



Designation: F1378 – 05

## Standard Specification for Shoulder Prostheses<sup>1</sup>

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### 1. Scope

1.1 This specification covers shoulder prostheses for total or hemiarthroplasty used to provide functioning articulation by employing glenoid and humeral components.

1.2 Devices for custom applications are not covered by this specification. Modular prostheses are included in this specification.

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

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

**F75** Specification for Cobalt-28 Chromium-6 Molybdenum Alloy Castings and Casting Alloy for Surgical Implants (UNS R30075)

**F86** Practice for Surface Preparation and Marking of Metallic Surgical Implants

**F90** Specification for Wrought Cobalt-20Chromium-15Tungsten-10Nickel Alloy for Surgical Implant Applications (UNS R30605)

**F136** Specification for Wrought Titanium-6Aluminum-4Vanadium ELI (Extra Low Interstitial) Alloy for Surgical Implant Applications (UNS R56401)

**F138** Specification for Wrought 18Chromium-14Nickel-2.5Molybdenum Stainless Steel Bar and Wire for Surgical Implants (UNS S31673)

**F562** Specification for Wrought 35Cobalt-35Nickel-20Chromium-10Molybdenum Alloy for Surgical Implant Applications (UNS R30035)

**F563** Specification for Wrought Cobalt-20Nickel-20Chromium-3.5Molybdenum-3.5Tungsten-5Iron Alloy for Surgical Implant Applications (UNS R30563)<sup>3</sup>

**F603** Specification for High-Purity Dense Aluminum Oxide for Medical Application<sup>3</sup>

**F648** Specification for Ultra-High-Molecular-Weight Polyethylene Powder and Fabricated Form for Surgical Implants

**F745** Specification for 18Chromium-12.5Nickel-2.5Molybdenum Stainless Steel for Cast and Solution-Annealed Surgical Implant Applications

**F746** Test Method for Pitting or Crevice Corrosion of Metallic Surgical Implant Materials

**F748** Practice for Selecting Generic Biological Test Methods for Materials and Devices

**F799** Specification for Cobalt-28Chromium-6Molybdenum Alloy Forgings for Surgical Implants (UNS R31537, R31538, R31539)

**F981** Practice for Assessment of Compatibility of Biomaterials for Surgical Implants with Respect to Effect of Materials on Muscle and Bone

**F983** Practice for Permanent Marking of Orthopaedic Implant Components

**F1044** Test Method for Shear Testing of Calcium Phosphate Coatings and Metallic Coatings

**F1108** Specification for Titanium-6Aluminum-4Vanadium Alloy Castings for Surgical Implants (UNS R56406)

**F1147** Test Method for Tension Testing of Calcium Phosphate and Metallic Coatings

**F1537** Specification for Wrought Cobalt-28Chromium-6Molybdenum Alloys for Surgical Implants (UNS R31537, UNS R31538, and UNS R31539)

**F1829** Test Method for Static Evaluation of Glenoid Locking Mechanism in Shear

**F2028** Test Methods for Dynamic Evaluation of Glenoid Loosening or Disassociation

#### 2.2 ANSI Standard:<sup>4</sup>

ASME B46.1–1995

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.22 on Arthroplasty.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

### 3. Terminology

#### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *collar*—flange at junction of neck and stem.

3.1.2 *glenoid component*—the prosthetic portion that replaces, in part or in total, the glenoid fossa of the scapula and articulates with the natural humeral head or a prosthetic replacement.

3.1.3 *head*—bearing member for articulation with the glenoid.

3.1.4 *humeral component*—the prosthetic portion that replaces, in part or in toto, the proximal humerus or humeral head and articulates with the natural glenoid fossa or a prosthetic replacement.

3.1.5 *keel, (or pegs)*—single or multiple projections that provide resistance to translation or rotation of the glenoid component, or both, by mating with cavities created in the glenoid fossa.

3.1.6 *neck*—segment connecting the head and the stem.

3.1.7 *reverse design shoulder implants*—implants that have a ball-shaped glenoid component and a concave humeral design.

3.1.8 *stem*—segment intended for insertion within the humeral medullary canal.

### 4. Classification

4.1 *Constrained*—A constrained joint prosthesis is used for joint replacement and resists dislocation of the prosthesis in more than one anatomical plane and consists of either a single, flexible, across-the-joint component or more than one component linked together or affixed.

4.2 *Partially Constrained*—A semi-constrained joint prosthesis is used for partial or total joint replacement and limits translation and rotation of the prosthesis in one or more planes via the geometry of its articulating surfaces. It has no across-the-joint linkages.

4.3 *Unconstrained*—An unconstrained joint prosthesis is used for partial or total joint replacement and restricts minimally prosthesis movement in one or more planes. Its components have no across-the-joint linkage.

### 5. Materials and Manufacture

5.1 The choice of materials is understood to be a necessary but not sufficient assurance of function of the device made from them. All devices conforming to this specification shall be fabricated from materials, with adequate mechanical strength and durability, corrosion resistance, and biocompatibility.

5.1.1 *Mechanical Strength*—Various components of shoulder prostheses have been successfully fabricated from the following materials. However, not all of these materials may possess sufficient mechanical strength for critical highly-stressed components. See Specifications **F75, F90, F136, F138, F562, F563** (nonbearing use only), **F603, F648, F745, F799, F1108, and F1537**.

5.1.2 *Corrosion Resistance*—Materials with limited or no history of successful use for orthopedic implant application must be determined to exhibit corrosion resistance equal to or better than one of the materials listed in **5.1.1** when tested in accordance with Test Method **F746**.

5.1.3 *Biocompatibility*—Materials with limited or no history of successful use for orthopedic implant application must be determined to exhibit acceptable biological response equal to or better than one of the materials listed in **5.1.1** when tested in accordance with Practices **F748** and **F981**.

### 6. Performance Requirements

6.1 *Wear of Alternative Materials*—It is important to understand the wear performance for articulating surfaces. Any new or different material should not exceed the wear rates of the following material couple when tested under physiological conditions. The current standard wear couple is CoCrMo alloy (Specification **F75**) against ultra high molecular weight polyethylene (Specification **F648**), both having prosthetic quality surface finishes according to **8.2**.

NOTE 1—In situations where the pin-on-flat test may not be considered appropriate, other test methods may be considered.

6.2 *Range of Motion of Shoulder Prosthesis Prior to Implantation*—Flexion shall be equal to or greater than 90°. Abduction shall be equal to or greater than 90°. Internal rotation shall be equal to or greater than 90°. External rotation shall be equal to or greater than 45°. Extension shall be equal to or greater than 45°.

6.3 Porous metal coatings shall be tested according to Test Method **F1044** (shear strength) and Test Method **F1147** (tensile strength).

#### 6.4 Guidelines for In-Vitro Laboratory Testing:

6.4.1 Implant testing should reflect current clinical failures and potential failure modes particular to the implant. These tests may be directed towards subluxation, glenoid loosening, insert dissociation from a metal backing, and humeral head dissociation. To facilitate such testing, several references on shoulder forces have been compiled.<sup>5, 6, 7</sup> Based upon the work by Anglin et al<sup>5</sup> and Poppen et al,<sup>6</sup> the normal shoulder joint reaction forces are on the order of 1 to 2 times body weight with the directions of loading being given in Figure 3 of the study by Anglin et al.<sup>5</sup> In the design of shoulder implants, this background information of the forces and their directions may be helpful in determining worst case shoulder joint forces. However, these joint reaction forces are based upon normal subjects. In order to generate pass/fail criterion (that is, forces, angles, and number of cycles) for a particular shoulder prosthesis, one should take into consideration the anticipated patient population, the worst-case physiological loads and angles, an appropriate safety factor, and the potential for unsupported surfaces.

6.4.2 All modular implants should be tested in accordance with Test Method **F1829**.

6.4.3 All prosthetic glenoid components shall be capable of withstanding sustained static and dynamic physiological forces

<sup>5</sup> Anglin, C., Wyss, U. P., Pichora, D. R., "Glenohumeral Contact Forces," *Proceedings of the Institution of Mechanical Engineers. Part H—Journal of Engineering in Medicine*, 214 (6), 2000, pp. 637–644.

<sup>6</sup> Poppen, N. K., Walker, P.S., "Forces at the Glenohumeral Joint in Abduction," *Clinical Orthopaedics & Related Research*, 135, Sept. 1978, pp. 165–170.

<sup>7</sup> Anglin, C., Wyss, U. P., Pichora, D. R., "Mechanical Testing of Shoulder Prostheses and Recommendations for Glenoid Design," *J. of Shoulder and Elbow Surgery*, 9, 2000, pp. 323–331.