Designation: A967 – 05$^{\varepsilon 2}$

StandardSpecification for Chemical Passivation Treatments for Stainless Steel Parts[1]

This standard is issued under the fixed designation A967; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε^1 NOTE—Section 6.1.1.1 was editorially corrected in July 2007.
ε^2 NOTE—Section references were editorially corrected in Section 22.1 in March 2010.

1. Scope*

1.1 This specification covers several different types of chemical passivation treatments for stainless steel parts. It includes recommendations and precautions for descaling, cleaning, and passivation of stainless steel parts. It includes several alternative tests, with acceptance criteria, for confirmation of effectiveness of such treatments for stainless steel parts.

1.2 Practices for the mechanical and chemical treatments of stainless steel surfaces are discussed more thoroughly in Practice A380.

1.3 Several alternative chemical treatments are defined for passivation of stainless steel parts. Appendix X1 gives some nonmandatory information and provides some general guidelines regarding the selection of passivation treatment appropriate to particular grades of stainless steel. It makes no recommendations regarding the suitability of any grade, treatment, or acceptance criteria for any particular application or class of applications.

1.4 The tests in this specification are intended to confirm the effectiveness of passivation, particularly with regard to the removal of free iron and other exogenous matter. These tests include the following practices:

1.4.1 *Practice A*—Water Immersion Test,
1.4.2 *Practice B*—High Humidity Test,
1.4.3 *Practice C*—Salt Spray Test,
1.4.4 *Practice D*—Copper Sulfate Test,
1.4.5 *Practice E*—Potassium Ferricyanide–Nitric Acid Test, and
1.4.6 *Practice F*—Free Iron Test.

1.5 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.6 The following precautionary caveat pertains only to the test method portions, Sections 14 through 18 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
B117 Practice for Operating Salt Spray (Fog) Apparatus
B254 Practice for Preparation of and Electroplating on Stainless Steel

2.2 *Federal Specification:*[3]
QQ-P-35C Passivation Treatments for Corrosion-Resistant Steels

3. Terminology

3.1 *Definition of Term Specific to This Standard*—It is necessary to define which of the several commonly used definitions of the term *passivation* will be used in this specification. (See Discussion.)

3.1.1 *Discussion*—Stainless steels are autopassivating in the sense that the protective passive film is formed spontaneously on exposure to air or moisture. The presence of exogenous surface contamination, including dirt, grease, free iron from contact with steel tooling, and so forth, may interfere with the formation of the passive film. The cleaning of these contaminants from the stainless steel surface will facilitate the spontaneous passivation by allowing the oxygen uniform access to the surface. The passive film may be augmented by chemical

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.14 on Methods of Corrosion Testing.

Current edition approved Sept. 1, 2005. Published September 2005. Originally approved in 1996. Last previous edition approved in 2001 as A967 – 01$^{\varepsilon 1}$. DOI: 10.1520/A0967-05E01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

***A Summary of Changes section appears at the end of this standard**

treatments that provide an oxidizing environment for the stainless steel surface.

3.1.1.1 In this specification, passivation, unless otherwise specified, is defined as the chemical treatment of a stainless steel with a mild oxidant, such as a nitric acid solution, for the purpose of the removal of free iron or other foreign matter, but which is generally not effective in removal of heat tint or oxide scale on stainless steel. In the case of stainless steels with additions of sulfur for the purpose of improved machinability, passivation may also include the removal of sulfides from the surface of the metal for the purpose of maximizing corrosion resistance.

3.1.1.2 The formation of the protective passive film on a stainless steel, also called passivation in a more general context, will occur spontaneously in air or other oxygen-containing environment when the stainless steel surface is free of oxide scale and exogenous matter.

3.1.1.3 Chemical treatments, such as sodium dichromate solutions, may facilitate the more rapid formation of the passive film on a stainless steel surface already free of scale or foreign matter. Such treatments, also sometimes called passivation in common usage, are designated as post-cleaning treatments in this specification in order to distinguish them from chemical treatments capable of removing free iron from stainless steels.

3.1.1.4 The chemical treatments capable of removing heat tint or oxide scale from stainless steel and capable of dissolving the stainless steel itself, typically called pickling, are substantially more aggressive than treatments used for passivation, as defined in 3.1.1.1. The surface of stainless steel that has been pickled is free of scale, free iron, and exogenous foreign matter, and does not require a separate treatment for passivation as defined in 3.1.1.1. The passivation process defined in 3.1.1.2 will occur without further chemical treatment but may be augmented and improved by the post-cleaning treatments defined in 3.1.1.3.

3.1.1.5 Electrochemical treatments, including electropickling and electropolishing capable of removing heat tint or oxide scale from stainless steel and capable of dissolving the stainless steel itself, are substantially more aggressive than treatments used for passivation, as defined in 3.1.1.1. The surface of stainless steel resulting from these treatments is free of scale, free iron, and exogenous foreign matter, and does not require a separate treatment for passivation as defined in 3.1.1.1. The passivation process defined in 3.1.1.2 will occur without further chemical treatment, but may be augmented and improved by the post-cleaning treatments defined in 3.1.1.3. Statements regarding chemical treatments, unless otherwise specified, are taken to include electrochemical treatments.

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify a test practice appropriate to any particular material and application. This specification was written for the purpose of providing an alternative to United States Federal Specification QQ-P-35C. Determination of the suitability of this specification for that purpose is the responsibility of the purchaser.

4.2 Unless specified by the purchaser, the chemical treatment applied to the stainless steel parts shall be selected by the seller from among the listed passivation treatments.

5. Materials and Preparation for Passivation Treatments

5.1 The passivation treatments shall be of one or more of the following types. The effectiveness of a particular treatment for a particular grade of stainless steel in a particular application is demonstrated by meeting the specified testing requirements:

5.1.1 Treatments in nitric acid,

5.1.2 Treatments in citric acid,

5.1.3 Other chemical treatments, including electrochemical treatments,

5.1.4 Neutralization, and

5.1.5 Post-cleaning treatments.

5.2 *Materials:*

5.2.1 The chemicals used for passivation treatments shall produce passivated surfaces that meet the requirements of one or more of the tests of this specification. Attention shall be given to maintaining adequate volume, concentration, purity, and temperature control appropriate to the size and amount of stainless steel to be treated.

5.2.2 The processor shall maintain a record with regard to concentration and temperature of the passivation solution sufficient to demonstrate that the specified passivation conditions were maintained for each lot of stainless steel parts processed. Such records shall be available for inspection when specified in the purchase order. The processor is not required to reveal the precise composition of proprietary chemical mixtures but shall maintain a unique identification of the mixture that will ensure its accurate representation for subsequent use.

5.2.3 The processor shall be responsible for the safe disposal of all material generated by this process.

5.3 *Preparation for Passivation Treatments:*

5.3.1 The pretreatment methods and procedures used prior to the passivation treatment, including mechanical and chemical methods, singly or in combination, for descaling and pickling, shall be in accordance with Practice A380. When electrochemical cleaning is required, it shall be performed in accordance with Practice B254.

5.3.2 The resulting pretreated surface shall be substantially free of oil, grease, rust, scale, and other foreign matter.

5.3.3 When the final pretreatment of a part includes pickling of the entire surface of the part, no further passivation treatment is required prior to testing of the surface unless specified by the purchaser.

6. Treatments in Nitric Acid Solutions

6.1 *Passivation Treatment:*

6.1.1 Stainless steel parts shall be treated in one of the following aqueous solutions and maintained within the specified temperature range for the specified time.

6.1.1.1 *Nitric 1*—The solution shall contain 20 to 25 volume percent of nitric acid and 2.5 ± 0.5 weight percent of sodium dichromate. The parts shall be immersed for a minimum of 20 min at a temperature in the range from 120 to 130°F (49 to 54°C).

6.1.1.2 *Nitric 2*—The solution shall contain 20 to 45 volume percent of nitric acid. The parts shall be immersed for a minimum of 30 min at a temperature in the range from 70 to 90°F (21 to 32°C).

6.1.1.3 *Nitric 3*—The solution shall contain 20 to 25 volume percent nitric acid. The parts shall be immersed for a minimum of 20 min at a temperature in the range from 120 to 140°F (49 to 60°C).

6.1.1.4 *Nitric 4*—The solution shall contain 45 to 55 volume percent of nitric acid. The parts shall be immersed for a minimum of 30 min at a temperature in the range from 120 to 130°F (49 to 54°C).

6.1.1.5 *Nitric 5*—Other combinations of temperature, time, and concentration of nitric acid, with or without other chemicals, including accelerants, inhibitors, or proprietary solutions, capable of producing parts that pass the specified test requirements.

6.2 *Water Rinse*—Immediately after removal from the passivating solution the parts shall be thoroughly rinsed, using stagnant, countercurrent, or spray washes singly or in combination, with or without a separate chemical treatment for neutralization (see 9.1) of the passivation media, with a final rinse being carried out using water with a maximum total solids content of 200 ppm.

7. Treatments in Citric Acid

7.1 *Passivation Treatment:*

7.1.1 Stainless steel parts shall be treated in one of the following aqueous solutions and maintained within the specified temperature range for the specified time.

7.1.1.1 *Citric 1*—The solution shall contain 4 to 10 weight percent of citric acid. The parts shall be immersed for a minimum of 4 min at a temperature in the range from 140 to 160°F (60 to 71°C).

7.1.1.2 *Citric 2*—The solution shall contain 4 to 10 weight percent of citric acid. The parts shall be immersed for a minimum of 10 min at a temperature in the range from 120 to 140°F (49 to 60°C).

7.1.1.3 *Citric 3*—The solution shall contain 4 to 10 weight percent of citric acid. The parts shall be immersed for a minimum of 20 min at a temperature in the range from 70 to 120°F (21 to 49°C).

7.1.1.4 *Citric 4*—Other combinations of temperature, time, and concentration of citric acid, with or without other chemicals to enhance cleaning, including accelerants, inhibitors, or proprietary solutions capable of producing parts that pass the specified test requirements.

7.1.1.5 *Citric 5*—Other combinations of temperature, time, and concentrations of citric acid, with or without other chemicals to enhance cleaning, including accelerants, inhibitors, or proprietary solutions capable of producing parts that pass the specified test requirements. Immersion bath to be controlled at a pH of 1.8–2.2.

7.2 *Water Rinse*—Immediately after removal from the passivating solution, the parts shall be thoroughly rinsed, using stagnant, countercurrent, or spray washes, singly or in combination, with or without a separate chemical treatment for neutralization of the passivation media (see 9.2), with a final rinse being carried out using water with a maximum total solids content of 200 ppm.

8. Treatments in Other Chemical Solutions, Including Electrochemical Treatments

8.1 It is recognized that the purpose of removal of all exogenous matter from a stainless steel surface, including the removal of free iron, can be accomplished by different media, with potential for benefits to be gained from use of proprietary skills and art, including proprietary passivation media. Such treatments may include externally applying an electrical potential on the stainless steel parts, as in the case of electropolishing. The suitability of such passivation treatments for use in meeting the requirements of this specification shall be determined by the capability of the processed parts meeting the specified test requirements.

8.2 Stainless steel parts shall be treated in a specified aqueous solution, with or without externally applied electrical potential, and maintained within a specified temperature range for a time sufficient for the processed parts to meet the specified test requirement.

8.3 *Water Rinse*—Immediately after removal from the passivating solution, the parts shall be thoroughly rinsed, using stagnant, countercurrent, or spray washes, singly or in combination, with or without a separate chemical treatment for neutralization of the passivation media (see 9.2), with a final rinse being carried out using water with a maximum total solids content of 200 ppm.

9. Neutralization

9.1 The chemical reactions of the passivating media on the surface of the stainless steel shall be stopped by rinsing of the stainless steel part, with or without a separate neutralization treatment.

9.2 The suitability of a neutralization procedure is determined by the capability of the processed parts meeting the specified test requirements (see Note 1).

NOTE 1—The selection of medium and procedures for a neutralization depends of the chemistry of the passivation and on economic considerations. An example of a neutralizing treatment would be immersion of the part for a minimum of 30 min in a solution of 5 % NaOH at 160 to 180°F (71 to 82°C), followed by a water rinse.

10. Post-Cleaning Treatments

10.1 Although the passive film characteristic of stainless steel will form spontaneously in air or any other oxygen-containing environment, the processor shall, when specified, apply a chemical treatment that will accelerate the formation of the passive film on a chemically clean stainless steel surface. An example of a medium that serves to accelerate the formation of the passive film but does not contribute to the removal of free iron from the stainless steel surface would be an aqueous solution of sodium dichromate.

10.2 When specified, within one hour after the final water rinse as required in 6.2, 7.2, or 8.3, all ferritic and martensitic steel parts shall be immersed in an aqueous solution containing