# INTERNATIONAL STANDARD 1503

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## Geometrical orientation and directions of movements

*Orientation géométrique et sens de mouvement*

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## FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.



International Standard ISO 1503 was developed by the Standing committee for the study of principles of standardization (STACO), and was circulated to the member bodies in December 1972.



It has been approved by the member bodies of the following countries :



| | | |
|---|---|---|
| Belgium | India | Romania |
| Canada | Iran | South Africa, Rep. of |
| Czechoslovakia | Japan | Sweden |
| Egypt, Arab Rep. of | Mexico | Turkey |
| Finland | Netherlands | U.S.A. |
| France | New Zealand | |

No member body expressed disapproval of the document.



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# Geometrical orientation and directions of movements

## 0 INTRODUCTION

The geometrical orientation of technical objects, as well as the unambiguous definition of the direction of movement of objects or their parts, is often of decisive importance : an unclear or wrong direction could, for example, seriously hinder the task of rescue teams in a burning building; the operation of a valve or steering lever in the wrong direction could, in dangerous circumstances, lead to a disaster.

Hence, the standardization of the directions of technical objects (geometrical orientation), as well as the standardization of directions of movement, is of great importance especially as regards safety.

For the electrotechnical field, IEC Publication No. 54, *Recommendations for standard direction of motion of operating devices and for indicating lamps for circuit-breakers*, was published in 1936 (Part 1 of this publication is now replaced by IEC Publication No. 447 — first edition, 1974). In the field of mechanical engineering, a whole series of International Standards exists for special fields of application.

On the other hand, many cases may be quoted where corresponding standards are lacking. It also happens that in the standards of various technical fields or in the various national standards the directions of movement have been specified in differing and conflicting ways.

This International Standard should help to solve problems in relation to geometrical orientation, directions of movement and steering elements, and to unify the relevant stipulations worldwide and in all disciplines.

Because alterations of existing practice and standards in relation to steering elements often result in danger, it is strongly recommended that note should be taken of the rules given in 10.4 of this International Standard.

## 1 SCOPE AND FIELD OF APPLICATION

This International Standard

— establishes and defines directional terms in stationary circumstances (geometrical orientation);

— defines directions of movement and gives rules for establishing them;

— gives rules for the co-ordination of directions of movements of control elements to the intentional changes in technical objects.

It is a fundamental standard to be used when drawing up other standards where the geometrical orientation or the direction of movement plays a role.

## 2 CONSIDERED OBJECT

Object whose geometrical orientation or whose movements are to be defined or established.



### 2.1 Geometrical orientation of the considered object

For a geometrical orientation of the considered object, the determination of a centre point as well as the three axes of the considered object described in 2.3 or the three reference planes described in 2.4 are required.

The considered object may already be by nature geometrically orientated or receive a geometric orientation by convention. The following distinctions are made depending on the degree of geometrical orientation :

#### 2.1.1 Fully orientated object geometrically speaking

Object which by nature possesses an individual complete directional system with longitudinal transverse and normal axis (see 2.3.1 to 2.3.3).

In these circumstances the directions right and left, above and below, in front and behind, are firmly unambiguous. With them the three reference axes are also established (see 2.3).

*Examples :*

— ship (see figure 1);

— aeroplane, automobile;

— interior of a church;

— interior of a theatre, lecture hall (with unidirectional seating arrangement);

— wind rose on a compass;

— switchboard, instrument panel;

— map (see figure 2);

— cabinet.

#### 2.1.2 Incompletely orientated object geometrically speaking

Object which by nature possesses only an incomplete directional system, not all of its three axes being determined. In the case of most such objects, only one or two directions are fixed, whilst the other one or two directions are undetermined and must be specified conventionally if necessary.

*Examples :*

a) Objects in which position and direction of the longitudinal axis X (see 2.3.1) are fixed :

- spear;
- rocket.

b) Objects in which position and direction of the normal axis Z (see 2.3.3) are fixed :

- flag pole;
- factory chimney (see figure 3).

c) Objects in which the **position and direction** of the normal axis Z and the **position** (but not the direction) of the longitudinal axis X and the transverse axis Y are fixed :

- railway wagon;
- container;
- pontoon.

d) Objects in which only the position of the transverse axis Y (see 2.3.2) is fixed :

- roller;
- wheel.

e) Objects in which only the position of one of the three axes X, Y or Z is fixed :

- cylinder;
- pipe (see figure 4);
- cable, wire.

#### 2.1.3 Object not geometrically orientated

Object which possesses by nature no directional system.

*Examples :*

- ball, balloon;
- cubical block;
- box without inscription on it.

### 2.2 Centre point

Assumed reference point for the geometrical orientation of the considered object and the determination of movements.

The imaginary centre point need not coincide with the centre of gravity of the considered object.

### 2.3 Axis of the considered object

One of the three assumed infinite mutually perpendicular straight lines through the centre of the considered object.

The three axes are designated X, Y and Z.

NOTE – These symbols have been adapted to the common practice in aeronautic (see ISO 1151/I, *Terms and symbols for flight dynamics – Part I : Aircraft motion relative to the air*).

The determination of the positive direction of the three axes has not yet been adhered to, because, up to now, it has not been possible to find a solution which unifies the various stipulations on the different special branches : for example mathematics, aviation, machine tools, electrical engineering, etc. But it is not absolutely necessary for the three-dimensional orientation and the determination of the directions of movement.

#### 2.3.1 Longitudinal axis X

Infinite straight line through the centre point of the considered object, running from back (behind) to front (see figures 5 and 6).

#### 2.3.2 Transverse axis Y

Infinite straight line through the centre point of the considered object, running from left to right (see figures 5 and 7).

#### 2.3.3 Normal axis Z

Infinite straight line through the centre point of the considered object, running perpendicularly to the longitudinal axis X and the transverse axis Y and from top to bottom (see figures 6 and 7).

### 2.4 Reference plane

One of three imaginary mutually perpendicular planes through the centre point of the considered object which, in each case, contains two axes of the same object.

The reference planes are needed for the geometrical orientation of the considered object and for the definition of linear movements. They are aligned according to the considered object and not according to the earth's surface.

Since the considered object can occupy any position relative to the earth's surface, the reference planes can also have any position relative to the earth's surface.

It is only with objects whose directional system is aligned according to the earth's surface or the earth's horizon that the basic plane is a horizontal plane, while the longitudinal and transverse planes are vertical planes.

#### 2.4.1 Basic plane $P_{xy}$

Reference plane through the centre point of the considered object containing the longitudinal axis X and the transverse axis Y (see figure 5).

### 2.4.2 Longitudinal plane $P_{xz}$

Reference plane through the centre point of the considered object containing the longitudinal axis X and the normal axis Z (see figure 6).

### 2.4.3 Transverse plane $P_{yz}$

Reference plane through the centre point of the considered object containing the transverse axis Y and the normal axis Z (see figure 7).

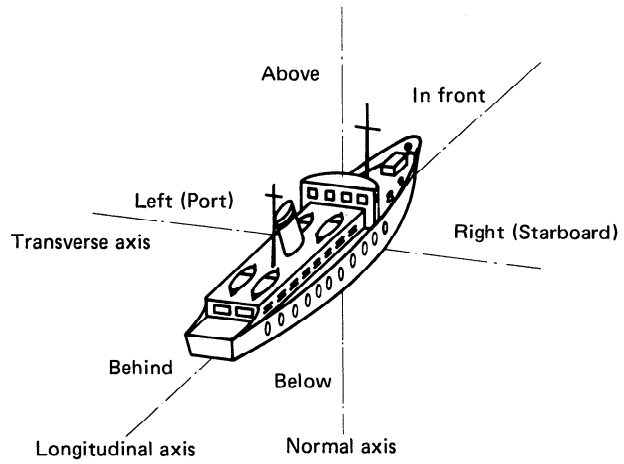




FIGURE 1 — **Ship as an example of a fully orientated object geometrically speaking**



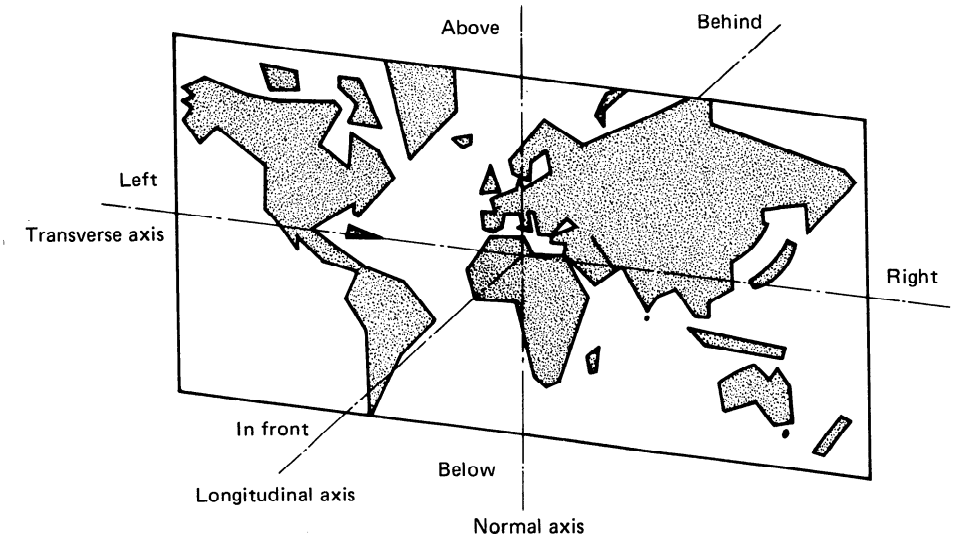


FIGURE 2 — **Map as an example of a fully orientated object geometrically speaking**

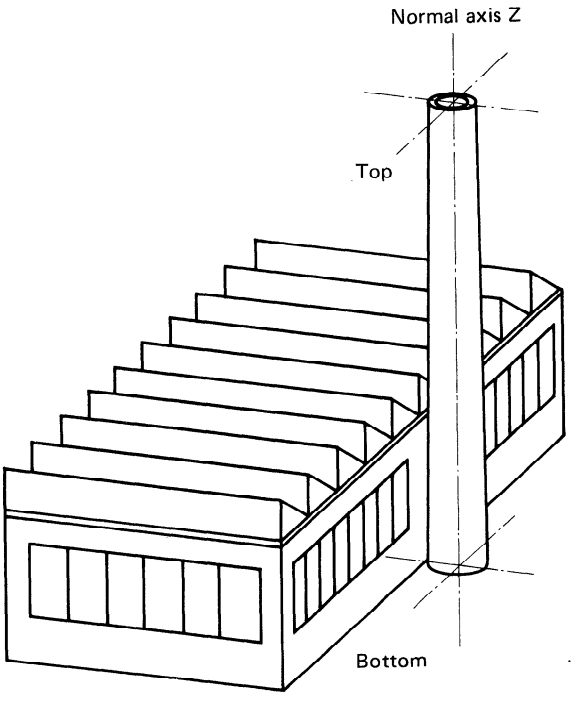




FIGURE 3 – **Factory chimney shown as example of incompletely orientated object, geometrically speaking**



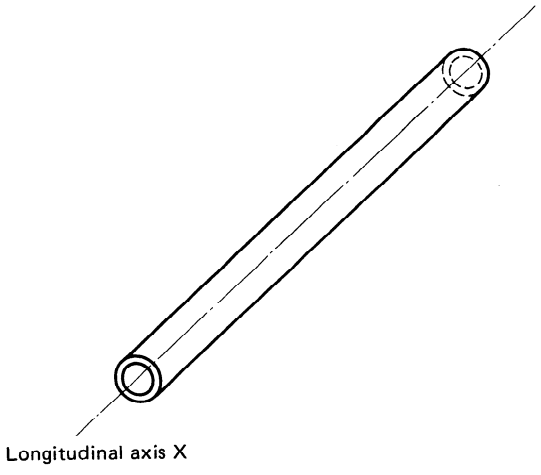


FIGURE 4 – **Pipe shown as example of incompletely orientated object, geometrically speaking**

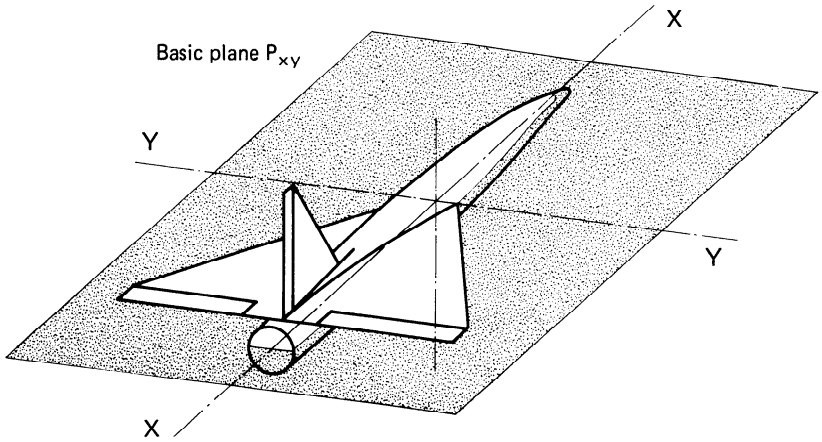


FIGURE 5 — **Basic plane $P_{xy}$; longitudinal axis X; transverse axis Y**



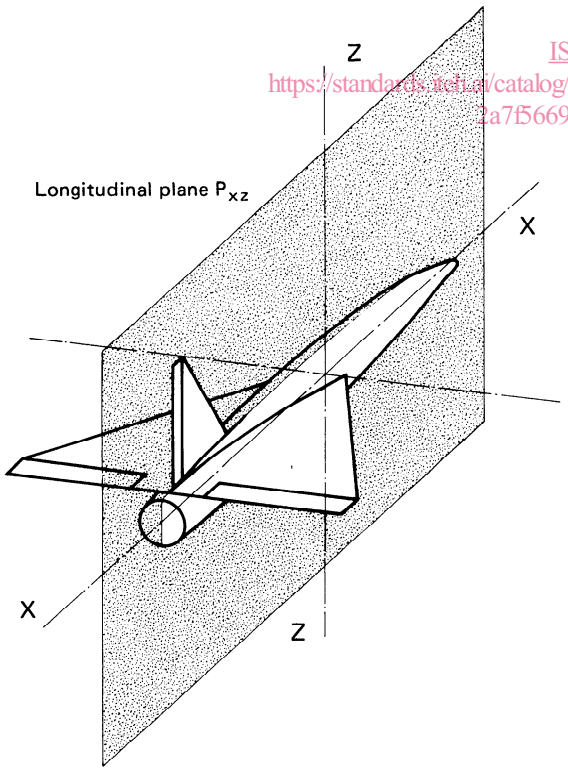


FIGURE 6 — **Longitudinal plane $P_{xz}$; longitudinal axis X; normal axis Z**

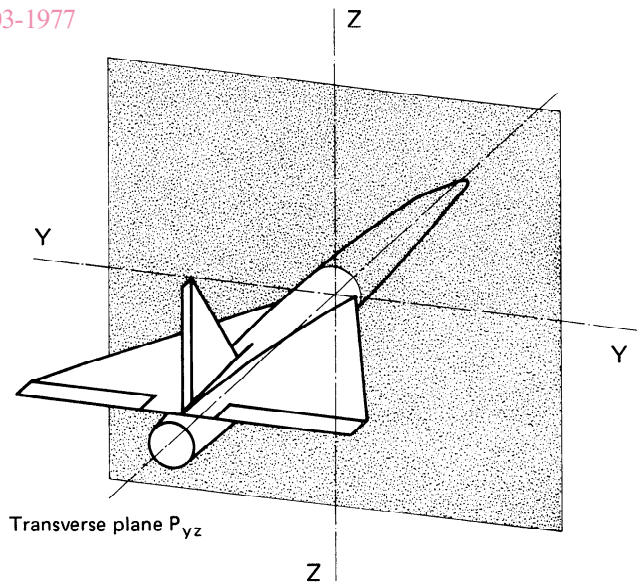


FIGURE 7 — **Transverse plane $P_{yz}$; transverse axis Y; normal axis Z**

## 3 OBSERVER

Real or imaginary person whose location, posture and viewing direction are the basis for all directional data.

The observer may be a person who views the considered object from without or within, in order to determine the direction of parts, points or movements of the same; he may, however, also be a person who actively controls the movements of the considered object or the movements of parts of the same. In this case the observer is the operator.

The correct choice of the imaginary location, posture of the body and viewing direction of the observer is of decisive importance for the three-dimensional orientation of objects and for the determination of directions of movements.

### 3.1 Location of the observer

Assumed place at which the observer is located for the determination of directions and movements.

For simpler and more accurate determination of directions, the location of the observer is taken to be on one of the three axes. This imaginary location is generally not identical with the real location of the observer and coincides with it only in exceptional cases.

NOTE – In the following illustrations the imaginary observer is shown in black and the actual observer in white.

It is important to specify whether the location of the observer is taken to be on the axis outside or inside the considered object.

Frequently the location of the observer is considered to be inside the considered object, although the object itself is so small that there would not be room for a person inside.

### 3.2 Posture of the observer

Assumed posture of the observer for the determination of directions.

For three-dimensional determination (geometrical orientation) of objects and determination of directions of movements, in most cases the upright posture (standing or sitting) or the posture bent forward is assumed irrespective of the true position of the observer. The body axis of the observer is in this hypothesis parallel to one of the axes and lies in a reference plane containing this axis.

*Example :*

– body axis of the observer parallel to the normal axis Z in the longitudinal plane $P_{xz}$.

### 3.3 Viewing direction of the observer

Assumed direction in which the observer looks, when determining the directions.

For simpler and more accurate determination of directions it is assumed that irrespective of the observer's actual viewing direction he is looking in the direction of one of the three axes of the considered object. It must not be assumed that the viewing direction is always perpendicular to the observer's body axis.



*Examples :*

– crane operator (see figure 8);

– person looking at a clock tower (see figure 9);

– person looking at a book (see figure 10);

– worker on a remote-controlled machine tool;

– passenger in a motor vehicle who looks sideways out of the window;

– passengers sitting opposite in a train (see figure 11).

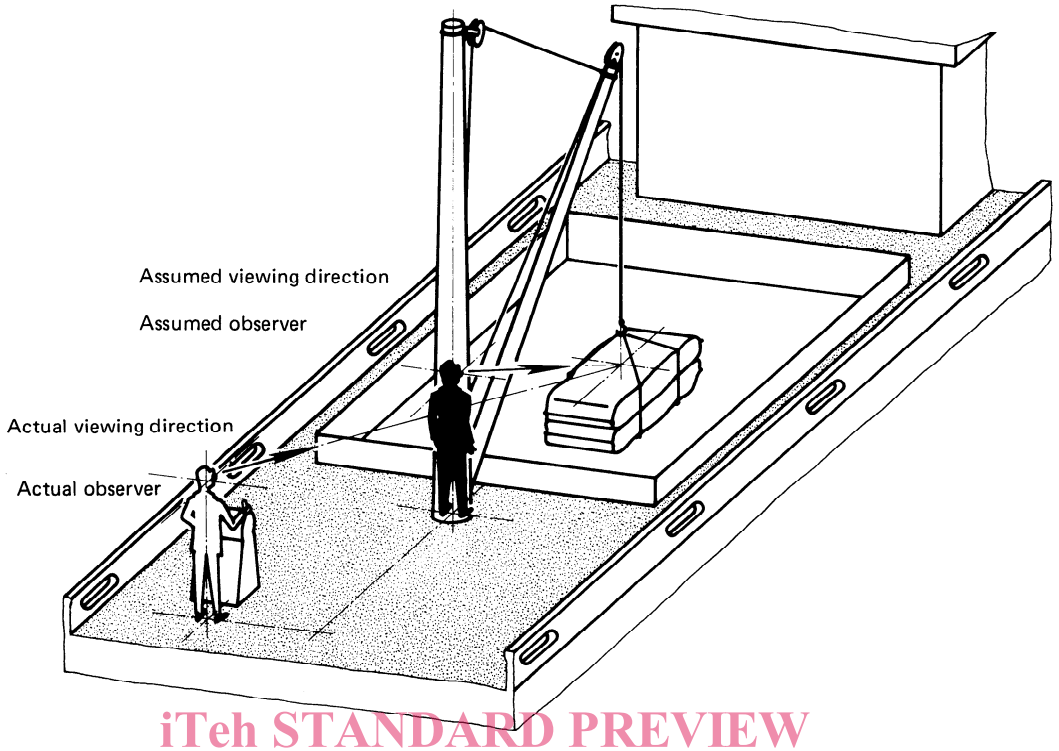




FIGURE 8 — **Assumed location, posture and viewing direction of the observer (— theoretical operator) of a crane (black figure) and actual location, posture and viewing direction of the operator (white figure)**



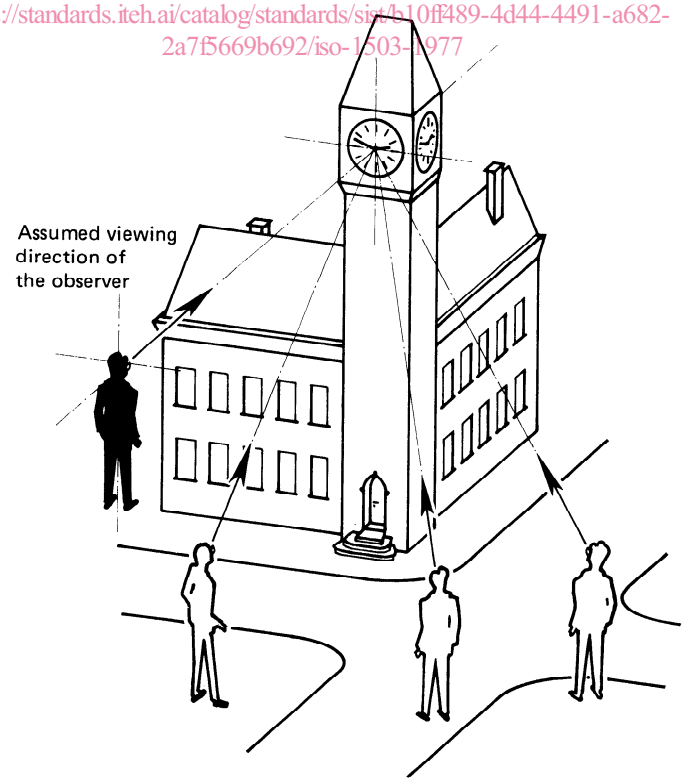


FIGURE 9 — **Assumed location, posture and viewing direction of the observer (black figure) and different actual observers and their location, posture and viewing direction (white figures)**

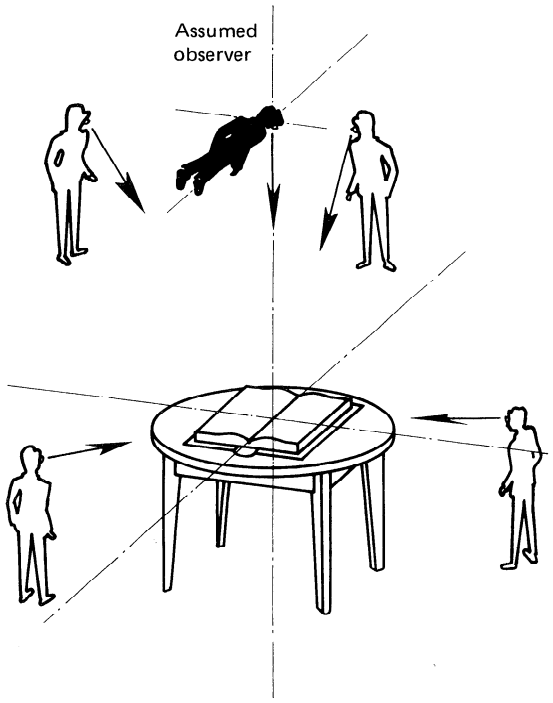


FIGURE 10 – **Assumed location, posture and viewing direction of the observer (black figure) and different actual observers and their location, posture and viewing direction (white figures)**



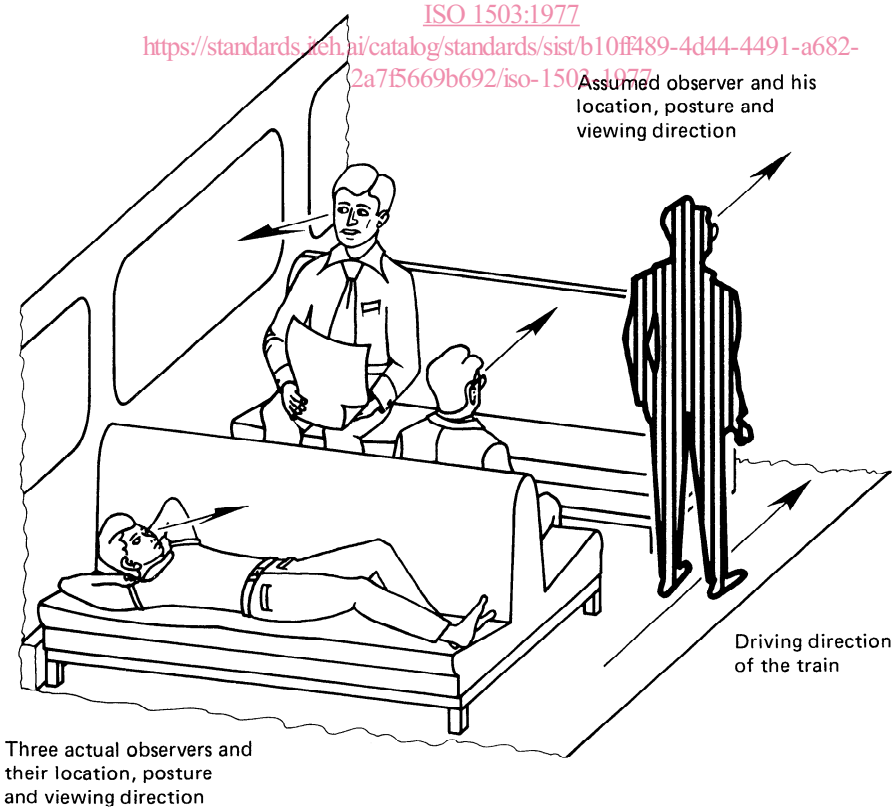


FIGURE 11 – **Assumed observer (black figure) and his location, posture and viewing direction in a railway train, and actual observers in their location, posture and viewing direction (white figures)**

## 4 VIEWING SYSTEM FOR THE DETERMINATION OF DIRECTIONS

System in which position, posture and viewing direction of the observer are fixed with reference to the three axes of the considered object in order to render possible its geometrical orientation and determination of its directions of movement unambiguously.

There exist two different systems, the external viewing system (VSE)[1] (see 4.1) and the internal viewing system (VSI)[2] (see 4.2). Which of the two systems should be chosen cannot usually be decided arbitrarily but will depend upon the nature of the observed object.

The fact that these two different viewing systems must be considered is frequently the cause of contradictions and misunderstandings. However, it is not possible to abandon one of them without provoking far-reaching changes in existing habits and the modification of many international and national standards. Changes initiated in this way would in all probability not be carried through in practice.

In both viewing systems the following viewing directions are used (see figures 12 and 13) :

a) direction X = viewing direction along the longitudinal axis X forwards[3] for a normally moving object (VSI) or towards[3] the front of the object if normally stationary (VSE);

b) direction Y = viewing direction along the transverse axis Y to the right;

c) direction Z = viewing direction along the normal axis Z downwards.[3]

The direction X, direction Y and direction Z together form a right-hand system of co-ordinates.

### 4.1 External viewing system (VSE)

Viewing system in which it is assumed that the location of the observer lies outside the considered object (see figure 12).

For the three-dimensional orientation (see 5.1 to 5.3), for the determination of linear movements (see 6.1 to 6.3) and for the determination of rotations about the longitudinal axis X (see 7.1), the assumed place of the observer is in front of the considered object on the longitudinal axis X. His posture is upright while he is looking in the direction of the longitudinal axis X (direction X) at the front of the considered object.

For the determination of rotations about the transverse axis Y (see 7.2), the assumed place of the observer is on the left side of the considered object on the transverse axis Y. His posture is upright while he is looking in the direction of the transverse axis Y (direction Y) at the left side of the considered object.

For the determination of rotations about the normal axis Z (see 7.3), the assumed place of the observer is above the considered object on the normal axis Z. His posture is lying, parallel to the longitudinal axis X, the right side of his body being on the right side of the longitudinal plane $P_{xz}$. In this posture, he is looking in the direction of the normal axis Z (direction Z) at the top of the considered object.

Generally, the external viewing system is used for objects which are usually regarded from the outside, but rarely for vehicles.

*Examples :*

- technical drawings, books, maps, magazines;
- pictures, sculptures;
- measuring devices, clocks, switchboards;
- showcases, theatre stages;
- containers, all kinds of wrappings;
- the exterior of buildings;
- landscape units.



### 4.2 Internal viewing system (VSI)

Viewing system in which the location of the observer is assumed to be inside the considered object (see figure 13).

For the three-dimensional orientation (see 5.1 to 5.3), for the determination of linear movements (see 6.1 to 6.3) and for the determination of rotations about the longitudinal axis X (see 7.1), the assumed place of the observer is in the centre of the observed object. His posture is upright while he is looking in the direction of the longitudinal axis X (direction X) from the centre forwards.

For the determination of rotations about the transverse axis Y (see 7.2), the posture of the observer is upright, while he is looking in the direction of the transverse axis Y (direction Y) from the centre to the right.

1) VSE = abbreviation for **V**iewing **S**ystem; **E**xternal

2) VSI = abbreviation for **V**iewing **S**ystem; **I**nternal

3) In the U.S.A. the preferred spelling is : forward, backward, upward, downward and toward.