

3-A[®] Sanitary Standards for Centrifugal and Positive Rotary Pumps, Number 02-11

*Standards Developing Organizations
3-A Sanitary Standards, Inc. (3-A SSI)
In Collaboration With
United States Public Health Service (USPHS)/
United States Food and Drug Administration (USFDA)
United States Department of Agriculture (USDA)
European Hygienic Engineering & Design Group (EHEDG)*

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Foreword

This 3-A Standard is to establish minimum sanitary (hygienic) requirements for Centrifugal and Positive Rotary Pumps. Standard English is the official language of 3-A Sanitary Standards and 3-A Accepted Practices.

This 3-A Standard is for voluntary use by directly and materially affected organizations such as equipment and machinery fabricators, processors, regulatory agencies and by 3-A Sanitary Standards, Inc. to assure adequate public health protection exist for the devices and covered products. 3-A Sanitary Standards, Inc. use these documents as the source for sanitary criteria as part of 3-A Symbol authorization.

This 3-A Standard was developed jointly by 3-A Sanitary Standards, Inc. (3-A SSI), the United States Public Health Service (USPHS), the United States Department of Agriculture – Dairy Programs (USDA), and the European Hygienic Engineering & Design Group (EHEDG).

It is our purpose to encourage inventive genius and provide a forum to discuss new developments. Suggestions for improvement and new technology are welcome any time for consideration by the 3-A Sanitary Standards Committees. Please forward comments to 3-A SSI, 6888 Elm Street, Suite 2D, McLean, VA 22101-3829, USA. By fax: 703-761-6284. By e-mail to: 3-ainfo@3-a.org.

- A **SCOPE**
- A1 These standards cover the sanitary aspects of centrifugal and positive rotary pumps for milk and milk products.
- A2 In order to conform to these 3-A Sanitary Standards, centrifugal and positive rotary pumps shall comply with the following design, materials, and fabrication criteria.
- B **DEFINITIONS**
- B1 *Product:* Shall mean milk and milk products.
- B2 **Surfaces**
- B2.1 *Product Contact Surfaces:* Shall mean all surfaces which are exposed to the product and surfaces from which liquids may drain, drop, or be drawn into the product.
- B2.2 *Nonproduct Contact Surfaces:* Shall mean all other exposed surfaces.
- B3 **Cleaning**
- B3.1 *Mechanical Cleaning or Mechanically Cleaned:* Shall mean soil removal by impingement, circulation or flowing chemical detergent solutions and water rinses onto and over the surfaces to be cleaned by mechanical means in equipment or systems specifically designed for this purpose.
- B3.2 *Manual (COP) Cleaning:* Shall mean soil removal when the equipment is partially or totally disassembled. Soil removal is effected with chemical solutions and water rinses with the assistance of one or a combination of brushes, nonmetallic scouring pads and scrapers, high or low pressure hoses and tanks(s) which may be fitted with recirculating pump(s) and with all cleaning aids manipulated by hand.
- B4 **Surface Modification¹**
- B4.1 *Surface Treatments:* Shall mean a process whereby chemical compositions or mechanical properties of the existing surfaces are altered. There is no appreciable, typically less than 1 µm build-up of new material or removal of existing material.
- B4.1.1 Surface treatments include:
1. Mechanical (shot peening², glass beading, polishing)
 2. Thermal (surface hardening laser, electron beam)
 3. Diffusion (carburizing, nitriding)
 4. Chemical (etching, oxidation)
 5. Ion Implantation
 6. Electropolishing
- B4.2 *Coatings:* Shall mean the results of a process where a different material is deposited to create a new surface. There is appreciable, typically more than 1 µm build-up of new material.
- B4.2.1 Coating processes include:
1. Chemical (conversion coatings)
 2. Electrodeposition³
 3. Spraying (pneumatic, flame, plasma, arc spray)
 4. Physical Vapor Deposition
 5. Chemical Vapor Deposition
- B5 *Simple Hand Tools:* Shall mean implements normally used by operating and cleaning personnel such as a screwdriver, wrench or hammer.
- B6 *Substantially Flush:* Shall mean mating surfaces or other juxtaposed surfaces shall be within 1/32 in. (0.794 mm).
- B7 *Readily or Easily Removable:* Shall mean quickly separated from the equipment with the use of simple hand tools if necessary.
- B8 *Easily or Readily Accessible:* Shall mean a location which can be safely reached by an employee from the floor, platform, or other permanent work area.

¹ Additional information on surface modification is contained in *Advanced Materials and Processes*, Volume 137(1). "Coatings and Coating Practices" by H. Herman, "Surface Modification" by F. A. Smidt, ASM International, Materials Park, OH 44073 (216) 338-5151.

² AMS-S-13165, *Shot Peening of Metal Parts*. Available from Society of Automotive Engineers, Inc. (SAE), 400 Commonwealth Drive, Warrendale, PA.

³ SAE-AMS-QQ-C-320, Chromium Plating (Electrodeposited). SAE-AMS QQ-N-290A, Nickel Plating (Electrodeposited). Society of Automotive Engineers (AWS), 400 Commonwealth Drive, Warrendale, PA 15096-0001.

C MATERIALS**C1 Metals**

C1.1 Product contact surfaces shall be of stainless steel of the American Iron and Steel Institute (AISI) 300 Series⁴ or corresponding Alloy Cast Institute (ACI)⁵ types (See Appendix, Section E4) or metal which under conditions of intended use is at least as corrosion resistant as stainless steel of the foregoing types, and is nontoxic and nonabsorbent, except that:

C1.1.1 Rotors, shafts, seals, rotor and impeller retaining devices, and housings may also be made of a metal or an alloy that is as corrosion resistant as AISI 300 Series Stainless Steel and be nontoxic and nonabsorbent under the conditions of intended use. (See Appendix, Section E5.)

C1.1.2 Product contact surfaces made of the materials provided for in C1.1 and C1.1.1 may have their surfaces modified by surface treatment or coating(s).

C1.1.3 Solder, when used, shall be silver bearing solder and shall be corrosion resistant, free of cadmium, lead and antimony, nonabsorbent, and shall not impart any toxic substance to the product when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization.

C2 Surface Modification Materials

C2.1 Surface modification materials that become a part of the parent material on product contact surfaces shall comply with the appropriate provisions of one or more of the following:

C2.1.1 FDA Regulation 21 CFR 175 Subpart C⁶, Substances for Use as Components of Coatings.

C2.1.2 FDA Regulation 21 CFR 177 Subpart B⁶, Substances for Use as Basic Components of Single and Repeated Use Food Contact Surfaces.

C2.1.3 FDA Regulation 21 CFR 177 Subpart C⁶, Substances for Use Only as Components of Articles Intended for Repeated Use.

C3 Nonmetals

C3.1 Rubber and rubber-like materials may be used for rotors, stators, liners, gaskets, O-rings, seals and parts having the same functional purposes.

C3.1.1 Rubber and rubber-like materials when used for the above specified application(s) shall conform to 3-A Sanitary Standards for Multiple-Use Rubber and Rubber-Like Materials Used as Product Contact Surfaces in Dairy Equipment, Number 18-.

C3.2 Plastic materials may be used for rotors, stators, liners, gaskets, O-rings, seals and parts having the same functional purposes.

C3.2.1 Plastic materials when used for the above specified application(s) shall conform to 3-A Sanitary Standards for Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment, Number 20-.

C3.3 Rubber and rubber-like materials and plastic materials 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 bactericidal treatment or sterilization.

C3.3.1 Materials used for O-rings, gaskets, or seals covered by D11.2.2 shall conform to Table 1.

⁴ The data for this series are contained in the *AISI Steel Products Manual, Stainless & Heat Resisting Steels*, Table 2-1. Available from the American Iron and Steel Society, 410 Commonwealth Drive, Warrendale, PA 15086 (412) 776-1535.

⁵ Steel Founders Society of America, Cast Metal Federation Building, 455 State Street, Des Plaines, IL 60016 (708) 299-9160.

⁶ For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (202) 783-3238.

Table 1: O-RING, GASKET, AND SEAL MATERIALS⁷

The following is a list of typically used materials for illustrative purposes only. It is not an exclusive list and other materials may be used as appropriate providing they meet the relevant criteria given in other parts of this document. The following materials may be used to form bacterially tight seals between product and thread areas.

Nitrile rubbers
 Ethylene (Polyethylenes) Propylenes
 Fluoro rubbers
 Silicone rubbers
 Urethane rubbers
 Natural rubbers
 PTFE (Polytetrafluoroethylene)
 ETFE (Ethylenetetrafluoroethylene)
 Polyamide
 Perfluoroelastomers

Note: Other materials that can meet the requirements of D11.2.2; and the European Hygienic Engineering and Design Group (EHEDG) test for bacterial tightness, which is an acceptable method of determining migration past the seal, or other equally effective tests; and that can meet the requirements of Section E, Enclosed Thread Seal Inspection, Maintenance, and Replacement and Enclosed Area Cleaning Methods, are also acceptable.

- C3.4 The final bond and residual adhesive, if used, on bonded ceramic, on bonded rubber and rubber-like materials, and on bonded plastic materials shall be nontoxic.⁸
- C3.5 Where materials having certain inherent functional purposes are required for specific applications, such as seals, carbon, and/or ceramic materials may be used. Carbon and/or ceramic materials shall be inert, nonporous, nontoxic, nonabsorbent, insoluble, resistant to scratching, scoring, and distortion when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization. These

⁷ EHEDG Doc 17. Hygienic Design of Pumps, Homogenizers and Dampening Devices (2004).

⁸ Adhesives shall comply with 21 CFR 175 - Indirect Food Additives: Adhesives and Components of Coatings. Document for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (202) 783-3238.

materials must meet the requirements of C2 or be generally recognized as safe (GRAS) by the FDA.

C4 **Heat-Resistant Materials**

- C4.1 In a processing system to be sterilized by heat and operated at a temperature of 250°F (121°C) or higher, all materials having product contact surface(s) used in the construction of centrifugal and positive rotary pump(s) and nonmetallic component parts shall be such that they can be (1) sterilized by saturated steam or water under pressure (at least 15.3 psig or 106 kPa) at a temperature of at least 250°F (121°C), and (2) operated at the temperature required for processing.

C5 **Nonproduct Contact Surfaces**

- C5.1 All nonproduct contact surfaces shall be of corrosion-resistant material or material that is rendered corrosion resistant. If coated, the coating used shall adhere. All nonproduct contact surfaces shall be relatively nonabsorbent, durable, and cleanable. Parts removable for cleaning having both product contact and nonproduct contact surfaces shall not be painted.

D **FABRICATION**

D1 **Surface Finish**

- D1.1 All product contact surfaces shall have a finish at least as smooth as a No. 4 ground finish on stainless steel sheets and be free of imperfections such as pits, folds and crevices in the final fabricated form. (See Appendix, Section E6.)

D2 **Permanent Joints**

- D2.1 All permanent joints in metallic product contact surfaces shall be continuously welded. Welded areas on product contact surfaces shall be at least as smooth as a No. 4 ground finish on stainless steel sheets, and be free of imperfections such as pits, folds, and crevices when in the final fabricated form except that:

- D2.1.1 In such cases where welding is impractical, soldering, press-fitting or shrink-fitting may be employed where necessary for essential functional reasons such as bushings, internal bearings, pins and mechanical seal components. (See Appendix, Section E7.)

- D2.1.2 Silver bearing solder may be used around pins for sealing joints and producing fillets for minimum radii.
- D2.1.3 Press-fitting, shrink-fitting or soldering shall produce product contact surfaces which are at least as smooth as a No. 4 ground finish on stainless steel sheets which are free of imperfections such as pits, folds and crevices. (See Appendix, Section E6.)
- D3 Coatings**
- D3.1 Coatings, if used, shall be free from surface delamination, pitting, flaking, spalling, blistering and distortion when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization.
- D3.2 The minimum thickness of electrodeposited coatings shall not be less than 0.0002 in. (0.005 mm) for all product contact surfaces when used on stainless steel or other corrosion resistant alloy. (See C1.1 and C1.1.1).
- D3.3 Ceramic materials used as coatings shall be at least 0.003 in. (0.08 mm) thick.
- D3.4 Plastic materials, when used as a coating, shall be at least 0.005 in. (0.125 mm) thick.
- D4 Cleaning**
- D4.1 Centrifugal and positive rotary pumps that are to be mechanically cleaned shall be designed so that the product contact surfaces of the pump and all nonremoved appurtenances thereto can be mechanically cleaned and are easily accessible and readily removable for inspection.
- D4.2 Product contact surfaces not designed to be mechanically cleaned shall be easily accessible for cleaning and inspection when in an assembled position or when removed. Demountable parts shall be readily removable.
- D5 Draining**
- D5.1 All product contact surfaces shall be drainable when disassembled.
- D6 Fittings**
- D6.1 All sanitary fittings and connections shall conform to the 3-A Sanitary Standards for Sanitary Fittings for Milk and Milk Products, Number 63-.
- D6.2 Rectangular flanges or round flange-type fittings may be used for specific applications such as connectors to hoppers or feeders.
- D7 Seals**
- D7.1 The shaft seal(s) shall be sanitary in design with all product contact parts demountable and accessible for inspection or cleaning, and shall not be of the packing type.
- D8 Gaskets**
- D8.1 Gaskets having a product contact surface shall be removable or bonded.
- D8.2 Grooves in gaskets shall be no deeper than their width.
- D8.3 Gasket retaining grooves in product contact surfaces for removable gaskets shall not exceed 1/4 in. (6.35 mm) in depth or be less than 1/4 in. (6.35 mm) wide except those for standard O-rings smaller than 1/4 in. (6.35 mm), and those provided for in Section D6.1.
- D8.4 Gaskets, when used, shall be self positioning and form a substantially flush interior joint.
- D9 Radii**
- D9.1 All internal angles of less than 135° on product contact surfaces shall have radii of not less than 1/8 in. (3.18 mm) except that:
- D9.1.1 Smaller radii may be used when they are required for essential functional reasons, such as those in seal components; slots in the heads of impeller or rotor retaining fasteners; and rotor-to-body clearance areas. In no case shall such radii be less than 1/32 in. (0.794 mm) except that:
- D9.1.1.1 The radius at the intersection of press-fits, shrink-fits and flat sealing surfaces is zero by nature of the design and definition of this type of fabrication.

- D9.1.2 The radii in grooves in gaskets or gasket retaining grooves shall be not less than 1/16 in. (1.59 mm), except for those for standard 1/4 in. (6.35 mm) and smaller O-rings and those provided for in Section D6.1.
- D9.1.3 Radii in standard O-ring grooves shall be as specified in Appendix E9.
- D9.1.4 Radii in nonstandard O-ring grooves shall be those radii closest to a standard O-ring as specified in Appendix E9.
- D10 **Springs**
Coil springs having product contact surfaces shall have at least 3/32 in. (2 mm) openings between coils including the ends when it is in a free position.
- D11 **Threads**
- D11.1 There shall be no threads on product contact surfaces except for holding the impeller or rotor to the shaft.
- D11.2 Shaft threads must conform to one of the following thread specifications:
- D11.2.1 **Exposed Threads**
1. Pumps with exposed shaft threads shall be designed for manual cleaning.
 2. Threads shall conform to Appendix E8.1.
 3. Threaded angles shall be not less than 60°.
 4. There shall not be more than 8 threads per in. (25. mm).
 5. The nut shall be of the open type.
 6. The length of the nut shall not exceed three-fourths of the thread's basic diameter.
- D11.2.2 **Enclosed Threads**
- D11.2.2.1 Pumps with enclosed shaft threads shall be designed for mechanical cleaning.
- D11.2.2.2 These are threads that have been sealed from the product by means of an O-ring, gasket or similar type seal. The seal shall have controlled compression by means of a positive stop.
- D11.2.2.2.1 This controlled compression shall provide a seal which has been validated to demonstrate that there is no migration past the seal under the intended conditions of use.
- D11.2.2.2.1.1 The European Hygienic Engineering and Design Group (EHEDG) test for bacterial tightness is an acceptable method of determining migration past the seal. Other equally effective tests may be used as well.
- D11.2.2.2.1.2 The manufacturer will provide seal replacement procedures that will ensure bacterial tightness as specified in D11.2.2.2.1.1, above.
- D11.2.2.3 Thread specifications are designated by the manufacturer.
- D11.2.2.4 Bolts, screws or nuts may be used for rotor or impeller retention.
- D11.2.2.4.1 If a nut is used, it shall be of the enclosed type.
- D11.2.2.4.2 If slotted fasteners are used, the slot(s) shall meet the criteria of Section D9, Radii, and the slot(s) shall be not less than 1/8 in. wide and no deeper than 2-½ times their width and shall be inspectable.
- D11.2.2.4.3 The seal shall be designed so it is capable of being maintained bacterially tight. The manufacturer will provide user guidance for inspection, maintenance, and replacement of the seal as justified by historical data or scientific evidence.
- D11.2.2.5 Enclosed threads shall be cleanable and drainable. The manufacturer will also provide validated cleaning procedures, should the area behind the seal become soiled.
- D12 **Bonded Parts**
- D12.1 Pump impellers, rotors, stators or housings may be made of, covered with or bonded with rubber, rubber-like or plastic materials.
- D12.2 Housing liners shall be removable or bonded.
- D12.3 Bonded rubber and rubber-like materials and bonded plastic materials having product contact surfaces shall be bonded in a manner that the bond is continuous and mechanically sound so that when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment or sterilization the rubber and

rubber-like material or the plastic material does not separate from the base material to which it is bonded.

D12.4 Components within seal assemblies may be bonded with adhesives.

D13 Sterilization Systems

D13.1 Pumps designed to be used in a processing system to be sterilized by heat shall comply with the following:

D13.1.1 All product contact surfaces shall be in conformance to Section C4.

D13.1.2 Pumps to be used in a processing system not designed so that the system automatically is shut down if the product pressure in the system becomes less than that of the atmosphere and cannot be started until the system is re-sterilized shall have a steam or other sterilizing medium chamber surrounding (1) the shaft(s), (2) the portion of the inlet and outlet connection adjacent to the product, and (3) the pump cover.

D13.1.3 Where steam or other sterilizing medium is used, the connection(s) on the pump(s) shall be such that the steam lines or other sterilizing medium lines can be securely fastened to the pump(s). The pump(s) shall be constructed so that the steam or other sterilizing medium chamber may be exposed for inspection.

D14 Inspectibility

D14.1 A pump shall be designed that (See Appendix, Section E10):

D14.1.1 The open area between the exterior of the driver or gear case housing to the exterior of the product chamber shall be 1/2 in. (12 mm) minimum width and of sufficient area to allow unrestricted viewing of the pump shaft(s) or seal components at the potential leak site. This area shall be self-draining.

D14.1.2 At least 1/4 in. (6mm) of the shaft(s) exclusive of the seal components shall be visible.

D14.1.3 Guards required by a safety standard that will not permit accessibility for cleaning and inspection shall be designed so that they can be removed with the use of simple hand tools.

D15 Nonproduct Contact Surfaces

D15.1 Nonproduct contact surfaces shall have relatively smooth finishes, and be relatively free of pockets and crevices, and be readily cleanable and those surfaces to be coated shall be effectively prepared for coating.

D16 Supports

D16.1 Baseplate Mounted

D16.1.1 A baseplate mounted unit consists of some or all of the following components:

1. Pump
2. Motor
3. Mechanical reduction unit such as a gearbox, gearhead drive, variable speed drive, chain and sprocket system or belt and pulley system.
4. Pedestal
5. Coupling
6. Guard
7. Baseplate
8. Legs

D16.1.2 The baseplate(s) shall be constructed of (a) solid metal plate(s) or (b) tubular metal that has all open ends sealed by welding.

D16.1.3 The metal shall be stainless steel or coated or painted mild steel.

D16.2 Legs

D16.2.1 Legs, when used, shall be adjustable or fixed with rounded ends or have flat load bearing feet suitable for mounting to the floor and have no exposed threads.

D16.2.2 Legs made of hollow stock shall be sealed.

D16.2.3 Legs shall be of sufficient length to provide a minimum clearance between the lowest part of the base, pump, motor or drive and floor no less than 4 in. (100 mm) on pumps with legs designed to be fixed to the floor or pumps having a horizontal base area of more than 1 ft² (0.095 m²).

D16.2.4 Legs shall be of sufficient length to provide a minimum clearance of 2 in. (50 mm) on pumps having a horizontal base area of 1 ft² (0.095 m²) or less and not designed to be fixed to the floor.

D16.2.5 If casters or wheels are used they shall be of sufficient size to provide a clearance between the lowest part of the base and the floor of not less than 4 in. (101.6 mm). Casters or wheels, if provided, shall be easily cleanable, durable, and of a size that will permit easy movement of the centrifugal or positive rotary pump.

APPENDIX

E **ENCLOSED THREAD SEAL INSPECTION, MAINTENANCE, AND REPLACEMENT AND ENCLOSED AREA CLEANING METHODS**

E1 **User Guidance**

The manufacturer will provide user guidance for inspection, maintenance, and replacement of the seal as justified by historical data or scientific evidence.

E2 **Seal Replacement Procedures**

The manufacturer will provide seal replacement procedures that will ensure bacterial tightness. The European Hygienic Engineering and Design Group (EHEDG) test for bacterial tightness is an acceptable method of determining migration past the seal. Other equally effective tests may be used as well.

E3 **Validated Cleaning Procedures**

The manufacturer will also provide validated cleaning procedures, should the area behind the seal become soiled.

E4 **Stainless Steel Materials**

Stainless steel conforming to the applicable composition ranges established by AISI for wrought products or by ACI (Steel Founders Society of America) for cast products should be considered in conformance to the requirements of Section C1.1 herein. Where welding is involved, the carbon content of the stainless steel should not exceed 0.08%. The first reference cited in C1.1 sets forth the chemical ranges and limits of acceptable stainless steels of the 300 series. Cast grades of stainless steel corresponding to type 303, 304, 316 and 316L are designated CF-16F, CF-8, CF-8M and CF-3M respectively. The chemical compositions of these cast grades are covered by ASTM specifications⁹ A351/A351M, A743/A743M and A744/A744M.

⁹ Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Phone: (610) 832-9500.

E5 TABLE 2: OPTIONAL METAL ALLOY

E5.1 The following alloys or metals have been shown to be as corrosion resistant as the 300 Series Stainless Steel:

	UNS N08367	UNS S21800	UNS S20161	UNS N26055	UNS N26455	UNS S17400	UNS S15500	UNS S32900	UNS R20500	UNS R50400
	ASTM A743 Grade	ASTM A743 Grade		ASTM A494 Grade	ASTM A494 Grade	ASTM A747 Grade	ASTM A747 Grade		ASTM A560 Grade	ASTM B67 Grade
	CN- 3MN	CF-10 SMnN		CY5SnBiM	CW-2M	CB7Cu-1	CB7Cu-2		50Cr-50Ni	C-2
C	0.03	0.10	0.15	0.05	0.02	0.07	0.07	0.20	0.10	0.10
Mn	2.00	7.00-9.00	4.00-6.00	1.5	1.00	0.70	0.70	1.00	0.30	
Si	1.00	3.50-4.50	3.00-4.00	0.5	0.80	1.00	1.00	0.75	1.00	
P	0.040	0.040	0.040	0.03	0.03	0.035	0.035	0.040	0.02	
S	0.010	0.030	0.040	0.03	0.03	0.03	0.03	0.030	0.02	
Cr	20.0- 22.0	16.00-18.00	15.0-18.0	11.0-14.0	15.0-17.5	15.50-17.7	14.0-15.50	23.0-28.0	48.0-52.0	
Ni	23.5- 25.5	8.00-9.00	4.00-6.00	Balance	Balance	3.60-4.60	4.50-5.50	2.50-5.00	Balance	
Mo	6.0-7.0			2.0-3.5	15.0-17.5			1.00-2.00		
Cb						0.15-0.35	0.15-0.35			
Cu	0.75					2.50-3.20	2.50-3.20			
N	0.18- 0.26	0.08-0.18	0.08-0.20			0.05	0.05		0.30	
Fe	Balance	Balance	Balance	2.00	2.00	Balance	Balance	Balance	1.00	0.30
Sn				3.0-5.0						
Bi				3.0-5.0						
W					1.0					
Ti									0.50	Balance
Al									0.25	
other										H = 0.015 N = 0.03 O = 0.25

* Percentage is maximum unless range is given.

E5.1.1 Metals other than the above may be as corrosion resistant as the 300 Series Stainless Steel. This may be shown when metals are tested in accordance with ASTM G31 - "Laboratory Immersion Corrosion Testing of Metals" and have a corrosion rate of less than 10 mil (250 μm) per year. The test parameters, such as the type of chemical(s) and their concentration(s) and temperature(s) should be representative of product cleaning and sanitizing conditions used in dairy equipment. Alloys containing lead or leachable copper should not be used.

E6 **Product Contact Surface Finishes**

Surface finish equivalent to 150 grit or better as obtained with silicon carbide, properly applied on stainless steel sheets, is considered in conformance to the requirements of Section D1.1 herein. A maximum R_a of 32 $\mu\text{in.}$ (0.80 μm), when measured according to the recommendations in American National Standards Institute (ANSI) and American Society of Mechanical Engineers (ASME) B46.1 - *Surface Texture Waviness and Lay*, is considered to be equivalent to a No. 4 finish.¹⁰

¹⁰ Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017-2392 (212) 705-7722.

E7

Press and Shrink Fits

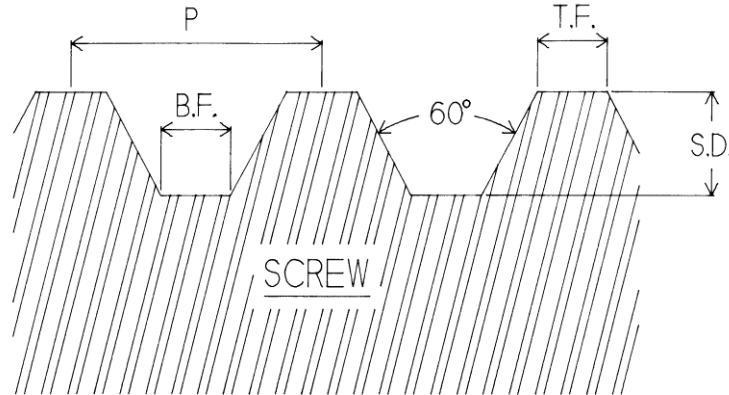
Press-fits or shrink-fits may be used to produce crevice free permanent joints in metallic product contact surfaces when neither welding nor soldering is practical. Joints of these types may only be used to assemble parts having circular cross sections, free of shoulders or relieved areas. For example: they may be used to assemble round pins or round bushings into round holes.

In both types of fits, the outside diameter of the part being inserted is greater than the inside diameter of the hole. In the case of the press-fit the parts are forced together by applying pressure. The pressure required is dependent upon the diameter of the parts, the amount of interference and the distance the inner member is forced in.

In shrink-fits, the diameter of the inner member is reduced by chilling it to a low temperature. Dry ice is commonly used to shrink the inner member. Heat may also be applied to the outer member of the press-fit. Less assembly force is required for this type of fit. The design of these fits depends on a variety of factors. The designer should follow recommended practices to assure that a crevice-free joint is produced. A recognized authoritative reference is *Machinery's Handbook*, published by Industrial Press Inc., 200 Madison Ave., New York, NY 10157.

E8 **Threads**

E8.1 **American Standard Stub Acme Thread**



P = PITCH	$P = 1/T.P.I.$
S.D. = SINGLE DEPTH	$S.D = 0.433 \times P$
T.F. = TOP FLAT	$T.F. = 0.250 \times P$
B.F. = BOTTOM FLAT	$B.F. = 0.227 \times P$
T.P.I. = THREADS PER INCH	

E9 **O-Ring Groove Radii**

TABLE 3 - Groove Radii Dimensions for Standard O-Rings

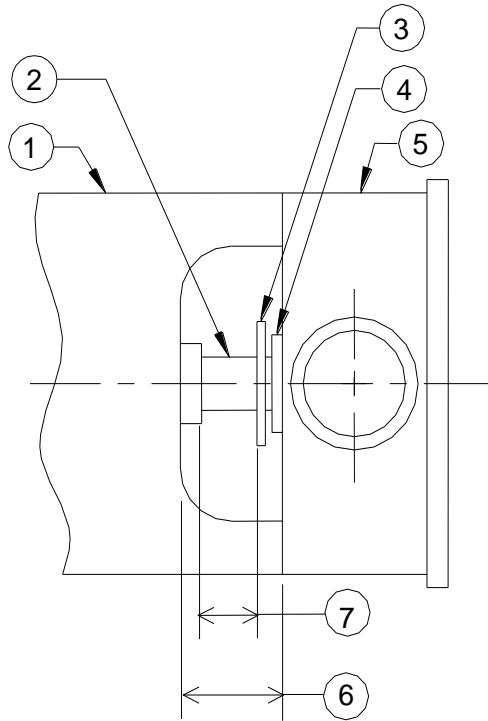
O-Ring Cross Section, Nominal (AS 568 ¹¹)	O-Ring Cross Section, Actual (AS 568)	O-Ring Cross Section, Actual (ISO 3601-1 ¹²)	Minimum Groove Radius
1/16 in.	0.070 in.	1.80 mm	0.016 in. (0.406 mm)
3/32 in.	0.103 in.	2.65 mm	0.031 in. (0.787 mm)
1/8 in.	0.139 in.	3.55 mm	0.031 in. (0.787 mm)
3/16 in.	0.210 in.	5.30 mm	0.062 in. (1.575 mm)
1/4 in.	0.275 in.	7.00 mm	0.094 in. (2.388 mm)

¹¹ The document establishing these standard dimensions is Aerospace Standard (AS) 568, published by SAE, 400 Commonwealth Drive, Warrendale, PA 15086 (412-776-4970).

¹² The document establishing these standard dimensions is ISO 3601-1: 1988 (E), published by the International Organization for Standardization (ISO), 1 Rue de Varembe, Case Postale 58, CH 1 1211, Geneva, Switzerland (41-22-734-1240).

E10 Diagrams

This diagram is intended to demonstrate general principles only, and is not intended to limit individual ingenuity. The design used should conform to the sanitary requirements set forth in these 3-A Sanitary Standards.



1. DRIVER OR GEARCASE HOUSING
2. DRIVE SHAFT
3. SLINGER (OPTIONAL)
4. SANITARY SEAL
5. PUMP BODY
6. 1/2" MINIMUM
7. 1/4" MINIMUM