3
	4.3.1	Preliminary operations.....	3
	4.3.2	Cleaning.....	3
	4.3.3	Surface preparation.....	3
	4.4	Impregnating methods.....	3
	4.4.1	Method A - internal pressure (individual castings).....	3
	4.4.2	Method B - dry vacuum and pressure (batch immersion).....	3
	4.4.3	Method C - wet vacuum and pressure (batch immersion).....	4
	4.4.4	Impregnation procedure restrictions.....	4
	4.5	Post-impregnation treatment.....	4
	4.5.1	Rinsing.....	4
	4.5.2	Curing process.....	4
	4.6	Leakage.....	4
	4.7	Discoloration.....	4
	4.8	Marking.....	4
	4.9	Responsibility for inspection.....	4
	4.10	Proof pressure test.....	5
	4.10.1	Proof pressure test method.....	5
	4.10.2	Alternate proof pressure test method.....	5
	4.10.3	Cleaning.....	5
	4.11	Reimpregnation.....	5
	5.	DETAILED REQUIREMENTS.....	5
	6.	NOTES.....	5
	6.1	Intended use.....	5
	6.2	Issue of DODISS .....	5
	6.3	Subject term (key word) listing.....	6
	6.4	Changes from previous issue.....	6
Appendix		Documents for obtaining waivers.....	7

## MIL-STD-276A

## 1. SCOPE

1.1 Scope. This standard covers the requirements and tests for the impregnation of structurally sound castings and powder metal components in aluminum, magnesium, copper, iron, (excluding steels) and zinc alloys. Components for Naval service shall be shown to be structurally sound in accordance with MIL-STD-278. It is also applicable to test specimens used for evaluating impregnating materials in accordance with MIL-I-17563.

1.2 Applicability.

1.2.1 Authorization. Components shall be impregnated or reimpregnated in accordance with this standard when authorized by NAVSEA for Naval applications and by the end user for other applications. When impregnation or reimpregnation is not specifically authorized, but is deemed necessary to satisfy performance requirements, a waiver may be obtained in accordance with MIL-STD-480 or MIL-STD-481 (see appendix). Impregnation should only be permitted in the following situations when it is agreed upon between the impregnator and the end user.

- (a) When components are to be exposed to fluids other than those tested for compatibility with the impregnating material in accordance with MIL-I-17563.
- (b) When impregnating materials other than those specified in 4.2 are used.
- (c) When impregnating methods other than those specified in 4.4 are used.

1.2.2 Restrictions on use of filled sodium silicate impregnants. Filled sodium silicate impregnants shall not be used unless all of the following conditions are applicable:

- (a) Measured leak rates are less than 0.75 cubic inches of air per second (750 cm<sup>3</sup> per minute).
- (b) The maximum service temperature of the casting is 250 degrees Fahrenheit (°F) or below. (Temperatures to 800°F are acceptable provided the impregnant is step cured to the maximum service temperature.)
- (c) Minimum Drying Time at ambient temperature shall be 48 hours. Drying time may be conducted at 175-200°F for 2 hours followed by polymerizing at the specified operating temperature.
- (d) Castings shall not be used in contact with concentrated acid or hydrogen peroxide.
- (e) Specific gravity of the uncured filled sodium silicate impregnant shall be 28 degrees Baume minimum.

1.2.3 Prohibitions on impregnating. Impregnation shall not be performed under any circumstances in the following situations:

- (a) When castings are to be exposed to temperatures greater than the maximum specified in MIL-I-17563 for the specific impregnant used except for sodium silicates properly cured as shown above.
- (b) When castings are to be exposed to oxygen gas at any pressure. (Since sodium silicate is totally inorganic, it can be used in contact with oxygen.)

## MIL-STD-276A

- (c) When castings must be welded after impregnation during fabrication.
- (d) When castings exhibit rejectable structural defects as defined by the specified radiographic standards.

Waivers shall not be granted for these applications.

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

2.1.1 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 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).

## SPECIFICATIONS

### MILITARY

MIL-I-17563 - Impregnants for Aluminum, Copper, Iron, Magnesium and Zinc Alloy Castings.

## STANDARDS

### MILITARY

MIL-STD-278 - Welding and Casting Standard.  
 MIL-STD-480 - Configuration Control-Engineering Changes, Deviations and Waivers.  
 MIL-STD-481 - Configuration Control-Engineering Changes (Short Form), Deviations and Waivers.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 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. DEFINITIONS - This section is not applicable to this standard.

## 4. GENERAL REQUIREMENTS

4.1 Preliminary test for pressure tightness. Components which have been thoroughly cleaned and completely machined shall be subjected to the hydrostatic or aerostatic pressure required by the applicable drawing or directive, or as specified in 4.10. If pressure tests are made on components before final machining and threading of bolt holes, the components shall be retested after final machining and before impregnation. Components which leak through the wall during this test may be repaired by impregnation provided they meet all the requirements of 1.2.

## MIL-STD-276A

4.2 Materials. The materials used to impregnate components shall conform to MIL-I-17563 unless filled sodium silicate can be shown to be a suitable alternative by showing all the restrictions of 1.2.2 have been met.

4.3 Preparation of castings for impregnation.

4.3.1 Preliminary operations. Unless otherwise specified, all heat treating, welding, brazing, and machining operations shall be performed prior to impregnation. Surface finishing shall be performed after impregnating.

4.3.2 Cleaning. Components shall be thoroughly cleaned free of oils and other machining compounds. Components after water rinse shall be dried by heating to 150 to 180°F for a minimum of one hour and shall be brought to ambient temperature before impregnating, if vapor degreasing is used for cleaning, no drying is necessary.

4.3.3 Surface preparation. Rough magnesium castings shall be treated to remove surface skin to a depth of approximately 0.002 inches by mechanical treatment.

4.4 Impregnating methods. Impregnation shall be by one of the following methods at the discretion of the contractor.

4.4.1 Method A - internal pressure (individual castings). Method A involves using the casting itself as the pressure containing vessel and can only be done on one casting at a time. It is primarily applicable to large castings. All of the openings in the casting, except for ports for the impregnant shall be plugged. The impregnant shall be injected into the casting until it is completely filled, or shall be circulated through the casting under pressure. Pressure from 50 to 75 pounds per square inch (lb/in<sup>2</sup>) above prescribed test pressure shall be applied (if factor of safety of the castings will permit). This pressure shall be maintained until the liquid is observed seeping through the pores or, in the case of extremely fine porosity where the liquid may not come noticeably to the outside surface, the length of time to hold the pressure shall be determined empirically. Loss of solution by seepage may be stopped by spot curing, care being taken not to heat the castings to the cure temperature over a larger volume than is to be cured. In cases of minute porosity in heavy walls, 6 hours or more under pressure may be required to effect complete penetration of the solution through the wall.

4.4.2 Method B - dry vacuum and pressure (batch immersion). Method B involves evacuating the component's porosity to remove air, water, and other foreign material and introducing the impregnant under pressure. The clean and dry components shall be placed in an empty pressure vessel. The vessel shall then be closed and the air evacuated until a vacuum of not less than 29 inches of mercury is attained. If the vapor pressure of the impregnant solution prohibits using a minimum vacuum of 29 inches of mercury, the maximum vacuum compatible with the solution shall be used, but shall not be less than 27 inches of mercury. The impregnating solution shall be drawn into the tank at such a rate that the above specified vacuum is maintained. When the tank contains a sufficient amount of solution to cover the components to a level of at least 2 inches above the load, atmospheric or greater pressure shall be applied. After a period of time which has

## MIL-STD-276A

been determined empirically. The pressure shall be released, the tank emptied of solution, and the parts removed. Sectioning of actual parts or samples may be required to determine penetration.

4.4.3 Method C - wet vacuum and pressure (batch immersion). The components shall be placed in a pressure vessel containing the impregnating solution. Each item shall be submerged until it is covered by at least 2 inches of impregnating solution. The vessel shall then be closed and the air exhausted until a vacuum of not less than 29 inches of mercury is attained. The vacuum shall be maintained for a period determined empirically to be sufficient for complete air removal. At the end of the vacuum cycle, a pressure of not less than 50 pounds per square inch shall be applied for a period shown by experience to be sufficient for complete porosity sealing. The pressure shall then be released and the castings removed from the solution. For components with a wall thickness not exceeding 1/2 inch, the pressure cycle may be omitted.

4.4.4 Impregnation procedure restrictions.

4.4.4.1 Sodium silicate. Impregnation with sodium silicate shall be permitted only by Methods A or B.

4.4.4.2 Hazardous wastes. All hazardous waste generated by this process, shall be disposed of in accordance with local and federal regulations.

4.5 Post-impregnation treatment.

4.5.1 Rinsing. The parts shall be well drained and the surface, including ducts, vents, and pockets, thoroughly rinsed in aqueous solution to remove excess impregnant. A corrosion inhibitor additive may be added to the final rinse water.

4.5.2 Curing process. The components shall be cured in accordance with the impregnant solution manufacturer's instructions.

4.6 Leakage. Impregnation shall be accomplished to the extent that the items do not leak under proof tests described in 4.10.1.

4.7 Discoloration. Discoloration which does not affect the quality of impregnation or the serviceability shall not be cause for rejection of the casting or powder metal component.

4.8 Marking. Each component which has been impregnated shall be marked "IMP" on the stamping pad or in a conspicuous place that will not impair its strength or serviceability. Marking shall be by low stress die stamps or vibrotool engraving.

4.9 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.

## MIL-STD-276A

4.10 Proof pressure test. Each component shall be subjected to the pressure test, either hydrostatic or aerostatic, in accordance with the applicable drawings, directives, or specifications. If the applicable drawings, directives, or specifications do not specify the proof pressure or other testing requirements, the requirements of 4.10.1 or 4.10.2 shall apply. In the event machining is necessary after impregnation, the final pressure test shall be performed after machining.

4.10.1 Proof pressure test method. The proof pressure to which the castings shall be subjected shall be double the normal working pressure, but in no case less than 10 pounds per square inch gauge. Air shall be forced into the castings at the required pressure for not less than 2 minutes while the part is immersed in water. As an alternate to immersion in water, neutral soap solution or kerosene may be brushed on the external surfaces of the part. Bubbling observed in the water or coming through the soap solution or kerosene shall indicate failure.

4.10.2 Alternate proof pressure test method. Components may alternatively be filled with water, kerosene, or other liquid compatible with the end use of the casting and subjected to internal pressure for not less than 2 minutes. The internal pressure shall be double the normal working pressure, but not less than 10 pounds per square inch gauge. Any evidence of leakage through the wall shall indicate failure of the component.

4.10.3 Cleaning. If a soap solution is used for testing, it shall be thoroughly rinsed from the parts. Parts shall be dry inside and out before storage. Machined surfaces of iron components shall be protected to prevent rusting.

4.11 Reimpregnation. Components may be reimpregnated once either before or after pressure testing unless there is reason to doubt the quality of the impregnation process or of the component. Parts which leak after one reimpregnation shall be rejected. An exception to this requirement shall be permitted if machining after impregnation is required. In which case, one additional impregnation shall be permitted before final rejection.

## 5. DETAILED REQUIREMENTS

This section is not applicable to this standard.

## 6. NOTES

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

6.1 Intended use. This standard contains the requirements and tests for the impregnating of porous aluminum-alloy, magnesium-alloy, copper-base-alloy, iron-alloy, and zinc-alloy castings or powder metal components.

6.2 Issue of DODISS. When this standard is used in acquisition, the issue of the DODISS to be applicable to this solicitation must be cited in this solicitation (see 2.1.1).

## MIL-STD-276A

6.3 Subject term (key word) listing.

Alloy, aluminum	Vacuum, dry
Alloy, copper	Vacuum, wet
Alloy, ferrous	Vacuum/pressure
Alloy, iron	
Alloy, magnesium	
Alloy, zinc	
Porosity	
Pressure, internal	

6.4 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.

## Custodians:

Army - MR

Navy - SH

## Preparing activity:

Navy - SH

(Project 9540-0142)

## Review activities:

Army - AR, MI

Navy - OS

DLA - DISC

## User activities:

Navy - AS

Army - AT

## MIL-STD-276A

### APPENDIX

#### DOCUMENTS FOR OBTAINING WAIVERS

##### 10. GENERAL

10.1 Scope. This appendix provides documents from which information on obtaining waivers may be found. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

##### 20. APPLICABLE DOCUMENTS

###### 20.1 Government documents.

20.1.1 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 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).

##### STANDARDS

###### MILITARY

- MIL-STD-480 - Configuration Control-Engineering Changes, Deviations and Waivers.
- MIL-STD-481 - Configuration Control-Engineering Changes (Short Form), Deviations and Waivers.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

##### 30. APPLICABILITY

30.1 Waivers. MIL-STD-480 and MIL-STD-481 establish requirements, formats, and procedures for the preparation, submission, and approval or disapproval of requests for deviations and waivers (see 1.2).

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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**NOTE:** This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

### I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER  
MIL-STD-276A

2. DOCUMENT DATE (YYMMDD)  
92-12-30

### 3. DOCUMENT TITLE

IMPREGNATION OF POROUS METAL CASTINGS AND POWDERED METAL COMPONENTS

### 4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

### 5. REASON FOR RECOMMENDATION

### 6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)  
(1) Commercial  
(2) AUTOVON  
(If applicable)

7. DATE SUBMITTED  
(YYMMDD)

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