NSF/3-A Standard 14159-3
For Food Processing Equipment —

Hygiene requirements for the design of mechanical belt conveyors used in meat and poultry processing

1 General

1.1 Purpose

This American National Standard establishes minimum food protection and sanitation requirements for the materials, design, fabrication, construction, and performance of meat and poultry processing equipment. This Standard does not contain operator safety requirements.

1.2 Scope

This American National Standard applies to exposed product mechanical belt conveyors, either singularly or as a component of equipment, intended for use in the slaughter, processing, and packaging of meat and poultry products.

1.3 Measurement

Decimal and Metric (SI) conversions provided parenthetically shall be considered equivalent. Metric conversions have been made according to IEEE/ASTM SI 10.

2 Normative references

The following documents contain provisions that, through reference, constitute provisions of this NSF/3-A/ANSI Standard. At the time of publication, the editions indicated were valid. All referenced documents are subject to revision, and parties are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

3-A Accepted Practice, No. 604-05 2004. *Supplying air under pressure in contact with milk, milk products, and product contact surfaces*


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

---

1 3-A SSI, 1451 Dolley Madison Boulevard, McLean, VA 22101-3850
2 American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990
Federal Food, Drug, and Cosmetic Act of 1938, as amended\textsuperscript{5}


NSF/3-A/ANSI 14159-1 – 2002. \textit{Hygiene requirements for the design of meat and poultry processing equipment}

3 Definitions

For the purposes of this Standard, the following definitions apply.

3.1 \textit{associated equipment}: All appurtenances associated with a piece of equipment, not defined as equipment, that are essential to the functioning of the equipment for it to hygienically process a product (e.g., fittings, piping, tubing).

3.2 \textit{bond}: The adhesive or cohesive forces holding materials together. This definition excludes press-fits and shrink-fits.

3.3 \textit{cleaned in place}: Cleaning of equipment by impingement or circulation of flowing chemical solutions, cleaning liquids, and water rinses, without dismantling, into, onto, and over surfaces in equipment or systems designed for this specific purpose.

3.4 \textit{cleaning}: Removal of soil.

3.5 \textit{coating}: The results of a process where a different material is deposited to create a new surface. There is appreciable, typically more than 40 \textmu m, build-up of new material. The coating material does not alter the physical properties of the substrate. Coating processes include, but are not limited to: chemical (conversion coatings), engineering plating (e.g., electrodeposition), thermal spraying (e.g., flame, plasma, arc spray), physical vapor deposition, chemical vapor deposition, and overlays and encapsulation.

3.6 \textit{corrosion resistant}: Capable of maintaining original surface characteristics under prolonged contact with the intended end use environment, and the normal use of cleaning compounds and sanitizing solutions.

3.7 \textit{crevice}: A sharp, cleft-like, irregular opening of small depth that adversely affects cleanability.

3.8 \textit{dead space}: Space wherein product, cleaning or sanitizing agents, or soils can be trapped, retained, or not completely removed during the operation of cleaning.

3.9 \textit{easily accessible}: A location that can be reached by an employee from the floor, other permanent work area, or other stable (permanent or movable) platform.

3.10 \textit{easily removable}: Capable of being detached and taken away from the parent unit without or with the use of simple hand tools.

3.11 \textit{equipment}: An assembly of parts or components, with the appropriate actuators, controls, and power circuits, joined together for a specific application, in particular for the processing, treatment, moving, or packaging of product.

3.12 \textit{hygiene}: The taking of all measures during product handling, preparation, and processing to ensure its suitability for use by humans.

\textsuperscript{4} ASTM International, 100 Barr Harbor Dr., West Conshohocken, PA 19428

\textsuperscript{5} NSF 2009 Issue 3 Revision 1 (October 2009)
3.13 **inspectable:** Designed such that all product contact surfaces can be made available for close visual observation.

3.14 **joint:** Junction of two or more pieces of material.

3.15 **manual cleaning:** Removal of soil by various methods that are manipulated by hand when equipment is open or partially or totally disassembled.

3.16 **microorganism (relevant):** Bacteria, fungi, yeasts, molds, spores, and viruses that are able to contaminate, multiply, or survive in a product and are able to be harmful.

3.17 **non-absorbent materials:** Those materials that under the intended conditions of their use do not retain substances with which they come in contact.

3.18 **non-product contact surface:** The exposed equipment surfaces that are not in contact with the product and from which product or other materials cannot drain, drip, diffuse, or be drawn (self-returned) into the product or product container.

3.19 **nontoxic materials:** Substances that, under the conditions of their use, are in compliance with applicable requirements of the Food, Drug, and Cosmetic Act of 1938, as amended.

3.20 **practical test:** Activities performed following a documented set of procedures and parameters used to determine an evaluation.

3.21 **product:** Any substance intended for human consumption (e.g., by ingestion, injection, topical application, insertion).

3.22 **product contact surface:** Equipment surfaces that are exposed to the product and from which the product or other materials can drain, drip, diffuse, or be drawn (self-returned) into the product or product container.

3.23 **sanitization:** The application of cumulative heat, chemicals, or other approved agents on clean surfaces that is sufficient to reduce the population of disease organisms by at least 99.999% (5 log reduction).

3.24 **seal:** To close an aperture so as to effectively prevent the entry or passage of unwanted matter.

3.25 **self-draining:** The combination of design, construction, installation, and surface finish so as to prevent the retention of liquid except for normal surface wetting.

3.26 **sensors:** Devices or instrumentation attached to equipment for process monitoring/control.

3.27 **smooth:** The condition of a surface that satisfies hygienic requirements and is free of pits, pinholes, cracks, crevices, inclusions, rough edges, and other surface imperfections detectable by visual and tactile inspection.

3.28 **soil:** Any unwanted matter.

3.29 **surface treatment:** The results of a process whereby chemical compositions or mechanical properties of the existing surface are altered. There is no appreciable, typically less than 40 µ in (1 µ m), build-up of new material or removal of existing material. Surface treatments include, but are not limited to, mechanical (shot peening, glass beading, polishing), thermal (surface hardening laser, electron beam), diffusion (carburizing, nitriding), chemical (etching, oxidation), ion implantation, or electropolishing.
4 Materials of construction

4.1 General

Materials shall be suitable for their intended use.

Surfaces of materials, coatings, and surface treatments shall be durable, cleanable, and if necessary, capable of being sanitized without breaking, cracking, chipping, flaking, delamination, erosion, corrosion, and/or abrasion, and shall be resistant to the penetration of unwanted matter under intended use.

Equipment used in the slaughter, processing, and packaging of meat and poultry products shall be constructed of materials that will withstand the generally humid operating environment, high pressure, hot water cleaning with chemical cleaning agents, and antimicrobial treatment.

4.1.1 Unacceptable materials

The following materials shall not be used in product contact surface areas or non-product contact surface areas:

- materials containing antimony, arsenic, cadmium, lead, or mercury;
- metals containing selenium in excess of 0.50%;
- materials classified as hazardous substances (such as carcinogens, mutagens, and teratogens);
- asbestos and asbestos containing materials;
- wood;
- enamelware;
- porcelain;
- leather;
- uncoated aluminum and aluminum alloys;
- uncoated anodized aluminum and aluminum alloys; or
- glass.

4.1.2 Paint

Paint shall not be used on product contact surfaces. Parts removable for cleaning having both product contact and non-product contact surfaces shall not be painted.

4.2 Product contact surfaces

In addition to the general requirements (see 4.1), materials used for product contact surfaces shall:

- be corrosion resistant to both product and cleaning/sanitization materials;
- be non-toxic;
- not contaminate or otherwise have any adverse effect on the product;
- be non-absorbent (except where technically or functionally unavoidable); or
- be temperature resistant to processing and heat treatments where necessary (e.g., freezing, heat-sterilization).

4.2.1 Metals

4.2.1.1 Product contact surfaces shall be:

- AISI 300 series stainless steel; or
– when necessary, stainless steel that has been hardened by heat treatment or precipitation hardening, including Martensitic stainless steel; or
– other alloys which can be shown to be as corrosion resistant as austenitic stainless steel; or
– other metals and metal alloys (including solder) suitable for the conditions of intended use (see annex B).

4.2.1.2 Copper and copper alloys, bronze, brass, and zinc galvanizing shall not be used for product contact surfaces. These materials may be used in supply air and supply water lines or for gears and bushings used in non-product surfaces.

4.2.1.3 Surface coatings and platings may be used if the base material is non-toxic. Non-metallic coatings shall meet the requirements of 4.2.2.

4.2.2 Non-metals

Product contact surfaces 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 use; or
– are regulated as indirect food additives under the provisions of 21 CFR, parts 174-189; or
– are exempt from regulation as food additives under the provisions of the 21 CFR, part 170.39; or
– can be demonstrated to be safe for the intended use, subject to the Food, Drug, and Cosmetic Act, Section 409(h)(1) [21 U.S.C. 348(h)(1)], Premarket Notification.

4.2.2.1 Elastomers and polymers having product contact surfaces shall be of such composition as to retain their surface and conformational characteristics when exposed to the conditions encountered in the environment of intended use and in cleaning and sanitization or sterilization.

4.2.2.2 Adhesives and the bonds created by their use shall be compatible with the surfaces, products, and cleaning/sanitizing materials in which they are in contact. All bonds shall be continuous and mechanically sound so that the adhesives do not separate from the base materials to which they are bonded.

4.2.2.3 Where materials having certain inherent functional purposes are required for specific application, product contact surfaces may be made of these materials (e.g., carbon, sapphire, quartz, fluorspar, spinel, ceramic materials).

4.2.2.4 Gaskets, O-rings, etc., shall be non-toxic, non-porous, non-absorbent, and unaffected by food products.

4.3 Non-product contact surfaces

In addition to the general requirements (see 4.1), materials used for non-product contact surfaces, (including splash areas) under the conditions of intended use, shall:

– be of corrosion resistant material or material that is treated (e.g., coating, painting) so as to be corrosion resistant to both product and cleaning/sanitizing materials. When coated, the coating shall adhere;
– be non-absorbent; and
– not contaminate or otherwise have any adverse effect on the product.

Parts removable for cleaning having both product contact and non-product contact surfaces shall be designed to ensure that hygiene risks are eliminated in accordance with the requirements for product contact surfaces.

5 Design and construction

5.1 Product contact surfaces

The following criteria apply to all product contact surfaces.

5.1.1 Surface texture

Surfaces shall be free of imperfections such as pits, folds, cracks, and crevices.

Surface textures shall have a maximum $R_a$ of 32 $\mu$ in (0.81 $\mu$ m). When necessary, due to functional needs, the following may be used:

– glass-beaded or shot-peened surfaces with a maximum $R_a$ of 125 $\mu$ in (3.2 $\mu$ m);
– coatings with a maximum $R_a$ of 200 $\mu$ in (5.0 $\mu$ m); or
– machined plastics with a maximum $R_a$ of 125 $\mu$ in (3.2 $\mu$ m).

NOTE – The 2B mill finish on stainless steel sheet is also considered as smooth or smoother than a No. 4 finish. No further finishing is required if the finish is free of defects, such as pits, scratches, chips, or flakes in the final fabricated form.

Belts are exempt from surface texture requirements. Belts (flat, modular, link, or wire) shall meet the requirements of 5.1.2.

5.1.2 Cleaning and inspection

Surfaces shall be cleanable. For mechanical belt conveyors intended to be disassembled, the design shall ensure that product contact surfaces are easily accessible for cleaning and inspection, and the demountable parts shall be easily removable. Alternatively, mechanical belt conveyors designed to be cleaned in place shall be designed so that product contact surfaces and all non-removed appurtenances thereto can be mechanically cleaned and are easily accessible and easily removable for inspection.

5.1.3 Disinfection and sanitization

Where appropriate, mechanical belt conveyors shall be designed such that surfaces can attain the required disinfection or sanitization conditions.

5.1.4 Microbial ingress

Where appropriate (e.g., aseptic process), mechanical belt conveyors shall be designed to prevent microorganisms migrating from the external environment onto product contact surfaces, either directly or via soils.
5.1.5 Draining

Surfaces of mechanical belt conveyors shall be self draining or drainable. Equipment that uses a single pass water flush shall have a drain that directs water to a non-product contact area.

5.1.6 Dead spaces

There shall be no dead spaces.

5.1.7 Joints

5.1.7.1 Permanent metal-to-metal joints shall be continuously welded. Jointed surfaces shall be flush.

5.1.7.2 Dismountable/removable joints shall be flush and sealed at the product contact surface.

5.1.7.3 Only in cases where welding or bonding is impractical, silver soldering, press-fitting, or shrink-fittings, may be employed where necessary for essential functional reasons.

5.1.7.4 Welding, press-fitting, shrink-fitting, or soldering shall produce product contact surfaces with a smooth finish free of imperfections such as pits, fold, inclusions, cracks, and crevices.

5.1.7.5 Belts (flat, modular, link, or wire) are exempt from the requirements of 5.1.7.1 through 5.1.7.4. Belts shall meet the requirements of 6.

5.1.8 Coatings

Coatings shall be free from surface delamination, pitting, flaking, spalling, blistering, and distortion. Surface coatings and platings must remain intact. Surface coatings shall not crack or peel. Coatings and platings shall not be used on product contact surfaces that are not inspectable. Paint shall not be used on product contact surfaces or on parts having both product contact and non-product contact surfaces.

5.1.9 Internal angles, corners and grooves

Internal corners and angles of less than 135° in product contact areas shall have a smooth and continuous radius of \(\frac{1}{8}\) in (0.13 in, 3.2 mm) or greater. Lesser radii may be used for necessary functional reasons or to facilitate drainage provided these areas can be readily cleaned. The radii shall not be less than \(\frac{1}{32}\) in (0.031 in, 0.79 mm) except that the radius intersection of press fits, shrink fits, and flat-sealing surfaces may be zero.

Internal, three-plane intersections shall have a radius of \(\frac{1}{8}\) in (0.25 in, 6.4 mm) or greater.

Grooves, where used, shall be wider than their depth.

5.1.9.1 Belts (flat, modular, link, or wire) are exempt from the requirements of 5.1.9. Belts shall meet the requirements of 6.

5.1.10 Seals, gaskets, O-rings

Seals, gaskets, and O-rings shall be designed to minimize product contact and be cleanable.

Thermal expansion and contraction shall be considered during design. Compression of rubber or plastic parts shall not adversely affect cleanliness.
5.1.11 Fasteners

Fasteners (e.g., screws, bolts, rivets) shall be avoided. Where technically unavoidable, fasteners shall be cleanable. There shall be no exposed screw threads or recesses. Roller-type chain may use rivet fasteners, provided they are cleanable.

Threads which may become product contact surfaces during dismantling operations should be designed to be cleanable, such as ACME 60° Stub, or equal, with not more than 14 threads per inch and a major diameter of not less than $\frac{5}{16}$ in (0.31 in, 7.9 mm).

5.1.12 Sprockets, rollers, and pulleys

5.1.12.1 Where sprockets are required, they and their means of attachment shall be hygienic in design. Hygienic design may be demonstrated by meeting the requirements of 6.

5.1.12.2 Internally driven rollers or pulleys shall be sealed to comply with 5.1.18.

5.1.12.3 Hollow rollers shall be fabricated of metal with continuously welded seams and no openings into the hollow area.

5.1.13 Shafts and bearings

5.1.13.1 Where shaft seals are required, they shall be hygienic in design (i.e., packless) and shall be easily accessible for cleaning, sanitizing, and inspection.

5.1.13.2 Where a shaft passes through a product contact surface, the portion of the opening surrounding the shaft shall be protected to prevent the entrance of contaminants.

5.1.13.3 Lubricated bearings, including the permanent sealed type, shall be located outside the product contact surface area with adequate clearance open for inspection between the bearing and any product contact surface. A minimum clearance of 1.0 in (25 mm) is recommended.

5.1.13.4 When provided, a shaft driving mechanism shall be securely mounted in a position that ensures a physical separation from product contact surfaces for cleaning and inspection.

5.1.14 Sensor and sensor connections

All sensors and sensor connections having product contact surfaces shall be installed to avoid crevices and dead spaces and be drainable.

5.1.15 Other connections

All pipelines and other appendages entering the mechanical belt conveyor shall be hygienically sealed and designed to prevent the ingress of soil.

5.1.15.1 Pneumatic equipment

Exhaust air shall be piped away from product contact surface areas. Air directly contacting product or product contact surfaces shall meet the requirements of 3-A Accepted Practice, Number 604-05.

5.1.16 Openings and covers

5.1.16.1 Panels, covers, and doors shall be so designed that they avoid any adverse influence (e.g., entry and/or accumulation of soil) and shall be cleanable.
5.1.16.2 If any exterior flange is incorporated in the opening, it shall slope and drain away from the opening.

5.1.16.3 Covers shall be sloped to an outside edge(s).

5.1.16.4 Hinges shall be able to be disassembled for cleaning and inspection. They shall not be of a continuous (piano) type.

5.1.17 Product contact with equipment fluids and lubricants

Equipment shall be designed, fabricated, and installed to prevent the ingress of unwanted fluids (e.g., lubricating and hydraulic fluids, and signal transfer liquids) into the product or onto product contact surfaces.

5.1.18 Belts

Belts with fabric carcasses (substrate materials) shall have edges sealed with an acceptable compound.

All fabric components of belting materials, including edges, shall have at least a 0.006 in (0.15 mm) thick cover of an acceptable material above the fabric and shall conform to the requirements of 4.2.2.

Conveyor belts shall be designed to be endless. Solid, flat, non-modular belts shall not be joined by exposed stitching or alligator clips.

Belts shall comply with 6.

5.1.18.1 Belt accessories

Belt accessories such as, but not limited to, guiding strips, flights, and spill edges shall comply with the applicable sections of this Standard.

5.1.19 Spraying devices

Radii on spraying devices may be less than 1/32 in (0.031 in, 0.79 mm). When radii are less than 1/32 in (0.031 in, 0.79 mm), the internal angles must be cleanable and inspectable.

There shall be no exposed threads or crevices on product contact surfaces of high and low pressure spraying devices except where required for functional and safety reasons.

5.2 Non-product contact surfaces

5.2.1 General

Mechanical belt conveyors shall be designed in such a manner as to prevent the retention of moisture, ingress, and harborage of pests and soils, and to facilitate cleaning, inspection, servicing, and maintenance. Equipment shall be designed such that non-product surfaces can attain the required sanitization or sterilization conditions.

The possibility of adverse galvanic reactions between dissimilar materials shall be taken into consideration.

5.2.2 Cleaning and inspection

Surfaces shall be cleanable. For equipment intended to be disassembled, the design shall ensure that relevant areas are easily accessible for cleaning and inspection and the demountable parts shall be easily removable. Alternatively, equipment may be designed to be cleaned in place. Cleaned in place equipment shall be designed to allow access for inspection after cleaning.
5.2.3 Joints

Permanent metal-to-metal joints shall be continuously welded wherever possible; when not possible, permanent metal-to-metal joints shall be completely sealed. Only in cases where welding or bonding is impractical, silver-soldering, press-fitting or shrink-fittings may be employed where necessary for essential functional reasons. Permanent metal-to-non-metal or non-metal-to-non-metal joints shall be continuously bonded.

5.2.4 Dead spaces

There shall be no dead spaces.

5.2.5 Insulation

The insulation material shall be properly mounted and completely sealed to prevent the ingress of contaminants (e.g., moisture or pests).

5.2.6 Supports

5.2.6.1 Supports for piping or mechanical belt conveyors shall be designed, fabricated, and installed such that no water or soil can remain on the surface or within the supports.

5.2.6.2 Supports (e.g., legs) are to be smooth with rounded ends or with flat, load-bearing feet suitable for sealing to the floor and have no exposed threads. Sufficient clearance around and under the equipment for cleaning and inspection shall be provided.

5.2.6.3 Where casters are used, they shall be of sufficient size to provide sufficient clearance between the lowest part of the base and the floor for easy cleaning and inspection. Casters shall be easily cleanable, durable, and of a size that permits easy movement of the equipment.

5.2.6.4 Where the equipment is to be floor or wall mounted, supports shall be designed for sealing to the mounting space.

6 Assessment for cleanability of belting materials

6.1 Performance requirement

Belting materials and components shall be cleanable.

6.2 Test method

6.2.1 Materials

- Riboflavin powder (reagent grade);
- sucrose (food grade);
- deionized water;
- UV lamp (long-wavelength);
- test apparatus (see annex A); and
- variety of hand tools for the disassembly of the samples.
6.2.2 Preparation

6.2.2.1 Test solution preparation

A fluorescent dye test solution shall be prepared. 0.2 g of riboflavin powder shall be added per 1.0 L of water (i.e., 0.02% riboflavin). The reagent water shall have a maximum of 30 ppm chlorine or shall be deionized to 1.0 meg-ohm cm. 100 g of sucrose shall be added per liter of riboflavin solution. The test solution may be re-used provided it is safeguarded to prevent dilution or degradation of the riboflavin concentration.

6.2.2.2 Belting sample preparation

Belt samples shall be not less than 6 in (150 mm) wide and not less than 48 in (1200 mm) long. Test samples shall include all component parts or segments such as edge segments, center segments, joints, hinges, cleats, and/or snap-on components, etc. Multiple narrow belt components may be grouped to achieve the proper width.

Drive components to be tested shall consist of two pulleys, rollers, or sprockets, etc., attached to a segment of drive shaft 24 in (600 mm) long. Components shall be attached to the drive shaft in the same manner as production units are attached. 1.5 in (38 mm) of each shaft end shall be machined to be ½ in (0.5 in, 13 mm) in diameter.

Two identically configured samples shall be submitted for testing.

Maintain belt samples at 72 ± 3 °F (23 ± 1.5 °C) prior to assay.

6.2.3 Procedure for belting

6.2.3.1 The following test procedures shall be conducted on each of the two samples submitted except that the procedures for sample one shall skip 6.2.3.5 through 6.2.3.8 in order to establish that the soil solution has fully penetrated to all of the potentially wetted surfaces (positive control).

6.2.3.2 Attach the sample to the oscillation mechanism described in annex A and submerge the sample in the test solution at 72 ± 3 °F (23 ± 1.5 °C) for 1 h under full oscillation. A minimum of 50% of the belt sample surface shall be submerged in the test solution.

6.2.3.3 Remove the sample from the soil solution and allow to drain by suspending from a horizontal bar by one end for 5 min to remove all excess soil solution except for normal adherence. During the suspended draining, the sample shall be protected from touching any surfaces of the testing or draining apparatus except for attachment clamps.

6.2.3.4 Air-dry the soiled sample at 72 ± 3 °F (23 ± 1.5 °C) until completely dry. Sample one to skip to 6.2.3.9.

6.2.3.5 Attach the sample to the oscillation mechanism and submerge the dried, soiled sample into clear, deionized water at 72 ± 3 °F (23 ± 1.5 °C) for 15 min under full oscillation. The volume of the rinse water shall be 150% of the volume of the test solution used to soil the sample.

6.2.3.6 Remove the sample from the cleaning water and allow to drain for 5 min to remove all excess rinse water except for normal adherence.

6.2.3.7 Place the sample on a 30° inclined drain board. Gently and uniformly rinse all surfaces with clear, flowing, deionized water from an open 0.625 to 0.75 in (16 to 19 mm) diameter hose, the pressure from which shall not exceed a column of water greater than 6 in (150 mm) when held vertically for the following orientations and times.
a) Front face, 1.5 min.
b) Front face turned 180° top to bottom, 1.5 min.
c) Turn the sample over front to back.
d) Back face, 1.5 min.
e) Back face turned 180° top to bottom, 1.5 min.

6.2.3.8 Inspect the assembled samples while still moist with the UV light source for any dye residue.

6.2.3.9 Disassemble the sample to reveal all interior surfaces. Disassembly may require the cutting of component parts and the grinding of rivets or welded areas. Inspect all of the interior surfaces with the UV light source for any dye residue.

6.2.3.10 Record, by size and location, all areas of residual dye.

6.2.3.10.1 Dye residue observed at the oscillation mechanism and draining clamp points shall not be criticized.

6.2.4 Procedure for drive components

6.2.4.1 The following test procedures shall be conducted on each of the two samples submitted except that the procedures for sample one shall skip 6.2.4.5 through 6.2.4.8 in order to establish that the soil solution has fully penetrated to all of the potentially wetted surfaces (positive control).

6.2.4.2 Attach the test apparatus drive pulley to the drive shaft of the rollers, sprockets, or pulleys to be tested. Attach a 0.16 - 0.25 in (4 - 6 mm) diameter, round, smooth polyurethane belt to the oscillation roller mechanism and around the test apparatus drive pulley mounted on the drive shaft to be tested. Submerge the sample in the test solution at 72 ± 3 °F (23 ± 1.5 °C) for 1 h under full oscillation.

6.2.4.3 Remove the sample from the soil solution and allow to drain for 5 min to remove all excess soil solution except for normal adherence.

6.2.4.4 Air dry the soiled sample at 72 ± 3 °F (23 ± 1.5 °C) until completely dry. Sample one to skip to 6.2.4.9.

6.2.4.5 Attach the sample to the oscillation mechanism and submerge the dried, soiled sample into clear, deionized water at 72 ± 3 °F (23 ± 1.5 °C) for 15 min under full oscillation. The volume of the rinse water shall be 150% of the volume of the test solution used to soil the sample.

6.2.4.6 Remove the sample from the cleaning water and allow to drain for 5 min to remove all excess rinse water except for normal adherence.

6.2.4.7 Place the sample on a 30° inclined drain board. Gently and uniformly rinse all surfaces with clear, flowing, deionized water from an open 0.625 to 0.75 in (16 to 19 mm) diameter hose, the pressure from which shall not exceed a column of water greater than 6 in (150 mm) when held vertically for the following orientations and times.

a) Front face, 1.5 min.
b) Front face turned 180° top to bottom, 1.5 min.
c) Turn the sample over front to back.
d) Back face, 1.5 min.
e) Back face turned 180° top to bottom, 1.5 min.

6.2.4.8 Inspect the assembled samples while still moist with the UV light source for any dye residue.
6.2.4.9 Disassemble the sample to reveal all interior surfaces. Disassembly may require the cutting of component parts and the grinding of rivets or welded areas. Inspect all of the interior surfaces with the UV light source for any dye residue.

6.2.4.10 Record, by size and location, all areas of residual dye.

6.2.4.10.1 Dye residue observed at the shaft testing apparatus and draining attachment points (i.e., shaft ends, drive pulley) shall not be criticized.

6.3 Acceptance criteria

The test sample shall be considered as satisfactory if no dye residue is observed except as noted in 6.2.3.10.1 and 6.2.4.10.1.

7 Instruction handbook, maintenance, and cleaning

7.1 Instruction handbook

The instruction handbook shall include the following items:

7.1.1 Installation of the equipment and associated equipment

Information shall be provided so that, after the equipment is installed, it maintains its hygienic integrity (e.g., drainability).

7.1.2 Instructions for use

Measures shall be described on the use of the equipment so that when used correctly the product is not exposed to factors that can lead to contamination.

7.2 Maintenance and cleaning

7.2.1 Maintenance

A system of measures shall be recommended to ensure that the hygienic integrity of the equipment is maintained during the intended lifetime.

7.2.2 Cleaning

The instructions shall specify typical routine procedures for cleaning, sanitizing, rinsing, and inspection for cleanliness and, where appropriate, sterilization. Recommended cleaning and sanitizing procedures, materials, implements, and agents shall be specified. Recommended cleaning and sanitizing procedures, materials, implements, and agents shall be compatible with the materials of construction. Where dismantling is required, specific instructions shall be provided.
This page is intentionally blank.
Annex A
(normative)

Test Apparatus

Figure 1 – Test apparatus
All 4 mounting blocks are the same.

Oscillating roller with machined belt drive groove for sprocket and shaft testing. Not used during belt testing.

Submerged roller is replaced by alternate configuration for sprocket and shaft testing.

A polyurethane drive belt is connected to the two rollers to oscillate the sprocket and shaft.

**Figure 2 – Test apparatus (frontal view)**
Figure 3 – Component detail
A.1 Test apparatus

The test apparatus shall incorporate:

- A container of sufficient size to hold the belting test sample and a roller and a drive shaft with sprockets, rollers, or pulleys, as applicable as required for testing, and the necessary volume of testing solutions;

- A drive mechanism that will induce an oscillating motion to the belt, sprockets, rollers, and pulley test samples. The drive shall produce 30 one-half rotations to a 6 in (150 mm) diameter belt roller. The oscillating belt roller shall be notched on one end to be able to accommodate a ¼ in (0.25 in, 6 mm) round belt for testing drive components;

- A 6 in (150 mm) diameter roller configured to be submerged by the testing solutions;

- Mounting blocks able to accommodate a 24 in (600 mm) long shaft with a diameter of ½ in (0.5 in, 13 mm);

- A 6 in (150 mm) diameter pulley able to be attached to drive shafts to be tested and able to accommodate a ¼ in (0.25 in, 6 mm) round belt; and

- A support for the drive mechanism which can accommodate the proper positioning of both the belt and drive component samples.
### Annex B

(Optional Informative)

Optional metal alloys

Optional metal alloys having the following compositions are examples considered in compliance with 4.2.1. This is not an all-inclusive list. Chemistries given are per ASTM specifications wherever possible and may deviate slightly from UNS chemistry. (Percentages are maximum unless range is given.)

<table>
<thead>
<tr>
<th>UNS</th>
<th>Name</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>Co</th>
<th>Cu</th>
<th>N</th>
<th>Fe</th>
<th>Sn</th>
<th>Bi</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>N08367</td>
<td>AL-6XN®</td>
<td>0.03</td>
<td>2.00</td>
<td>1.00</td>
<td>0.040</td>
<td>0.010</td>
<td>20.0-22.0</td>
<td>23.5-25.5</td>
<td>6.0-7.0</td>
<td>0.15-0.35</td>
<td>0.75</td>
<td>0.18-0.26</td>
<td>0.18-0.20</td>
<td>Balance</td>
<td>Balance</td>
<td>1.0</td>
</tr>
<tr>
<td>S21800</td>
<td>Nitronic®60</td>
<td>0.10</td>
<td>7.00-9.00</td>
<td>3.50-4.50</td>
<td>0.05</td>
<td>0.03</td>
<td>16.00-18.00</td>
<td>8.00-9.00</td>
<td>2.0-3.5</td>
<td>0.03</td>
<td>0.08-0.18</td>
<td>0.08-0.20</td>
<td>Balance</td>
<td>Balance</td>
<td>Balance</td>
<td></td>
</tr>
<tr>
<td>S20161</td>
<td>Gall-Tough</td>
<td>0.15</td>
<td>4.00-6.00</td>
<td>3.00-4.00</td>
<td>0.05</td>
<td>0.03</td>
<td>15.0-18.00</td>
<td>4.00-6.00</td>
<td>15.0-17.5</td>
<td>0.03</td>
<td>0.08-0.18</td>
<td>0.08-0.20</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>N26055</td>
<td>Alloy 88</td>
<td>0.05</td>
<td>1.50</td>
<td>4.50</td>
<td>0.50</td>
<td>0.30</td>
<td>15.0-18.00</td>
<td>4.00-6.00</td>
<td>15.0-17.5</td>
<td>0.05</td>
<td>0.08-0.18</td>
<td>0.08-0.20</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>N26455</td>
<td>Hastelloy C®</td>
<td>0.02</td>
<td>1.00</td>
<td>0.80</td>
<td>1.00</td>
<td>0.30</td>
<td>14.0-15.50</td>
<td>3.60-4.60</td>
<td>14.0-15.50</td>
<td>0.05</td>
<td>0.08-0.18</td>
<td>0.08-0.20</td>
<td>4.50</td>
<td>3.50-5.50</td>
<td>2.50-5.00</td>
<td></td>
</tr>
<tr>
<td>S17400</td>
<td>17-4 PH</td>
<td>0.07</td>
<td>0.70</td>
<td>1.00</td>
<td>0.30</td>
<td>0.30</td>
<td>23.0-28.0</td>
<td>3.60-4.60</td>
<td>23.0-28.0</td>
<td>0.05</td>
<td>0.08-0.18</td>
<td>0.08-0.20</td>
<td>4.50</td>
<td>3.50-5.50</td>
<td>2.50-5.00</td>
<td></td>
</tr>
<tr>
<td>S15500</td>
<td>15-5 PH</td>
<td>0.07</td>
<td>0.70</td>
<td>1.00</td>
<td>0.30</td>
<td>0.30</td>
<td>48.0-52.0</td>
<td>3.50-5.50</td>
<td>48.0-52.0</td>
<td>0.05</td>
<td>0.08-0.18</td>
<td>0.08-0.20</td>
<td>4.50</td>
<td>3.50-5.50</td>
<td>2.50-5.00</td>
<td></td>
</tr>
<tr>
<td>S32900</td>
<td>329 Duplex</td>
<td>0.08</td>
<td>1.00</td>
<td>0.75</td>
<td>0.30</td>
<td>0.30</td>
<td>23.0-28.0</td>
<td>4.50</td>
<td>3.50-5.50</td>
<td>2.50-5.00</td>
<td>1.00</td>
<td>0.20</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R20500</td>
<td>50/50</td>
<td>0.10</td>
<td>1.00</td>
<td>1.00</td>
<td>0.30</td>
<td>0.30</td>
<td>Balance</td>
<td>Balance</td>
<td>Balance</td>
<td>1.00</td>
<td>0.20</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R50400</td>
<td>Titanium</td>
<td>0.10</td>
<td>1.00</td>
<td>1.00</td>
<td>0.30</td>
<td>0.30</td>
<td>Balance</td>
<td>Balance</td>
<td>Balance</td>
<td>1.00</td>
<td>0.20</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Com.: Component Name

**Note:** Percentages are maximum unless range is given.
Metal alloys or metals other than the above may be as corrosion resistant as AISI 300 Series Stainless steel. This may be shown when metal alloys or metals are tested in accordance with ASTM G31 *Laboratory Immersion Corrosion Testing of Metals* and have a corrosion rate of less than 10.0 mil (250 μm) per year. The test parameters such as the type of chemical(s), their concentration(s), and temperature(s) should be representative of cleaning and sanitizing conditions used in meat and poultry processing equipment. Alloys containing lead, leachable copper, or other toxic metals should not be used.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ti</td>
<td>0.50 Balance</td>
</tr>
<tr>
<td>Al</td>
<td>0.25</td>
</tr>
<tr>
<td>Other</td>
<td>H=0.015, N=0.050, O=0.40</td>
</tr>
</tbody>
</table>

---

5. ASTM International, 100 Barr Harbor Dr., West Conshohocken, PA 19248
Annex C
(Informative)

Strategy for selecting hygiene measures

The risk assessment strategy for selecting hygiene measures is applicable to both product and non-product contact areas. The basic strategy for selecting hygiene measures for equipment and the design of equipment shall include the following:

– identification of the process for which the equipment is intended;
– hazards associated with the product(s) produced (see annex D);
– risk assessment associated with each hazard identified (see below);
– design methods/measures that can eliminate hazards or reduce risks associated with these hazards (see 5);
– identification of any other hygienic hazards, which can be introduced by methods used to reduce the risk associated with the hazard under analysis;
– means of verification of the effectiveness of the hazard elimination or the risk reduction method (see annex G); and
– description of residual risks and any additional precautions necessary in the information for use where applicable (see 7 and annex E).

After this process has been undertaken for all hazards identified, it may be applicable to define the item of equipment according to one of the hygiene levels described in this annex in order to help clarify the intended use.
This page is intentionally blank.
Annex D  
(informative)

Hazards

The hazards that can be associated with product handling, preparation, and processing can arise from:

– biological causes, such as pathogens, spoilage microorganisms, or toxins (e.g., ingress or retention of bacteria, spores, viruses, yeasts/molds);

– chemical causes, including those from cleaning and sanitizing substances (e.g., lubricants, cleaning fluids); and/or

– physical causes, including foreign materials arising from raw materials, equipment, or other sources (e.g., allergens, pests, metals, materials used in the construction of the equipment).
This page is intentionally blank.
Annex E
(informative)

Additional information (limitations of use)

In the event of a hygienic design (see 5) being unable to control the risk associated with a specific hazard identified (see annex D), or in the event of a product compromise, additional information shall be required. Additional information could include, for example:

- further monitoring, cleaning and disassembly instructions;
- specific processing conditions (e.g., controlled temperature environment); and/or
- limitations to the range of products that can be safely processed.
This page is intentionally blank.
Annex F
(informative)

Elements of risk assessment

When undertaking the elements of the risk assessment, the following parameters are presented as guidance to the range and type of factors that shall be considered for the equipment and its associated equipment.

– The intended use of the equipment: Will the equipment be used for one specific purpose only, for which the hazards are readily identifiable, or could the equipment be used for a wide range of products in many industries (e.g., a pump)?

– The product type to be processed by the equipment: Will the product be already contaminated (e.g., a raw material) or will it be “preserved” or aseptic?

– The degree of further processing: Will the product processed by the equipment subsequently undergo a further process which functions as a hazard elimination step (e.g., a heat treatment), or is the process for which the equipment is intended the final process?

– Specific application of the product:
  – Is the product to be used by the consumer immediately after processing, or is there a product shelf life in which the severity of the hazard could increase (e.g., relevant microbial growth)?
  – Will the product be used by a specific consumer group to whom the hazard may present a more serious risk (e.g., an infant, elderly, or infirm person)?

– The degree of cleaning, sanitization, sterilization, and/or inspection: Is the equipment to be cleaned, sanitized, sterilized, and/or inspected after every use, routinely during the day, every day, or every week, etc.?

– The use of the equipment: Is the equipment likely to be well maintained or used infrequently? Is it designed for high or continuous use? Is misuse foreseeable?
This page is intentionally blank.
Verification of hygiene measures and test methods

Verification of compliance with hygiene requirements is undertaken using one or more of the following:

- examination of the functional specifications and drawings;
- examination of the fabricated equipment; and/or
- undertaking of specific practical tests (if available).

The methods of verification of hygienic design depend on both the original risk analysis (see annex F) and the specific purpose for which the equipment was designed.

The majority of open product processing equipment is considered to be cleanable if its design complies with the requirements of 5 and of the specific standards. More complicated equipment may require assessment by means of a practical cleanability test.

The majority of closed product processing equipment is considered cleanable if the cleaning procedure can be verified by means of a practical test of the entire plant or its individual components. Some closed product processing equipment may be considered to be cleanable if its design complies with the requirements of 5.

Equipment designed to be sterilized or for aseptic production, usually for closed product processing, shall require practical testing.
This page is intentionally blank.
Annex H
(informative)

Table H1 – Categorization of equipment and associated equipment for intended use

<table>
<thead>
<tr>
<th>Hygiene level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equipment which, following a hygiene risk assessment, needs only to partially conform with the requirements of this Standard to meet the identified risk(s) and to produce safe product.</td>
</tr>
<tr>
<td>2</td>
<td>Equipment which, following a hygiene risk assessment, conforms with the requirements of this Standard but requires planned disassembly for cleaning.</td>
</tr>
<tr>
<td>3</td>
<td>Equipment which, following a hygiene risk assessment, conforms fully with this Standard and can be cleaned without disassembly.</td>
</tr>
<tr>
<td>4</td>
<td>Equipment which, following a hygiene risk assessment, conforms fully with this Standard and has been designed for a specified heat, chemical or physical treatment to free the equipment from relevant microorganisms.</td>
</tr>
<tr>
<td>5</td>
<td>Equipment which, following a hygiene risk assessment, conforms fully with this Standard, will prevent microbial ingress and has been designed for a specified heat, chemical or physical treatment to free the equipment from relevant microorganisms.</td>
</tr>
</tbody>
</table>