

ANSI/NSF 51-1997

Food Equipment Materials

**American National Standard/
NSF International Standard**

ANSI/NSF 51-1997



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American National Standard/
NSF International Standard
for Food Equipment—

Food Equipment Materials

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Foreword (This foreword is not part of Standard 51.)

The purpose of this Standard is to establish minimum food protection and sanitation requirements for the materials used in the construction of commercial food equipment.

In this edition of the Standard, the title and scope have been changed from *Plastic Materials and Components Used in Food Equipment* to *Food Equipment Materials*. This Standard now contains requirements for all types of materials, including plastics, used in the manufacture of commercial food equipment. Requirements from the *Materials* sections of other ANSI/NSF Food Equipment Standards have been consolidated into this edition of ANSI/NSF 51. By way of reference, this Standard will define the basic materials requirements for all equipment covered by ANSI/NSF Food Equipment Standards.

This Standard establishes requirements intended to ensure that a material is not formulated such that it may impart deleterious substances to food in its intended end use application. This Standard does not define specific extraction test methods or acceptance criteria to be used to assess the extent of chemical migration from food contact surfaces to food. Instead, the appropriate US Federal Regulations have been cited as references upon which conformance with this Standard is based. Other ANSI/NSF Standards may establish extraction tests and acceptance criteria, as needed, for specific types of equipment based on the materials used in their construction and the nature of the food contact (i.e., beverage dispensing equipment, ice making equipment).

This Standard establishes cleanability requirements for food equipment materials. This edition incorporates the test method and acceptance criteria used by NSF for many years to determine if textured surfaces can be easily cleaned. Corrosion resistance requirements, including criteria for evaluating shelving products used in refrigeration and warewashing environment, have also been incorporated in this edition.

This edition of ANSI/NSF 51 establishes specific requirements and use limitations for a variety of material types including stainless steel, aluminum, copper and copper alloys, metallic and organic coatings, glass and wood.

The style and format of the Standard have been modified for consistency with the guidelines published by the American National Standard Institute.

This Standard was developed by the NSF Joint Committee on Food Equipment using the consensus process described by the American National Standards Institute.

Suggestions for improvement of this Standard are welcome. Comments should be sent to NSF International, Standards Department, PO Box 130140, Ann Arbor, Michigan 48113-0140, USA.

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ANSI/NSF International Standard for Food Equipment —

Food Equipment Materials

1 General

1.1 Purpose

This Standard establishes minimum public health and sanitation requirements for materials used in the construction of commercial food equipment. The requirements of this Standard are intended to ensure that the composition and finish of food equipment materials are such that a material will not adulterate food nor render food equipment difficult to clean and sanitize.

1.2 Scope

This Standard is applicable to complete pieces of food equipment (e.g., a commercial broiler, a beverage dispenser, a cutting board, a stock pot) with respect to the materials and finishes used in their construction. The Standard is also applicable to components such as tubing, sealants, gaskets, valves, and other items intended for various food equipment applications. These components shall also meet the relevant design and construction requirements of the NSF Standard applicable to the type of food equipment on which the component is used.

The requirements of Section 4 of this Standard may also be applied separately to determine if a material is suitable for use in a food zone based on its formulation alone. The other relevant requirements of this Standard, including those for cleanability and corrosion resistance, would apply to the finished product for which the material is used.

Materials other than those specifically mentioned in this Standard may be used provided such materials meet the minimum requirements described herein.

2 Normative references

The following documents contain provisions that, through reference, constitute provisions of this ANSI/NSF Standard. At the time of publication, the editions listed below were valid. All standards are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the standards indicated below.

ANSI/NSF 2 – 1996 *Food Equipment*

ASTM B 117– 95 *Standard Practice for Operating Salt Spray (Fog) Apparatus*¹⁾

Code of Federal Regulations, Title 21, (21 CFR) Parts 170-199, *Food and Drugs*²⁾

3 Definitions

3.1 corrosion resistant: Capable of maintaining original surface characteristics under prolonged contact with the intended end use environment and exposure to appropriate cleaning compounds and sanitizing solutions.

3.2 easily cleanable: Manufactured such that food and other soiling material may be removed by manual cleaning methods.

3.3 exposed: Open to view from at least one angle.

3.4 food: Any raw, cooked, or processed edible substance, ice, water, beverage or ingredient intended for human consumption.

3.5 food zone: Equipment surfaces intended to be in direct contact with food and equipment surfaces that food may contact and then drain drip, or splash back into food or onto surfaces that are intended to be in direct contact with food.

3.6 heated food zone: Food zone surfaces that are intended to be maintained at a minimum temperature of 180°F (82°C) during operation.

3.7 nonfood zone: Exposed equipment surfaces other than those in food zone or splash zone.

3.8 smooth: Free of pits, pinholes, cracks, crevices, inclusions, rough edges and other surface imperfections detectable by visual and tactile inspection.

¹⁾ *Annual Book of ASTM Standards, Vol. 06.01*, American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428

²⁾ US Government Printing Office, Washington, DC 20402

3.9 splash zone: Equipment surfaces other than those in a food zone, that are subject to splash, spillage, or other food soiling during operation of the equipment.

3.10 textured: Having a surface onto which a repeated pattern has been established to obtain a desired visual or tactile effect and which may hinder the removal of soil from the surface during cleaning.

4 Material formulation

4.1 Food zone materials shall be manufactured from or composed of substances that:

- may not reasonably be expected to result, directly or indirectly, in their becoming a component of food, or otherwise affecting the characteristics of food, including the imparting of a color, taste, or odor to food; or
- are generally recognized as safe or have received prior sanction for their intended use³⁾; or
- are regulated as indirect food additives under the provisions of the US Code of Federal Regulations, Title 21 Parts 174 through 189 (21 CFR 174-189); or
- are exempt from regulation as food additives under the provisions of the 21 CFR 170.39 *Threshold of regulation for substances used in food contact articles*.

4.2 Food zone materials shall not contain lead, arsenic, cadmium, or mercury as intentional ingredients, except where brass and bronze are specifically permitted for use under 7.3.2.

4.3 Coatings containing lead as an intentional ingredient shall not be used on food equipment surfaces, including splash zones and nonfood zones. Coatings with an unintentional lead content (lead impurity) greater than 0.06% shall not be used.

5 Surface cleanability

5.1 Materials shall be smooth and easily cleanable.

5.2 If a material is textured such that it may hinder the removal of soil during cleaning, the material

shall be demonstrated to be cleanable when tested in accordance with 5.2.1.

5.2.1 Test method

When required by this Standard, the surface cleanability of a textured material shall be determined by quantifying the amount of applied soil that remains on a material sample after cleaning. Four material test plaques (5 in. × 5 in. (127 mm × 127 mm)) shall be washed with Alcojet[®] laboratory detergent, or equivalent, and water at 162° F ± 2° F (72° C ± 1° C) and shall be air dried. 200 µL of a standardized radioactive synthetic lard shall be applied to each of four equal quadrants on each test plaque. The synthetic lard shall be comprised of glycerol trioleate (62.5%) and glycerol tristearate (37.5 %) that has been made radioactive by the addition of trace amounts of ¹⁴C-labeled glycerol trioleate (0.845 µCi per gram of synthetic lard) and ¹⁴C-labeled stearic acid (0.514 µCi per gram of synthetic lard). The lard shall be spread in a uniform layer onto the quadrants while under an infrared heat source to maintain the lard in a liquid state. The mass of soil on each quadrant shall be quantified using a beta radiation counting system; each quadrant shall have 20 mg ± 5 mg applied to its surface. The soiled test plaques shall be washed in a single-temperature, total-dump dishwashing machine having the following characteristics:

- no overhead spray;
- no detergent added;
- wash and rinse water temperature: 162° F ± 2° F (72° C ± 1° C);
- wash cycle time: 120 seconds ± 2 seconds;
- total wash cycle volume: 2.3 gallons ± 0.2 gallons (8.7 liters ± 0.8 liters);
- dwell cycle time: 30 seconds ± 2 seconds;
- rinse cycle time: 30 seconds ± 2 seconds;
- total rinse cycle volume: 2.3 gallons ± 0.2 gallons (8.7 liters ± 0.8 liters)

After washing, the residual soil on each of the sixteen quadrants shall be quantified using a beta radiation counting system. The average residual soil value shall be compared to the control value for the zone in which the material is located.

³⁾ As defined in the Federal Food, Drug, and Cosmetic Act [United States Code, Title 21, Section 321(s)].

5.2.2 Acceptance criteria

The average residual soil on the quadrants shall not exceed the predetermined control value for the zone in which the material is located.

Zone	Control Value	Examples
food zone	30 μg	Stainless Steel - No.3 (100 grit) finish
heated food zone	1750 μg	Cast Iron
ice bin materials	650 μg	Rotationally Molded Polyethylene
splash and nonfood zone	220 μg	Hot Rolled Steel

6 Corrosion resistance

6.1 General

Materials shall be corrosion resistant in the intended end use environment. Protective coatings may be used to render a material corrosion resistant, except as prohibited in 7.4, 7.5, and 7.6. Protective coatings shall remain intact under use conditions and shall conform to the applicable requirements in 7.4, 7.5, and 7.6.

NOTE – Materials that are worked (e.g., bent, cut, sheared, extruded, drawn) during equipment fabrication may require additional treatment following fabrication in order to render them corrosion resistant.

6.2 Storage shelving intended for wet environments

Storage shelving that is fabricated, in whole or in part, of metallic materials and is intended for use in refrigerator or freezer interiors or warewashing areas shall not show evidence of corrosion when exposed to 192 hours of testing in accordance with ASTM B 117– 95 *Standard Practice for Operating Salt Spray (Fog) Apparatus*. Shelving constructed of stainless steel in the American Iron and Steel Institute (AISI) 200 or 300 series is exempt from this requirement. The other requirements of this Standard, including the coating requirements in 7.4 and 7.5, shall also apply to storage shelving.

6.2.1 Test Method

Using a vertical band saw or similar equipment, five test samples shall be cut from the corners of

finished shelving product, ensuring that shavings are blown away to prevent them from becoming embedded in the sample. Samples shall be approximately 8 in. x 11 in. (200 mm x 275 mm) in the horizontal plane. If the shelving has vertical legs or supports, samples shall include a vertical length of approximately 6 in. (150 mm). The total exposed surface area of each sample shall be determined, excluding all surfaces within ½ in. (13 mm) of a cut edge.

Testing shall be conducted in accordance with ASTM B 117– 95 *Standard Practice for Operating Salt Spray (Fog) Apparatus*. The period of exposure shall be 192 hours. The samples shall be arranged in the salt spray chamber so that salt solution will drip away from the cut edges without contacting the other parts of the sample and without dripping on other samples. At the end of the test, samples shall be gently rinsed with a stream of clean running water at 73°F ±10°F (23°C ± 5°C). Samples shall be allowed to air dry immediately at 73°F ± 3°F (23°C ± 2°C). Once dry, samples shall be carefully examined for visible evidence of corrosion, such as blistering, peeling, cracking, or the formation of corrosion products on the sample surface. All surfaces within ½ in. (13 mm) of a cut edge are not considered part of the sample and so evidence of corrosion on these surfaces shall be disregarded.

6.2.2 Acceptance criteria

There shall be no visible evidence of blistering, peeling, cracking on any sample. There shall be no visible evidence of red corrosion products (red rust) on the surface of any sample. White corrosion products shall be limited to 5% or less of the total exposed surface area of any sample.

7 Requirements for specific types of materials

This section establishes limitations on the use of specific types of materials. The intent is to ensure conformance with the requirements in Sections 4 through 6 of this Standard. Additional requirements for some types of materials are also established in this section.

7.1 Stainless steel

7.1.1 Stainless steel used in food equipment shall be of a type in the AISI 200 series, AISI 300 series, or AISI 400 series⁴⁾.

⁴⁾ Under the Unified Numbering System (UNS) these types are designated as S2xxxx, S3xxxx, and S4xxxx, respectively.

7.1.2 When used in a food zone, stainless steel shall have a minimum chromium content of 16%. Stainless steel with a chromium content of less than 16% may be used for cutlery, blades, and similar applications requiring a sharp edge, provided the alloy has been hardened or tempered by an appropriate post-weld heat treatment process.

7.2 Aluminum alloys

When used in a food zone, aluminum alloys shall have one the following Aluminum Association alloy designations or equivalent:

Wrought Alloys (sheet and extrusion)

- 1xxx series alloys;
- 3xxx series alloys;
- 4xxx series alloys;
- 5xxx series alloys;
- 6xxx series alloys.

Casting Alloys

- 218.x;
- 308.0;
- 319.0;
- 332.0;
- 356.0;
- 360.0;
- 413.0;
- B443.0;
- 514.0;
- 520.0;
- 713.0.

7.3 Copper and copper alloys

7.3.1 Copper and copper alloys shall not be used in a food zone except where exposure to food is limited to potable, non-carbonated water under constant service pressure. Exceptions to this requirement are specified in 7.3.2 for brass and bronze and in 7.3.3 for copper-nickel alloys.

7.3.2 Brass and bronze may be used in a food zone where exposure to food is clearly and specifically limited to tea, coffee, or water. When used, the lead content of brass and bronze components shall not exceed 8.0 percent.

7.3.3 Copper-nickel alloys may be used in a food zone where exposure to food is clearly and specifically limited to non-acidic foods and beverages (i.e., food and beverages with a pH of 6.0 or greater).

7.4 Metallic coatings

7.4.1 Metallic coatings and platings shall be applied in accordance with the appropriate ASTM Standard Specification or equivalent.

Annex A identifies the appropriate ASTM Standard Specification for a number of metallic coating processes commonly used for food equipment materials. The coating thickness and designation shall be appropriate for the intended end use of the coated material.

7.4.2 Zinc coated materials

Galvanized materials and other zinc coated materials shall not be used on surfaces intended for direct food contact.

7.5 Organic (non-metallic) coatings

7.5.1 Direct food contact

Paint and other organic coatings shall not be used on surfaces intended for direct contact with food, except where fluoropolymer resin coatings (e.g., polytetrafluoroethylene) are specifically permitted for use under other NSF Standards.

7.5.2 Abrasion resistance of organic coatings

An organic coating used to render a material corrosion resistant shall be abrasion resistant.

7.5.2.1 Test Method

The abrasion resistance of an organic coating shall be evaluated using three coated test plaques that represent the finished product. The coated test plaques shall be conditioned for at least 24 hours at 73°F ± 3°F (23°C ± 2°C) and 50% ± 5% relative humidity and weighed to the nearest milligram. The samples shall be mounted on a Taber Abraser with calibrase wheels No. CS-10 and an applied load of 4.4 lb (2 kg). Samples shall undergo 500 wear cycles. The final mass of each sample shall be recorded and subtracted from its initial weight. Each sample shall be inspected for substrate exposure.

7.5.2.2 Acceptance criteria

The mass of coating lost from each test sample shall be less than 100 milligrams and the substrate shall not be exposed on any of the samples.

7.5.3 Impact resistance of organic coatings

An organic coating used to render a material corrosion resistant shall resist cracking, chipping, and peeling when subject to impact.

7.5.3.1 Test Method

The impact resistance of an organic coating shall be evaluated using samples of the coating applied to three test plaques of the intended substrate. The coated test plaques shall be conditioned for at least 24 hours at $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 2^{\circ}\text{C}$) and $50\% \pm 5\%$ relative humidity. Each of the samples shall be subjected to a single impact force of a 1 in. (25 mm) diameter stainless steel ball weighing $0.15\text{ lb} \pm 0.01\text{ lb}$ ($68\text{ g} \pm 4\text{ g}$) dropped from a height of $200\text{ in.} \pm 1\text{ in.}$ ($5\text{ m} \pm 25\text{ mm}$). At the time of impact, test samples shall be supported by a $\frac{1}{4}$ in. (6 mm) thick neoprene rubber pad with a durometer hardness value of 60 ± 5 .

7.5.3.2 Acceptance criteria

The samples shall not exhibit any cracking, chipping, or peeling at the impact site. If the substrate is coated on both sides, neither side of each test sample shall exhibit any cracking, chipping, or peeling at the impact site.

7.5.4 Heat resistance of organic coatings

An organic coating used to render a heated surface corrosion resistant shall be heat resistant.

7.5.4.1 Test Method

The heat resistance of an organic coating shall be evaluated using samples of the coating applied to the intended substrate. The coated test plaques shall be conditioned for at least 24 hours at $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 2^{\circ}\text{C}$) and $50\% \pm 5\%$ relative humidity. Three unpolished steel washers [outer diameter: 2 in. (50 mm); inner diameter: $\frac{13}{16}$ in. (21 mm); thickness: $\frac{1}{8}$ in. (3 mm)] shall be heated for 30 minutes in an oven at $400^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($204^{\circ}\text{C} \pm 3^{\circ}\text{C}$). Upon removal from the oven, one heated washer shall be placed at the center of each test plaque. Laying flat, the plaques and washers shall be allowed to cool to room temperature. The plaques shall be slanted to a 45° angle and any movement of the washers shall be observed.

7.5.4.2 Acceptance criteria

Each washer shall slide freely along the surface of the test plaque and the coating shall not exhibit blistering or other visible degradation.

7.6 Glass and glass-like materials

7.6.1 Direct food contact

Glass and glass-like materials, including porcelain and porcelain enamels, shall not be used on surfaces intended for direct food contact that are also subject to impact by hard objects during use such as countertops, tabletops, cutting boards, cooking surfaces, and food preparation utensils.

7.6.2 Impact resistance of porcelain enamel, ceramic coatings, and glass-like coatings

When used on non-food contact surfaces that may be subject to impact by hard objects during use, porcelain enamels, ceramic coatings, and other glass-like coatings shall be impact resistant.

7.6.2.1 Test method

The impact resistance of a glass-like coating shall be evaluated using samples of the coating applied to three test plaques of the intended substrate. The coated test plaques shall be conditioned for at least 24 hours at $73^{\circ}\text{F} \pm 3^{\circ}\text{F}$ ($23^{\circ}\text{C} \pm 2^{\circ}\text{C}$) and $50\% \pm 5\%$ relative humidity. Each of the samples shall be subjected to a single impact force of a 1.5 in. (38 mm) diameter stainless steel ball weighing $0.5\text{ lb} \pm 0.01\text{ lb}$ ($230\text{ g} \pm 5\text{ g}$) dropped from a height of 15 in. (381 mm).

7.6.2.2 Acceptance criteria

The test samples shall not exhibit any fractures at the impact site.

7.7 Wood

7.7.1 Wood shall not be used in a food zone, except in wood-top bakers tables and cutting boards conforming to ANSI/NSF 2 -1996.

7.7.2 When used for structural, nondecorative purposes, wood shall be totally encapsulated, so as not to be exposed.

7.7.3 When used for decorative purposes, wood shall be sanded smooth and sealed with an appropriate sealant. Decorative wood shall not be used on surfaces exposed to excessive moisture or wear.

Annex A

(This Annex is not part of Standard 51,
but is provided for information only.)

**Table A.I – ASTM¹⁾ standard specifications
for common metallic coating processes**

Coated steel sheet	
Coating type	ASTM specification
Hot dip zinc (galvanized) ²⁾	A 653/ A 653M-95
Electrolytic zinc (electrogalvanized) ²⁾	A 879-93
Electrolytic zinc/nickel ²⁾	A 918-93
Hot-dip zinc-5% aluminum alloy (Galfan) ²⁾	A 875/ A 875M-95
Hot-dip 55% aluminum-zinc alloy (Galvalume) ²⁾	A 792/ A 792M-95
Hot-dip aluminum	A 463/ A 463M-95
Metallic coated articles	
Coating type	ASTM specification
Electrodeposited nickel	B 689-90
Electrodeposited nickel plus chromium	B 456-95
Autocatalytic (electroless) nickel-phosphorus	B 733-90
Electrodeposited zinc ²⁾	B 633-85
Mechanically deposited zinc ²⁾	B 695-91
Electrodeposited chromium	B 650-95
Electrodeposited tin	B 545-92
Electrodeposited tin-nickel alloy	B 605-95a

¹⁾ American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

²⁾ Zinc-coated materials are not considered acceptable for direct food contact (see 7.4.2).

STANDARDS AND CRITERIA

The following standards and criteria established and adopted by NSF as minimum voluntary consensus standards are used internationally:

- 2 Food Equipment
 - 3 Commercial Spray-Type Dishwashing and Glasswashing Machines
 - 4 Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transport Equipment
 - 5 Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
 - 6 Dispensing Freezers
 - 7 Commercial Refrigerators and Storage Freezers
 - 8 Commercial Powered Food Preparation Equipment
 - 12 Automatic Ice Making Equipment
 - 13 Refuse Compactors and Compactor Systems
 - 14 Plastics Piping System Components and Related Materials
 - 18 Manual Food and Beverage Dispensing Equipment
 - 20 Commercial Bulk Milk Dispensing Equipment
 - 21 Thermoplastic Refuse Containers
 - 24 Plumbing System Components for Manufactured Homes and Recreational Vehicles
 - 25 Vending Machines for Food and Beverages
 - 26 Pot, Pan, and Utensil Washers
 - 29 Detergent and Chemical Feeders for Commercial Spray-Type Dishwashing Machines
 - 30 Cabinetry and Laboratory Furniture for Hospitals
 - 35 Laminated Plastics for Surfacing Food Service Equipment
 - 36 Dinnerware
 - 37 Air Curtains for Entranceways in Food and Food Service Establishments
 - 40 Residential Wastewater Treatment Systems
 - 41 Wastewater Recycle/Reuse and Water Conservation Devices
 - 42 Drinking Water Treatment Units – Aesthetic Effects
 - 44 Cation Exchange Water Softeners
 - 46 Evaluation of Components and Devices Used in Wastewater Treatment Systems
 - 49 Class II (Laminar Flow) Biohazard Cabinetry
 - 50 Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs
 - 51 Food Equipment Materials
 - 52 Supplemental Flooring
 - 53 Drinking Water Treatment Units – Health Effects
 - 55 Ultraviolet Microbiological Water Treatment Systems
 - 58 Reverse Osmosis Drinking Water Treatment Systems
 - 59 Mobile Food Carts
 - 60 Drinking Water Treatment Chemicals – Health Effects
 - 61 Drinking Water System Components – Health Effects
 - 62 Drinking Water Distillation Systems
 - 100 Environmental Auditing Principles and General Practices
 - 110 Environmental Management Systems – Guiding Principles and Generic Requirements
- C-2 Special Equipment and/or Devices



THE HOPE OF MANKIND rests in the ability of man to define and seek out the environment which will permit him to live with fellow creatures of the earth, in health, in peace, and in mutual respect.