Designation: F 703 – 96 (Reapproved 2002)

Standard Specification for Implantable Breast Prostheses [1]

This standard is issued under the fixed designation F 703; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the requirements for silicone gel-filled, saline inflatable silicone gel–filled, and saline inflatable, smooth-shell implantable breast prostheses intended for use in surgical reconstruction, augmentation, or replacement of the breast.

1.2 *Limitations*—This specification does not cover custom fabricated implantable breast prostheses.

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

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Rubber and Thermoplastic Elastomers—Tension[2]

D 1349 Practice for Rubber—Standard Temperatures for Testing[2]

F 604 Specification for Silicone Elastomers Used in Medical Applications[3]

F 748 Practice for Selecting Generic Biological Test Methods for Materials and Devices[4]

F 1251 Terminology Relating to Polymeric Biomaterials in Medical and Surgical Devices[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *barrier coat*—a silicone elastomer layer as a part of the shell of a silicone gel implantable breast prostheses that retards silicone bleed.

3.1.2 *fixation site*—an area of the shell of an implantable breast prosthesis containing material that allows tissue ingrowth.

3.1.3 *fused or adhered joints (seams)*—sites in the shell or other parts of an implantable breast prosthesis where materials have been joined (fused or bonded) together, with or without an adhesive, as part of the manufacturing process.

3.1.4 *gel bleed*—diffusion of liquid silicone components of silicone gel through the shell of an implantable breast prosthesis.

3.1.5 *gel filled breast prosthesis*—implantable breast prosthesis designed and provided with a pre-filled, fixed volume of silicone gel.

3.1.5.1 *Type I*—a fixed volume gel filled breast prosthesis—implantable breast prosthesis comprised of a single lumen containing a fixed amount of silicone gel. The lumen of Type I breast prostheses is not accessible for volume adjustments of any kind.

3.1.5.2 *Type II*—double lumen inflatable gel filled breast prosthesis—an implantable breast prosthesis comprised of two complete lumens, one inside the other. The inner lumen contains a fixed amount of silicone gel and is not accessible for volume adjustments of any kind. The outer lumen is provided with a valve to facilitate filling the void between the inner and outer lumens with saline to adjust the total volume of the prosthesis, only at the time of use.

3.1.5.3 *Type III*—reverse double lumen inflatable gel filled breast prosthesis—an implantable breast prosthesis comprised of two complete lumens, one inside the other. The volume between the inner and outer lumens contains a fixed amount of silicone gel and is not accessible for volume adjustments of any kind. The inner lumen is contained within the silicone gel contained in the outer lumen and has a valve system to facilitate filling the inner lumen with saline to increase the volume of the prosthesis at the time of use. The valve system is also designed to facilitate post-operative volume adjustment by following the instructions provided in product literature.

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[2] *Annual Book of ASTM Standards*, Vol 09.01.

[3] Discontinued; See 2000 *Annual Book of ASTM Standards*, Vol 13.01.

[4] *Annual Book of ASTM Standards*, Vol 13.01.

3.1.6 *inflatable breast prosthesis*—implantable breast prostheses not containing silicone gel—implantable breast prostheses designed and provided empty and to be filled, all or in part, with saline at the time of use to adjust the volume of the prosthesis.

3.1.6.1 *Type 1—fixed volume inflatable breast prosthesis*, an implantable breast prosthesis comprised of a single lumen, empty when supplied and having a valve to facilitate filling the lumen with the entire volume of saline at the time of use.

3.1.6.2 *Type II—adjustable inflatable breast prosthesis*, an implantable breast prosthesis comprised of a single lumen, empty when supplied and having a valve to facilitate filling the lumen with a system is designed to facilitate further postoperative adjustment with saline as instructed in product literature.

3.1.7 *low bleed*—silicone gel implantable breast prostheses designed to have minimal silicone bleed when tested by the method in 9.1.1.

3.1.8 *lumen*—a cavity within a shell of an implantable breast prosthesis. A lumen may contain either a fixed, nonadjustable volume of silicone gel, or it may be entirely or partly empty and intended to be inflated (filled) with saline. Inflatable lumens are accessible by valve to facilitate the addition of saline to adjust the volume of the prosthesis at the time of use. More than one lumen may be formed within a shell by silicone elastomer membrane partitions.

3.1.9 *orientation means*—any mark or palpable portion of an implantable breast prosthesis to assist the surgeon in positioning the implant.

3.1.10 *saline*—only sodium chloride injection USP is recommended for filling lumens of implantable breast prosthesis.

3.1.11 *shell*—a silicone elastomer continuous layer or membrane container (sac) that encloses a lumen or multiple lumens of an implantable breast prosthesis.

3.1.12 *silicone elastomer*—an elastomer containing crosslinked silicone polymer and fumed amorphous (noncrystalline) silica as a reinforcing filler.

3.1.13 *silicone gel*—a semisolid material consisting of a crosslinked silicone polymer network in which liquid silicone polymer is held (see definition of *gel* in Terminology F 1251).

3.1.14 *valve*—user sealable or self sealing opening in an inflatable or gel saline prosthesis, extending from the exterior surface of the shell into a lumen, designed to facilitate addition of saline at the time of use to fill the prosthesis and increase prosthesis volume.

4. Materials and Manufacture

4.1 *Silicone elastomer*—Select and specify elastomers for use in implantable breast prostheses in keeping with Specification F 604.

4.1.1 *Shell*—The following describes suitable silicone elastomer compositions for use as the primary material of construction of the shell including the exterior (tissue contact) surface:

Polymer types	MQ or VMQ
Fillers	A, B or C
Additive	J (for radiopacity)
Catalysts	B, G, J, or K

4.1.2 *Barrier Coatings*—The following are suitable compositions of for use in barrier coat elastomers:

Polymer composition	FVMQ or VMP_2 M_2 Q
Fillers	B or C
Catalyst/cure	J or K

NOTE 1—The compositions listed in this section are not intended to limit the composition that may be used providing all other requirements of this specification are satisfied.

4.1.3 *Fabrication*—Fabrication techniques must necessarily be varied depending on the type of elastomer, the portion of an implantable breast prosthesis fabricated, its shape and its location and function on the prosthesis.

4.1.4 *Vulcanization and Postcure*—Time and temperature of vulcanization and postcure must be adjusted with consideration of the elastomer type and the multi-step fabrication requirements of specific prostheses. Final postcure is typically done only after the shell or shells and all other portions have been completely assembled. Time and temperature of final postcure shall be adequate to drive the chemistry of vulcanization of all elastomers to completion and remove by-products of the cure in keeping with the chemical stoichiometry of the specific cure systems (for example, after postcure no additional vulcanization should occur when heated additionally at recommended cure temperature).

4.1.5 *Physical Property Testing and Requirements*—Silicone elastomer shells shall demonstrate an acceptable response in physical property tests. Prostheses for testing should be selected from standard production batches which have gone through all manufacturing processes, including sterilization. With silicone gel prostheses, remove gel and clean shell with appropriate polar (for example, 2-propanol) or non-polar (aliphatic, aromatic, or chlorinated hydrocarbon) solvent, or both. If solvent cleaned, condition shell afterwards for 3 h 150°F (65.6°C) in an air circulation oven to remove solvent.

4.1.5.1 *Specimen Preparation*—Cut required tensile test specimens from shells with Test Methods D 412 dies. Specimens shall be conditioned before testing for at least 3 h at 23 ± 2°C (73.4 ± 3.6°F).

4.1.6 *Test Procedure*— Unless otherwise specified, the standard temperature for testing shall be 23 ± 2°C (73.4 ± 3.6°F). When testing at any other temperature is required, use one of the temperatures specified in Practice D 1349. Requirements are as follows:

4.1.6.1 *Percent Elongation*—Percent elongation shall be 350 % minimum when tested in accordance with Test Methods D 412.

4.1.6.2 *Breaking Strength*—Ultimate breaking force in tension shall be no less than 11.12 N (2.5 lbs) when tested in accordance with Test Methods D 412.

4.1.6.3 *Tensile Set*— Determine tensile set at 300 % elongation, stress the specimen for 3 min then allow 3 min for relaxation. The tensile set shall be <10 %, determined in accordance with Test Methods D 412.

4.1.6.4 *Critical Fused or Adhered Joints*—Joints or seams that are critical to the integrity of the prosthesis envelope shall not fail when the shell adjacent to the joint is stressed to 200 % elongation for 10 s (see Fig. 1).

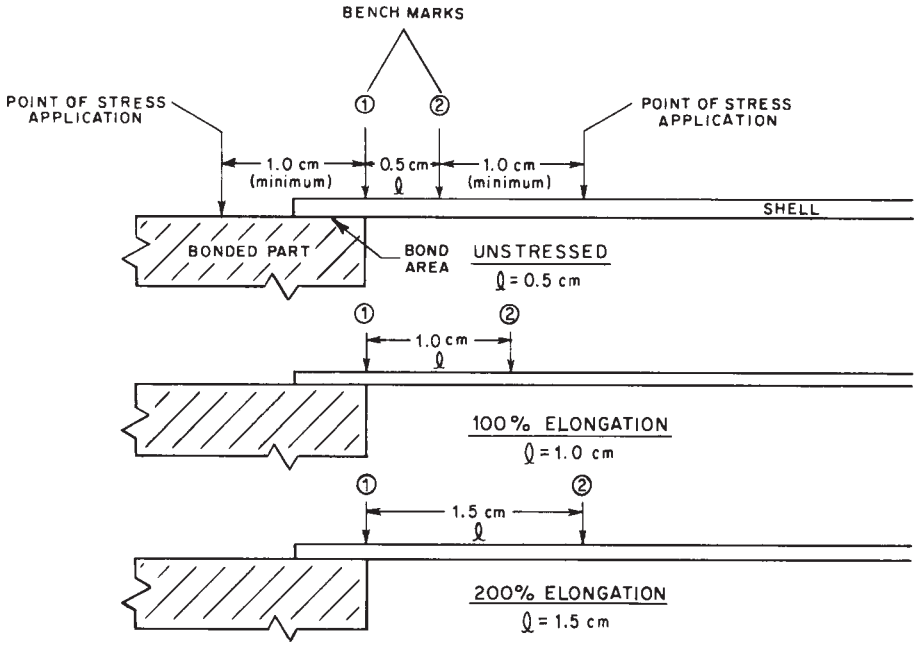

FIG. 1 Testing Fused or Adhered Joints

4.1.6.5 *Non-Critical Fused or Adhered Joints*—Fused joints or seams that are bonded to the prosthesis envelope but are not critical to the envelope integrity (fixation sites, orientation means, valve covers etc.) shall not fail when the shell adjacent to the joint is stressed to 100 % elongation for 10 s (see Fig. 1).

4.1.7 *Shell Rupture/Failure Testing*—No standard test for assessing shell rupture/failure has yet been developed. When such test method has been developed it will be added to this specification.

4.1.8 *Shell Leakage Testing*—Fill a 5 to 8 qt stainless steel bowl with 70 % isopropyl alcohol. Submerge patched shell in bowl and gently apply pressure to the shell assembly. Visually inspect for any bubbles. Reposition shell in hand until entire surface of shell has been tested while exposed. Reject shells whenever any bubbles are seen.

4.2 *Silicone Gel*—Select and specify ingredients in keeping with Specification F 604.

4.2.1 *Polymers and Catalysts*—The following are suitable for use in silicone gel:

Polymers	MQ and VMQ blend
Filler	A (no filler or additive)
Catalyst/cure	J or K

4.2.2 *Fabrication, Vulcanization and Postcure*:

4.2.2.1 *Fabrication and Curing*—Unvulcanized liquid gel is typically placed in the lumen of a shell and cured and postcured in situ while the shell is maintained in its desired final shape. Fabrication techniques must necessarily be varied to satisfy the requirements of the specific implant type and shape.

4.2.2.2 *Vulcanization and Postcure*—The time and temperature of vulcanization and postcure shall be adequate to drive the vulcanization chemistry of the gel to completion in keeping with the chemical stoichiometry of specific silicone gels. When postcure is adequate silicone gel does not undergo further vulcanization with additional heating at cure temperature.

4.2.3 *Testing and Requirements*:

4.2.3.1 *Specimens*—Remove test samples of gel from finished production batches of silicone gel—containing implantable breast prostheses after all manufacturing, including sterilization has been completed.

4.2.3.2 *Weight Loss From Heating*—When a 2 to 3 g sample is spread in an aluminum weighing cup and heated in an air circulating oven for 4 h at approximately 150°C the weight loss shall not exceed 1 %.

4.2.4 *Gel Cohesion*:

4.2.4.1 *Cone/Pendant Gel Test Method Described in Appendix X1*—This test is particularly useful to manufacturers for use in silicone gel development and quality control and quality control of unused silicone gel breast implants in that it provides quantitative results. The cohesive properties of silicone gel shall be considered suitable for use in silicone gel breast prostheses in the length of the pendant gel remains <4.5 cm when tested in accordance of the method in Appendix X1.

NOTE 2—The test results from cone/pendant gel testing are highly dependent on strict adherence to the specifications for the test apparatus and the procedures described in Appendix X1. A similar method contained in the 1986 edition and earlier editions of this specification was reported by most who used it to give highly variable and erratic results resulting in modifications of the test method as contained in Appendix X1. Precision and bias data for this method has not been established.

4.2.4.2 *Hypodermic Syringe/Pendant Gel Test Method*—A pass/fail test methods that can be used as an alternative to the cone/pendant gel test of 4.2.4.1. This test method may be applied by surgeon users, manufacturers, and others for evaluating the cohesive properties of silicone gel in breast prostheses including the gel from used, explanted devices.

4.2.5 *Test Fixture*— 60 cm^3 plastic hypodermic syringe with barrel having inside diameter of 26 to 28 mm. Prepare for use by sharply cutting off the tapered end circumferentially flush with the 0 cm^3 line leaving an unobstructed open barrel.

4.2.6 *Test Sample*—Cut the shell of the prosthesis to be tested diametrally across the apex from edge to edge. Push the plunger of the syringe forward until it is flush with the cut end of the barrel. Insert the plunger end of the syringe well into the gel on one side of the prosthesis and slowly draw the gel into syringe until the plunger is flush with the 60 cm^3 line. Care must be exercised to avoid drawing in either air or the shell. After one minute cut the gel sharply across the cut end of the syringe with scissors and remove syringe with test sample. Discard any samples where air was drawn in or if the shell interrupted obtaining the sample. With care, two gel samples may be obtained from most prosthesis.

4.2.7 *Testing*—Suspend the syringe in a vertical position with the open end down and at least 25 cm above a flat surface. Slowly move the plunger from the 60 cm^3 line to the 40 cm^3 line to extrude an unsupported 20 cm^3 gel mass and commence timing.

4.2.8 *Requirements*—The gel is considered to have passed this test if, after 30 min, all of the gel remains attached as a mass at the end of the open syringe barrel no liquid drops are visible. The test should be repeated if the whole mass falls from the syringe.

NOTE 3—The precision and bias of the syringe/pendant gel test method has not been established.

NOTE 4—Correlation between the cone/pendant gel and syringe tests has not been established.

5. Volume and Dimensions

5.1 *Volumes of Prostheses*:

5.1.1 *Silicone Gel and Gel-Saline Prostheses*—Volumes of silicone gel-containing prostheses are typically controlled by weight, 1 g = approximately 1 cm^3. Weight tolerances of silicone gel-containing prostheses with volume ≥250 cm^3 shall be ±5 g, and when prostheses volume <250 cm^3 weight tolerance shall be ±2 % of labeled volume in equivalent grams.

5.1.2 *Saline Inflatable and Gel-Saline Prostheses*—The design or maximum recommended volume of saline fill shall be listed in instructions for use.

5.2 *Dimensions*—The ranges of shapes, volumes, base sizes, and anterior projections are determined by the manufacturer. Pertinent information shall be contained in the package insert.

6. Significance and Use

6.1 This specification contains requirements based on state-of-the-art science and technology as applicable to various considerations that have been identified as important to ensure reasonable safety and efficacy in implantable breast prostheses.

6.1.1 This specification is not intended to limit the science and technology which may be considered and applied to ensure performance characteristics of subject breast prostheses in intended applications. When new information becomes available or changes in state-of-the-art science and technology occur and relevance to subject prostheses has been established by valid science, it is intended that this specification will be revised in keeping with this new information or advances in state-of-the-art science.

7. Fixation Sites

7.1 The presence of fixation sites on any type of implantable breast prosthesis is optional. When used, the size and locations of fixation sites shall be clearly stated in instructions for use.

8. Orientation Means

8.1 Orientation means are optional features of subject prostheses. When orientation means are claimed, the location and recommended techniques for use shall be clearly described in instructions for use.

9. Gel Bleed

9.1 *Test Method*—See Annex A2.

9.1.1 *Requirements*—The allowable quantities of gel bleed in this testing have not been established.

10. Biocompatibility

10.1 *Practice F 748*—Biocompatibility assays of materials with no or limited history of prior biocompatibility testing and successful clinical use for implant applications shall follow guidelines of Practice F 748. Assays recommended by Practice F 748 include Cell Culture Cytotoxicity Assays, Short-Term Intramuscular Implantation Assay, Short-Term Subcutaneous Assay, Carcinogenicity, Long-Term Implant Test, Systemic Injection (Acute Toxicity) Assay, Sensitization Assay, Mutagenicity, and Pyrogenicity.

10.1.1 *Silicone Gel Prostheses*—Test specimens for chronic implantation assays (carcinogenicity and long term implant tests) shall be fabricated from the same combination of silicone elastomer and gel and by the same or similar procedures and conditions used in fabricating prostheses. The thickness of shell in specimens shall be typical of thickness used in prostheses.

NOTE 5—To minimize palpability of prostheses and to effectively mimic the softness of breast tissue, silicone gels used in implantable breast prostheses must be soft (have low modulus). State-of-the-art silicone gels with required low modulus are also low strength. When implanted long term without an enclosing silicone elastomer shell, silicone gel may not retain its physical shape and integrity. Clinical implantation of free silicone gel sans shell is neither intended nor recommended. If shell rupture occurs in an implanted silicone gel breast prostheses resulting in direct contact between silicone gel and tissue, revision surgery for removal of ruptured prostheses and any free gel is recommended, with or without prosthetic replacement. To help assure relevancy of long term biocompatibility assays in animals to recommended clinical use of silicone gel implantable breast prostheses, the specimens used in chronic biocompatibility assays shall have silicone gel contained in an enclosing silicone elastomer shell, similar to silicone gel prostheses. Specimens of free silicone gel may be used in all other biocompatibility assays as specified in Practice F 748 for implants used in tissue and tissue fluid contact applications, including short term intramuscular implantation assay.

10.1.2 *Prior Biocompatibility Assays*—When prior biocompatibility data are available for silicone elastomers and gels that may also have histories of use in clinical use in breast implants, even if not done by the exact protocols described in more recently developed biocompatibility test method standards, such data may satisfy all or part of the specific biocompatibility requirements of Practice F 748.

11. Valve Competence

11.1 *Test Method*—Prior to testing manipulate valve to duplicate its use for filling an inflatable prosthesis with saline as described in instructions for use. Test such manipulated valve at both high and low retrograde pressures. Use air, distilled water or isotonic saline as test media. Pressures, in the order to be tested, are 30 cm and 30 cm H_2O pressure resp. Maintain each test pressure for 5 min. When air is test media immerse valve opening in water to check for leakage (bubbles). With water or isotonic saline check for droplets at the valve opening.

11.2 *Test Requirements*—No observable or detectable leakage.

12. Sterilization

12.1 Implantable breast prostheses may be supplied presterilized in accordance with current AMI AND PDA procedures and good manufacturing practices (GMP) established by FDA.[5]

12.2 If user sterilization or re-sterilization of prostheses are intended, validated instructions for cleaning and sterilization shall be supplied with the package insert.

13. Packaging, Labelling, and Package Inserts

13.1 *Packaging*—Prostheses shall be packaged to protect against damage and maintain cleanliness and sterility during the customary conditions of processing, storage, handling and distribution.

13.2 *Labelling*—Each package shall be labelled in a manner that ensures the labelling arrives at the point of use with the prostheses. The package labelling shall include the following information:

13.2.1 Manufacturer's name and address,

13.2.2 Product name, shape, type and lot number,

13.2.3 Volume and dimension information,

13.2.4 Date (month and year) of sterilization or packaging,

13.2.5 Special storage requirements, if any,

13.2.6 Self-adhering label suitable for application to the patient's medical records containing following information:

13.2.6.1 Prosthesis name and manufacturer;

13.2.6.2 Lot number; and

13.2.6.3 Type and volume.

13.3 *Implant Marking*—Each individual implant unit shall be clearly and permanently marked with a manufacturer's unique identifying mark and the nominal volume of the device in millilitres (mL). The marking method shall not compromise the strength nor integrity of the device.

13.4 *Package Insert*—Shall contain information: to identify the manufacturer; to describe the prosthesis; on storage, handling, cleaning and sterilization; to provide directions for use to the surgeon, and warnings and precautions concerning known and potential patient adverse reactions and risks.

14. Keywords

14.1 breast prosthesis; gel-saline prosthesis; implant; saline inflatable prosthesis; silicone elastomer; silicone gel prosthesis; soft tissue implant

[5] Federal Register, Vol. 43, No. 141, Friday, July 21, 1978 Part II.

APPENDIXES

(Nonmandatory Information)

X1. RATIONALE

X1.1 Implantable breast prostheses are soft tissue implants used to simulate breast tissue in surgical procedures for breast augmentation, reconstruction, or replacement.

X1.2 Implantable breast prostheses are constructed with continuous, closed outer shells of silicone elastomer in various shapes, sizes and combinations. Lumens are spaces enclosed by shells. Prostheses may be have a single lumen or multiple lumens. Silicone gel prostheses contain fixed volume of silicone gel in the lumen or lumens and are implanted without alteration. The lumen or lumens of saline inflatable prostheses are empty as supplied and are filled through a valve at the time of use with isotonic, injection grade saline in fixed or variable volume. Gel saline prostheses contain a fixed volume of silicone gel with provisions for size adjustment at the time of use with either fixed or variable volumes of isotonic, injection grade saline.

X1.3 The only materials currently acceptable as materials of construction for implantable breast prostheses are silicone elastomer and silicone gel. This specification addresses the composition and vulcanization/cure of both silicone elastomer and gel and the physical properties of both materials as determined from specimens obtained from final prostheses. These requirements include bonded (fused, adhered or joined) areas of the shells. Provisions for softness and cohesiveness of silicone gel are included.

X1.3.1 There are a variety of other tests and considerations that have been proposed for incorporation into this specification including total energy to rupture, abrasion resistance, cyclic compression testing specific chemical characterization of all silicone species and others as such contained FDA's *Draft Guidance for Preparation of FDA Submissions of Silicone Gel-Filled Breast Prostheses.*[6] These proposals merit consideration, and the current content of this specification is not intended to limit its revision and updating to appropriately

[6] Available from Food and Drug Administration, Rockville, MD 20850.

reflect changes and advancements in the state-of-the-art and the availability of relevant consensus test methods. The current content of this specification is believed to accurately represent currently available technology where there has been consensus on test methods and requirements.

X1.4 To ensure integrity of subject prostheses this specification contains provisions for testing shells and any associated inflation valves for leakage.

X1.5 Diffusion of liquid silicone component of silicone gel through the shell is commonly known as silicone bleed. This specification contains provisions for measuring silicone bleed in finished silicone gel—containing prostheses.

X1.6 *Biocompatibility Assays*—Because the prostheses covered in this specification are soft tissue implants this specification contains provisions for state-of-the-art biocompatibility assays in accordance test methods as described in Practice F 748. Other biocompatibility assays were considered in the revisions to this specification as follows:

X1.6.1 *Tripartite Biocompatibility Guidance for Medical Devices*[7]—This guideline essentially duplicates Practice F 748, and in addition, references pharmacokinetics and reproductive and developmental toxicity, biological testing procedures typically associated with substances that are absorbed systemically and have biochemical reactivity.

X1.6.1.1 *Pharmacokinetics*—Young **(1)**[8] reported that in animal studies where data were available for analyses, including a study done at his own institution (National Center For Toxicological Research, FDA) little, if any, of injected silicone moved from the site of origin. He reported "Because of the extremely slow and limited movement of silicone from the initial site of administration, pharmacokinetics as a tool is really of limited usefulness." Further, "Based on these reports, it would appear that silicone implants would have very little or no movement and therefore any potential toxicity would be minimal." Young concluded "Regardless of the final placement of the PDMS and experimental design, any pharmacokinetics analysis of the data will be of limited usefulness due to the slow and limited movement of the material." In comparing injections of liquid silicone, as done in the studies analyzed, to the silicone gel of breast prostheses, Young noted that the enclosures (shells) would increase containment of the silicone. He also noted that pharmacokinetics is not the tool to use with silicone elastomers because some measurable movement is needed in order to use pharmacokinetics. Young's data demonstrate that techniques for conducting meaningful pharmacokinetics studies of polydimethylsiloxane elastomers and gels as used in the implantable breast prostheses covered by this specification have not been developed. When improved and validated techniques for conducting pharmacokinetics assays of polydimethylsiloxane have been developed evaluation of the elastomers and gels used in the implantable breast prostheses covered by this specification may be considered. Continued research on pharmacokinetics study techniques is encouraged.

X1.6.1.2 *Reproductive and Developmental Toxicology*—Bates reported **(2)** that Sprague-Dawley rats injected with up to 20 g/kg PDMS liquid, 350 cs, five days prior to insemination did not result in maternal toxicity or adversely affect fetal viability, fetal growth, or fetal development. Reporting on the findings from multiple studies, LeVier concluded that with regard to teratology no present evidence exists to lead to any serious concern about risk **(3)**. The reproductive and developmental toxicology of polydimethylsiloxane, the materials of concern in the implantable breast prostheses covered by this specification appear to have been well characterized.

X1.6.1.3 *Systemic Toxicological Considerations*—Anecdotal reports of systemic illness in patients with implantable breast prostheses have included immune disorders, human adjuvant disease, arthritis, connective tissue disease, scleroderma and others. These same health conditions are known to occur in persons who have not had implantable breast prostheses. There is no scientific evidence at present that persons with breast implants have an increased risk of adverse health effects **(4)**. Theories speculating a possible cause-and-effect relationship between silicone implants and immune phenomena were published more than a decade ago **(5, 6)**. With time these theories have changed and have become increasingly elaborate, but remain only hypothetical and unproven **(7, 8, 9)**. ASTM standards must be based on stable, proven and state-of-the-art technology. It was thus considered inappropriate and impossible to attempt development of new biological test methods for assay of biological or other considerations that are merely hypothetical, particularly since the hypotheses have not stabilized but are constantly changing. If cause-and-effect relationships between silicone implantable breast prostheses and systemic health conditions become established by valid science, rather than hypotheses, the need for testing in addition to Practice F 748 can then be considered and when validated standardized procedures are developed such procedures should be included in this specification and in Practice F 748.

X1.7 Implantable breast prostheses covered by this specification may vary widely in shape, size, design, intended use and other features. This specification contains provisions for labeling and package inserts to help ensure subject prostheses are appropriately identified and that adequate directions for use are available to users.

X1.8 Sterility of implantable breast prostheses is essential to prevention of infection. This specification addresses sterility by manufacturers and cleaning/sterilization/resterilization by users.

X1.9 Packaging is also addressed in this specification because prostheses must be protected against damage and all types of contamination (including microorganisms) during expected conditions of exposure in the course of distribution and handling.

X1.10 Identified limitations in technology and test methods have been noted in this specification.

[7] Prepared by Toxicology Sub-Group of the Tripartite Subcommittee on Medical Devices, representatives of governmental regulatory agencies of Canada, United Kingdom, and United States, September, 1986.

[8] The boldface numbers given in parentheses refer to a list of references at the end of the text.

X2. FEASABILITY PROTOCOL FOR GEL BLEED IN–VITRO TESTING BY MEANS OF A SILICONE DISK

X2.1 Scope

X2.1.1 The following test protocol details a method to evaluate the diffusion of silicone gel through the silicone elastomeric membrane or shell of silicone gel-filled mammary implants. This diffusion is commonly referred to as "gel-bleed."

X2.1.2 The results of this bleed test method can not be correlated with the actual physiological performance of an implant since the chemical gradient is not replicated. Attempts to devise a test method representative of the aqueous in vivo environment by ASTM to date, have been unsuccessful.

X2.1.3 This test method, which utilizes a silicon disk substrate in direct contact with a gel-filled mammary prosthesis can be used however for comparison of gel bleed diffusion rate's of various product configuration in a laboratory setting.

X2.1.4 Since the silicone disk, implant shell and implant gel are similar in chemical composition and structure (primarily polydimethylsiloxane), the diffusion of gel bleed through the implant shell into the silicone disk is accelerated in comparision to other collection media due to the lower surface transport gradient.

X2.1.5 The intent of this test method is for the comparison of smooth, non-textured, implants only.

X2.2 Summary of Test Method

X2.2.1 This test method is performed at 110°F, a temperature exceeding an extremely high fever condition in humans. This serves to expose the breast prosthesis to a worst case temperature condition that can occur after implantation. Test results, however, are not intended to be indicative of the actual in vivo situation.

X2.2.2 A cleaned gel-filled breast prosthesis test specimen is placed on top of a pre-weighed silicone disk.

X2.2.3 Gravimetric analysis will be employed to determine weight gained by the disk after contact with the prosthesis. The weight gained on the disk is equated with the amount of gel that diffuses from the breast prosthesis at the localized contact surface area. Environmental control disks which do not come in contact with breast prostheses are gravimetrically analyzed to measure weight gain and loss as a result of factors such as humidity in the test facility. The test shall be run for a total of 8 weeks.

X2.3 Apparatus

X2.3.1 *Test containers*, standard outer polycarbonate thermoforms, or glass dishes of suitable size,

X2.3.2 *Silicone disks*, with 19.635 cm^2 surface area. Silicone disks are cut from platinum cured 70 durometer slabs having a thickness of 0.125 ± .010 in. A 50 mm cutter is used to cut the disks,

X2.3.2.1 It is recommended when possible, that the disks used for any particular study be within ±0.002 in thickness of each other.

X2.3.3 *Analytical balance* (Mettler AE 260 Precision Instrument with accuracy ±0.0001 gm),

X2.3.4 *Incubator*, or oven capable of maintaining 110 ± 3°F,

X2.3.5 *Isopropyl alcohol*, electronic or ACS reagent grade,

X2.3.6 *Non-Talc gloves*,

X2.3.7 *Kimwipes*,

X2.3.8 *Metal tray*, and

X2.3.9 *Forceps.*

X2.4 Test Specimen Configuration

X2.4.1 Test specimens shall be in the same form as breast prostheses intended for implantation. Alterations will not be necessary prior to testing. Unless otherwise specified test specimens should be sterilized in the same manner as actual end use implants.

X2.5 Number of Test Specimens

X2.5.1 For each product type, at least 3 test specimens and corresponding sets of silicone disks shall be used to measure the amount and rate of gel diffusion. Three additional silicone disks shall be used as environmental controls to measure unalterable factors which cause the silicone disks to gain or lose weight (for example, humidity).

X2.6 Test Specimen Preparation

X2.6.1 Test specimens shall be wiped clean (not soaked or submerged), using lint-free tissue and isopropyl alcohol, then left to dry patch side down at room temperature for at least two hours. Silicone disks shall be immersed in isopropyl alcohol and scrubbed to remove possible mold release agents or skin oil from handling. The cleaned disks shall be handled with gloved hands at all times to prevent contamination. They shall be placed on Kimwipes on a clean tray and allowed to equilibrate in the preheated incubator held at 110 ± 3°F for at minimum of 12 h.

X2.7 Procedure for Cleaning Test Containers

X2.7.1 Test containers shall be cleaned with an appropriate cleaning agent. They shall then be further wiped with Kimwipes soaked with isopropyl alcohol and allowed to dry for at least 10 min. They shall be labeled with an appropriate numbering system representing test specimens as well as the environmental controls.

X2.8 Procedure for Testing

X2.8.1 Non-talc gloves shall be worn when handling the test specimens and all manipulations shall be at the periphery of the specimen only. Forceps shall be used for handling the silicone disks.

X2.8.2 Remove silicone disk from incubator and allow to equilibrate for one hour at room temperature. Weigh each disk with analytical instrument to ±0.0001 g. Place each test specimen, patch side up, on top of the silicone disk. It is necessary to ensure good contact between the surfaces of the test specimen and disk. Environmental control specimens are placed alone in their own test containers. Place uncovered containers with specimens in incubator.

X2.8.3 At weekly intervals, test containers will be removed from the incubator. The test specimens will be removed from the containers and placed patch side down on top of clean Kimwipes. An equilibration period of one hour at room temperature and room humidity shall be allowed. Each silicone disk shall then be weighed individually to ±0.0001 g. It is necessary to ensure that the side of the silicone disk in contact with the test specimens shall be facing upward at all times. After each weighing, each silicone disk shall be returned to the bottom of its test container. The test specimen corresponding to the test container shall be placed, patch side up, on top of the silicone disk. Again, it is necessary to ensure good contact between the surfaces of the test specimen and disk. Environmental control specimens will also be weighed and returned to their containers. Return containers with specimens to incubator until the next measurement.

X2.8.4 The test shall be run for 8 weeks with measurements at one week intervals.

X2.9 Recording of Data

X2.9.1 Record all information on data sheet provided in Appendix X1 of this test protocol.

X2.10 Calculation

X2.10.1 Express the results of the gel diffusion test as the amount of silicone gel per surface area and rate of gel diffusion, calculated as follows:

$$W_g = [(T_t - T_i) - (C_t - C_i)]/A_s \quad \text{(X2.1)}$$

$$R_g = W_g/t$$

where:

W_g = average weight of gel diffusion per surface area (g/cm^2),
R_g = average weight of gel diffusion per surface area per time interval ($g/cm^2/t$),
T_t = average weight of test disks at each time interval (g),
T_i = average weight of test disks at beginning of test (g),
C_t = average weight of environmental control disks at each time interval (g),
C_i = average weight of environmetal control disks at beginning of test (g),
A_s = surface area of silicone disk (cm^2), and
t = cumulative time from beginning of test to each interval (weeks).

X2.11 Test Limitations

X2.11.1 The conditions of this test method do not replicate physiological conditions. This test method is designed to accelerate the bleed diffusion process in order to evaluate various implant designs comparatively, in a reasonable time frame.

X2.11.2 Validation of the repeatability and accuracy of this test method has not been demonstrated. Typically a round robin test battery at different laboratories at different locations around the country is done for this validation.

X2.11.3 The variation in climate, particularly (humidity) in different locations may to some degree affect results.

X2.11.4 Although control specimens are always used to compensate for humidity changes, the exposed area of the conrols differs from that of the test disks since the test disks are covered by a prosthesis. This again may alter the accuracy of the test method.

X2.11.5 The intent of this test method is for the comparison of smooth, non-textured, implants only.

X2.12 Report

X2.12.1 The report shall include the following:

X2.12.1.1 Records of all measurements of silicone disk weight for each time interval,

X2.12.1.2 Records of temperature and humidity of laboratory at each time period,

X2.12.1.3 Calculated average amount of gel per surface area diffusing out of test specimens,

X2.12.1.4 Calculated average rate of gel diffusing out of test specimens,

X2.12.1.5 Records of any non-anticipated events that may affect measurements of gel diffusion during the test period, and

X2.12.1.6 Records of test specimens information and traceability (when available).

X2.12.1.6.1 Lot No.,
X2.12.1.6.2 Part No.,
X2.12.1.6.3 Volumes(s) of devices,
X2.12.1.6.4 Type of product,
X2.12.1.6.5 Sterilization Method, and
X2.12.1.6.6 Sterilization Lot Nos.

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