 Cardiovascular implants — Cardiac valve prostheses —

Part 2: 
Surgically implanted heart valve substitutes

Implants cardiovasculaires — Prothèses valvulaires —
Partie 2: Prothèse valvulaires implantées chirurgicalement
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO’s adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 150, Implants for surgery, Subcommittee SC 2, Cardiovascular implants and extracorporeal systems.

This first edition of ISO 5840-2, together with ISO 5840-1 and ISO 5840-3, cancels and replaces ISO 5840:2005, which has been technically revised.

ISO 5840 consists of the following parts, under the general title Cardiovascular implants — Cardiac valve prostheses:

— Part 1: General requirements
— Part 2: Surgically implanted heart valve substitutes
— Part 3: Heart valve substitutes implanted by transcatheter techniques
Introduction

This part of ISO 5840 has been prepared for surgical heart valve substitutes with emphasis on specifying types of *in vitro* testing, preclinical *in vivo* and clinical evaluations, reporting of all *in vitro*, preclinical *in vivo*, and clinical evaluations and labelling and packaging of the device. This process is intended to clarify the required procedures prior to market release and to enable prompt identification and management of any subsequent issues.

This part of ISO 5840 is to be used in conjunction with ISO 5840-1.
Cardiovascular implants — Cardiac valve prostheses —

Part 2:
Surgically implanted heart valve substitutes

1 Scope

This part of ISO 5840 is applicable to heart valve substitutes intended for implantation in human hearts, generally requiring cardiopulmonary bypass and generally with direct visualization.

This part of ISO 5840 is applicable to both newly developed and modified surgical heart valve substitutes and to the accessories, packaging, and labelling required for their implantation and for determining the appropriate size of the surgical heart valve substitute to be implanted.

This part of ISO 5840 outlines an approach for qualifying the design and manufacture of a surgical heart valve substitute through risk management. The selection of appropriate qualification tests and methods are derived from the risk assessment. The tests may include those to assess the physical, chemical, biological, and mechanical properties of surgical heart valve substitutes and of their materials and components. The tests may also include those for pre-clinical in vivo evaluation and clinical evaluation of the finished surgical heart valve substitute.

This part of ISO 5840 defines performance requirements for surgical heart valve substitutes where adequate scientific and/or clinical evidence exists for their justification.

For novel surgical heart valve substitutes, e.g. sutureless, the requirements of both this International Standard and ISO 5840-3 might be relevant and shall be considered as applicable to the specific device design and shall be based on the results of the risk analysis.

This part of ISO 5840 excludes heart valve substitutes designed for implantation in artificial hearts or heart assist devices.

This part of ISO 5840 excludes homografts.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5840-1:2015, Cardiovascular implants and extracorporeal systems — Cardiac valve prostheses —
Part 1: General requirements

ISO 10993-1, Biological evaluation of medical devices — Part 1: Evaluation and testing within a risk management process

ISO 10993-2, Biological evaluation of medical devices — Part 2: Animal welfare requirements

ISO 14155, Clinical investigation of medical devices for human subjects — Good clinical practice

ISO 14630, Non-active surgical implants — General requirements

ISO 14971, Medical devices — Application of risk management to medical devices

ISO 16061, Instrumentation for use in association with non-active surgical implants — General requirements
ISO 5840-2:2015(E)

ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories

ISO 22442 (all parts), Medical devices utilizing animal tissues and their derivatives

ASTM F2052, Standard Test Method for Measurement of Magnetically Induced Displacement Force on Medical Devices in the Magnetic Resonance Environment


ASTM F2213, Standard Test Method for Measurement of Magnetically Induced Torque on Medical Devices in the Magnetic Resonance Environment

ASTM F2503, Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment

3 Terms and definitions

For the purposes of this document, the following terms and definitions given in ISO 5840-1 and the following apply.

3.1 cycle rate
number of complete cycles per unit of time, usually expressed as cycles per minute (cycles/min)

3.2 internal orifice diameter
numerical indication of the minimum diameter within a surgical heart valve substitute through which blood flows

Note 1 to entry: See Figure 1.

3.3 intra-annular sewing ring
sewing ring designed to secure the surgical heart valve wholly or mostly within the patient’s tissue annulus

Note 1 to entry: See Figure 1.

Note 2 to entry: See also 3.2, 3.10, and 3.12.
### Key
1. internal orifice diameter
2. tissue annulus diameter
3. external sewing ring diameter

**Figure 1 — Designation of dimensions of surgical heart valve substitute sewing ring configurations**

#### 3.4 major bleeding
any episode of major internal or external bleeding that causes death, hospitalization, or permanent injury (e.g. vision loss) or necessitates transfusion

#### 3.5 major paravalvular leak
paravalvular leakage leading to death or re-intervention, or causing heart failure requiring additional medication, or causing moderate or severe regurgitation or prosthesis ‘rocking’ on investigation even in the apparent absence of symptoms, or causing hemolytic anemia

#### 3.6 nonstructural valve dysfunction
abnormality extrinsic to the heart valve substitute that results in stenosis, regurgitation, and/or haemolytic anemia

#### 3.7 prosthetic valve endocarditis
any infection involving a valve in which an operation has been performed, based on reoperation, autopsy or the Duke Criteria for Endocarditis

Note 1 to entry: See Reference [16].

#### 3.8 structural valve deterioration
change in the function of a heart valve substitute resulting from an intrinsic abnormality that causes stenosis or regurgitation

Note 1 to entry: This definition excludes infection or thrombosis of the heart valve substitute. It includes intrinsic changes such as wear, fatigue failure, stress fracture, occluder escape, suture line disruption of components of the prosthesis, calcification, cavitation erosion, leaflet tear, and stent creep.
3.9 support structure
component of a heart valve substitute that houses the occluder(s)
EXAMPLE Stent, frame, housing.

3.10 supra-annular sewing ring
sewing ring designed to secure the valve wholly above the patient's tissue annulus
Note 1 to entry: See Figure 1.

3.11 thromboembolism
any embolic event that occurs in the absence of infection after the immediate perioperative period and may be manifested by a neurological event or a noncerebral embolic event

3.12 tissue annulus diameter
TAD diameter in millimetres of the smallest flow area within the patient's valve annulus

3.13 valve size
manufacturer's designation of a surgical heart valve substitute which indicates the tissue annulus diameter (TAD in millimetres) of the patient into whom the surgical heart valve substitute is intended to be implanted (i.e. TAD = designated valve size)
Note 1 to entry: This takes into consideration the manufacturer's recommended implant position relative to the annulus and the suture technique.

3.14 valve thrombosis
any thrombus not caused by infection attached to or near an operated valve that occluded part of the blood flow path, interferes with valve function, or is sufficiently large to warrant treatment
Note 1 to entry: See Reference [14].

4 Abbreviations
For the purposes of this document, the following abbreviations apply.
EOA Effective Orifice Area
CFD Computational Fluid Dynamics
FEA Finite Element Analysis
IFU Instructions For Use
OPC Objective Performance Criteria

5 Fundamental requirements
The manufacturer shall determine, at all stages of the product life cycle, the acceptability of the product for clinical use.
6 Device description

6.1 Intended use

The manufacturer shall identify the physiological condition(s) to be treated, the intended patient population, potential adverse events, and intended claims.

6.2 Design inputs

6.2.1 Operational specifications

The manufacturer shall define the operational specifications for the device, including the principles of operation, expected device lifetime, shelf life, shipping/storage limits, and the physiological environment in which it is intended to function. The manufacturer shall carefully define all relevant dimensional parameters that will be required to accurately select the size of device to be implanted. ISO 5840-1:2015, Table 1 and Table 2 define the expected physiological parameters of the intended adult patient population for surgical heart valve substitutes for both normal and pathological patient conditions.

NOTE See the paediatric annex of ISO 5840-1:2015, Annex E.

6.2.2 Performance specifications

6.2.2.1 The manufacturer shall establish (i.e. define, document, and implement) the clinical performance requirements of the device and the corresponding device performance specifications for the intended use and device claims. The following list of desired clinical and device-based performance characteristics describes a safe and effective surgical heart valve substitute.

NOTE For novel devices, portions of ISO 5840-3 can be applicable

6.2.2.2 Specifications shall be defined with respect to at least the following performance characteristics:

— ability to allow forward flow with acceptably small mean pressure difference;
— ability to prevent retrograde flow with acceptably small regurgitation;
— ability to resist embolization;
— ability to resist haemolysis;
— ability to resist thrombus formation;
— biocompatible;
— compatible with in vivo diagnostic techniques;
— deliverable and implantable in the target population;
— ability to ensure effective fixation within the target implant site;
— has an acceptable noise level;
— has reproducible function;
— maintains structural and functional integrity during the expected lifetime of the device;
— maintains its functionality and sterility for a reasonable shelf life prior to implantation.