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Hydrometry — Vocabulary and symbols

Hydrométrie — Vocabulaire et symboles

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Foreword

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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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 113, *Hydrometry,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 318, *Hydrometry,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This sixth edition cancels and replaces the fifth edition (ISO 772:2011) which has been technically revised. The main changes compared with the previous edition are as follows:

— terms related to precipitation have been added in a new Clause 9;

— additional terms have been added in Clause 10;

— Figures 1, 3, 4, 5, 6, 9, 11 and 12 have been modified and updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In the preparation of this document, the following principles were adopted wherever possible:

a) to standardize suitable terms and symbols without perpetuating unsuitable ones;

b) to discard any term or symbol with differing meanings in different countries, or for different people, or for the same person at different times, and to replace that term or symbol by one which has an unequivocal meaning;

c) to exclude terms which are self-evident.

Terms in existing International Standards have been included as much as possible; however, these terms can be subject to future amendments.

NOTE Similar or identical terms can have separate definitions under the different categories.

It is recognized that it is not possible to produce a complete set of definitions which will be universally acceptable, but it is hoped that the definitions provided and the symbols used will find widespread acceptance and that their use will lead to a better understanding of hydrometric practices.

The terminology entries are presented in systematic order, grouped into sections according to particular methods of determination or in relation to particular subjects. Annex A lists the symbols used in this document.

The structure of each entry is in accordance with the ISO 10241 series. Country codes are in accordance with ISO 3166-1.

Hydrometry — Vocabulary and symbols

1 Scope

This document defines terms and symbols used in standards in the field of hydrometry.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
hydrometry
science and practice of measuring the components of the *hydrological cycle* (3.92), including *rainfall* (9.10), *water level* (3.64), flow and *sediment transport* (8.2) of surface waters, and *groundwater* (11.1) characteristics

3.2
hydrology
science that deals with the waters above and below the land surfaces of the Earth, their occurrence, circulation and distribution, their properties and their reaction with the environment

3.3
flow
water flowing on or below the land surface under gravitational influence

3.4
runoff
volume of water flowing through a given channel cross-section related to a given *drainage basin* (3.103) in a defined period of time

3.5
discharge
Q
volume of water flowing through a given channel cross-section in unit time

3.6
current
directed movement of water

3.7
steady flow
flow (3.3) in which parameters [such as *velocity* (3.113), pressure, density and temperature] are constant with respect to time

3.8
unsteady flow
flow (3.3) in which one or more parameters [such as *velocity* (3.113), pressure, density and temperature] change with respect to time

3.9
uniform flow
flow (3.3) in which the magnitude and direction of flow at a given moment are constant with respect to distance

Note 1 to entry: For uniform flow, the velocity vector is constant along every stream line. Uniform flow is possible only in an *open channel* (3.19) of constant slope and cross-section.

3.10
non-uniform flow
flow (3.3) in which the magnitude and direction of flow at a given moment are changing with respect to distance

3.11
critical flow
<open channel flow> *flow* (3.3) in an *open channel* (3.19) in which the specific energy is a minimum for a given *discharge* (3.5)

Note 1 to entry: Under this condition, the *Froude number* (3.89) is equal to unity and small surface disturbances cannot travel upstream.

3.12
subcritical flow
flow (3.3) in an *open channel* (3.19) at less than *critical velocity* (3.17), which has a *Froude number* (3.89) of less than unity and in which small surface disturbances can travel upstream

3.13
supercritical flow
flow (3.3) in an *open channel* (3.19) at more than *critical velocity* (3.17), which has a *Froude number* (3.89) of greater than unity and in which small surface disturbances cannot travel upstream

3.14
transverse flow
lateral flow
flow (3.3) horizontally perpendicular to the main direction of flow

Note 1 to entry: Transverse (lateral) flow is frequently associated with secondary flow.

Note 2 to entry: Transverse (lateral) flow in *open channels* (3.19) with a curved plan form causes superelevation of the water surface at the outside of the bend.

3.15
stratification
state of a water body that consists of two or more layers arranged according to their density, the lightest layer being on top and the heaviest at the bottom

3.16
critical depth
depth (3.78) of *flow* (3.3) at which *critical flow* (3.11) occurs

3.17
critical velocity
velocity (3.113) of *flow* (3.3) that has minimum specific energy for a given *discharge* (3.5) or has unit *Froude number* (3.89)

3.18
channel
course of a *river* (3.27), *stream* (3.26) or other watercourse

3.19
open channel
longitudinal boundary surface consisting of the bed and banks or sides within which water flows with a free surface

3.20
canal
man-made *channel* (3.18), usually of regular cross-sectional shape

3.21
stable channel
open channel (3.19) in which the bed and the sides remain essentially stable over a substantial period of time in the *reach* (3.34) under consideration, and in which the scour and *deposition* (10.5) during the rising and falling stages are negligible

3.22
unstable channel
open channel (3.19) that changes frequently and significantly in its plan form and/or cross-sectional form for the *reach* (3.34) under consideration

3.23
tidal channel
open channel (3.19) in which the *flow* (3.3) is subject to tidal influence

3.24
tide
periodic rise and fall of water due principally to the gravitational attraction of the sun and the moon

3.25
estuary
lower tidal *reaches* (3.34) of a *river* (3.27) that is freely connected with the sea which receives fresh water supplies from upland drainage areas

3.26
stream
water course, water flowing in an *open channel* (3.19)

3.27
river
large natural water course

3.28
large river
major river
large natural water course that generally flows into the sea

3.29
creek
brook
small natural water course

3.30
torrent
small natural water course that is characterized by steep slopes and significant rapid changes in *discharge* (3.5) and that can transport considerable volumes of solid material

3.31
alluvial river
river (3.27) which flows through alluvium formed from its own deposits

3.32
incised river
river (3.27) which has formed its *channel* (3.18) by a process of erosion

3.33
braided river
river (3.27) characterized by a wide and shallow *open channel* (3.19) in which *flow* (3.3) passes through a number of small interlaced *channels* (3.18)

3.34
reach
length of *open channel* (3.19) between two defined cross-sections

3.35
meandering channel
water course formed by natural flow processes and movement of sediments following generally an alternating regular sinuous path

3.36
thalweg
line joining the lowest points of successive cross-sections of a water course

3.37
unit discharge
discharge per unit width
q_u
discharge (3.5) through a unit width of a given vertical section

3.38
yield specific discharge
q
discharge (3.5) per unit area of catchment or *aquifer* (11.15)

3.39
stream gauging
discharge measurement
flow measurement
stream flow measurement
river gauging
all of the operations necessary for the measurement of *discharge* (3.5) of a *stream* (3.26)

3.40
gauge
device installed at a gauging station for measuring the level of the surface of water relative to a datum

3.41
left bank
bank to the left of an observer looking downstream

3.42
right bank
bank to the right of an observer looking downstream

3.43
channel bed
invert
stream bed
stream bottom
channel bottom
lower part of the stream channel situated between the banks

3.44
bed slope
bottom slope
S_o
difference in elevation of the bed per unit horizontal distance, measured in the direction of *flow* (3.3)

Note 1 to entry: The slope is usually mathematically negative in the direction of flow.

3.45
bed profile
shape of the bed in a longitudinal vertical plane

3.46
side slope
difference in elevation between the bottom and top of a bank per unit horizontal distance

3.47
surface slope
S_w
inclination of the surface of the *stream* (3.26) in a *reach* (3.34) measured in the direction of *flow* (3.3)

3.48
fall
difference in elevation of the water surface between the extremities of a defined *reach* (3.34) at a given instant of time

EXAMPLE As recorded at a *slope station* (3.71).

3.49
top width
width of the *open channel* (3.19) measured across the *stream* (3.26) at the water surface normal to the direction of *flow* (3.3)

3.50
wetted perimeter
P_w
contact length between a *stream* (3.26) of flowing water and its containing *open channel* (3.19), measured in a direction normal to the *flow* (3.3)

3.51
wetted cross-section
<of a stream> section normal to the mean direction of *flow* (3.3) bounded by the free surface and *wetted perimeter* (3.50)

3.52
gauging section
measuring section
section at which *discharge* (3.5) measurements are taken

3.53
high water mark
flood mark
mark left on a structure or any other object indicating exceptional stages of flood

3.54
debris line
trash line
traces of any kind left on the banks or obstacles or flood plain by a flood

Note 1 to entry: The debris line may be used to determine the highest level attained by the water surface during a flood.

3.55
surface velocity
flow (3.3) *velocity* (3.113) at a given point on the surface

3.56
mean velocity
<at a cross-section> *flow* (3.3) *velocity* (3.113) at a given cross-section of a *stream* (3.26), obtained by dividing the *discharge* (3.5) by the cross-sectional area

3.57
slush ice
mass of loosely packed *anchor ice* (3.105) that is released from the bottom, or *frazil ice* (3.104) that floats or accumulates under *surface ice* (3.107)

3.58
velocity head
theoretical vertical height to which liquid particles can be elevated by kinetic energy

Note 1 to entry: It is expressed as the square of the *velocity* (3.113) divided by twice the acceleration due to gravity.

3.59
gauged head
elevation of the free surface above the horizontal datum of a section

3.60
total head
energy head
H
sum of the elevation of the free surface above the horizontal datum of a section plus the *velocity head* (3.58) based on the *mean velocity* (3.56) at that section

Note 1 to entry: The total head, *H*, is given by the following formula:

$$H = h + \alpha \frac{\bar{v}^2}{2g}$$

where

h is the gauged head of *water level* (3.64);

$\bar{v}$ is the mean velocity of the water;

α is the Coriolis coefficient;

g is the acceleration due to gravity.

Note 2 to entry: The Coriolis coefficient ($\alpha \geq 1$), also known as “energy coefficient” or “energy correction factor”, takes into account the non-uniform velocity distribution. In many cases, α is assumed to equal unity.

3.61
total head line
energy head line
plot of the *total head* (3.60) in the direction of *flow* (3.3)

3.62
energy gradient
difference in *total head* (3.60) per unit horizontal distance, measured in the direction of *flow* (3.3)

3.63
energy loss
head loss
difference in *total head* (3.60) between two cross-sections in the direction of *flow* (3.3)

3.64
water level
stage
gauge height
elevation of the free surface of a *stream* (3.26), lake or reservoir relative to a specified datum

3.65
reference gauge
stage gauge that *discharge* (3.5) is normally linked to

3.66
stage-discharge relation
rating curve
rating table
equation, curve or table that expresses the relation between the stage and the *discharge* (3.5) in an *open channel* (3.19) at a given cross-section

3.67
hydrograph
<open channel flow> graphical representation of changes of hydrometric parameters with respect to time

Note 1 to entry: Typically, stage and discharge hydrographs are used for open channel flows.

3.68
cumulative volume curve
curve in which the cumulative value of a hydrometric parameter is plotted against time

Note 1 to entry: Integral of the *hydrograph* (3.67), such as cumulative discharge curve.

3.69
storage curve
table
curve depicting the volume of stored water plotted against *water level* (3.64)

3.70
gauging station
site on a *stream* (3.26), *river* (3.27) or lake at which systematic measurements of *water level* (3.64), *velocity* (3.113) or *discharge* (3.5) or any combination of the three are made

3.71
slope station
twin-gauge station
gauging station (3.70) at which two water-level *gauges* (3.40) define a *reach* (3.34) for measurement of water-surface slope as an essential parameter for establishing a *stage-discharge relation* (3.66)

3.72
control
physical properties of a cross-section or a *reach* (3.34) of an *open channel* (3.19), either natural or artificial, that govern the relation between stage and *discharge* (3.5) at a location in the open channel

3.73
rating
relation between *discharge* (3.5) and other variables, or the taking of observations and making of calculations needed to establish the relation

3.74
unit-fall rating
relation between stage and *discharge* (3.5) when the *fall* (3.48) is equal to one

3.75
afflux
rise in *water level* (3.64) immediately upstream of, and due to, an obstruction

3.76
backwater curve
profile of water surface, along an *open channel* (3.19), from the raised surface at an obstruction or confluence to the point upstream at which the *flow* (3.3) is at normal *depth* (3.78)

Note 1 to entry: The term is also used to denote all liquid surface profiles that are non-uniform with respect to distance upstream or downstream. However, this usage is deprecated.

3.77
drawdown curve
profile of the liquid surface when its *surface slope* (S_w) (3.47) exceeds the *bed slope* (S_o) (3.44)

Note 1 to entry: From the point at which the bed slope increases, or bed level drops abruptly, to the point at which normal *depth* (3.78) occurs, the profile along an *open channel* (3.19) is convex upwards in an upstream direction and concave upwards in a downstream direction.

3.78
depth
D
linear dimension measured in the vertical direction from the water surface to the bed

3.79
peak stage
maximum instantaneous stage during a given period

3.80
friction
drag
boundary shear resistance that opposes the *flow* (3.3) of a liquid

3.81
conveyance
K
carrying capacity of a *channel* (3.18)

Note 1 to entry: The term "conveyance factor" is also used, e.g. in the formula:

$$K = QS^{-1/2}$$

where

K is the conveyance factor;

Q is the total *discharge* (3.5);

S is the *energy gradient* (3.62).

3.82
hydraulic jump
sudden transition from *supercritical flow* (3.13) to *subcritical flow* (3.12)

Note 1 to entry: Immediately upstream of the hydraulic jump, the *velocity* (3.113) and the *depth* (3.78) are respectively greater and less than their critical values. Beyond the jump, the velocity and the depth are respectively less and greater than their critical values.

3.83
hydraulic mean depth
mean depth
D_m
area of the cross-section of water flowing in an *open channel* (3.19) divided by the width of the open channel at the water surface

3.84
hydraulic radius
r_h
wetted cross-sectional area of water flowing in an *open channel* (3.19) divided by the length of the *wetted perimeter* (3.50) at that cross-section

3.85
gauge datum
elevation of the zero of the *gauge* (3.40) to which the level of the liquid surface is referred

Note 1 to entry: The gauge datum is related to a *benchmark* (3.86).

3.86
benchmark
permanent mark, the elevation of which should be related, where practicable, to a national datum

3.87
gauge/float well
stilling well/tube
chamber open to the atmosphere and connected with the *stream* (3.26) in such a way as to permit the measurement of the *water level* (3.64) in relatively still water

3.88
roughness coefficient
coefficient that characterizes the roughness of the channel cross-section and which is taken into account when computing the resistance to *flow* (3.3) or the *energy gradient* (3.62)

Note 1 to entry: The common types are the Manning's/Strickler n, Chezy C or an element roughness height, k.

3.89
Froude number
Fr
mean velocity (3.56) divided by the square root of the product of the *hydraulic mean depth* (3.83) and the acceleration due to gravity

$$Fr = \frac{\bar{v}}{(gD_m)^{1/2}}$$

where

$\bar{v}$ is the mean velocity of the liquid;

g is the acceleration due to gravity;

D_m is the hydraulic mean depth of the cross-section.

Note 1 to entry: The Froude number is dimensionless.

3.90
Reynolds number
Re
ratio of the forces of inertia to forces of *viscosity* (11.68)

Note 1 to entry: For *open channels* (3.19):

$$Re = \frac{\bar{v} r_h}{\eta}$$

where

$\bar{v}$ is the *mean velocity* (3.56) of the liquid;

r_h is the *hydraulic radius* (3.84) of the cross-section;

η is the *kinematic viscosity* (11.69) of the liquid.

Note 2 to entry: The Reynolds number is dimensionless.

3.91
free surface flow
flow (3.3) within a closed or open conduit, under gravity and having a free surface

Note 1 to entry: Where the flow exceeds the free surface capacity of the conduit, the flow will become surcharged with the consequent disappearance of the free surface. Instances of surcharging of short duration do not normally affect the overall concept of free surface flow in closed conduits.

3.92
hydrological cycle
constant movement of water in all states of its form, above, on and below the Earth's surface

3.93
hydrogeology
study of subsurface water in its geological context

3.94
live storage
reservoir storage which can be drawn off for users downstream

3.95
total storage
reservoir storage between the lowest bed level and the top *water level* (3.64)

3.96
flood storage
volume of water temporarily held above the top *water level* (3.64) of a reservoir during a flood event

Note 1 to entry: Flood storage is not retained in the reservoir but is discharged through an overflow until the normal top water level is reached.

3.97
standing wave
stationary wave
curved symmetrically shaped wave on the water surface and on the *channel bed* (3.43) that is virtually stationary

Note 1 to entry: When standing waves form, the water surface and the bed surfaces are roughly parallel and in phase.

3.98
tributary
surface or underground *stream* (3.26) which contributes its water, continuously or intermittently, to another stream

3.99
river delta
reach (3.34) of a *river* (3.27) when it approaches a body of quieter water with very gradual *bed slope* (S_0) (3.44) and *surface slope* (S_w) (3.47), and, at low *velocity* (3.113), deposits its sediment and divides out into *channels* (3.18) on either side of the deposits, resulting in the formation of deltas

3.100
annual flood
highest momentary peak *discharge* (3.5), recorded at the respective point of observation, which is equalled or exceeded once every year

3.101
annual storage within-the-year storage
difference between the maximum and minimum volumes in storage over a year of reservoir operation

3.102
base flow
sustained flow of a *stream* (3.26) resulting from outflow of *groundwater* (11.1) and from drainage of large lakes and swamps

Note 1 to entry: Base flow includes water sustained in *glaciers* (10.9), snow and other sources, not a result of direct *runoff* (3.4).

3.103
drainage basin
catchment area
part of the land area enclosed by a topographic divide from which direct surface *runoff* (3.4) from *precipitation* (9.9) drains by gravity into a *stream* (3.26) or other water body

3.104
frazil ice
fine spicules, plates or discoids of ice suspended in water that are generally formed by the supercooling of turbulent water

Note 1 to entry: Frazil ice may float or accumulate under *surface ice* (3.107) or adhere to the *channel bed* (3.43) as *anchor ice* (3.105).

3.105
anchor ice
submerged ice found attached to the bed, irrespective of the nature of its formation

3.106
rime ice
white mass of tiny ice crystals or granular ice tufts formed on exposed objects due to atmospheric moisture

3.107
surface ice
ice cover
ice sheet
layer of ice formed on the surface of a lake or *river* (3.27)

3.108
flow regime
state of *flow* (3.3) in alluvial *streams* (3.26) characterized by a bed configuration of *ripples* (3.111), *dunes* (3.109) (lower regime), plane bed (transition), *standing waves* (3.97) and *antidunes* (3.110) (upper regime)

Note 1 to entry: The lower-regime flow is subcritical. The upper-regime flow is supercritical.

3.109
dune
large bed form having a triangular profile, a gentle upstream slope and a steep downstream slope

Note 1 to entry: Dunes are formed in quiet flow and thus are out of phase with any possible water surface disturbance they produce. They travel slowly downstream as sand is moved across their comparatively gentle upstream slopes and deposited on their steeper downstream slopes.

3.110
antidune
bed form of a curved symmetrically shaped sand or gravel wave that may move upstream, remain stationary or move downstream

Note 1 to entry: Antidunes are curved in a wave train but they are in phase and interact strongly with gravity water surface waves.

3.111
ripple
small triangular-shaped bed form similar to a *dune* (3.109)

Note 1 to entry: Ripples have much smaller and more uniform amplitudes and lengths than dunes. Ripple wavelengths are less than 0,6 m and wave heights are less than 0,06 m.

3.112
transition
crossover
inflection *reach* (3.34) between two meander loops in which the main *flow* (3.3) crosses from one side of the *channel* (3.18) to the other

Note 1 to entry: The *depth* (3.78) of flow in a transition is usually reduced from normal depth and is more uniform than in the curved reach.

3.113
velocity
speed of *flow* (3.3) past a point in a specified direction

3.114
gauge height of zero flow
highest point on the *thalweg* (3.36) downstream from the *gauge* (3.40) in a natural or artificial *channel* (3.18)

3.115
shift adjustment
correction made to the recorded *water level* (3.64) to compensate for vertical movement of the bed or for shifting of the control reach

3.116
shift diagram
curve or set of curves expressing the relation between *water level* (3.64) and *shift adjustment* (3.115) for a given *rating* (3.73)

3.117
turbulent flow
flow (3.3) in which water particles move in irregular paths that is not laminar or streamline flow and for which the *Reynolds number* (3.90) is greater than the critical Reynolds number

3.118
laminar flow
flow (3.3) of a fluid in which the viscous forces are predominant and in which, in channel flow, the fluid particles move in approximately definite and relatively smooth paths with no significant transverse mixing

Note 1 to entry: The *Reynolds number* (3.90) is smaller than 500 to 2 000 in flow channels and smaller than 1 to 10 in flow through porous media.

Note 2 to entry: Groundwater flow is laminar flow under natural conditions.

4 Terms related to velocity-area methods

4.1
current-meter
instrument for measuring water *velocity* (3.113)

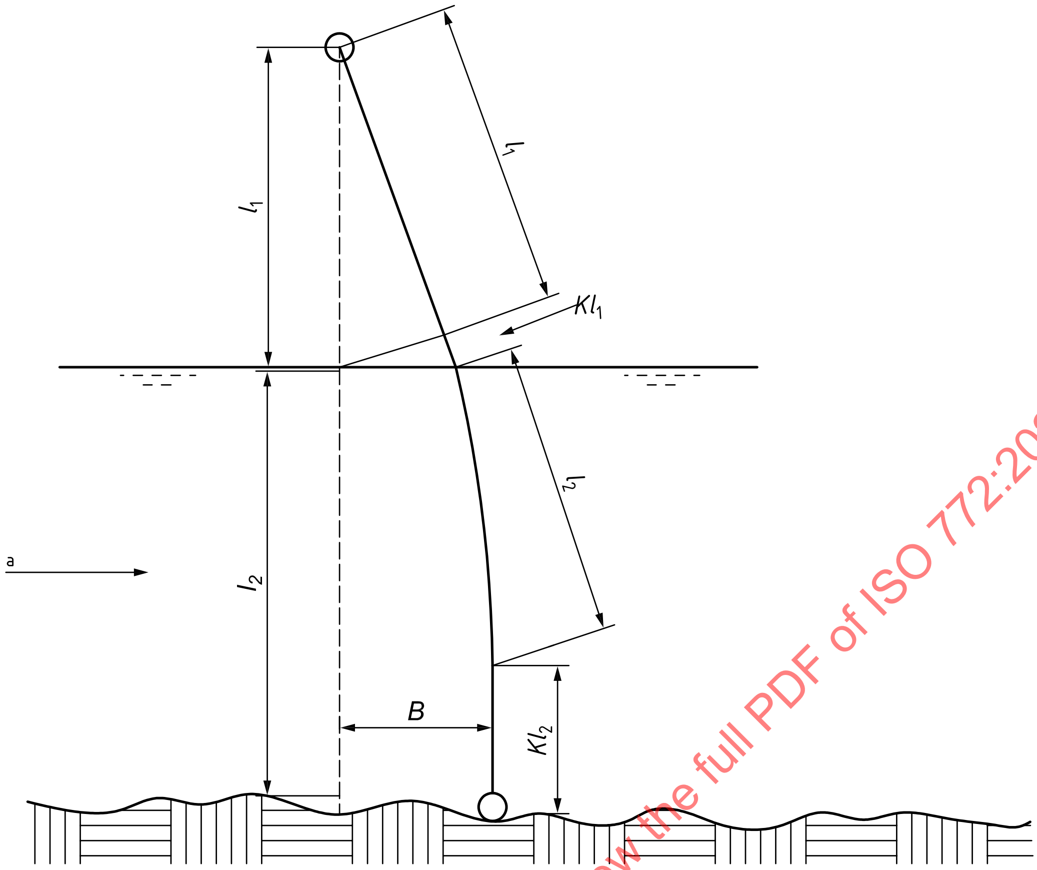
4.2
drift
<measuring boat> distance that a measuring boat travels during the time taken to make a stationary *velocity* (3.113) observation/measurement

4.3
period of pulsation
average period of a cycle of pulsation during which the *velocity* (3.113) in the cross-section fluctuates between limiting high and low values

4.4
sounding
operation of measuring the *depth* (3.78) from the free surface to the bed

4.5
air line correction
correction to the *sounding line* (7.16) measurement applied to that part of the sounding line above the liquid surface

Note 1 to entry: See Figure 1.



Key

kl_1 *air line correction* (4.5)

kl_2 *wet line correction* (4.6)

B *drift* (4.2)

a Direction of flow.

Figure 1 — Sounding line corrections

4.6
wet line correction
correction to the *sounding line* (7.16) measurement applied to that part of the sounding line below the liquid surface

Note 1 to entry: See Figure 1.

4.7
standard current-meter
calibrated *current-meter* (4.1) used as a basis of comparison with other current-meters

4.8
velocity integration method
<velocity-area measurement> method of measuring the *velocity* (3.113) along a *vertical* (4.29), involving the raising and lowering of a *current-meter* (4.1) at a constant rate through the entire *depth* (3.78) of the vertical

4.9
point velocity method
method of measuring the *velocity* (3.113) along a *vertical* (4.29) by placing a *current-meter* (4.1) at a number of designated points in the vertical

Note 1 to entry: The velocity is usually measured at one, two, three, five or six points on the vertical.

4.10
one-point method
method in which observations of *velocity* (3.113) are made in each *vertical* (4.29) at one point below the surface

4.11
multi-point method
method in which observations of *velocity* (3.113) are made in each *vertical* (4.29) at two points or more points (up to six) below the surface

4.12
moving boat method
method of measuring *discharge* (3.5) from a boat by traversing the *stream* (3.26) along the *gauging section* (3.52) while continuously measuring *velocity* (3.113), *depth* (3.78) and distance travelled, and angle of current velocity

4.13
cubature
numerical technique for computing *discharge* (3.5) in a *tidal channel* (3.23) at a cross-section from the rates of change in volume of water up to the tidal limit, with algebraic allowance for the fresh water discharges entering the channel

Note 1 to entry: The maximum volume is usually that occurring at high water of spring *tide* (3.24).

4.14
looped stage-discharge curve
hysteresis of the stage-discharge relation
effect on the *stage-discharge relation* (3.66) at a *gauging station* (3.70) where, for the same *water level* (3.64), the *discharge* (3.5) on the rising stage is different from that on the falling stage

4.15
sensitivity of the stage-discharge relation
measure of the change in stage of a *gauging station* (3.70) due to a change in *discharge* (3.5)

Note 1 to entry: When a small change in discharge produces a relatively large change in stage, the relation is said to be sensitive. When a large change in discharge produces a relatively small change in stage, the relation is said to be non-sensitive.

4.16
stilling well lag
difference at a given instant between the channel stage and the stilling well stage

4.17
stage fall-discharge relation
slope-stage-discharge relation
family of curves that expresses the relationship between the free water surface slope (S_w) stage and *discharge* (3.5) in a given *reach* (3.34) of an *open channel* (3.19) subject to variable backwater

4.18
seiche
oscillation of the surface of a liquid caused mainly by winds and variations in atmospheric pressure

4.19
salt-water wedge
wedge-like intrusion of a large mass of salt water flowing in from the sea under the fresh water in a tidal waterway

4.20
flood flow
flow (3.3) corresponding to or exceeding the natural *bankfull stage* (4.21)

4.21
bankfull stage
water level (3.64) at which an open watercourse just overflows its natural banks

4.22
tidal amplitude
one-half of the difference in height between consecutive high water and low water, hence half the *tide* (3.24) range

4.23
tidal prism
volume of water flowing into a *tidal channel* (3.23) on high *tide* (3.24)

4.24
index velocity method
method used to compute the *discharge* (3.5) by multiplying mean channel *velocity* (3.113) and cross-sectional area using outputs from index velocity rating and cross-sectional area, which are derived from stage-area rating, respectively

4.25
rating change
any change in the *stage-discharge relation* (3.66) due to temporary or permanent, sudden or gradual modifications of the *controls* (3.72)

4.26
rating shift
correction of the *stage-discharge relation* (3.66), usually the offsets of one or several *controls* (3.72) to account for a *rating change* (4.25)

4.27
velocity-area method
method of determining *discharge* (3.5) from the area of the cross-section, bounded by the *wetted perimeter* (3.50) and the free surface, while integrating the component *velocities* (3.113) in the cross-section

4.28
slope-area method
indirect method of determining *discharge* (3.5) in a *reach* (3.34) which is based on the friction (energy) slope (S), the reach roughness, the *wetted perimeters* (3.50) and the flow areas of the various *wetted cross-sections* (3.51) in the reach

4.29
vertical
vertical line on which *velocity* (3.113) measurements or *depth* (3.78) measurements are made

4.30
vertical velocity curve
vertical velocity distribution
variation in *velocity* (3.113) in a *stream* (3.26) or *river* (3.27) between the surface and bed which can be represented as a curve for that specific *vertical* (4.29)

4.31
vertical velocity coefficient
coefficient applied to a single velocity determination at any *depth* (3.78) on a vertical to infer the *mean velocity* (3.56) on that *vertical* (4.29)

4.32
reference current-meter
current-meter (4.1) that is immersed at a fixed position in the cross-section during the *discharge* (3.5) measurement

Note 1 to entry: For slight changes in discharge during the gauging operation, it is assumed that the change in *velocity* (3.113) indicated by the reference current-meter is proportional to the change in discharge.

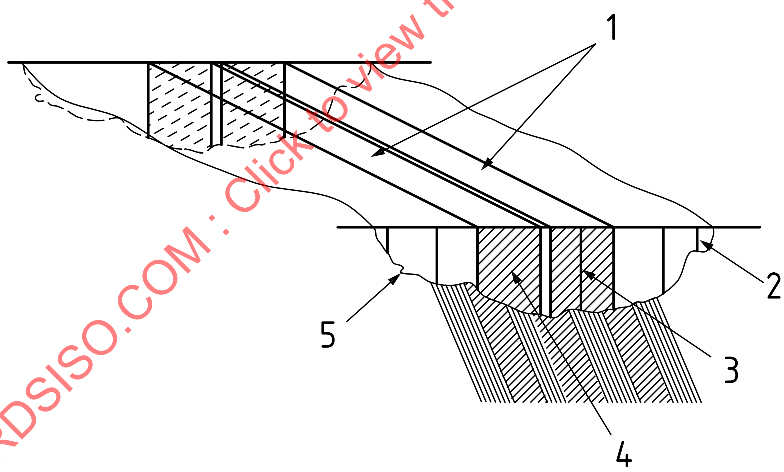
4.33
float gauging
measurement of *velocity* (3.113) of a *stream* (3.26) by means of a *float* (7.19) or floats

4.34
mean section segment
area bounded by two consecutive *verticals* (4.29) in a cross-section, the bed of the *open channel* (3.19) and the water surface

Note 1 to entry: See Figure 2.

4.35
mid-section segment
area at a *vertical* (4.29) defined by the *depth* (3.78) at that vertical multiplied by one-half of the distance between the preceding and succeeding verticals

Note 1 to entry: See Figure 2.



Key

1 stream panels
2 *vertical* (4.29)
3 *mid-section segment* (4.35)
4 *mean section segment* (4.34)
5 *bed profile* (3.45)

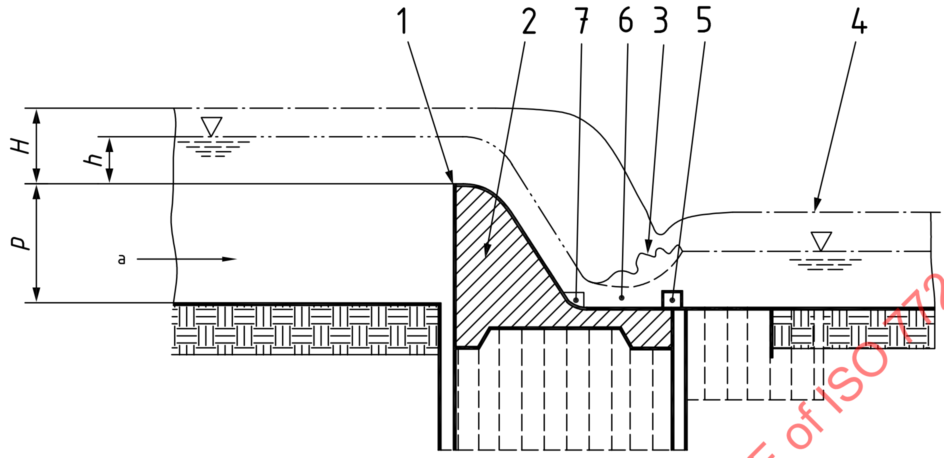
Figure 2 — Geometric definitions

5 Terms related to flow measurement structures

5.1
flow measurement structure
hydraulic structure [e.g. *weir* (5.2), *flume* (5.49), gate] installed in an *open channel* (3.19) where in most cases the *discharge* (3.5) can be derived from the measured upstream *water level* (3.64)

5.2
weir
overflow structure that may be used for controlling the upstream *water level* (3.64) or for measuring *discharge* (3.5) or both

Note 1 to entry: See Figure 3.



Key

1 weir crest
2 *weir block* (5.8)
3 *hydraulic jump* (3.82)
4 *total head line* (3.61)
5 *control block* (5.19)
6 *stilling basin* (5.20)
7 *baffle* (5.18)
H total head over crest
h head over crest
p *height of weir* (5.3)
a Direction of flow.

Figure 3 — Weir

5.3
height of weir
apex height
height from the upstream bed to the lowest point of the crest

5.4
head over the weir
elevation of the water surface above the lowest point of the crest, measured at a point sufficiently upstream to be unaffected by the *drawdown curve* (3.77) of the *weir* (5.2)

Note 1 to entry: The distance upstream of the point of measurement depends on the type of weir used.

5.5
upstream total head
elevation of the *total head* (3.60) relative to the flume invert level or the level of lowest point of the crest, measured upstream of the structure

5.6
downstream total head
elevation of the *total head* (3.60) relative to the flume invert level or the level of lowest point of the crest, measured downstream of the structure

5.7
weir abutment
abutment
wing wall
wall at the side of a *channel* (3.18), generally parallel to the longitudinal axis of the *weir* (5.2), against which the weir terminates

5.8
weir block
weir body
part of a *weir* (5.2) lying between the *weir abutments* (5.7) and over which the water flows

5.9
full-width weir
suppressed weir
weir (5.2) whose crest fills the width of the *channel* (3.18) in which it is placed, thus eliminating the side contraction of the *stream* (3.26)

5.10
divide wall
wall running in the direction of *flow* (3.3) and separating the individual sections of a *compound structure* (5.47)

5.11
glacis
sloping downstream face of a *weir block* (5.8) and continuation of the crest

5.12
weir slope
ratio of the horizontal to the vertical components of the upstream face, the downstream face or the *cross-slope* (5.15) of a *weir* (5.2)

5.13
upstream face weir slope
ratio of the horizontal to the vertical components of the upstream face of a *weir* (5.2)

5.14
downstream face weir slope
ratio of the horizontal to the vertical components of the downstream face of a *weir* (5.2)

5.15
cross-slope
ratio of the horizontal to the vertical components of the slope of a *weir* (5.2)

5.16
approach channel
reach (3.34) of the *channel* (3.18) upstream of the gauging structure in which suitable flow conditions have to be established to ensure correct gauging

5.17
straightening vane
guide vane
device placed in the approach to improve flow conditions

Note 1 to entry: A similar purpose is served by the use of *baffles* (5.18).

5.18
baffle
wall or block placed downstream of a structure to dissipate energy or to cause improved velocity distribution

5.19
control block
baffle pier
energy-breaking block
block constructed in a *channel* (3.18) or *stilling basin* (5.20) to increase turbulence and thereby dissipate the energy of water flowing at high *velocity* (3.113)

Note 1 to entry: See Figure 3 for the application of a control block to a weir construction.

5.20
stilling basin
basin constructed downstream of a structure to dissipate the energy of fast-flowing water and to protect the bed and banks from erosion

Note 1 to entry: See Figure 3.

5.21
separation pocket
<at a corner or at a point of large curvature> region of recirculating *flow* (3.3) in a structure caused by separation of the main flow from the structure

Note 1 to entry: This phenomenon can occur at *broad-crested weirs* (5.31) which do not have rounded upstream or downstream corners or which do not have a crest of sufficient length in the direction of flow.

5.22
separation pocket
<triangular-profile weir> near-cylindrical volume of slowly moving water immediately downstream of the crest of the structure

5.23
throat
part of a *flume* (5.49) at which *critical flow* (5.29) occurs, usually where the wetted cross-sectional area is at a minimum

Note 1 to entry: The throat can be rectangular, trapezoidal, U-shaped or another specially designed shape.

5.24
modular flow
free flow
flow (3.3) over or through a structure when the upstream *water level* (3.64) is independent of the downstream water level for a given *discharge* (3.5)

5.25
discharge coefficient
coefficient in the discharge equation depending on the type and shape of the measuring structure and the *head over the weir* (5.4)

5.26
modular limit
submergence ratio (5.28) for *flow* (3.3) over a *weir* (5.2) at which the upstream *water level* (3.64) just begins to be affected by the downstream water level for a given *discharge* (3.5)

5.27
drowned flow
non-modular flow
submerged flow
flow (3.3), over or through a structure, when it is affected by changes in the *water level* (3.64) downstream

5.28
submergence ratio
ratio of the *downstream total head* (5.6) to the *upstream total head* (5.5) in a structure

5.29
critical flow
<flow measurement structures> flow conditions for which the *total head* (3.60) above the *channel bed* (3.43) reaches a minimum at a given *discharge* (3.5) and for given channel dimensions

Note 1 to entry: The water *depth* (3.78) for these flow conditions is called *critical depth* (3.16) and occurs during the *transition* (3.112) from *subcritical flow* (3.12) to *supercritical flow* (3.13).

Note 2 to entry: Critical flow in overflow structures and undershot gates occurs at the critical section, also called the "control section". Critical flow in a measuring structure is a condition for *modular flow* (5.24).

5.30
double gauging
measurement of two simultaneous but independent heads to facilitate measurement in the *drowned flow* (5.27) range

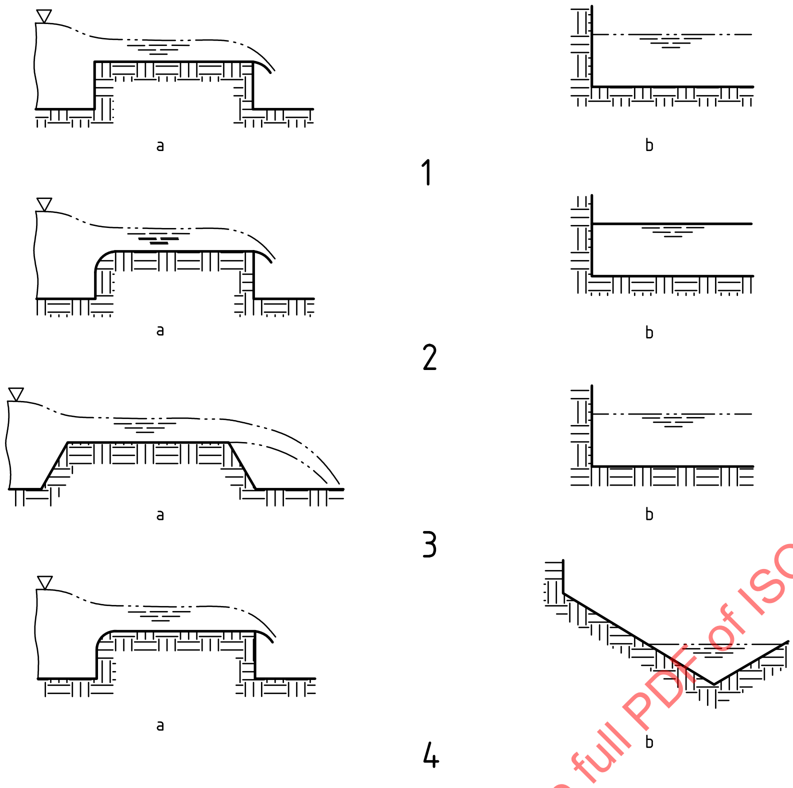
Note 1 to entry: The usual head measurement locations lie between 3 H_{max} upstream of the *weir* (5.2) and 3 H_{max} downstream of the weir, where H_{max} is the maximum total head over the weir crest.

5.31
broad-crested weir
weir (5.2) with a horizontal longitudinal crest which has a length equal to or greater than the maximum operating head

Note 1 to entry: The streamlines above the crest are approximately straight and parallel, at least over a short distance.

Note 2 to entry: The maximum operating head is the maximum head up to which the weir can be used for *discharge* (3.5) measurement as per the limits of design.

Note 3 to entry: See Figure 4.



Key

1 *rectangular broad-crested weir* (5.32)
2 *round-nosed broad-crested weir* (5.33)
3 *trapezoidal broad-crested weir* (5.34)
4 *V-shaped broad-crested weir* (5.35)

a Longitudinal profile.
b Cross-section.

Figure 4 — Broad-crested weirs

5.32
rectangular broad-crested weir
broad-crested weir (5.31) of which the crest is a horizontal rectangular plane surface and of which the upstream face forms a sharp right-angled corner at its intersection with the plane of the crest

Note 1 to entry: See Figure 4.

5.33
round-nosed broad-crested weir
broad-crested weir (5.31) of which the crest is a horizontal rectangular plane surface and of which the upstream corner is rounded to avoided flow separation

Note 1 to entry: See Figure 4.

5.34
trapezoidal broad-crested weir
broad-crested weir (5.31) of which the crest is a horizontal plane surface and of which the upstream face and the downstream face are sloping

Note 1 to entry: See Figure 4.

5.35
V-shaped broad-crested weir
broad-crested weir (5.31) with a triangular cross-sectional profile, rounded off at the upstream corner

Note 1 to entry: See Figure 4.

5.36
nappe
jet formed by the *flow* (3.3) over a *weir* (5.2)

Note 1 to entry: See Figure 5.

5.37
clinging nappe
nappe (5.36) that maintains contact with the downstream face of a *weir* (5.2)

5.38
unconfined nappe
nappe (5.36) where the guide walls of the structure end at the crest (or at the edge), thus permitting free lateral expansion of the *flow* (3.3)

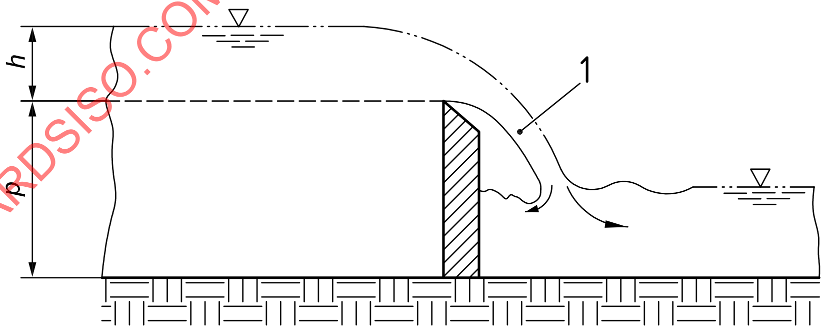
5.39
fully ventilated nappe
fully aerated nappe
nappe (5.36) springing clear of the downstream face of the *weir* (5.2) with atmospheric pressure on the underside of the nappe

5.40
fully developed contraction
<nappe> contraction that occurs when further increases in the *depth* (3.78) or width of the *approach channel* (5.16) no longer affects the *nappe* (5.36)

5.41
thin-plate weir
sharp-crested weir
weir (5.2) constructed of a vertical thin plate from which the *nappe* (5.36) springs clear of the crest, provided that the nappe is ventilated

Note 1 to entry: The streamlines above the crest are strongly curved.

Note 2 to entry: See Figure 5.



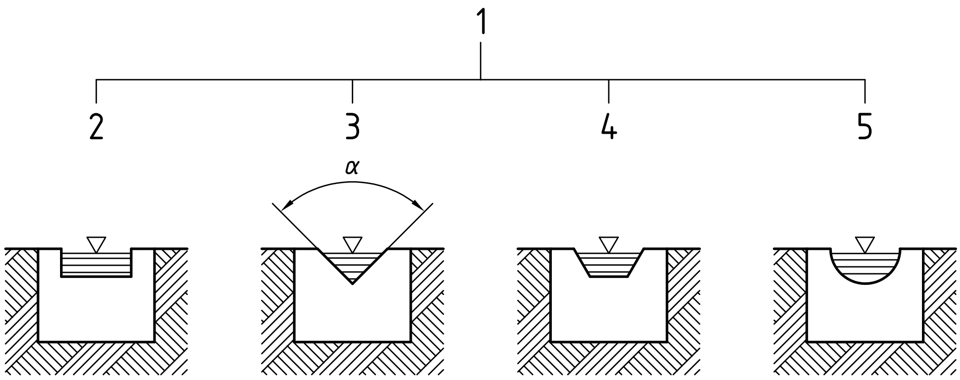
Key

1 *nappe* (5.36)
p *height of weir* (5.3)
h head

Figure 5 — Thin-plate weir longitudinal section

5.42
thin-plate notch weir
weir (5.2) whose crest is a notch cut in a thin plate

Note 1 to entry: See Figure 6.



Key

1 *thin-plate notch weir* (5.42)

2 rectangular

3 triangular (V-notch)

4 trapezoidal

5 circular

Figure 6 — Thin-plate weirs cross-section

5.43
short-crested weir
weir (5.2) with a horizontal longitudinal crest that is shorter in length than half the maximum operating head or with a longitudinal crest which is concave, convex or uneven

Note 1 to entry: The streamlines above the crest are curved.

Note 2 to entry: The maximum operating head is the maximum head up to which the weir can be used for *discharge* (3.5) measurement as per the limits of design.

5.44
triangular-profile weir
two-dimensional *weir* (5.2) with a triangular longitudinal profile

Note 1 to entry: Usually, the upstream slope is 1:2 and the downstream slope is 1:5.

Note 2 to entry: See Figure 7.

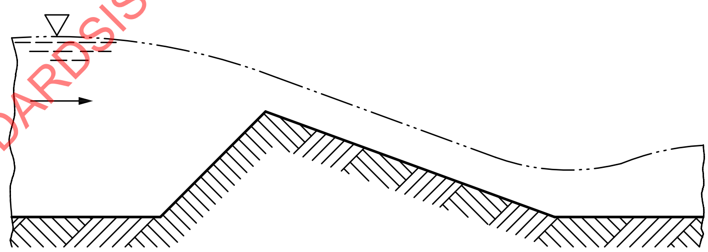


Figure 7 — Triangular-profile weir (longitudinal profile)

5.45
streamlined triangular-profile weir
two-dimensional *weir* (5.2) with a triangular longitudinal profile in which the sharp edge between the two sloping faces is replaced by a circular arc connecting the two faces tangentially

5.46
flat-V weir
triangular-profile weir (5.44) with a crest that is shallow and V-shaped when viewed in the direction of *flow* (3.3)

Note 1 to entry: Usually, the *cross-slope* (5.15) of the V shape is 1:10, 1:20 or 1:40.

Note 2 to entry: See Figure 8.

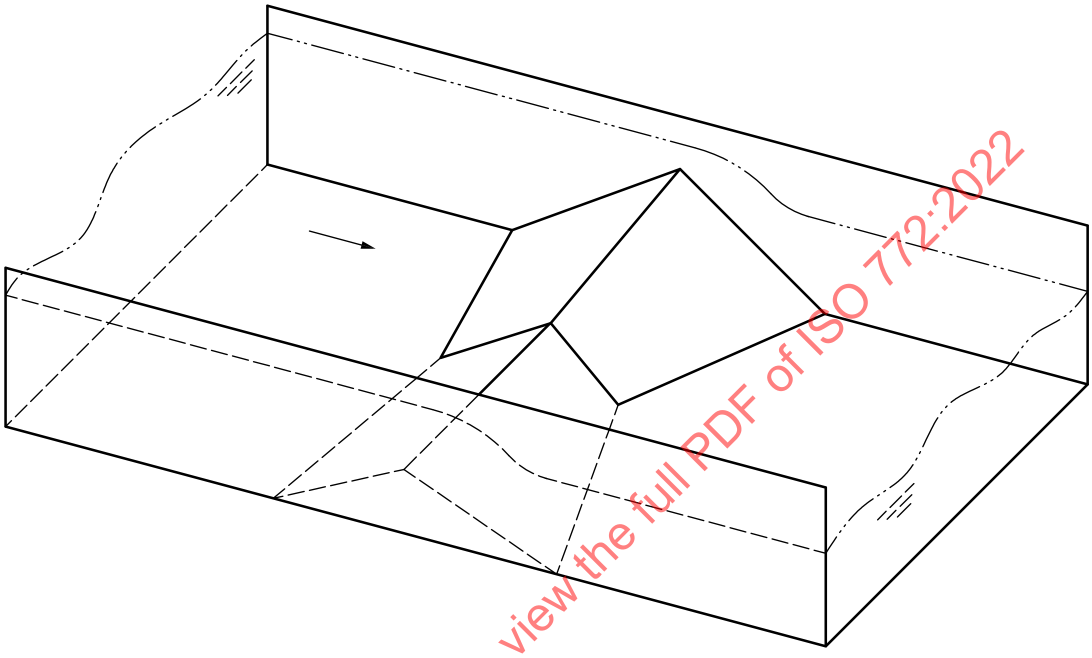
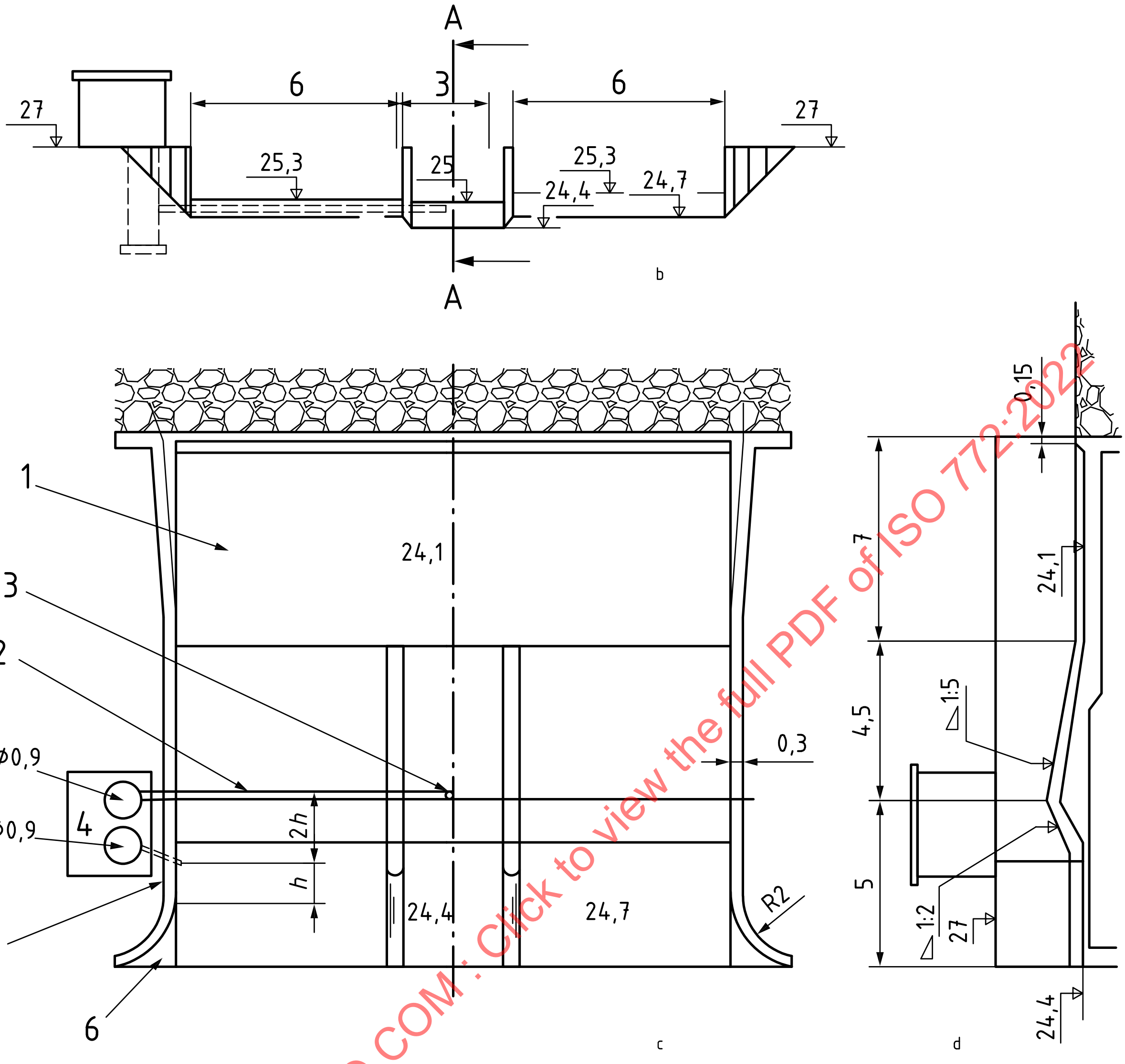


Figure 8 — Flat-V weir

5.47
compound structure
series of *weirs* (5.2) and/or *flumes* (5.49) that may be of different crest levels, which are disposed across the width of an *open channel* (3.19) and separated by *divide walls* (5.10)

Note 1 to entry: See Figure 9 for an example of a compound structure design.

Dimensions in metres



Key

1 *stilling basin* (5.20)

2 crest-tapping pipe: ø0,1

3 connecting pipe to crest-tapping box (0,3×0,6×0,15): ø0,01

4 recorder housing

5 intake: ø0,1

6 transition formed

h head over weir

a Direction of flow.

b Section.

c Plan.

d Longitudinal section.

Figure 9 — Example of compound structure design

5.48
end-depth method
approximate method to establish the *discharge* (3.5) in a horizontal or gently sloping *channel* (3.18), when the bed is discontinued abruptly, by measuring the head exactly at the commencement of the free overfall

5.49
flume
streamlined constriction in an *open channel* (3.19) usually consisting of an entrance section, a *throat* (5.23) section and a downstream expansion, that can be used for measurement of *flow* (3.3)

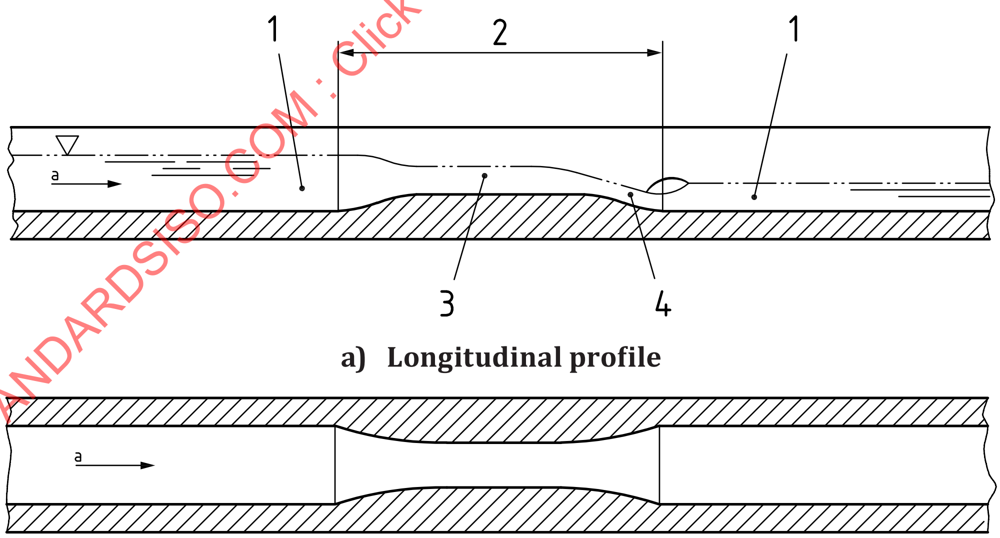
5.50
critical-depth flume
standing-wave flume
measuring *flume* (5.49) of dimensions that produce *critical flow* (5.29) in the *throat* (5.23) and in which the measurement of only the upstream *water level* (3.64) permits the calculation of *discharge* (3.5)

5.51
long-throated flume
measuring *flume* (5.49) having a *throat* (5.23) length equal to or greater than the maximum operating head

Note 1 to entry: The streamlines in the throat section are approximately straight and parallel, at least over a short distance.

Note 2 to entry: The maximum operating head is the maximum head up to which the *weir* (5.2) can be used for *discharge* (3.5) measurement as per the limits of design.

Note 3 to entry: See Figure 10.



a) Longitudinal profile

b) Plan view

Key

1 *subcritical flow* (3.12)

2 *throat* (5.23)

3 *critical flow* (5.29)

4 *supercritical flow* (3.13)

a Direction of flow.

Figure 10 — Long-throated flume

5.52
short-throated flume
measuring *flume* (5.49) having a shorter *throat* (5.23) length than the maximum operating head

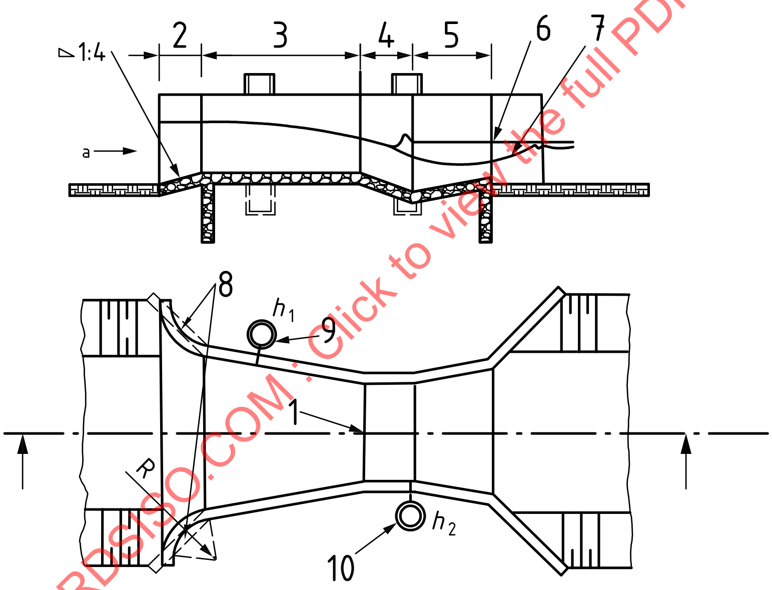
Note 1 to entry: The streamlines in the throat section are curved.

Note 2 to entry: The maximum operating head is the maximum head up to which the *weir* (5.2) can be used for *discharge* (3.5) measurement as per the limits of design.

5.53
throatless flume
measuring *flume* (5.49) which does not have a parallel-walled *throat* (5.23) and which does not generate parallel flow at the critical section

5.54
Parshall flume
measuring *flume* (5.49) having a converging entrance section with a level floor, a short-throat section with a floor inclined downwards at a gradient of 3:8, a diverging exit section with a floor inclined upwards at a gradient of 1:6, and a specified cross-section depending upon the range of *discharge* (3.5) flowing in the *channel* (3.18)

Note 1 to entry: See Figure 11.



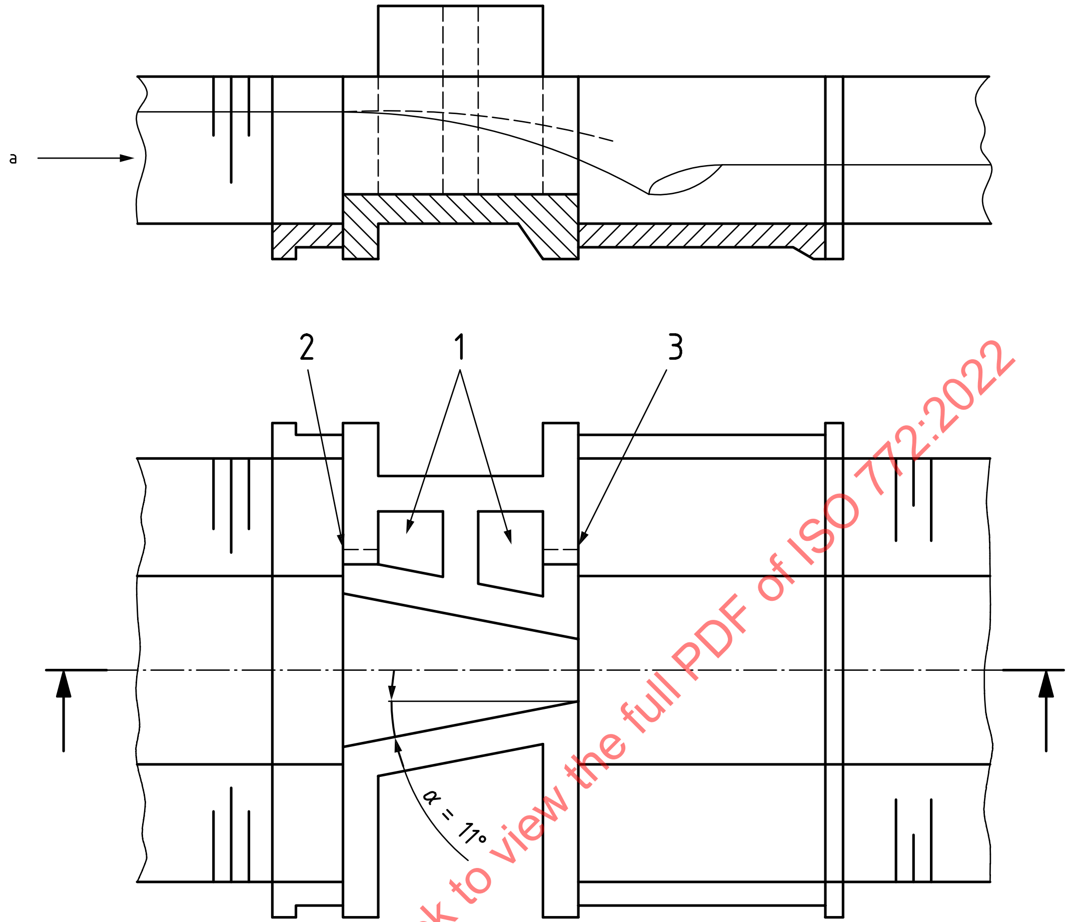
Key

1 crest
2 approach floor
3 level floor – converging section
4 *throat* (5.23)
5 diverging section
6 partially submerged flow
7 *modular flow* (5.24)
8 alternative 45° *weir abutment* (5.7)
9 upstream gauge well
10 downstream gauge well
a Direction of flow.

Figure 11 — Parshall flume

5.55
Saniiri flume
measuring *flume* (5.49) with a converging entrance section having a level floor with a *fall* (3.48) at its downstream end and vertical walls to join it to the downstream *channel* (3.18)

Note 1 to entry: See Figure 12.



Key

1 stilling wells

2 h_1 intake

3 h_2 intake

a Direction of flow.

Figure 12 — Saniiri flume

5.56
vertical underflow gate
vertical gate, situated in a *channel* (3.18) of rectangular cross-section with a flat bed, for regulating the *water level* (3.64) upstream of the gate or the *discharge* (3.5) through the gate opening

Note 1 to entry: The gate is movable in vertical slots and it can be raised or lowered by hand or mechanically.

Note 2 to entry: The underflow is two-dimensional except at vertically narrow gate openings.

5.57
velocity of approach
approach velocity
mean velocity (3.56) immediately upstream from a hydraulic structure or a measuring site

5.58
crest
section of the structure having the highest elevation, as seen in a longitudinal profile of the *channel* (3.18) and structure

6 Terms related to dilution method

6.1
tracer
chemical or physical markers that are injected in a flow system to track the behaviour of some components of the system

Note 1 to entry: For investigations and measurements of flow behaviour, tracers are used which shall have the following properties:

— the variables to be observed [e.g. flow rate, *discharge* (3.5)] shall not change noticeably when a tracer is added;

— they shall not occur in the water or only in low concentrations;

— they shall dissolve well in the water or mix well with the water;

— they shall not be adsorbed or reduced on the *channel bed* (3.43) or on particles in the water during the measurement;

— the concentration used shall be easy to determine;

— the concentration used shall be biologically compatible and shall not be harmful to the environment.

Note 2 to entry: The used tracers are usually salts (e.g. sodium chloride or potassium chloride), fluorescent substances (e.g. Uranine, Rhodamine B or Amidorhodamine G) or various food colours. Radioactive substances were used as tracers in the past but are no longer used.

6.2
dilution gauging
gauging method in which the *discharge* (3.5) is deduced from the determination of the ratio of the concentration of the injected *tracer* (6.1) to that of the tracer at the *sampling cross-section* (6.12)

6.3
background concentration
concentration of the *tracer* (6.1) substance or a substance that reacts like the tracer in the detection scheme used in the liquid in the *channel* (3.18), and that is not attributable to the injection of the tracer for the gauging, i.e. present upstream or before the injection

6.4
adsorption
fixation of a *tracer* (6.1) from a solution onto the surface of a solid (e.g. sediment in suspension, biological material or snow and ice)

6.5
constant-rate injection method
method of measuring the *discharge* (3.5) in which a *tracer* (6.1) of known concentration is injected at a constant and known rate at one cross-section and its dilution is measured at another section located sufficiently downstream that complete mixing has taken place

6.6
integration method
method of measuring the *discharge* (3.5) in which a known quantity of *tracer* (6.1) is injected over a short time at one cross-section and its dilution is measured at another cross-section located sufficiently downstream that complete mixing has taken place, and allowing sufficient time for all the tracer to pass that cross-section so that the mean concentration of tracer during the sampling time can be determined

6.7
multiple injection
simultaneous injection of *tracer* (6.1) at several points in the injection cross-section with the aim of an improved transverse mixing in a downstream measuring cross-section

6.8
Mariotte vessel
measuring equipment for the injection of a concentrated tracer solution at a constant rate

Note 1 to entry: Constant-rate injection is achieved by means of an airtight vessel provided with an orifice plate or nozzle at its bottom portion. The liquid flows through the constriction and air enters the vessel through a tube maintaining atmospheric pressure at the lower end of the tube set at a determined height above the constriction. This keeps the rate of the injection constant, regardless of the *water level* (3.64) in the vessel.

6.9
mixing length
minimum length of the *reach* (3.34) between the injection cross-section and cross-sections where the *tracer* (6.1) concentration is *homogeneous* (11.94) in the section

6.10
degree of mixing
extent of the mixing of a *tracer* (6.1) which is achieved in a cross-section downstream of the point of injection of the tracer

Note 1 to entry: The degree of mixing immediately downstream of an injection is nearly zero. Complete (100 %) mixing does occur only further downstream.

6.11
dilution ratio
dilution factor
ratio between the concentration of the injected tracer solution and the concentration of added *tracer* (6.1) detected at the *sampling cross-section* (6.12)

6.12
sampling cross-section
cross-section of an *open channel* (3.19), downstream of the injection cross-section, at which *samples* (12.7) are taken or in which *tracer* (6.1) concentration is directly measured

Note 1 to entry: It is recommended to measure at several points in the *sampling cross-section* (6.12) to check that the tracer is well mixed.

6.13
standard solution
calibration solution
reference solution containing a selected concentration of the *tracer* (6.1)

Note 1 to entry: The reference solutions should be prepared on site using the water from the *stream* (3.26) to be measured.

6.14
dispersion of a tracer
process in which different *velocities* (3.113), turbulent motions and the rate of diffusion of a liquid cause the spread of a cloud of dissolved or suspended substances in the liquid

Note 1 to entry: In a *stream* (3.26), the dispersion occurs vertically [in the *verticals* (4.29)], horizontally [in the cross-sections) and longitudinally (in the direction of *flow* (3.3)].

6.15
dispersion coefficient of a tracer
coefficient used to describe the capacity of a moving liquid to dissipate an initially localized *tracer* (6.1) throughout the liquid

Note 1 to entry: In open channel flow, dispersion takes place vertically, transversely and longitudinally. Each component of the dispersion has its own dispersion coefficient.

6.16
mean velocity
<of a reach> *velocity* (3.113) calculated by dividing the flow path length and the median run time of the *tracer* (6.1)

Note 1 to entry: The median run time of tracer is the time difference between the tracer injection (at the input point) and the passage of the centre of gravity of the tracer concentration cloud at the *measuring point* (11.80).

6.17
time of travel of a tracer
time difference between the *tracer* (6.1) injection at the injection point and the occurrence of a certain quantity of tracer at the *sampling cross-section* (6.12)

Note 1 to entry: Time of travel can refer to the first occurrence (minimum time of travel), the peak concentration (intensive time of travel), the centre of gravity concentration (median time of travel) or the last occurrence of the tracer in a *stream* (3.26).

6.18
concentration of a tracer
mass of the substance of the *tracer* (6.1) per volume of the mixture

Note 1 to entry: The tracer concentration is determined by measuring a physical secondary variable (e.g. the conductivity with a conductivity sensor or the intensity of radiation with a fluorometer/photometer). The probe *calibration* (12.18) should therefore be carried out on site with the water to be measured and not with other water.

7 Terms related to instruments and equipment

7.1
vertical gauge
staff gauge
graduated vertical scale, fixed to a staff or to a structure against which the *water level* (3.64) can be read

7.2
inclined gauge
ramp gauge
gauge (3.40) on a slope generally graduated directly on the surface of the gauge to indicate vertical heights

7.3
float gauge
gauge (3.40) consisting essentially of a *float* (7.19) that rides on the water surface and rises or falls with it, its movement being transmitted to a recording or indicating device

7.4
point gauge
gauge (3.40) whose essential element is a graduated pointed rod that is lowered until it touches the water surface

Note 1 to entry: The instant when the point touches the water surface is often indicated by an electrical device.

Note 2 to entry: See Figure 13.

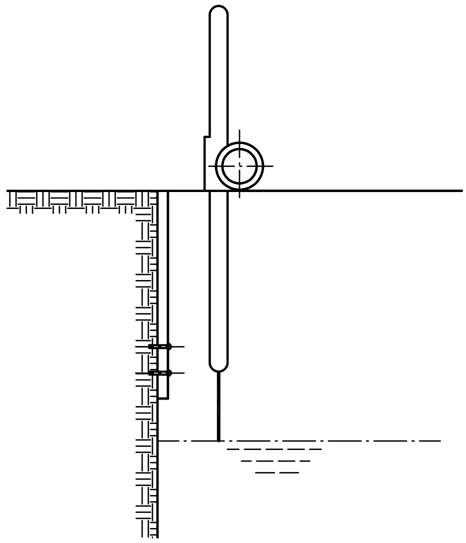


Figure 13 — Point gauge

7.5
hook gauge
gauge (3.40) whose essential element is a pointed hook which, after immersion, is raised until it touches the surface

Note 1 to entry: See Figure 14.

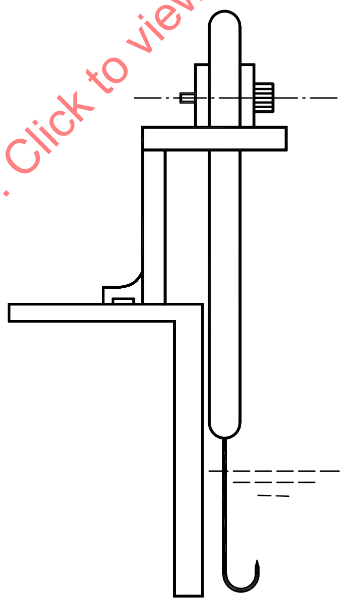


Figure 14 — Hook gauge

7.6
crest stage gauge
peak level gauge
gauge (3.40), usually vertical, used to indicate *peak stage* (3.79)

7.7
bubbler system
gas purge system
water level (3.64) sensor using the method of transmitting liquid pressure in which a small *discharge* (3.5) of non-corrosive gas or compressed air is allowed to bleed through a tube to an immersed fixed orifice

Note 1 to entry: The pressure measured by a pressure sensor is directly proportional to the liquid head.

7.8
water level recorder
stage recorder
device that records automatically, either continuously or at regular time intervals, the liquid level as detected by a sensor

7.9
rotating element current-meter
device for the measurement of flow *velocity* (3.113) provided with a rotor or propeller with axis mounted either horizontally or vertically

7.10
propeller pitch
degree of inclination or slope of the blade, or the distance that a given rotor or propeller would advance in one revolution

Note 1 to entry: The distance that a given propeller or rotor would advance in one revolution in a solid such as a screw in wood.

7.11
spin test
test in which the rotor or propeller of a *current-meter* (4.1) is spun, either with the fingers or by blowing into the cup or into the propeller, to check that it rotates freely and uniformly

7.12
minimum response speed
velocity of response
velocity (3.113) of the liquid, relative to the rotor or propeller of a *current-meter* (4.1), at which the rotor or propeller attains continuous and uniform angular motion

Note 1 to entry: It is determined by increasing the cart velocity until the rotating element revolves at a constant angular velocity.

7.13
rating tank
calibration tank
tank containing still water through which the *current-meter* (4.1) is moved at a constant *velocity* (3.113) in order to calibrate the meter

7.14
cableway
cable and carriage, often incorporating a winch, used for placing measuring or sampling instruments at any desired point in the cross-section

7.15
sounding weight
sinker
streamline-shaped weight attached to a sounding line or to the suspension of a *current-meter* (4.1) when observing *depths* (3.78) or *velocities* (3.113) in *streams* (3.26)

7.16
sounding line
sounding rod
graduated rigid rod or a chain or cable, usually with a weight attached to its lower end, used for determining *depth* (3.78)

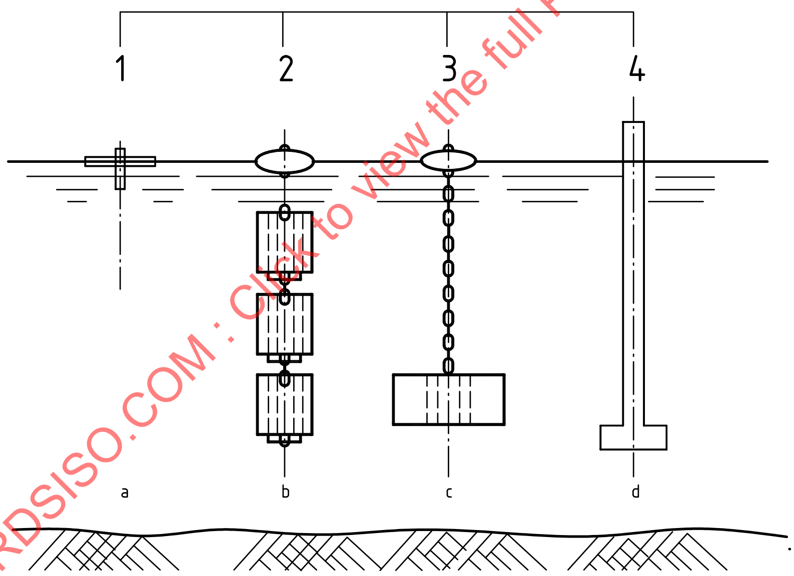
7.17
wading rod
light, hand-held, graduated rigid rod for sounding *depth* (3.78) and positioning the *current-meter* (4.1) for measuring the *velocity* (3.113) in shallow *streams* (3.26) suitable for wading

7.18
tag-line
wire or cord marking the *gauging section* (3.52) and carrying pendants or markers to indicate the position of the observation points

Note 1 to entry: The wire or cord is not used for suspending apparatus.

7.19
float
any natural or manmade body which is buoyant and partly or fully immersed in water

Note 1 to entry: See Figure 15.



Key

1 *surface float* (7.37)
2 *subsurface float* (7.38)
3 *double float* (7.39)
4 *velocity rod* (7.40)

Figure 15 — Types of floats

7.20
echo sounder
device to determine the *depth* (3.78) of water by measuring the time taken for an acoustic signal emitted by the device to return back from the bed

7.21
electromagnetic current-meter
current-meter (4.1) which creates a magnetic field perpendicular to the flow direction, thus enabling the *velocity* (3.113) to be deduced from the induced electromotive force produced by the motion of a conducting liquid in the magnetic field

7.22
ultrasonic (acoustic) velocity meter
current-meter (4.1) that analyses the transmission of ultrasonic pulses in water to estimate *velocity* (3.113)

Note 1 to entry: There are several different techniques, which include travel time, frequency and echo (acoustic) correlation.

7.23
acoustic Doppler current profiler
ADCP
device that uses the principle of Doppler shift to compute water velocity profiles, flow *depth* (3.78) and compute *discharge* (3.5)

Note 1 to entry: The ADCP can be stationary or can be mobile and boat-mounted that transits across a river *channel* (3.18), generally perpendicular to *flow* (3.3). Discharge can be computed by integrating over the entire cross-section of the channel.

7.24
side-looking/horizontal ADCP
H-ADCP
device that uses the principle of Doppler shift, mounted on the side of the *channel* (3.18) for measuring the velocity distribution in a horizontal layer

Note 1 to entry: These instruments are usually fixed at the side of the channel and sample *velocity* (3.113) is obtained in what is effectively a horizontal wedge across the watercourse.

Note 2 to entry: With the right surrounding conditions, it is not necessary to sample velocity across the full width of the channel.

7.25
acoustic Doppler velocity meter
device that uses the principle of Doppler shift to compute water *velocity* (3.113) at a point

Note 1 to entry: These devices are usually deployed at a fixed point in a cross-section and commonly used to develop an index velocity for the computation of an average velocity for that cross-section.

Note 2 to entry: Some devices can measure velocity not only in one but in two or all three dimensions.

7.26
blanking distance
distance travelled by the signal when the vibration of the transducer during transmission prevents the transducer from receiving echoes or return signals

Note 1 to entry: This is the distance near to the ACDP transducers in which no measurement is taken.

Note 2 to entry: The main reason for the blanking distance is the minimum possible time shift between send and receive of a signal.

7.27
recording device
device that records automatically, either continuously or at regular time intervals, the parameters sensed by any associated sensors

7.28
transect
single pass across a *river* (3.27), lake or *estuary* (3.25)

Note 1 to entry: A transect may be described as a collection of ensembles.

Note 2 to entry: One transect may constitute a single measurement of *discharge* (3.5).

7.29
data logger
device that can read various types of electrical signals and record the data in internal memory for later transmission by telemetry or downloaded to a laptop or memory card

7.30
bottom tracking
method where the *velocity* (3.113) of the *acoustic Doppler current profiler* (7.23) relative to the *channel bed* (3.43) is measured so the system can correct for the movement of the vessel

7.31
radar velocity meter
device that transmits an electromagnetic beam directed at the fluid surface at an oblique angle, thus collecting scattered radiation and its frequency compared with the frequency of transmission

7.32
optical velocity meter
laser Doppler, particle image velocimetry and laser particle velocimetry devices located above the water that can be used to track the movement of disturbances and particles at, or close to, the water surface

7.33
echo (cross) correlation velocity meter
device that uses the transmitting and receiving of consecutive ultrasound pulses to track the movement of flowing particles, both in time and space

7.34
wire weight gauge
graduated *gauge* (3.40) connected to a weighted wire or chain, which is lowered to make contact with the surface of the liquid

Note 1 to entry: Contact with the liquid is determined visually.

7.35
hand-held suspension
suspension of a measurement device by a hand-held suspension cable or rod, used for gauging from bridges or similar structures

7.36
bridge winch board
hardwood plank, reinforced with brass or steel, to which a hand-operated suspension cable winch is bolted, constructed to slide along bridge handrails to travel between gauging observation points

7.37
surface float
float (7.19) with its greatest *friction* (3.80) near the surface, used to determine *surface velocities* (3.55)

Note 1 to entry: See Figure 15.

7.38
subsurface float
float (7.19) with its greatest *friction* (3.80) below the surface for measuring subsurface *velocities* (3.113)

Note 1 to entry: See Figure 15.

7.39
double float
body of slightly negative buoyancy that moves with the *stream* (3.26)at a known *depth* (3.78) and whose position is indicated by a small *surface float* (7.37) from which it is suspended

Note 1 to entry: See Figure 15.

7.40
velocity rod
rod float
float (7.19), in the form of a rod, weighted at its base so that it travels in a *current* (3.6) in an almost vertical position, used for determining stream *velocities* (3.113)

Note 1 to entry: The immersed portion may be adjustable.

7.41
ping
series of acoustic pulses, of a given frequency, transmitted by acoustic *current-meters* (4.1)

7.42
ensemble
collection of *pings* (7.41)

Note 1 to entry: Because the measurement from a single ping has relatively high *uncertainty* (12.35), the measurements from more than one ping are averaged to represent a single measurement.

7.43
side-lobe interference
reflections of the side-lobe energy from the riverbed that overwhelm the echoes of the main beam from particles near the bottom of the water column

7.44
ultrasonic level sensor
device measuring the level by calculating the duration of ultrasonic sound waves that are reflected off the surface of the water and back to the sensor

Note 1 to entry: The time taken is relative to the distance between the sensor and the water surface.

7.45
pulse radar
device that determines the range to a target using pulse-timing techniques, and uses the Doppler effect of the returned signal to determine the water *velocity* (3.113)

8 Terms related to sediment transport

8.1
fluvial sediment
solids derived from *rocks* (11.3), biological materials (or chemical precipitants) that are transported by, suspended in or deposited by flowing water

Note 1 to entry: Sediment usually means inorganic material and consists of clay, silt, sand, gravel, cobble or boulder.

8.2
sediment transport
movement of solids transported in any way by flowing water

Note 1 to entry: This is usually expressed as the mass or volume of sediment passing a cross-section per unit time.

8.3
rate of sedimentation of reservoir
annual or periodic reduction in the capacity of a reservoir caused by the deposit of *suspended loads* (8.8) and *bed loads* (8.9) in the reservoir

8.4
suspended sediment
solids kept in suspension by turbulence in flowing water

Note 1 to entry: Suspended sediment moves with practically the same *velocity* (3.113) as the flowing water.

8.5
normal ponded reservoir
storage reservoir normally ponded up to full reservoir level

8.6
sediment load
mass, volume or weight of *fluvial sediment* (8.1) transported past a cross-section over a given period of time

8.7
bed material
material found in the riverbed

8.8
suspended load
part of the *sediment load* (8.6) that continues to remain in suspension by turbulence in the flowing water

8.9
bed load
part of the *sediment load* (8.6) that is in almost continuous contact with the bed, carried forward by rolling, sliding or hopping

8.10
wash load
part of the *total sediment load* (8.11) that is determined by the supply rate, is less than the sediment-transport capacity of the *river* (3.27) and is composed of *grain sizes* (8.41) that are found in very small quantities in the *bed material* (8.7)

Note 1 to entry: The wash load is in near-permanent suspension and, therefore, is transported through the river without *deposition* (10.5).

Note 2 to entry: The *discharge* (3.5) of the wash load through a *reach* (3.34) depends only on the rate at which these particles become available in the catchment and not on the transport capacity of *flow* (3.3).

8.11
total sediment load
<transport> sum of the *bed load* (8.9) and the *suspended load* (8.8)

8.12
sediment concentration
proportion by mass or volume of the dry sediment in a water-sediment mixture to the total mass or volume of the mixture

8.13
suspended (sediment) concentration
proportion by mass or volume of the dry *suspended sediment* (8.4) in a water-sediment mixture to the total mass or volume of the mixture

8.14
average of the suspended concentration in a cross-section
flow-weighted mean *suspended sediment* (8.4) concentration within a *stream* (3.26) cross-section

8.15
suspended sediment transport
proportion by mass or volume of the dry *suspended sediment* (8.4), transported over the entire width of the riverbed and per unit time

8.16
bed load transport
rate of *bed load* (8.9) movement, expressed in mass or volume of bed load transported over the entire width of the riverbed and per unit time

8.17
unit bed load discharge
mass or volume of *bed load* (8.9) material passing a cross-section (1 m width) per unit time

8.18
suspended sediment sample
water sample
water *sample* (12.7) collected to determine some physical or chemical characteristic (or characteristics) of the sediment carried in suspension

8.19
depth integration method
method of sampling *suspended sediment* (8.4) in which, by traversing the *depth* (3.78) of the *stream* (3.26) both in the downward and upward directions at a uniform speed, the sampler takes, in each *vertical* (4.29), a specimen of the water-sediment mixture, each increment of which is proportional to the local sediment *discharge* (3.5), so that the sampler is filled with a water-sediment mixture that is adequate for sample analysis without overfilling

8.20
point-integration method
method of sampling of *suspended sediment* (8.4) in which the sampler, held stationary at a point, is filled at stream *velocity* (3.113) to almost its full capacity during the sampling period with water-sediment mixture

Note 1 to entry: Prior to allowing filling, it is necessary to equalize the pressure inside the sampler with the water pressure at the point of sampling.

Note 2 to entry: The method of sampling of suspended sediment with respect to time is expressed as follows:

$$\bar{g}_s = \frac{1}{t_i}\int_0^{t_i} g_s \, dt$$

where

$\bar{g}_s$ is the sediment transport mean flow rate;

t_i is the time interval of integration;

g_s is the instantaneous transport flow rate.

8.21
direct method of measurement
method in which the time-average suspended-sediment load at a point is measured directly

Note 1 to entry: One way of measuring directly is by using a point-integrating *isokinetic* (8.23) sampler.

8.22
indirect method of measurement
surrogate method
method in which the suspended concentration or the *bed load transport* (8.16) is estimated by measuring other parameters such as optical or acoustic backscatter

Note 1 to entry: Indirect measurement methods have the advantage of continuously recording surrogate parameters. They have to be calibrated with direct measurements.

8.23
isokinetic
condition where the *velocity* (3.113) in the intake nozzle of suspended-sediment sampler is equal to the incident stream velocity

8.24
depth-integrating sampler
instrument that obtains a *sample* (12.7) of the water-sediment mixture while it is moved vertically at a uniform rate through a given distance in a column of moving water

8.25
instantaneous sampler
instrument that attempts to trap instantaneously a *sample* (12.7) of water-sediment mixture

8.26
point-integrating sampler
instrument that obtains a *sample* (12.7) of water-sediment mixture at a given point over a fixed period of time

8.27
pumping sampler
instrument that consists of a pumping system with the outlet leading to a container or a flushing system

Note 1 to entry: There are two types of pumping samplers, those with a fixed orifice that are operated in automatic mode and typically located at or near the stream bank and those with a movable orifice that are deployed from a boat, *cableway* (7.14) or bridge.

8.28
single-stage sampler
combination of a sample bottle, stopper, and intake and exhaust tubes for collecting a suspended-sediment *sample* (12.7) during the rising *water level* (3.64) of a *stream* (3.26) or *river* (3.27)

Note 1 to entry: This device is useful for obtaining sediment data in streams where the remoteness of the site location and rapid changes in stage make it impractical to use a conventional *depth-integrating sampler* (8.24).

8.29
specific mass
ratio of the mass of a given volume of the sediment to the mass of an equal volume of water

8.30
bulk density
<deposited sediment> total dry mass of a unit volume [including *pores* (11.6)] of undisturbed deposit

8.31
sedimentation-decantation-evaporation method
method of obtaining the *sediment concentration* (8.12) in a *sample* (12.7) containing *suspended sediment* (8.4) by letting the sample stand undisturbed so that the sediment settles out from suspension, then successively decanting the sediment-free liquid and ultimately allowing the sample to dry by *evaporation* (10.7)

8.32
filtration method
method for determining *sediment concentration* (8.12) by filtering sediments from a known volume of water-sediment mixture and determining the ratio of the mass of dry sediments captured on the filter to the volume of water-sediment mixture

Note 1 to entry: The result of the filtration method is the *suspended sediment* (8.4) concentration expressed as ratio of the mass of dried filtered material to the volume of water-sediment mixture.

8.33
pipette method
method for determining the particle-size distribution of fine sediments by sampling from a settling column of initially well-mixed water-sediment mixture over time with a pipette

8.34
fall velocity
settling velocity
velocity (3.113) reached asymptotically by a sediment particle settling in water

8.35
hydrometer
device used to estimate the relative density of liquids based on the concept of the Archimedes principle of buoyancy and often used to determine the *suspended sediment* (8.4) concentration (< 0,063 mm)

8.36
siltometer
instrument that separates into different size classes the particles of a *sample* (12.7) of sediment, either by *deposition* (10.5) through a water column or by means of an air current, and measures the volume or mass of the different size classes thus separated

8.37
bottom withdrawal tube
instrument for analysis of sediment particles of less than 0,5 mm in diameter, based on the principle that in a uniformly dispersed suspension (such as used in the bottom withdrawal tube), the suspended concentration at any level remains constant until the largest particle has had time to settle from the surface to the level in question

8.38
sedimentation tube
basic component of many items of equipment through which particles settle in a water column

8.39
pycnometer
instrument for measuring the *specific mass* (8.29) of liquids and solids

8.40
grain size distribution
particle size distribution
proportion by mass of each *grain size* (8.41) present in a given sediment *sample* (12.7)

Note 1 to entry: In *braided rivers* (3.33) and *torrents* (3.30), other methods (e.g. the line-probe method) can be used.

8.41
grain size
particle size
diameter of sediment particles

8.42
mean grain diameter
mean particle diameter
arithmetic mean of the individual particle diameters

8.43
median grain diameter
median particle diameter
d_{50}
grain size (8.41) of a given *sample* (12.7) such that the mass of particles of larger diameter are equal to the mass of particles of smaller diameter

8.44
geometric mean grain diameter
geometric mean particle diameter
$\bar{d}_g$
diameter whose logarithm is the mean of the logarithms of the individual particle diameters

$$\log_{10}\bar{d}_g = \frac{\Sigma\left(\rho_i \log_{10}\bar{d}_i\right)}{\Sigma \rho_i}$$

where ρ_i is the probability or percentage of a *sample* (12.7) having a particle diameter d_i

8.45
nominal diameter
diameter of a sphere of the same volume as the given particle

8.46
sieve diameter
length of the side of the smallest square opening through which the particles will pass

8.47
bed load sampler
device that collects sediment transported as *bed load* (8.9)

Note 1 to entry: The sampler is placed on the bed for a fixed time period. The bed load enters the sampler intake (nozzle) and is trapped. The *unit bed load discharge* (8.17) can be determined from the mass of the trapped bed load and the time over which the sampler was deployed.

8.48
bed-load sampler efficiency
ratio of the quantity of sediment trapped in a *bed-load sampler* (8.47) to the quantity of the sediment in the *stream* (3.26) that would be transported as *bed load* (8.9) through the width of the *flow* (3.3) occupied by the intake of the sampler, without the sampler in position (sediment trap efficiency)

8.49
reservoir delta
delta formed by a *river* (3.27) discharging into a reservoir, causing sediment *deposition* (10.5) where the river enters the reservoir

8.50
reservoir trap efficiency
ratio of sediment retained in the reservoir to the sediment brought in by the *streams* (3.26), *rivers* (3.27), creeks and *torrents* (3.30)

9 Terms related to precipitation

9.1
areal precipitation
value of *precipitation* (9.9) within a specified time interval averaged over a specified area

9.2
automatic raingauge
recording raingauge
collecting raingauge (9.4) that measures *rainfall* (9.10) by automatic means

Note 1 to entry: This may include data processing and logging capability.

9.3
calibration
<measurement of precipitation> process which establishes, under specified conditions, the relationship between the values indicated by a raingauge and the corresponding known values indicated by a measurement standard with associated *measurement uncertainties* (12.36)

9.4
collecting raingauge
instrument that collects *precipitation* (9.9) falling through an orifice of a known cross-sectional area for the measurement of its water equivalent volume, mass or weight accumulated over a measured period

9.5
daily precipitation
total *precipitation* (9.9) that accumulates over 24 h

9.6
non-catching raingauge
raingauge where the rain is not collected in a container/vessel

Note 1 to entry: The *rainfall intensity* (9.11) or amount is either determined by a contactless measurement using optical or radar techniques or by an impact measurement. This type of *gauge* (3.40) includes optical disdrometers, impact disdrometers, microwave radar disdrometers and optical/capacitive sensors.

9.7
manual precipitation reading
measurement of *precipitation* (9.9) made by an observer using a *storage raingauge* (9.15) and a *rain measure* (9.13)

9.8
monthly precipitation
total *precipitation* (9.9) on the first day of the month to the first day of the following month

9.9
precipitation
liquid or solid product of the *condensation* (10.3) of water vapour falling from clouds or deposited from air onto the ground

Note 1 to entry: Precipitation includes rain, hail, snow, dew, rime, hoar frost and fog precipitation.

Note 2 to entry: Measured in terms of the *depth* (3.78) in mm of its liquid equivalent.

9.10
rainfall
total liquid component of *precipitation* (9.9), including *condensation* (10.3) from the atmosphere, collected and measured by a raingauge

9.11
rainfall intensity
RI
amount of liquid precipitation [*rainfall* (9.10)] collected per unit time interval

Note 1 to entry: Due to its variability from minute to minute, RI is measured or derived (from the measurement of the amount) over 1 min time intervals and the measurement units are vertical *depth* (3.78) of water per hour, usually in millimetres per hour or mm h^{-1}.

9.12
raingauge exposure
extent of shelter or protection from the weather

9.13
rain measure
graduated measuring cylinder made of clear glass or plastic used by the observer for measuring the volume of collected liquid and melted solid *precipitation* (9.9)

9.14
snowfall
total amount of snow

Note 1 to entry: Snowfall is recorded when the *precipitation* (9.9) type is snow.

Note 2 to entry: Snowfall is expressed in terms of the vertical *depth* (3.78) of water equivalent to which it would cover a horizontal projection of the Earth's surface. Snowfall is also expressed by the depth of fresh, newly fallen snow covering an even horizontal surface.

9.15
storage raingauge
collecting raingauge (9.4) that accumulates *rainfall* (9.10) and melted solid *precipitation* (9.9) in a collecting vessel for manual measurement of its volume

10 Terms related to snow

10.1
ablation
combined processes [such as *sublimation* (10.50), fusion or melting, *evaporation* (10.7) and movement due to wind and avalanches] that remove snow or ice from the surface of a *glacier* (10.9) or from a snow field

10.2
blowing snow
snow being transported by wind high (approximately 2 m) above a *snowpack* (10.49) surface, where visibility is noticeably reduced

Note 1 to entry: See also *drifting snow* (10.6).

10.3
condensation
change of the physical state of matter from gaseous phase into liquid phase or solid phase.

Note 1 to entry: Condensation is the opposite of *evaporation* (10.7).

10.4
crust
layer of hard-compacted snow resulting from a melt-freeze process or wind

10.5
deposition
process by which water vapour is deposited as ice without first forming liquid water

Note 1 to entry: Deposition is the opposite of *sublimation* (10.50).

Note 2 to entry: As a result, it is possible that stationary snow deposits such as snow *dunes* (3.109), *snowdrifts* (10.48) or the *snowpack* (10.49) itself will form.

10.6
drifting snow
snow being lifted from the *snow surface* (10.55) and transported by wind just above the snow surface, where visibility is not noticeably reduced

Note 1 to entry: See also *blowing snow* (10.2).

10.7
evaporation
conversion of a liquid into vapour, at temperatures below the boiling point

Note 1 to entry: Evaporation is the opposite of *condensation* (10.3).

10.8
firn
well-bonded and compacted snow that has survived the summer season but has not been transformed to *glacier ice* (10.10)

Note 1 to entry: Typical densities are 400 kg/m^3 to 830 kg/m^3. Thus, firn is the intermediate stage between snow and glacial ice where the pore space is at least partially interconnected. Firn usually results from both melt-freeze cycles and compaction by overload, or from compaction alone, as in inland Antarctic snow.

10.9
glacier
mass of land ice formed by the further *recrystallization* (10.15) of *firn* (10.8), which normally flows continuously from higher to lower elevations

Note 1 to entry: A glacier includes firn, *old snow* (10.12) and *new snow* (10.11) on the land ice.

10.10
glacier ice
product of the metamorphoses of *firn* (10.8), with *pores* (11.6) not connected to each other

Note 1 to entry: Densities more than 830 kg/m^3.

10.11
new snow
snow layer that is not transformed, densified or settled, from current or recent *precipitation* (9.9) having characteristic *grain size* (8.41) range of 1 mm to 3 mm

Note 1 to entry: New snow height can be measured by use of a *snow board* (10.21).

10.12
old snow
snow layers deposited from earlier *precipitation* (9.9), prior to fresh fallen snow, composed of metamorphosed snow crystals

10.13
perennial snow
snow persisting for an indefinite time significantly longer than one year

Note 1 to entry: See also *seasonal snow* (10.18) and *firn* (10.8).

10.14
powder snow
dry snow composed of loose, fresh ice crystals

Note 1 to entry: Typical densities are 50 kg/m^3 to 100 kg/m^3.

10.15
recrystallization
process in which deformed grains of snow are replaced by a new set of stress-free grains that grow until all the original grains have been consumed

10.16
retention
process in which water supplied in liquid form is retained by freezing or by storage in the pore space

10.17
snow redistribution
distribution of previously deposited snow that was eroded and transported by the wind

Note 1 to entry: Redistribution features such as *snowdrifts* (10.48) are usually formed from densely packed and friable snow.

10.18
seasonal snow
snow that accumulates during one season and does not last for more than one year

Note 1 to entry: See also *perennial snow* (10.13).

10.19
snow accumulation
all processes that add mass to the *snowpack* (10.49)

EXAMPLE Solid and liquid *precipitation* (9.9), ice *deposition* (10.5) from atmospheric water vapour, snow deposited by wind, avalanches, etc.

Note 1 to entry: Snow accumulation is the opposite of *ablation* (10.1).

10.20
snow avalanche
rapidly moving snow masses in volumes exceeding 100 m^3 and with a minimum length of 50 m

Note 1 to entry: Large snow avalanches may contain *rocks* (11.3), soil, vegetation and/or ice.

10.21
snow board
specially constructed board used to measure *new snow* (10.11) height manually

10.22
snow core
sample (12.7) of snow, either just the freshly fallen snow or the combined *old snow* (10.12) and *new snow* (10.11) on the ground, obtained by pushing, or drilling, a cylinder down through the snow layer and extracting it

10.23
snow course
established line, or *transect* (7.28), of measurements of *snow water equivalent* (10.46) across a snow-covered area in a representative terrain, where *snow accumulation* (10.19) is not *homogeneously* (11.94) distributed in the terrain

10.24
snow cover
accumulation of snow on the ground in its natural consistency

Note 1 to entry: See also *snowpack* (10.49).

10.25
snow cover extent
areal extent of snow-covered ground in relation to the total catchment

Note 1 to entry: It is usually expressed as per cent of total area in a given region.

10.26
snow creep
internal deformation of the *snowpack* (10.49) due to gravity- and metamorphism-driven densification

10.27
snow density
mass per unit volume of snow

Note 1 to entry: Sometimes total and dry snow densities are measured separately. Total snow density encompasses all constituents of snow (ice, liquid water and air) while dry snow density refers to the ice matrix and air only.

10.28
snow depth
total height of the *snowpack* (10.49), measured vertically from the base to the *snow surface* (10.55)

Note 1 to entry: The slope-perpendicular equivalent of snow depth is the *snowpack thickness* (10.53).

10.29
snow distribution
spatial and temporal variability of *snow cover* (10.24) affected by *snowfall* (9.14), wind speed, elevation, topography, vegetation and *ablation* (10.1)

10.30
snow erosion
process by which the surface of the *snowpack* (10.49) is worn away, primarily by the action of wind

Note 1 to entry: Wind erosion is a very important factor in *snow redistribution* (10.17).

10.31
snow extent
total land area covered by some amount of snow

Note 1 to entry: The snow extent is typically reported in square kilometres.

Note 2 to entry: See also *snow cover extent* (10.25).

10.32
snow height
vertical distance from a base to a specific level in the snow, or to the *snow surface* (10.55)

Note 1 to entry: Ground surface is usually taken as the base, but on firn fields and *glaciers* (10.9) it refers to the level of either the firn surface or *glacier ice* (10.10). The snow height is used to denote the locations of layer boundaries but also measurements such as snow temperatures relative to the base. Where only the upper part of the *snowpack* (10.49) is of interest, the snow surface may be taken as the reference. This should be indicated by using negative coordinate values. *Snow depth* (10.28) is the total height of the snowpack.

10.33
snow layering
stratification (3.15) of the *snowpack* (10.49), where each layer is characterized by grain shape, *grain size* (8.41), layer hardness, temperature, water content and density

10.34
snow line
line that separates areas with and without *snow cover* (10.24)

10.35
snow load
downward and sideward force on an object or structure caused by the weight of accumulated snow

10.36
snowmelt
change of the physical state of the *snowpack* (10.49) from solid to liquid phase, mainly affected by various meteorological factors (e.g. temperature, air humidity, radiation, wind, rain)

10.37
snow metamorphism
process which changes the shape and size of snow grains in the *snowpack* (10.49)

Note 1 to entry: Meteorological conditions as well as mechanical or gravitational stresses are the primary external factors that affect snow metamorphism.

10.38
snow pillow
device for automatic measurements of the snow equivalent of the *snowpack* (10.49) using pressure sensors

10.39
snow pit
pit dug vertically into the *snowpack* (10.49) where snowpack stratigraphy and characteristics of individual snow layers are observed

Note 1 to entry: See also *snow profile* (10.41).

10.40
snow probe
instrument to manually measure large *snow depths* (10.28)

10.41
snow profile
stratigraphic record of the *snowpack* (10.49) including characteristics of individual snow layers, usually performed in *snow pits* (10.39)

10.42
snow sampler
instrument used for the collection of *snow samples* (10.52) in an undisturbed *snowpack* (10.49)

10.43
snow scale
device for automatic measurements of the weight of snow accumulated on a plate and also for automatic measurements of the *snow water equivalent* (10.46)

10.44
snow stake
instrument for manual measurements of the *snow depth* (10.28)

10.45
snow survey
process of determining snow parameters, most often depth and density, at representative points, usually along a *snow course* (10.23)

10.46
snow tube
instrument for manual measurement of the *snow water equivalent* (10.46)

10.47
snow water equivalent
h
height of the water layer, which would develop after the melting of the *snowpack* (10.49), if the melting water remained without *infiltration* (11.37) or *evaporation* (10.7) on a given horizontal surface

Note 1 to entry: It can represent the *snow cover* (10.24) over a given region or a confined *snow sample* (10.52) over the corresponding area. The snow water equivalent is the product of the *snow height* (10.32) and the *snow density* (10.27) divided by the density of water. It is typically expressed in millimetres of water equivalent, which is equivalent to kilograms per square metre or litres of water per square metre.

10.48
snowdrift
mound or bank of deposited snow often behind obstacles, irregularities and on lee slopes, due to eddies in the wind field

Note 1 to entry: See also *deposition* (10.5).

10.49
snowpack
accumulation of snow on the ground at a given site and time

Note 1 to entry: It often consists of various layers with different physical and mechanical properties.

Note 2 to entry: See also *snow cover* (10.24).

10.50
sublimation
change of physical state of matter from solid phase to gaseous phase without entering liquid phase

Note 1 to entry: Sublimation is the opposite of *deposition* (10.5).

10.51
snow glide
downhill movement of the *snowpack* (10.49) relative to the ground

10.52
snow sample
sample (12.7) of snow with a defined volume extracted from the *snowpack* (10.49)

10.53
snowpack thickness
total height of the *snowpack* (10.49) measured perpendicularly from base to *snow surface* (10.55)

10.54
snow season
time period when the ground usually is covered by snow

10.55
snow surface
uppermost part of the *snow cover* (10.24), forming the interface to the atmosphere

11 Terms related to groundwater

11.1
groundwater
subterranean water that completely fills subterranean voids [*pores* (11.6), *fractures* (11.9), etc.] and is subjected to pressure equal to or exceeding atmospheric pressure

Note 1 to entry: The movement of groundwater is determined by gravity and the forces of *friction* (3.80).

11.2
formation
geologic unit or series of member units

11.3
rock
natural mass that may be consolidated or loose (excluding top soil), which usually is a microscopically heterogeneous substance consisting of minerals, rock fragments, glasses or remnants of organisms where the ratio of constituents is mostly constant

11.4
lithology
physical character and mineralogical composition that gives rise to the appearance and properties of a *rock* (11.3) or sediment

11.5
zone of weathering
layer of superficial deposits or bedrock subject to weathering and broadly coinciding with the belt of soil water

11.6
pore
void spaces of different shapes and sizes between rock- and soil-particles, that are filled with air and/or water and may be interconnected

11.7
pore pressure
pressure of water in the *pores* (11.6) of a *rock* (11.3) or soil mass

11.8
specific yield
volume of water released from storage by gravity from a unit area of the *aquifer* (11.15) per unit decline of the hydraulic head

11.9
fracture
joint
narrow gap in solid *rock* (11.3), that originated through fracturing as a consequence of endogenous activity where only a small amount of displacement has occurred

Note 1 to entry: A fracture may be enlarged by weathering.

Note 2 to entry: A set of crossing fractures is referred to as a “joint network”. Parallel fractures are referred to as a “set of joints”.

11.10
permeable material
material that permits water to move through it at perceptible rates under the *hydraulic gradients* (11.54) naturally present

11.11
impermeable material
material that does not permit water to move though it at perceptible rates under the *hydraulic gradients* (11.54) normally present

11.12
adhesive water
water forming a film around soil particles, over absorbed water, and held by forces of molecular attraction after gravity water has drained, but having less strength than *adsorbed water* (11.13) and without perceptible emission of heat

Note 1 to entry: Adsorbed water is entirely fixed, whereas adhesive or pellicular water may move from one particle to another.

11.13
adsorbed water
water held on the surface of individual soil particles by the forces of molecular attraction, with emission of heat (heat of wetting)

11.14
connate water
water that was entrapped in the *rock* (11.3) during rock formation and that does not participate in the *hydrological cycle* (3.92)

11.15
aquifer
geologic unit capable of transmitting *groundwater* (11.1) due to its *porosity* (11.63)

11.16
unconfined aquifer
aquifer (11.15) with a *phreatic surface* (11.26) and a superimposed *unsaturated zone* (11.32)

11.17
confined aquifer
body of *groundwater* (11.1) overlaid by material sufficiently impermeable to inhibit free hydraulic flow of groundwater, except at the recharge area

Note 1 to entry: In a confined aquifer, the *potentiometric surface* (11.53) lies above the *zone of saturation* (11.31).

Note 2 to entry: Confined groundwater moves under the pressure caused by the difference in head between recharge area and discharge areas of the confined water body.

11.18
aquifer property
properties of an *aquifer* (11.15) that determine its hydraulic behaviour and its response to *abstraction* (11.88) and/or injection

11.19
aquitard
semi aquiclude
geologic unit which is significantly less permeable than *aquifer* (11.15) units

11.20
impermeable formation
geologic unit which is not water permeable in relation to its surrounding strata

Note 1 to entry: This is either an *aquiclude* (11.21) or an *aquifuge* (11.22).

11.21
aquiclude
geologic unit which may absorb but not transmit water and that can thus be considered a functional hydraulic boundary of an *aquifer* (11.15)

11.22
aquifuge
geologic unit that can neither absorb nor transmit water

11.23
confining bed
bed or body of *impermeable material* (11.11) adjacent to an *aquifer* (11.15) that restricts or reduces the natural flow of *groundwater* (11.1) to or from the aquifer

11.24
groundwater bottom
lower boundary of an *aquifer* (11.15)

11.25
groundwater surface
upper boundary of a groundwater body

Note 1 to entry: In an *unconfined aquifer* (11.16), this corresponds to the *groundwater level* (11.28) at which the water pressure is equal to the atmospheric pressure. In a *confined aquifer* (11.17), this corresponds to the upper surface of the *aquifer* (11.15).

11.26
phreatic surface
unconfined groundwater surface
groundwater surface (11.25) identical to *potentiometric surface* (11.53) and thus equal to atmospheric pressure

11.27
zone of fluctuation of phreatic surface
zone of phreatic fluctuation
zone of *phreatic surface* (11.26) fluctuation from its highest to its lowest level in response to the *discharge* (3.5) and recharge conditions

11.28
groundwater level
groundwater table
groundwater (11.1) and atmosphere interface, measurable at *observation wells* (11.78), bore holes, etc.

11.29
gradient of groundwater level
difference in *groundwater level* (11.28) in two *observation wells* (11.78) in the direction of groundwater flow divided by their horizontal distance

11.30
groundwater thickness
vertical distance between *groundwater surface* (11.25) and *groundwater bottom* (11.24)

Note 1 to entry: In *confined aquifers* (11.17), the groundwater thickness is equal to the aquifer thickness.

11.31
zone of saturation
saturated zone
zone in which interstices of *rock* (11.3) or other materials are filled with water at a pressure above atmospheric pressure

Note 1 to entry: From a scientific point of view, the saturated *capillary fringe* (11.33) where the pressure is less than atmospheric pressure is sometimes interpreted as part of the zone of saturation.

11.32
unsaturated zone
zone between the ground surface and the *phreatic surface* (11.26)

Note 1 to entry: From a scientific point of view, the saturated *capillary fringe* (11.33) is sometimes interpreted as part of the *zone of saturation* (11.31).

11.33
capillary fringe
capillary zone
zone immediately above the *phreatic surface* (11.26) extending up to the limit of capillary rise of water

Note 1 to entry: It may consist solely of capillary water or it may be combined with gravity water in transit to the phreatic surface.

Note 2 to entry: The zone where all *pores* (11.6) are filled with water is referred to as the "saturated capillary fringe". The zone where pores are partly filled with water and partly with air is referred to as the "open capillary fringe". In the capillary fringe, water is subject to a pressure less than air pressure.

Note 3 to entry: It is of significant extent only in fine-fractured *rocks* (11.3) or rocks of small pores.

11.34
vadose water
water in the *unsaturated zone* (11.32)

11.35
seepage water
water percolating downwards, through the *unsaturated zone* (11.32) (gravity water) or flowing through or under a technical structure (e.g. a dam)

11.36
leachate
liquid that has percolated through solid waste

11.37
infiltration
slow percolation of surface water through *pores* (11.6) of *rock* (11.3) or soil material leading to the formation of *seepage water* (11.35)

Note 1 to entry: Seepage from a surface stream or lake into the ground is referred to as "bank filtrate".

11.38
groundwater recharge
recharge of an aquifer
replenishment or addition of water to the groundwater storage by natural processes or artificial methods

11.39
artificial recharge
augmentation of the natural *infiltration* (11.37) of *precipitation* (9.9) or surface water into underground strata by methods of construction (e.g. infiltration wells), spreading of water or artificially changing natural conditions

11.40
groundwater mound
elevated area on a *potentiometric surface* (11.53), resulting from *groundwater recharge* (11.38)

11.41
groundwater depression
drawdown
reduction in static head within the *aquifer* (11.15) resulting from an *abstraction* (11.88)

11.42
cone of depression
portion of the *groundwater surface* (11.25) or *potentiometric surface* (11.53) that is perceptibly lowered as a result of *abstraction* (11.88) of *groundwater* (11.1) from a well

Note 1 to entry: Flow lines and *equipotential lines* (11.55) are distinctly, curved in this zone.

11.43
radius of influence
radius of the *cone of depression* (11.42)

11.44
groundwater balance
concept according to which all inputs of *groundwater* (11.1) [groundwater natural and *artificial recharge* (11.39), *infiltration* (11.37), groundwater inflow] in a defined space and time are equal to the sum of all outputs of groundwater (groundwater outflow, capillary rise and evapotranspiration, groundwater withdrawal) and the changes of water storage in the same space and time

11.45
groundwater budgeting
change in water volume stored within an *aquifer* (11.15) calculated by detailed estimate of the amount of water added to the groundwater reservoir of a given area [*groundwater recharge* (11.38)] balanced against estimates of amounts of withdrawals from the groundwater reservoir of the area during a specified period

11.46
groundwater basin
physiographic or geological unit containing at least one *aquifer* (11.15) of significant areal extent capable of furnishing a substantial water supply

11.47
groundwater divide
groundwater ridge
line on *groundwater surface* (11.25), on each side of which the groundwater surface slopes downward in the direction away from the line

Note 1 to entry: Such a ridge line constitutes a boundary between different discharge areas. The precise position of a groundwater divide depends on geological, hydrological and anthropogenic factors and may vary with time.

11.48
groundwater dam
groundwater barrier
natural or artificial body of material of low *permeability* (11.62) which impedes the horizontal movement of *groundwater* (11.1)

11.49
groundwater cascade
descent of *groundwater* (11.1) on a steep *hydraulic gradient* (11.54) to a lower and flatter *phreatic surface* (11.26) slope

Note 1 to entry: A cascade can occur below a *groundwater dam* (11.48), and downslope at the contact of less *permeable material* (11.11) with more permeable material.

11.50
saline interface
boundary between waters of different salt content

11.51
subterranean stream
body of flowing water that passes through a very large interstice, such as a cave or cavern, or a group of large communicating interstices

11.52
total hydraulic head
piezometric head
groundwater level (11.28) in a piezometer above or below a datum

11.53
potentiometric surface
surface that represents the *total hydraulic head* (11.52) of every point of the *groundwater surface.* (11.25)

11.54
hydraulic gradient
ratio of difference in *total hydraulic head* (11.52) at two observation points along the same flow line and their actual geodetic distance

Note 1 to entry: In practice, it is only possible to determine the gradient of *groundwater level* (11.29).

11.55
equipotential line
line connecting points having the same *total hydraulic head* (11.52)

Note 1 to entry: The traces of the equipotential lines on the *groundwater surface* (11.25) are referred to as "groundwater contours".

11.56
flownet
net of intersecting *equipotential lines* (11.55) and flow lines

11.57
Darcy's law
law expressing the proportionality of the specific *discharge* (3.5) flowing through a porous medium to the *hydraulic gradient* (11.54) and the cross-sectional flow area under *laminar flow* (3.118) conditions

Note 1 to entry: The factor of proportionality is a property of the medium and is referred to as *hydraulic conductivity* (11.58).

Note 2 to entry: It is expressed as:

$$Q_g = k_f \cdot A \cdot I$$

where

Q_g is the quantity of water flowing through the porous medium per time unit: *groundwater flow rate* (11.60);

k_f is a constant depending on the *porosity* (11.63) and *permeability* (11.62) of the aquifer material and on the properties of the water, called *hydraulic conductivity* (11.58);

A is the *cross-sectional flow area of groundwater* (11.59);

I is the loss of head per unit length [or *hydraulic gradient* (11.54)].

Note 3 to entry: This definition requires the porous medium to be isotropic, and the *pores* (11.6) to be almost completely filled with water.

Note 4 to entry: The hydraulic gradient is defined between two positions on the same flow line: in a strict sense therefore Darcy's Law is valid only for that flow line.

11.58
hydraulic conductivity
coefficient of permeability
property expressing the ease of water moving through an *aquifer* (11.15) substrate

Note 1 to entry: It is used as a measure for *permeability* (11.62).

Note 2 to entry: It is determined in the laboratory as the volume of water, at a certain temperature and density, that will move in unit time under a unit *hydraulic gradient* (11.54) through a unit area measured perpendicularly to the direction of *flow* (3.3):

$$k_f = v_f / I = Q_g / (A \cdot I)$$

where

k_f is the hydraulic conductivity;

v_f is the *Darcy velocity* (11.61);

I is the *hydraulic gradient* (11.54);

Q_g is the *groundwater flow rate* (11.60);

A is the *cross-sectional flow area of groundwater* (11.59).

Note 3 to entry: See also *Darcy's law* (11.57).

11.59
cross-sectional flow area of groundwater
cross-section of that part of an *aquifer* (11.15) where *groundwater* (11.1) is flowing

Note 1 to entry: This cross-section shall be perpendicular to the main direction of the *flow* (3.3) of groundwater.

11.60
groundwater flow rate
groundwater discharge
groundwater volume passing through a known *aquifer* (11.15) cross-section divided by time

11.61
Darcy velocity
groundwater flowrate divided by the *cross-sectional flow area of groundwater* (11.59)

11.62
permeability
characteristic of a material that determines the rate at which fluid passes through it under the influence of differential pressure

Note 1 to entry: In the case of water, this is referred to as *hydraulic conductivity* (11.58):

$$K_p = k_f \cdot \eta / g$$

where

K_p is the permeability;

k_f is the *hydraulic conductivity* (11.58);

η is the *kinematic viscosity* (11.69);

g is the acceleration of gravity.

11.63
porosity
ratio of the volume of pore space in a *sample* (12.7) to the bulk volume of that sample

$$\phi = V_h / V_g$$

where

ϕ is the porosity;

V_h is the volume of pore space;

V_g is the bulk volume.

11.64
effective porosity
ratio of the pore volume available for groundwater flow to the bulk volume of a *sample* (12.7)

$$\phi_f = V_f / V_g$$

where

ϕ_f is the effective porosity;

V_f is the pore volume available for groundwater flow;

V_g is the bulk volume.

11.65
pore velocity
average interstitial velocity
apparent distance covered per unit time by *groundwater* (11.1) in the *zone of saturation* (11.31)

Note 1 to entry: It is defined as the product of *hydraulic conductivity* (11.58) and *hydraulic gradient* (11.54), divided by the *porosity* (11.63) of the porous medium through which the groundwater is moving [*effective porosity* (11.64)]:

$$v_a = (k_f \cdot I) / \phi_f$$

where

v_a is the pore velocity;

k_f is the *hydraulic conductivity* (11.58);

I is the *hydraulic gradient* (11.54);

ϕ_f is the *effective porosity* (11.64).

11.66
transmissivity
rate at which water of the prevailing *kinematic viscosity* (11.69) is transmitted through a unit width of the saturated *aquifer* (11.15) under a unit *hydraulic gradient* (11.54)

Note 1 to entry: If *hydraulic conductivity* (11.58) is constant, transmissivity can be calculated by multiplication of *groundwater thickness* (11.30) and hydraulic conductivity:

$$T = k_f \cdot h_{GW}$$

where

T is the transmissivity;

k_f is the *hydraulic conductivity* (11.58);

h_{GW} is the *groundwater thickness* (11.30).

Note 2 to entry: In a *confined aquifer* (11.17), the transmissivity is constant. In an *unconfined aquifer* (11.16), it varies with the *total hydraulic head* (11.52).

11.67
storage coefficient
volume of water released from or added to storage in an *aquifer* (11.15) per unit area of the aquifer per unit decline in hydraulic head

11.68
viscosity
temperature-dependent property of a fluid due to inner *friction* (3.80) between molecules

Note 1 to entry: It affects the behaviour of fluid flow whereby it tends, within itself, to resist relative motion.

Note 2 to entry: For Newtonian fluids such as water, absolute viscosity is equal to dynamic viscosity.

11.69
kinematic viscosity
η
ratio of the absolute *viscosity* (11.68) of a liquid to its specific gravity at the temperature at which the viscosity is measured

11.70
dispersion
<groundwater> process by which a liquid substance introduced into a groundwater system spreads as it moves through the system

Note 1 to entry: This effect derives from molecular diffusion, mechanical dispersion and macrodispersion [due to in *homogeneities* (11.94) within the *aquifer* (11.15)].

11.71
drilled well
well that is excavated by means of a hand or power auger, the material being brought up, for the most part, by the auger to determine ground conditions, extract water or measure the *groundwater level* (11.28)

11.72
artesian well
flowing well
overflowing well
well from which *groundwater* (11.1) is discharged at the ground surface without the aid of pumping

11.73
casing
well casing
lining
tubular retaining structure which is installed in a drilled borehole or excavated well to maintain it opening

11.74
lining tube
preformed tube used as the lining for a well

Note 1 to entry: See also *casing* (11.73) and *screen* (11.75).

11.75
screen
type of *lining tube* (11.74), with apertures designed to permit the flow of water into a well or borehole while preventing the entry of *aquifer* (11.15) or filter pack material

11.76
access tube
pipe inserted into a well to permit safe installation of instruments, thus safeguarding them from touching or becoming entangled with the pump or other equipment in the well

11.77
packer
device placed in a borehole to seal or plug it at a specific point

11.78
observation well
monitoring well
borehole or well used to measure the *groundwater level* (11.28) or groundwater quality

11.79
land surface datum
ground level
average altitude of land surface at an *observation well* (11.78)

11.80
measuring point
dipping datum
<groundwater> permanent point of reference, marked on *observation well* (11.78) to mark the reference level from which the distance to the *groundwater level* (11.28) is measured

11.81
electric tape
dipper
dip-meter
water-level measuring device that uses an electrical signal, sent through a cable with fixed distance marks, to determine the *groundwater level* (11.28) relative to a fixed reference point [*measuring point* (11.80)]

Note 1 to entry: When the tip of the sensor at the end of the measuring tape enters the water the circuit is closed and a signal-lamp is lit (or a buzzer or a needle is activated).

11.82
graduated steel tape
water-level measuring device consisting of a flat measuring tape with permanently fixed distance marks that can be wound on a reel

Note 1 to entry: It is only used for measuring in shallow *groundwater levels* (11.28).

11.83
sonde
cable-suspended probe or tool containing a sensor

11.84
air line
water-level measuring device where pressurized air is pumped through a thin tube into the water

Note 1 to entry: The pressure necessary to feed the air into the water varies depending on the column of water above the level of pressurized air-release. This pressure-variation is recorded in a pressure-sensor. Variations of atmospheric air pressure must be compensated for.

11.85
hydrograph
<groundwater> graph which shows the variation in *groundwater level* (11.28) against time

11.86
drift correction
quantitative adjustment to account for a uniform change in the reference value with time

11.87
rest water level
static water level
groundwater level (11.28) in the pumped well observed under equilibrium when the pump is off

11.88
abstraction
removal of water from a borehole or well

11.89
aquifer loss
energy loss (3.63) at a pumped or *artesian well* (11.72) associated with groundwater flow through the *aquifer* (11.15) to the well face

11.90
well development
physical and chemical treatment of a well to achieve minimum resistance to movement of water between well and *aquifer* (11.15)

11.91
well efficiency
measure of the performance of a production well

11.92
well loss
energy loss (3.63) resulting from the flow of *groundwater* (11.1) across the well face, including any part of the *aquifer* (11.15) affected by drilling and any filter pack or *lining tube* (11.74), into the well and up or down the well to the pump

11.93
anisotropy
variation in physical property with direction of measurement

Note 1 to entry: In the electrical resistivity method, micro-, macro- and pseudo-anisotropy are involved.

11.94
homogeneity
characteristic of a *formation* (11.2) with uniform physical property or properties

Note 1 to entry: It is a function of the scale of measurement in relation to the uniformity in physical property.

Note 2 to entry: Inhomogeneity or heterogeneity indicates non-uniformity or dissimilarity in physical property with reference to the scale of measurement.

12 Terms related to uncertainties in hydrometric determinations

12.1
resolution
quantitative expression of the ability of an indication device to distinguish meaningfully between closely adjacent values of the quantity indicated

12.2
precision
closeness of agreement between independent test/measurement results obtained under stipulated conditions

Note 1 to entry: The smaller the random part of the experimental errors which affect the results, the more precise the procedure.

12.3
average value
$\overline{x}$
arithmetic mean of n readings of the value x

$$\overline{x}=\frac{1}{n}\sum_{i=1}^{n}x_{\mathrm{i}}$$

12.4
sensitivity coefficient
influence coefficient
θ_x
ratio of the change in result of a function/model R, to a change in an input parameter, x

$$\theta_x=\frac{\Delta R}{\Delta x}$$

Note 1 to entry: In relative terms, this becomes:

$$\theta_x=\frac{\Delta R/R}{\Delta x/x}$$

12.5
frequency distribution
relationship between the measured values of variables and their frequency of occurrence

12.6
population
totality of items under consideration

12.7
sample
subset of a *population* (12.6) made up of one or more sampling units

12.8
sample size
n
number of sampling units in a *sample* (12.7)

12.9
true value
value which characterizes a quantity or quantitative characteristic perfectly defined in the conditions which exist when that quantity or quantitative characteristic is considered

Note 1 to entry: It is an ideal value which can be determined only if all causes of *measurement error* (12.24) are eliminated, however, true value is never known, in practice.

12.10
degree of freedom
v
number of parameters of the system that may vary independently

EXAMPLE The standard deviation is said to have (n − 1) degrees of freedom because it is necessary to use one degree of freedom to estimate the mean, an element of the equation for the standard deviation.

12.11
deviation
difference between the value of a quantity and a standard reference value

Note 1 to entry: Particularly in statistics, the reference value is frequently the arithmetic mean of a series of measurements.

12.12
sample standard deviation
s
series of n measurements of the same measure and the parameter characterizing the dispersion of the results

$$s=\sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}}$$

where

x_i is the result of the ith measurement;

$\bar{x}$ is the arithmetic mean of the n results considered.

Note 1 to entry: The sample standard deviation should not be confused with the standard deviation σ of a *population* (12.6) of size N and of mean m, given by the formula:

$$\sigma=\sqrt{\frac{\sum_{i=1}^{N}(x_i-m)^2}{N}}$$

Note 2 to entry: If the series of n measurements is considered to be an example of a population, s is an estimate of the population standard deviation.

12.13
sample standard deviation of the mean
$s(\bar{x})$
estimate of the standard deviation of the arithmetic mean $\bar{x}$ calculated from a *sample* (12.7) of n measurements with respect to the mean m of the overall *population* (12.6)

$$s(\bar{x})=\frac{s(x)}{\sqrt{n}}$$

12.14
sample variance
s^2
measure of the scatter or spread of a distribution, estimated by calculating the sum of the squares of *deviations* (12.11) of measurements about the means, divided by the number of degrees of freedom

$$s^2=\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}$$

12.15
residual variance
s_R^2
square of the *standard error of estimation* (12.31)

12.16
weight of measurement
w_i
number which expresses the degree of confidence in the result of a measurement of a certain quantity, in comparison with the result of another measurement of the same quantity

12.17
arithmetic weighted mean
weighted average
$\bar{x}_w$
sum of the products of each value and their *weight of measurement* (12.16) divided by the sum of the weights of measurement

$$\bar{x}_w = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$

12.18
calibration
<uncertainty> process of comparing the response of a measuring device with a calibrator or a measuring standard over the measurement range

12.19
calibration hierarchy
sequence of *calibrations* (12.18) from a reference to the final measuring instrument, where the outcome of each calibration depends on the outcome of the previous calibration

12.20
normal distribution
Laplace-Gaussian distribution
probability distribution of continuous random variable *x* such that the probability density is:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{x-m}{\sigma}\right)^2\right]$$

where

$m = E(x)$	is the arithmetic mean;
σ	is the standard deviation of the normal distribution.

12.21
method of least squares
technique used to estimate the coefficients of an equation, when a particular form of equation is chosen for fitting a curve to data

Note 1 to entry: The principle of the method of least squares is to minimize the sum of squares of *deviations* (12.11) of the data from the curve.

12.22
regression
process of quantifying the dependence of one variable on one or more other variables

12.23
least-squares regression
procedure for determining the unknown constants of a proposed model in such a manner that predictions from the model are as close as possible to the data

Note 1 to entry: "As close as possible" is taken to mean that the sum of squares of the *deviations* (12.11) is a minimum.

12.24
measurement error
result of a measurement minus the *true value* (12.9) of the measurand

Note 1 to entry: The term relates equally to:

— the uncorrected result;

— the corrected result.

Note 2 to entry: The known parts of the error of measurement may be compensated by applying appropriate corrections. The error of the corrected result can only be characterized by an *uncertainty* (12.35).

12.25
absolute error of measurement
result of a measurement minus the conventional *true value* (12.9) of the measurand

Note 1 to entry: The term relates equally to:

— the uncorrected result;

— the corrected result.

Note 2 to entry: The known parts of the error of measurement may be compensated by applying appropriate corrections. The error of the corrected result can only be characterized by an *uncertainty* (12.35).

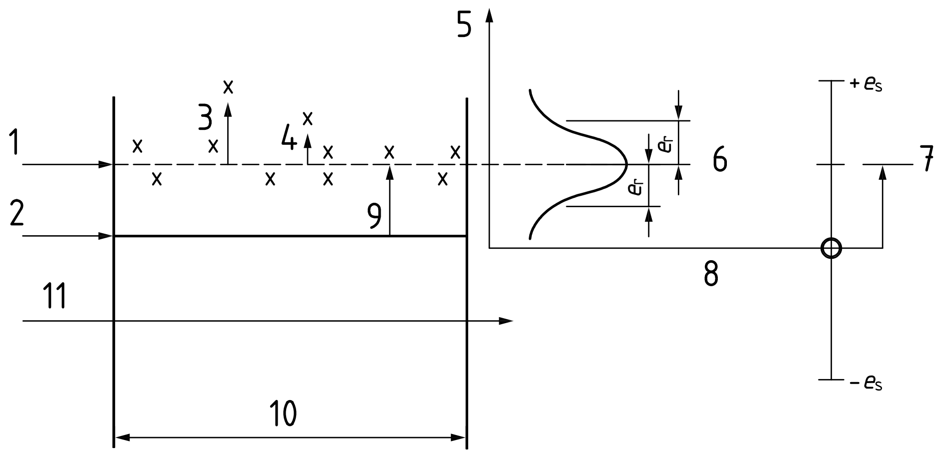
Note 3 to entry: "Absolute error", which has a sign, should not be confused with "absolute value of an error", which is the modulus of an error.

12.26
outlier
observed value in a set of data which appears to be inconsistent with the remainder of the set of data

12.27
spurious error
error which invalidates a measurement

Note 1 to entry: This type of error generally has a single cause, such as the incorrect recording of one or more significant digits or the malfunction of instruments.

Note 2 to entry: See Figure 16.



Key

1 mean measured value of quantity
2 true value of quantity (unknown)
3 *spurious error* (12.27)
4 *random error* (12.28)
5 value of measured quantity
6 random uncertainty, e_r, assessed with specific confidence level
7 systematic error, e_s, unseen within limits
8 probability density
9 *systematic error* (12.29)
10 time during which a constant value of the quantity Y is being assessed
11 time

Figure 16 — Diagram illustrating the terms relating to errors and uncertainties

12.28
random error
component of the error of measurement which, in the course of a number of measurements of the same measurand, varies in an unpredictable way

Note 1 to entry: It is not possible to correct for random error.

Note 2 to entry: See Figure 16.

12.29
systematic error
component of the error of measurement which, in the course of a number of measurements of the same measurand, remains constant or varies in a predictable way

Note 1 to entry: Systematic errors and their causes may be known.

Note 2 to entry: See Figure 16.

12.30
elemental error
random error (12.28) or *systematic error* (12.29) associated with a single source or process in a chain of sources or processes

12.31
standard error of estimation
residual standard deviation
s_R
measure of dispersion of the dependent variable (output) about the least-squares line obtained by curve fitting or regression analysis

$$s_R = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \bar{y})^2}{n-k}}$$

where

n is the number of data points;

k is the number of coefficients in the equation.

Note 1 to entry: This equation is similar to the expression for standard deviation, except that the curve-fit value, $\bar{y}$, replaces the mean value, $\bar{x}$, and k replaces 1.

Note 2 to entry: The number of coefficients, k, is equal to the number of explanatory variables plus one (to include the intercept).

12.32
confidence limit
lower and upper limits within which the *true value* (12.9) is expected to lie with a specified probability, assuming negligible *systematic error* (12.29)

12.33
confidence level
probability that the *true value* (12.9) will lie between the specified *confidence limits* (12.32), assuming negligible *systematic error* (12.29)

Note 1 to entry: The confidence level is expressed as a percentage.

12.34
Student's distribution
Student's *t* distribution
t
distribution of the *deviations* (12.11) of the mean values of the *samples* (12.7) from the *population* (12.6) means

EXAMPLE

$$(e_r)_{95} = t_{95} s$$

where

$(e_r)_{95}$ is the random uncertainty at the 95 % confidence level;

t_{95} is the appropriate value of Student's distribution;

s is the *sample standard deviation* (12.12).

Note 1 to entry: Student's distribution is used to set the *confidence limits* (12.32) of the population mean, in particular in cases where the mean has been estimated from small *samples* (12.7). It is obtained from tables giving the number of degrees of freedom and the *confidence level* (12.33), where:

$$t = \frac{\bar{x} - \mu}{s\sqrt{N}}$$