

FOREWORD

(This Foreword is not part of ASME/ANSI F2.1-1986.)

In 1965, within The American Society of Mechanical Engineers, the first organizational meeting was held leading to the formation of the present Food, Drug, and Beverage Equipment Committee. The purposes of the Committee are to assemble and/or develop design, manufacturing, and construction standards for food, drug, and beverage equipment, to recommend these for adoption by the Board on Safety Codes and Standards on behalf of the ASME, and to submit them to the American National Standards Institute, Inc., for acceptance as American National Standards.

The Committee considers the needs of users, manufacturers, and inspectors along with advancements in design and materials and the growth of experience. However, the Standards established by the Committee are not to be interpreted as approving, recommending, or endorsing any proprietary or specific design or as limiting in any way the manufacturer's freedom to choose any method of design or any form of construction that conforms to the Standards. The Committee deals with the care and inspection of equipment already in service only to the extent of providing suggested rules of good practice as an aid to owners and their inspectors.

In formulating its Standards, the Committee considers materials, construction, method of fabrication, inspection, and safety devices. Regulatory bodies and organizations developing safety standards are urged to incorporate the Standard, or sections of it, by reference in appropriate regulations or safety standards. If usage of a Section, such as Section 15, involves exceptions, omissions, or changes in provisions, the intent of the Standard might not be attained. Where a state or other regulatory body makes additions or omissions in the printing of any Section of this Standard, it is requested that such changes be clearly indicated.

This Standard, which was approved by the Main Committee and by the ASME, was approved and designated as an American National Standard by the American National Standards Institute, Inc., on November 21, 1986.

CORRESPONDENCE WITH THE FDBE COMMITTEE

General. ASME Codes and Standards are developed and maintained with the intent of representing the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, FDBE Main Committee
The American Society of Mechanical Engineers
United Engineering Center
345 East 47th Street
New York, NY 10017

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes which appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal including any pertinent documentation.

Interpretations. On request, the FDBE Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the Main Committee.

The request for interpretation should be clear and unambiguous. It is recommended that the inquirer submit his request in the following format:

Subject: Cite the applicable paragraph number(s) and provide a concise description.
Edition: Cite the applicable edition of the Standard for which the interpretation is being requested.
Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests which are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information which might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The FDBE Main Committee regularly holds meetings which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the Main Committee.

THE ASME FOOD, DRUG, AND BEVERAGE EQUIPMENT COMMITTEE

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FOOD, DRUG, AND BEVERAGE EQUIPMENT

INTRODUCTION

The purposes of this Standard are to serve manufacturers in the design, construction, and installation of machinery and equipment; to serve users of such equipment in the selection, purchase, installation, and modification of the equipment; and to serve federal, state, county, district, and municipal health and safety authorities and other food regulatory agencies associated with the acceptance and use of this equipment.

The first five Sections contain general criteria that apply to all food, drug, and beverage equipment unless they are in conflict with the criteria in those Sections (6 and higher) which cover specialized types of equipment. Sections 6 and higher contain specific criteria, or refer to nationally recognized standards applicable only to the type of equipment covered by each particular Section.

1 GENERAL

This Standard sets forth standards with respect to sanitation, safety, contamination, and noise, as related to the design, manufacture, and construction of equipment used in the production, preparation, and service of foods, drugs, and beverages where there are not now existing nationally recognized standards, or where nationally recognized standards development organizations do not exist. It also includes consideration of accessibility, durability, maintenance, installation, and environment which pertains to the preceding items. This Standard does not cover equipment efficiency or investment cost.

1.1 General Objectives

It is intended that this Standard provide design criteria which will result in equipment that is:

(a) able to be quickly exposed, using simple tools used by operating or cleaning personnel, for cleaning or inspection when needed. However, disassembly should not be assumed to be necessary for cleaning all equipment and components where specifically designed to be cleaned and/or inspected by other means.

(b) cleanable and able to be easily sanitized;

(c) made of materials which do not deteriorate in their use environment or cause degradation or contamination of the product;

(d) made to protect the product, while in the equipment, from entrance of and contact with contaminants from any external source. If good design practices indicate that such protection need not necessarily be an integral part of the equipment, then such protection may be external to the equipment.

(e) safe for use by operating, cleaning, and maintenance personnel;

(f) free of areas, inside and out, where product or contaminants can be trapped and stagnate;

(g) free of areas that may harbor vermin.

1.2 Limitations

(a) This Standard does not approve, recommend, or endorse proprietary or specific designs or materials, nor does it intend to limit in any way the manufacturer's right to choose any method of design or form of construction that meets the objectives of this Standard.

(b) The design and construction of beer kegs, compressed gas cylinders, and air compressors are not within the scope of this Standard.

1.3 Modifications and Changes

It is anticipated that changes and modifications to this Standard will be required periodically due to improved technology. Requests for such modification and requests for interpretation shall be referred to ASME for review and action by the Committee.

2 DEFINITIONS

accessible — quickly exposed for inspection and cleaning using simple tools used by operating or cleaning personnel

accessible, readily or easily — easily and quickly exposed for inspection and cleaning without the use of tools

adequate — equal to a requirement or occasion; sufficient; suitable

bins, portable — receptacles or vessels used to transport and/or store raw materials, food in process, or finished foods during the manufacturing process

bins, stationary — receptacles or vessels used for the storage of raw materials, food in process, or finished foods during the manufacturing process

cleanable — made of such materials, so finished, and so fabricated that soil may be effectively removed by normal cleaning means

cleanable, readily or easily — readily accessible, of such materials and finish, and so fabricated that soil may be easily and effectively removed by normal cleaning methods

cleaning — the removal of soil

cleaning, dry — the removal of product residue and soil by scraping, vacuuming, or other dry methods

cleaning-in-place — a procedure dependent upon circulating appropriate cleaning and sanitizing solutions at relatively high velocities (5 fps min.) for a specified time and specified temperature in a closed system specifically designed for this purpose

NOTE: The 3-A Accepted Practices for Permanently Installed Sanitary Product Pipelines and Cleaning Systems, Number 605-02, shall be used as guidelines in determining design criteria for products. (See Section 6 below.)

When acceptable, specific clean-in-place procedures are developed by ASME, they will be included in this definition.

cleaning, manual — cleaning with brushes, scouring pads (other than steel wool), scrapers, hoses providing water, cleaning solutions, or steam under pressure, all manipulated by hand

cleaning, mechanical — a method of wet cleaning by which circulating and/or flowing chemical (cleaning and/or sanitizing) solutions and water rinses are sprayed or flowed onto, over, or around surfaces to be cleaned by mechanical means

cleaning, wet — the removal of product residue and soil by washing, flooding, or spraying methods

closed — fitted together tightly enough to have no openings large enough to permit the entry and harborage of vermin, including insects

closed, airtight — two parts fitted together tightly by means of a gasket or other means so that air cannot pass either way with a pressure differential of 5 psi (35 kPa)

contact, accidental — inadvertent physical contact

which could result from slipping, falling, sliding, tripping, or any other unplanned action or movement

container — any type of rigid or nonrigid packaging enclosure holding the food

contamination — the presence of soil, unwanted or unacceptable numbers of microorganisms, or any other unwanted organic or inorganic matter

corrosion resistant — capable of maintaining original surface characteristics under prolonged influence of the use environment, including expected food contact, cleaning methods, compounds, and sanitizing solutions

cover — a protective shield which is used to prevent materials from entering or escaping from the covered area

dead end — a space wherein a product, ingredient, cleaning or sanitizing agent, or extraneous matter may be trapped, retained, or not completely displaced in operational or cleaning procedures

detergent — a chemical cleaning agent which is suitable for use in washing operations and which, when used effectively, aids the removal of soil

equipment — a general term including material, fittings, devices, appliances, fixtures, apparatus, machines, and the like used as part of or in connection with an installation

excessive amount — an amount which may cause contamination of the food

food — see *food-drug-beverage*

food-drug-beverage — any edible raw, cooked, or processed substance, liquid, drug, or ingredient used or intended for use in whole or in part for human consumption

food contact surfaces — those surfaces of the equipment with which the food comes in contact; with which the food is likely to come into contact and from which it returns to surfaces in contact with the food; from which contaminants may drain, drop, or be drawn into the food

food zone — all of the food contact surfaces and the volume that the food occupies

guarded — shielded, fenced, enclosed, or otherwise protected by means of enclosure guards, covers, railings, or by the nature of the location (remoteness from floor, platform, working level, etc.) so as to remove the likelihood of accidental contact or approach dangerous to persons or objects

joints or seams — the line of meeting and/or joining of two or more pieces of material

location, accessible — a location which can be safely and easily reached by an employee standing on the floor, platform, or other permanent working area

nonabsorbent — material, to be nonabsorbent under conditions of use, shall not retain an excessive amount of substances with which it comes in contact. The 3-A Sanitary Standards Tests for Rubber and Rubber-Like Materials, Number 18-OC, and the 3-A Sanitary Standards Tests for Multiple Use Plastic Materials, Number 20-11, shall be used as the criteria for determining compliance of such material with this definition (see Section 6). When absorbency tests acceptable to ASME are developed for other materials, they will be included in this definition.

nonfood contact surfaces — all surfaces other than food or splash contact surfaces

nonfood zone — all surfaces, except splash surfaces, and volumes of the equipment other than the food zone

nonproduct zone — see *nonfood zone*

nontoxic materials — materials which under conditions of their use are in compliance with applicable requirements of the Food, Drug, and Cosmetic Act of 1938, as amended

normal — the usual operational and/or environmental condition or procedure

normal operation — all operation of equipment during which it is accomplishing the designed purpose including the clearing of jams and product spilled during jams but not including routine cleaning, sanitizing, or maintenance of the equipment

normally — in a manner that is the usual operational and/or environmental condition or procedure

plastic — a material that contains as an essential ingredient an organic substance of high molecular weight, is solid in its finished state, and at some stage in its manufacture, or in its processing into finished form, can be shaped by flow

product — see *food-drug-beverage*

product zone — see *food zone*

protective coating — a material applied over a base material which protects the base material

quickly — in a short time not more than 30 min. Not more than 5 min for a single, small, uncomplicated part. The exact time depends on the shape, size, and complexity of the parts and equipment.

readily accessible — see *accessible, readily or easily*

readily (or easily) cleanable — see *cleanable, readily or easily*

regulatory agency — the agency responsible for enforcing the Food, Drug, and Beverage Sanitation and Safety Requirements

removable — quickly separated from the machine or equipment, using simple tools normally used by operating or cleaning personnel

removable, readily or easily — easily and quickly separated from the equipment without the use of tools

resin — a solid, semisolid, or pseudosolid liquid organic material which has an indefinite and often high molecular weight, exhibits a tendency to flow when subjected to stress, usually has a softening or melting range, and usually fractures conchoidally

resin system (compound) — an intimate admixture of a resin with other ingredients, such as fillers, reinforcements, softeners, stabilizers, plasticizers, catalysts, pigments, and/or dyes

sanitizing — treatment of surfaces by a process that is effective in destroying vegetative cells of pathogenic bacteria and substantially reduces other microorganisms. Such treatment shall not adversely affect the food.

sealed — the condition resulting from the filling of a crack, crevice, joint, or opening so as to effectively prevent the entry or passage of liquids and solids

self-draining — that the design and construction is of such shape and surface finish as to prevent pools of liquid from standing except for normal cleaning

shall — indicates that the requirements of these standards can be met only by literal compliance

should — indicates a preferred condition

simple tools — tools normally used by operating and cleaning personnel such as a screwdriver, single purpose wrench, hammer, and hoist. Not included are other tools normally used only by maintenance personnel.

soil — unwanted organic or inorganic matter on or in equipment, including food residue

splash contact surfaces — any surfaces other than food contact surfaces which are subject to routine splash (wet or dry), spillage, and contamination during normal use

substantially flush — flush with the mating surfaces within $\pm 1/16$ in. (1.5 mm)

washdown — see *cleaning, wet*

3 MATERIALS OF CONSTRUCTION

Only such materials shall be used in construction as will withstand normal wear, penetration by vermin, the corrosive action of foods, cleaning compounds, and such other elements as may be found in the use environments and which will not impart an undesirable odor, color, or taste to the food, or contribute to contamination of the food. Paints or coatings containing lead or other toxic materials shall not be used. Wood shall not be used.

3.1 Food Zone

Surface materials in the food zone shall be cleanable, corrosion resistant, nontoxic, stable, noncracking, and nonabsorbent under use conditions and shall not impart undesirable odors, color, or taste, or contribute to the contamination of food.

3.2 Splash Contact Surfaces

Splash contact surfaces shall be cleanable and of corrosion resistant materials, or shall be rendered corrosion resistant with a material that is nontoxic and resistant to cracking, chipping, and spalling.

3.3 Nonfood Contact Surfaces

Nonfood contact surfaces shall be cleanable and of corrosion resistant material or shall be rendered corrosion resistant. Parts directly over and adjacent to the food zone and parts having both food contact and nonfood contact surfaces shall have nonfood contact surfaces rendered corrosion resistant. If coated, the coating shall be nontoxic and resistant to cracking, chipping, and spalling.

3.4 Welding

The weld area and deposited weld material shall be corrosion resistant and meet other requirements for the surface of which it is a part.

3.5 Gasket and Seal Materials

Gasket and seal materials shall be stable under use conditions, nonabsorbent, and unaffected by the foods or environment with which they are in normal contact. They shall be impervious to penetration and harborage of microorganisms and shall be suitable for the cleaning and sanitizing methods in the machine of which they are a part. Gaskets and seal materials used in the food zone

shall be nontoxic and odor free and shall not impart an odor or taste to the product.

3.6 Solder

When used as a food contact surface, solder shall be of such formulation as to be nontoxic and nonabsorbent.

3.7 Plastic or Resin Materials

Plastic materials or a resin system may be used provided they meet the applicable requirements of this Standard.

3.8 Inspection Windows, Sight Glasses, and Light Ports

Inspection windows, sight glasses, and light ports shall be of shatter resistant material.

3.9 Protective Coatings

Protective coatings shall comply with paras. 3.1, 3.2, and 3.3 as appropriate and shall be bonded to the underlying surface so as to be resistant to chipping and peeling. Protective coatings shall have a durable, cleanable surface without breaks exposing the base material and shall resist abrasion under prolonged exposure to environmental elements such as food, cleaning, and sanitizing agents.

4 SANITARY DESIGN AND CONSTRUCTION

(a) *General Design and Construction.* All equipment shall be so designed and of such workmanship as to be cleanable. The design and construction of such equipment shall preclude the contamination of food with lubricants, fuel, metal fragments, glass, contaminated water, or any other contaminants. Culinary steam, process air, and water shall not be excluded from this consideration and requirements of the applicable regulatory agencies shall be met.

(b) *Function.* Equipment shall be designed and constructed so that ingredients or food can be added and processed, and the finished food dispensed or removed in a sanitary manner.

4.1 Food Contact Surfaces

4.1.1 Accessibility

(a) All food contact surfaces that require manual cleaning and/or sanitizing shall be readily accessible or

removable. Relatively horizontal areas shall be pitched to facilitate self-draining.

(b) In equipment of such design that cleaning in place is intended, the design shall ensure that all food contact surfaces with the exception of removable parts can be cleaned in place.¹

4.1.2 Internal Corners or Angles of Food Contact Surfaces. Internal corners or angles of food contact surfaces with a total included internal angle from the intersection of surface of 135 deg. or less shall have a minimum internal radius of $\frac{1}{4}$ in. (6.4 mm) tangential to both adjacent surfaces except where smaller radii are required for essential functional reasons, such as for small parts and sealing ring grooves. Gasket retaining grooves for removable gaskets shall be no deeper than their width. The minimum radius of any internal angle in a gasket retaining groove shall not be less than $\frac{1}{8}$ in. (3.2 mm), except that a $\frac{3}{32}$ in. (2.4 mm) radius is permissible where a standard $\frac{1}{4}$ in. (6.4 mm) diameter cross section O-ring is to be used. However, when smaller radii are required for functional reasons, contact surfaces shall be accessible for cleaning and inspection.

4.1.3 External Corners and Angles of Food Contact Surfaces. All external corners and angles in the food zone shall be sealed, shall have an equal or better surface finish than surfaces being joined, and shall be formed with sufficient radii to eliminate sharp edge(s) which might be an accident hazard or which may interfere with proper drainage.

4.1.4 Permanent Joints and Seams, Cracks, and Crevices. All joints and seams in the food zone shall be sealed and sanitary, and shall be free of recesses, gaps, crevices, protruding ledges, inside shoulders, and dead ends.

4.1.5 Gasketed Joints. Gasketed joints shall be installed in a manner which results in a true fit with a substantially flush interior surface.

4.1.6 Fastening Methods

(a) Exposed threads, bolt and rivet heads, nuts and screws, projecting screws, and studs shall be eliminated from food contact surfaces. Drilled and tapped holes,

keyways, sockets, or other recesses shall be eliminated or shall comply with para. 4.1.2.

(b) Pins, keys, or other locking devices shall be secured to eliminate the possibility of loss into food.

4.1.7 Openings to Food Zones

(a) All openings to food zones shall be provided with covers or other equivalent protection to prevent contamination of food. Such covering shall be effected in a manner to prevent external seepage, condensation, or spillage from entering food zones.

(b) When covers or doors are provided to prevent contamination from reaching the food zone, they shall be so designed as to provide a flange which overlaps the opening and shall be sloped to provide drainage from the cover surface. Any port opening through the horizontal covers shall be flanged upward to at least $\frac{1}{4}$ in. (6.4 mm) and shall be provided with a cover which overlaps the flange. Covers shall be designed with sufficient clearance to avoid contact with foods that they cover. All covers should be readily removable as a unit or in sections. Hinges or pivots shall be designed to be easily cleaned and of simple take-apart design and construction. Piano hinges are not permissible. Sliding or hinged covers, where used, shall be constructed in such a manner as to prevent seepage of liquids, condensate, or other foreign materials into the food zone when the covers are closed or opened.

4.1.8 Entry Points. All joints and seams where piping, thermometers, sight glasses, rotary shafts, and other functional parts extend into the food zones shall either be sealed at the point of entry or shall have a drip deflecting apron provided.

(a) Inspection windows, sight glasses, and light ports shall be permanently sealed or readily removable.

(b) All bearings shall be located outside of the food zone except where this is impractical for functional reasons. If the bearing is in the food zone, it shall be self- or product-lubricated and accessible for cleaning.

(c) Shaft seals of rotating shafts shall be self- or product-lubricated and readily cleanable.

4.1.9 Surface Finish. All surfaces within the food zone shall have a surface roughness height no greater than 32 μ in. AA, as defined by ANSI B46.1-1978, Surface Texture. Stainless sheets will meet this requirement if the surface finish complies with the criteria in ASTM A 480-75, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resistant Steel Plate, Sheet, and Strip, for:

(a) a No. 2B finish if the surface is free from imperfections such as chips, flakes, or pits; or

(b) a No. 4 finish.

¹Typical acceptable systems include systems equal to the 3-A Sanitary Standards Committees (see Section 6) accepted practices for permanently installed sanitary product-pipelines and cleaning systems, including amendments. Clean-in-place systems used in federally inspected meat and poultry packing plants must meet the requirements listed in the USDA (U.S. Department of Agriculture) Sanitation Handbook of Consumer Protection Programs. (See Appendix A of this Standard.)

4.1.10 Worked Surfaces. Food contact surfaces which, during the course of fabrication, are so worked as to reduce their corrosion resistant characteristics, shall receive such additional treatment as is necessary to render or return them to their original state.

4.1.11 Soldering. Whenever solder is used, it shall be securely bonded to the metal so that it will not crack or chip. Flux and catalytic material shall be neutralized and removed.

The use of solder shall be limited to use in joining metal or sealing seams between abutting metal surfaces of structurally sound joints. Solder fillets shall not be used to comply with para. 4.1.2.

4.1.12 Belting. Nonmetal belting shall be coated, impregnated, or made odorless, nontoxic, moisture resistant, and nonabsorbent with no exposed absorbent core. Conveyor guides, splash guards, etc., shall be easily removed or be of open construction to permit cleaning. If required for cleaning, conveyor designs shall include provisions for quickly removing tension from the belt so that the undersides of belts and conveyors can be cleaned. All belting, including belts with perforations, openings, or made up of wires or rods, shall be removable or readily cleanable.

4.1.13 Control and Measuring Devices. All non-metallic devices shall be fabricated from shatterproof and heat resistant material.

(a) Food contact portions of control and measuring devices, sensing elements, final control elements, valves, and dampers shall comply with applicable paragraphs of Sections 1 through 4 of this Standard, and in addition shall be designed to prevent contamination of the food or food zone by portions of the measuring elements.

(b) Where mercury, bromine-containing oils, or other potentially toxic material is used in a sensing element, the element shall be isolated from the food zones by a protective well to guard against failure of the sensing element and resulting food contamination.

(c) Where a protective well is used, a weep hole shall be provided to the outside of the food zone so that failure of the protective well will be readily apparent.

4.1.14 Coil Springs. Coil springs having product contact surfaces shall have a minimum of $\frac{3}{32}$ in. (2.4 mm) opening between the coils, including the end coils, when in the free and use positions, and shall be accessible for cleaning and inspection.

4.2 Splash and Nonfood Contact Surfaces

4.2.1 General Design and Construction. All equipment shall be designed and constructed in such a

manner as to minimize the retention of moisture and dust and the shelter of vermin and soil, and to facilitate inspection, servicing, maintenance, and cleaning.

4.2.2 Fastening Methods

(a) In the nonfood zone, exposed threads, projecting screws, and studs shall be used only when other fastening methods are not practical. Where used, exposed fasteners shall be easily cleanable and shall be located so as to eliminate the possibility of loose pieces being lost into the food zone.

(b) In areas subject to cleaning, interior fastenings shall be accomplished in such a manner as to minimize projections, ledges, and recesses.

4.2.3 Surface Coatings. Surfaces subject to corrosion that require cleaning shall be rendered corrosion resistant by plating or coating and/or chemical type surface treatment; for example, by anodizing or parkerizing. The coating shall be suitable for the intended purpose.

4.2.4 Louvers and Openings. Louvers or openings located in the splash zone shall be of drip deflecting design or be so located as not to be subject to splash, splatter, spillage, or overhead drippage, or they shall be so designed and constructed as to be readily accessible and the space behind them shall be easily cleanable. Louvers shall be designed to eliminate contamination from spillage and/or upward splash. Screening on openings, if provided, shall be 16 mesh or the equivalent, and in a removable sash to facilitate cleaning. Louvers shall be large enough, or so spaced, to allow for ease of cleaning between louvers and shall be free of sharp edges and burrs.

4.2.5 Joints and Seams. In the splash zone, all joints and seams shall be sealed. Horizontal joints may be made by overlapping sheets of suitable material so as to eliminate soil catching horizontal ledges.

4.2.6 Soldering. Whenever solder is used, it shall be securely bonded to the metal so that it will not crack or chip. Flux and catalytic material shall be neutralized and removed.

The use of solder shall be limited to use in joining metal surfaces of structurally sound joints or sealing seams between abutting metal.

4.3 General Nonproduct Zone

4.3.1 Exposed Edges and Nosings. All exposed edges and nosings shall be free of sharp edges to minimize physical hazard and shall be cleanable.

4.3.2 Reinforcing and Framing. Reinforcing and framing members not totally enclosed or within walls

shall be placed in such manner as to be easily cleanable. All framing and reinforcing members shall be so placed as to eliminate harborage for vermin. Tubular material shall be sealed and shall be preferred for all framing and reinforcing members. Horizontal ledges of frame members shall be kept to a minimum. Horizontal angle reinforcing shall be used only where dictated by specific mechanical and/or structural requirements, and if used shall not be placed where food or soil may accumulate upon them. Where angles are used horizontally, they shall have one leg turned down wherever the nature of the equipment permits or shall be formed integral with the sides as for use with removable shelves or draw slides. All vertical channel sections shall be either completely closed or open to the floor.

4.3.3 Fixed Panels. Where fixed panels are applied to the outside or inside, or set into angle or other reinforced body or frames, the method of fastening shall be such as to minimize projections. Welding is preferred. Areas enclosed shall be accessible for cleaning.

4.3.4 Removable Panels. Panels should be provided which are readily accessible and easily removable. They shall be of adequate size to serve the purpose intended, but otherwise confined in size and so constructed that they may be removed and transported by no more than one workman without use of cranes, chainfalls, or other lifting devices. Methods of attachment should eliminate bolts and screws wherever possible.

4.3.5 Covers. Covers shall be of the overlapping type and if they are in two or more parts, they shall be designed with drip protectors. Hinged covers shall pivot outboard. Doors and covers shall be manufactured to conform with the standard of manufacture for the equipment proper and shall be sized to fit and close properly. Metal doors and covers to enclose openings and provide access to interior compartments shall be fabricated in two basic types of construction, i.e., single or double panel. Sliding doors, when used, shall slide easily and freely and be readily removable. Hinges shall be easily cleanable and of simple take-apart design and construction, and so constructed that when apart no cracks or crevices exist.

(a) *Single Panel.* Single panel construction shall be such as to minimize the collection of soil particles, spillage, and other foreign matter, and be preferably without channel sections at the bottom. If channel sections are used, they shall be inverted or shall be shallow and wide enough to be easily cleanable. Cleanout holes shall be provided.

(b) *Double Panel.* Double panel construction shall be fabricated in such a manner as to minimize the collec-

tion of food particles, spillage, and foreign matter thereon. Hollow sections of double panel doors shall be sealed.

4.3.6 Tracks and Guides. All tracks and guides for doors, covers, and access panels shall be built in such a manner as to be easily cleaned and to minimize the collection of food particles, condensation, spillage, and foreign matter. The following are examples of design features that are in compliance with this requirement:

(a) overhead door suspension with lower guides that are constructed integral with the bottom of the opening;

(b) open-end cleanout at ends of track or guide bottom;

(c) stopping tracks or guides 1 in. (25.4 mm) minimum short of framing at each end;

(d) forming tracks or guides integral with interior bottoms of the enclosure and without square corners.

4.3.7 Openings and Rims. To prevent seepage, all openings over storage spaces and containers shall be protected by a raised rim at least 1/2 in. (12.7 mm) above the highest level at which spillage, condensate, or other liquids may collect.

4.3.8 Gasketed Joints and Connections. Exposed edges of gaskets shall be readily cleanable and shall be installed in a manner that results in a true fit to prevent creating recesses or ledges between the gasketed parts. Where flange design requires less than a full face gasket, the flanges shall be spaced apart at least 1/8 in. (3.2 mm) to facilitate cleaning.

4.3.9 Shelving. All shelving, fixed or removable, shall be constructed to be readily cleanable.

(a) *Removable Shelves.* Removable shelves shall be readily removable and sized to facilitate their handling. Where shelves are used as removable false bottoms, the flanged corners shall be sealed or sufficiently open to permit cleaning.

(b) *Fixed Shelving.* Fixed shelving shall have the back and ends (where against side panels) turned up a minimum of 1 in. (25.4 mm) and sealed throughout their length, or an open space of 1 in. (25.4 mm) provided between the shelf and back and/or side panels, or the resulting joint or seam sealed.

(c) *Shelf Brackets.* When removable and/or adjustable shelving is provided, the shelf support bracket or pilaster shall be readily removable or easily cleanable.

4.3.10 Provision for Mounting

(a) Unless the equipment is designed to be placed on a raised island or sealed to the floor, counter, or table, so as to prevent seepage underneath, the mounting method shall provide a floor clearance of at least 6 in. (152 mm) or the area beneath the equipment shall be

readily accessible for cleaning. Structural members shall be arranged so as not to form traps, recesses, or pockets. If made of hollow stock, frame members shall have the ends sealed.

(b) Where applicable, the unit shall be mounted on casters, rollers, or gliders of cleanable design and construction so as to permit its being easily moved. Casters complying with NSF² Basic Criteria C-2 for Special Equipment and/or Devices, revised 1972, for use with small lightweight equipment, and with BISSC³ Standard No. 15 for Caster Assemblies and Wheels, dated 10/8/77, for use with large heavyweight equipment, meet the cleanability requirement stated above.

4.3.11 Legs and Feet (Design and Construction). Legs and feet shall be of sufficient rigidity to provide support with a minimum of cross-bracing and so fastened to the body of the equipment and so shaped at the floor contacts as to prevent accumulation of dirt and harborage of vermin.

(a) Adjustable legs of the threaded type shall have no exposed threads.

(b) Adjustable legs of the threaded or slip tube type shall have the bottom end of the leg extension sealed. The outside dimension of the leg shall be greater than the outside dimension of the leg extension. The leg extension shall, at minimum adjustment, extend at least 1 in. (25.4 mm) below the leg. All openings to hollow sections between the legs and the leg extension shall be of drip-proof construction with no openings greater than 1/32 in. (0.8 mm). All other openings to hollow sections shall be sealed.

Where weights and measures codes require that a seal be placed on the legs to detect height adjustment after the tank (equipment) has been leveled or calibrated, the holes for the seals shall be designed and located, or sealed to prevent entrance of moisture into the legs.

(c) Round, square, or rectangular shapes shall be used for legs and feet. Angle or channel or similar open shapes shall not be used.

4.3.12 Lubrication. Where lubrication is required, the design and construction of the equipment shall be such that the lubricant cannot leak, drain, be forced, or be drawn into the food or onto food contact surfaces.

4.3.13 Nameplates. Nameplates, if present, shall be sealed to the surface.

4.3.14 Electrical System. The electrical system, including wiring, shall be designed to prevent seepage

into the electrical equipment of spillage or cleaning solutions. Conduit terminal boxes, relay boxes, fuse boxes, and switch boxes shall either fit tightly against the supporting members so that open cracks or crevices are not formed, or shall be mounted so that the back of the box shall be not less than 1 in. (25.4 mm) from its supporting members. Conduit piping shall be so installed that it does not form hard-to-clean areas or crevices against adjacent surfaces, including suitable supports. If flexible conduit is used, it shall have a smooth external surface.

NOTE: Where sanitary motors are required by the environment, acceptable electrical motors and components are those meeting BISSC Standard No. 29 for Electric Motors and Accessory Equipment, dated 10/8/77. (See Section 12 below.)

4.3.15 Light Fixtures. Where breakage may contaminate the food, all lights on equipment shall be housed in shatter resistant fixtures and protected against breakage. Where required, moisture-proof or explosion-proof fixtures shall be used.

5 SAFETY DESIGN AND CONSTRUCTION

(a) Equipment shall be so designed and employ such materials of construction and degree of workmanship that adequate health and safety protection for personnel will be provided.

(b) The criteria of these standards are not intended to conflict with or supersede the pertinent rules and regulations of Part 1910 — Occupational Safety and Health Standards of the Department of Labor (OSHA).

(c) There are other standards that may be of interest. Some are listed in Appendix A.

5.1 Frame and Enclosure

(a) Equipment shall be so formed and assembled that it will have the strength and rigidity necessary to resist the uses and abuses to which it is liable to be subjected, without increasing its hazard due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

(b) Equipment shall be provided with adequate enclosures of material suitable for the particular application that will house electrical parts that may present a fire or accident hazard under any condition of use. See also para. 5.2(a).

(c) The arrangement and guarding of parts of equipment shall permit easy and safe installation and removal of strainers, baskets, and the like, and recharging of vessels (such as detergent dispensers) that must be removed, cleaned, and replaced or recharged by the operator. The removal and replacement of these vessels

²National Sanitation Foundation. (Refer to Section 8 below.)

³Baking Industry Sanitation Standards Committee. (See Section 12 below.)

and ingredients shall not result in damage to or contamination of wiring, electrical components, or other parts, or expose operators to hazards.

5.2 Motors and Electrical Components

(a) Motors shall be sized for the use intended with enclosures suitable for the environment.

(b) Electrical ratings for motors, controls, and wiring devices shall not be exceeded.

(c) Each electrical component shall be suitable for its use and for the environment in which it is used.

5.3 Stability

(a) Equipment shall have such stability that it is not likely to be readily overturned in normal use.

(b) Equipment that is stationary during operation but is movable shall have sufficient locking devices on its support members that it will not move while it is being operated.

5.4 Casualty Hazard

(a) If the normal operation of equipment involves accident hazards, suitable protection shall be provided.

(b) Moving parts in accessible locations, such as, but not limited to, rotors of motors, chains, pulleys, drive belts, gears, and sprockets, shall be guarded.

(c) Cranks or crank disks, crank shafts, connecting rods, and clutches in accessible locations shall be guarded.

(d) Eccentrics and cams in accessible locations shall be guarded.

(e) Equipment parts in accessible locations having reciprocating or oscillating motion such that a shearing or crushing hazard is created shall be guarded.

(f) Where guards are called for in these rules, they shall conform to the following.

(1) Guards shall be securely fastened in place and so maintained, except as specifically provided otherwise. Railings should not be easily removable.

(2) Guards shall be so constructed that fluids, splash, and spillage will not be retained within the guarded area and that the enclosed area can be cleaned. Guards shall be easily removable or of hinged construction for easy cleaning where they must be opened for cleaning. [See para. 5.4(f)(4).]

(3)(a) Guards or covers that enclose hazardous moving parts and must be opened during production operation shall be provided with an interlocking device that

stops the equipment when the cover or guard is open or removed.

(b) If the equipment must be operated for cleaning or maintenance with the guards or covers opened, a means to override the interlocks may be provided in the form of a jog button(s) so designed and installed that the operator is not exposed to the hazard.

(4) Adjustments necessary while equipment is in operation shall be such that they can be made without removing any safety guards, except as noted in para. (f)(3) above.

(g) Pipes carrying steam or other hot materials in an area where accidental contact is a hazard shall be covered with an insulating material or guarded in such a manner as to prevent such contact.

(h) Open-top vats, tanks, and hoppers should extend at least 42 in. (1070 mm) above the floor or platform, but if good design prohibits this, a railing designed for the operation shall be provided.

(i) Equipment should be designed and built so as not to expose the operator or nearby persons to a higher sound level than 90 dB using the A weighting network and slow time weighting of a sound level meter meeting Type 2 requirements of ANSI Standard S1.4-1983, Specification For Sound Level Meters (and its amendment ANSI S1.4A-1985), in accordance with the OSHA rules and regulations. If equipment exceeds this sound level, the manufacturer shall inform the purchaser.

(j) Handwheels should not turn when equipment is operating. Handwheels, if they rotate while equipment is operating, shall be either solid disk type without spokes or knobs and have a round edge of uniform diameter, or be guarded.

(k) Projecting rotating shaft ends, in an accessible location, shall have beveled or rounded edges without keyways and shall not project a distance greater than one-half the shaft diameter outside the frame or housing of equipment unless guarded by nonrotating cap or other means.

(l) Where equipment must be lubricated while in motion, stationary lubricating fittings shall be provided with extension piping, where necessary, to a safe location outside guards or enclosures.

(m) Methods shall be provided to relieve pressure on air operated mechanisms if failure to relieve pressure on stopping machine may cause exposure of employees to hazard.

(n) If mechanisms or operations exist for which full guarding is truly impractical, then an equipment mounted warning must be affixed near the point of hazard. Generous use shall be made of legible warning or instructional signs where such use will promote operator safety. [See para. 5.6(f).]