
**Mechanical vibration and shock — Human
exposure — Biodynamic coordinate
systems**

*Vibrations et chocs mécaniques — Exposition de l'individu — Systèmes de
coordonnées biodynamiques*



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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8727 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 4, *Human exposure to mechanical vibration and shock*.

Annexes A to C of this International Standard are for information only.

Introduction

For many purposes in biodynamics and in human vibration engineering practice, it is necessary to define the point of origin, magnitude, and direction of a mechanical input or response (force or motion) with respect to a specific orthogonal coordinate system. Biodynamic coordinate systems require a defined point of origin within the human body or within an external frame of reference to which an anatomical coordinate system may be related. Applications include the evaluation of human exposure to vibration and shock, the precise definition of the functional location and orientation of biodynamic instrumentation systems, the biodynamic modelling of force and motion inputs to the human body and its parts or segments, and inter-subject or inter-species comparisons of biodynamic data.

For the purpose of data comparison between individuals (or between repeated measurements in the same individual), between persons and human analogues, or between measured data and a standard prescribing boundaries of acceptable mechanical inputs to the human body or its segments, it is imperative that any anatomical coordinate system used originates in and is oriented with respect to recognized, firm, and radiographically or stereotactically determinable (hence, skeletal) anatomical landmarks. This International Standard embodies that fundamental principle: it specifically deprecates using systems loosely defined as centred in the heart or other soft and mobile structures. Precise definition of anatomical coordinate systems is fundamental to biodynamical science, because all biodynamic measurements must ultimately be related to the bony anatomy of the human body.

Mechanical vibration and shock – Human exposure – Biodynamic coordinate systems

1 Scope

This International Standard specifies anatomical and basicentric coordinate systems for biodynamical measurements, for reference purposes in cognate standards development, and for precisely describing human exposure to mechanical vibration and shock. The segmental anatomical coordinate systems defined in this International Standard are for the head, root of the neck (driving-point for the head and neck system), pelvis, and hand. General principles are stated for the establishment of corresponding anatomical coordinate systems for other skeletal body segments. The biodynamic coordinate systems defined in this International Standard can serve as frames of reference for the description and measurement of both translational and rotational vibration and shock motion affecting humans.

NOTES

1 Although defined for human subjects, these anatomical coordinate systems are adaptable, using a knowledge of comparative anatomy, to non-human primates or to other animal species whose skeletal anatomy is recognizably comparable, radiographically, with the relevant anatomy of humans.

2 When the need arises for other segmental anatomical coordinate systems (e.g. for the arm, wrist, leg or foot), these should be defined according to corresponding principles of anatomy and of standardization, and may be proposed for inclusion in subsequent revisions of this International Standard.

3 This International Standard recognizes no difference between male and female skeletal anatomy bearing upon the definition and use of biodynamic coordinate systems. Moreover, the same principles apply when defining anatomical coordinate systems for children, and for non-human mammalian species used in ethical biodynamics research, development, testing and evaluation.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subjected to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1503:1977, *Geometrical orientation and directions of movements*.

ISO 5805:1997, *Mechanical vibration and shock — Human exposure — Vocabulary*.

3 Biodynamic coordinate systems

Standard biodynamic coordinate systems shall be used, if practicable, whenever collecting, transforming, analysing, reporting, describing, comparing, or evaluating human mechanical vibration and shock input data and consequent human body structural and system responses.

NOTES

1 A biodynamic coordinate system may be oriented with respect to a hierarchy of coordinate systems within inertial space (see figures A.1 and A.2). Such inertial reference systems may be geocentric, in which the principal or normal axis lies in the direction of earth's gravity, or basicentric, originating in the contacting surface (or some fully orientatable structure connected rigidly thereto) through which the force or motion of interest is transmitted to the body. Basicentric coordinate systems may, for example, be defined with respect to the structure of a vehicle, a workplace, or a laboratory, to an immediate source of vibration or shock affecting persons, such as a vibrating tool or appliance, or to a research vibration machine, motion simulator or impact device. For research and evaluation purposes, a biodynamic coordinate system may itself provide the external frame of reference for an instrumentation coordinate system, used to define inertial measurements made upon or within the human body.

2 Geometrically speaking, the human body may, for any given posture, be treated as a fully-oriented object (see figure A.3).

3 The use of coordinate systems originating in amorphous or flexible soft-tissue or surface anatomical features which are deformable or freely mobile within the body (e.g. coordinate systems loosely defined as centred in the heart or the buttocks) precludes the precise acquisition or comparison of biodynamic data, and is accordingly deprecated. The anatomical systems defined in this International Standard all originate in, and are oriented with respect to, radiographically or stereotactically determinable (including palpable) bony landmarks. Moreover, these systems are adaptable, for the purpose of comparative biodynamics, to mammalian species other than humans, and to mechanical analogue models (dummies or manikins) of humans.

4 A radiographically determinable landmark means one that, for research or reference purposes, can be visualized, and its position measured, by methods of X-ray or ultrasonic radiographical anthropometry. It may also be (but not necessarily is) determinable stereotactically, if it is palpable (or reliably related to structures that are palpable) in the surface anatomy. It is of course recognized that in many areas and applications it may be impossible or impractical to define the relevant bony anatomy by radiographical methods. Nevertheless, the applicable anatomical coordinate system or systems should be identified when inertial measurements are made on humans, and the measurements related to the standard anatomical coordinate system(s) to the extent practicable.

3.1 Direction

All orthogonal coordinate systems adopted in biodynamics shall be defined as right-handed (see figure A.4). Definitions of x-, y- and z-axes for anatomical coordinate systems shall be in accordance with ISO 5805 (see figures A.5 and A.6 for examples of these axes). Definitions of orientations and axes for basicentric systems (e.g. in vehicles) shall be in accordance with the principles of ISO 1503.

NOTE — An exception to the rule regarding right-handedness of the coordinate system may be made in the case of the anatomical coordinate system (hand) adopted specifically for measurements in the left hand (see 3.4.1).

3.2 Biodynamic coordinate systems for the whole body

3.2.1 Whole-body anatomical coordinate system

For most purposes (for example, when considering force or motion inputs to the whole body from a contact or supporting surface upon which the person is standing, sitting or lying), the anatomical coordinate system of choice shall be that defined for the pelvis (see 3.3.4).

NOTES

1 When practical considerations clearly dictate that it is more appropriate to do so, whole-body inputs may be defined with reference to an alternative system within the torso, which, together with the posture and the orientation of the body with respect to the source of the vibration or shock, should be defined unambiguously when reporting data referenced to this alternative coordinate system. For example, whole-body inputs applied mainly to a person's back, as from a vibrating seat-back or a motorized backpack appliance, may be related to the upper torso anatomical coordinate system. Unless otherwise specified, whole-body vibration or shock shall be deemed to be applied to persons in the (conventional) "normal" anatomical position, that is, with the z-axis of the principal axial segmental (i.e. head and trunk) anatomical coordinate systems approximately parallel, the limbs aligned, and the palms facing forward. When a particular posture is adopted (e.g. sitting) during human vibration