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TECHNICAL SPECIFICATION

Marine energy – Wave, tidal and other water current converters – Part 1: Terminology

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Part 1: Terminology

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MARINE ENERGY – WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 1: Terminology

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62600-1, which is a technical specification, has been prepared by IEC technical committee 114: Marine energy – Wave, tidal and other water current converters.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
114/65/DTS	114/76/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This Technical Specification has been developed as a tool for the international marine energy community, to assist in creating clarity and understanding. The wave, tidal and water current energy industry has recently experienced a period of rapid growth and sector development. With this expansion, it became apparent that a glossary of terms for the sector was required. The aim of this Technical Specification is to present clear and consistent language that will aid the development of programs, projects, and future standards.

This Technical Specification lists the terms that the marine energy industry commonly uses. It is an evolving document that will change as new terms and symbols are added. The terminologies herein have been harmonized with IEC 60050 and other IEC documents as far as possible.

MARINE ENERGY – WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –

Part 1: Terminology

1 Scope

This part of IEC 62600 defines the terms relevant to ocean and marine renewable energy. For the purposes of this Technical Specification, sources of ocean and marine renewable energy are taken to include wave, tidal current, and other water current energy converters.

Terms relating to conventional dam and tidal barrage, offshore wind, marine biomass, ocean thermal and salinity gradient energy conversion are not included in the scope of this Technical Specification.

This Technical Specification is intended to provide uniform terminology to facilitate communication between organizations and individuals in the marine renewable energy industry and those who interact with them.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
added mass
extra mass associated with the additional force necessary to accelerate a body through a fluid compared to the same acceleration in a vacuum

NOTE 1 In general, added mass is a variable that depends on the state of the unsteady motion and is not a constant.

NOTE 2 In a viscous (real) fluid, the added mass would include kinetic energy of a fluid layer entrained by the accelerating body.

2.2
added mass at infinity
limit of the mass corresponding to the added mass as the frequency tends to infinity

NOTE The value of added mass at infinity is normally necessary for time domain modelling of wave-body interaction.

2.3
added mass coefficient
ratio between added mass and the mass of the water displaced by the submerged body

2.4
amplitude control
method to obtain the optimum oscillatory motion amplitude to capture a maximum of wave energy

NOTE For a simple oscillating system, the object of amplitude control is to obtain a given oscillatory velocity amplitude that should be related with the wave excitation force.

2.5
annual energy production (marine energy converter)
estimate of total energy production of a marine energy converter system during a one-year period obtained by applying its power performance assessment to a prospective marine energy resource characterization and assuming 100 % availability

NOTE Actual annual energy production is unlikely to exceed this estimate.

[IEC 60050-415:1999, 415-05-09, modified]

2.6
array (marine energy)
farm of marine energy converters arranged specifically so as to enhance energy capture

NOTE Array spacing is dictated by hydrodynamic considerations and may be very closely packed so as to constitute a single platform or an arrangement of identical devices.

2.7
attenuator device
energy converter which is aligned parallel to the predominant direction of wave incidence

2.8
availability (marine energy converter)
ability of a marine energy conversion system to be in a state to perform a necessary function under given conditions at a given instant of time or over a given duration, assuming that the necessary external resources are provided

NOTE 1 For continuously running equipment availability equates to: uptime/(uptime + downtime).

NOTE 2 Where reliability is specified in Mean Time Between Failures (MTBF) and maintainability in Mean Time To Repair (MTTR), availability also equates to: MTBF/(MTBF + MTTR).

[IEC 60050-191:1990, 191-02-05, modified]

2.9
capture area (tidal)
equal to the power captured by the hydrodynamically functional part of a TEC divided by power per square metre of the incident tidal stream

2.10
capture length (wave)
capture width
equal to the power captured by the hydrodynamically functional part of a WEC divided by power per metre of the incident wave field

2.11
centre of buoyancy
centroid of the submerged volume

2.12
centre of flotation
point coinciding with the centroid of the water-plane area

NOTE The water-plane area is the cross-sectional area of the floating body at mean water level in calm water.

2.13
chart datum
reference level of water, typically from a selected phase of the tide at a specific location

NOTE Different hydrographic organizations have differing conventions for defining chart datum.

2.14
conversion efficiency (resource to wire)
measure of the overall effectiveness of a marine energy converter calculated as the ratio of electrical power output in relation to the incident power in the water resource

NOTE 1 For WECs, conversion efficiency (resource to wire) is sometimes referred to as wave-to-wire conversion efficiency.

NOTE 2 Conversion efficiency (resource to wire) is normally calculated over extended periods (e.g. tidal cycle, years, etc.).

2.15
current profile
variation in velocity throughout the water column, typically displayed as a function of height above the sea bed

2.16
deep water (offshore)
spatial location where the depth of the water is greater than or equal to half the wave length

NOTE The deep water (offshore) spatial location is based on the kinematic properties of waves. The dispersion equation is

$$L = \frac{gT^2}{2\pi} \tanh \frac{2\pi d}{L}$$

where

L is the wave length;

d is the water depth;

T is the period;

g is the gravitation acceleration.

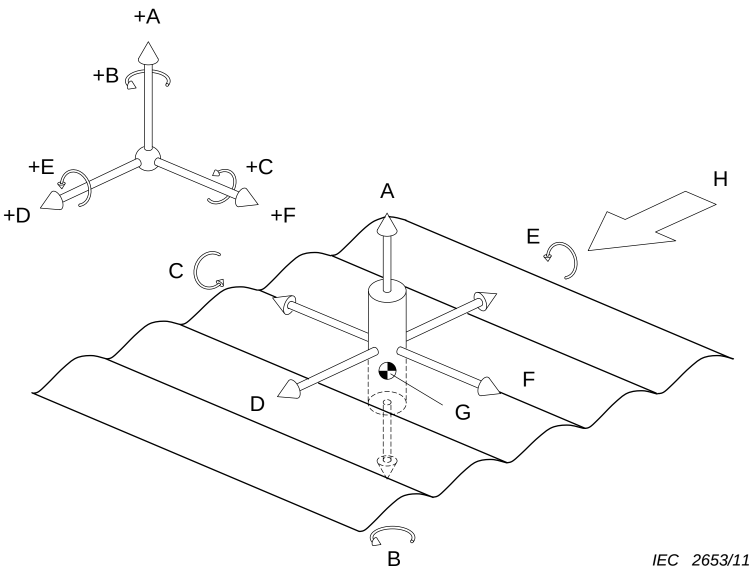
In deep water, the dispersion equation may be simplified to

$$L = \frac{gT^2}{2\pi} = 1{,}56\,T^2$$

2.17
degree of freedom
independent displacements and/or rotations that specify the orientation of a body or system

NOTE 1 A marine body may experience three linear and three rotational motions as depicted in Figures 1 and 2.

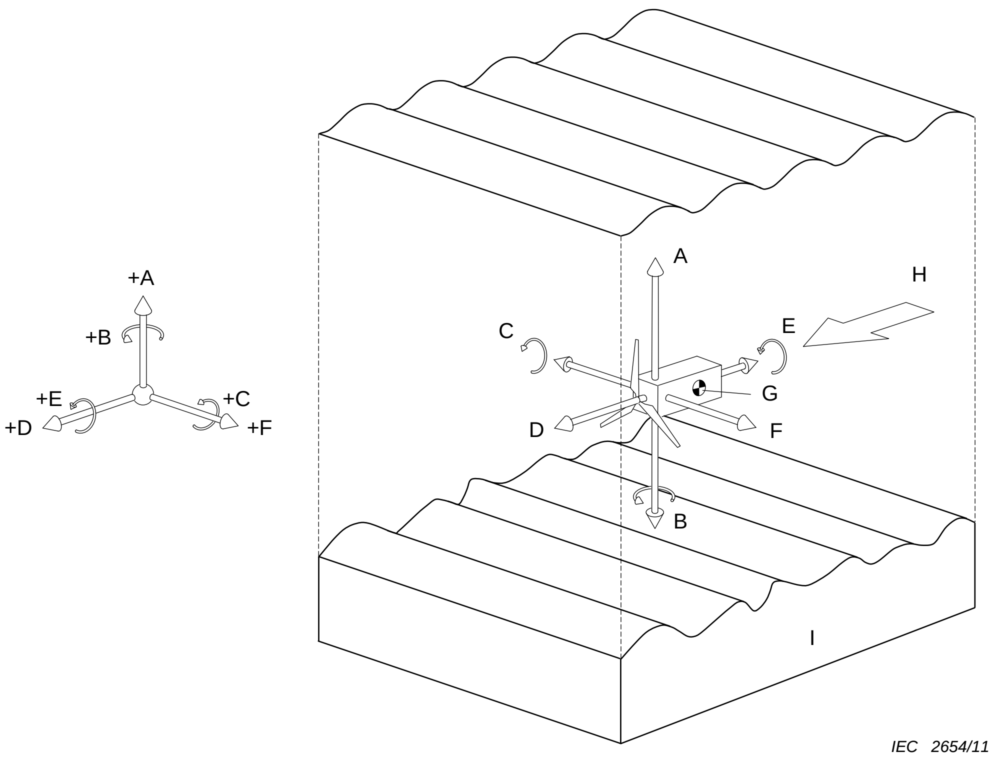
NOTE 2 The principal axis is parallel to the mean water surface and aligned with the direction of incident energy, and the rotations act about the centre of gravity.



Key

A	Heave	D	Surge	G	Centre of gravity
B	Yaw	E	Roll	H	Incident energy
C	Pitch	F	Sway		

Figure 1 – Six degrees of freedom – Floating device



Key

A	Heave	D	Surge	G	Centre of gravity
B	Yaw	E	Roll	H	Incident energy
C	Pitch	F	Sway	I	Seabed

Figure 2 – Six degrees of freedom – Submerged device

2.17.1
heave
motion in a direction perpendicular to the mean water surface

2.17.2
pitch
rotation about the sway axis

2.17.3
roll
rotation about the surge axis

2.17.4
surge
motion parallel to the principal axis

2.17.5
sway
motion perpendicular to the principal axis and parallel to the mean water surface

2.17.6
yaw
rotation about the heave axis

2.18
directionally resolved power (wave)
distribution of wave power in a given sea state as a function of the angle of incidence

2.19
directional spreading function
normalized distribution of wave energy, D, for a given frequency, f, over the angle of incidence, θ

NOTE Since $\int_0^{2\pi} D(\theta, f)\, d\theta = 1$ it may be considered to be a probability density function over direction.

2.20
directional wave spectrum
distribution of the spectral density as a function of incident wave frequency and direction

NOTE The directional wave spectrum is calculated as the product of the spectral density, as a function of incident wave frequency, multiplied with the directional spreading function.

2.21
diurnal tides
occurrence of only one high water and one low water in each tidal day

NOTE A tidal day is equal to 24,8 h.

2.22
energy period (wave)
T_e
characteristic wave period associated with energy propagation expressed as the group velocity weighted mean period of the frequency spectrum

NOTE 1 A monochromatic wave in deep water, whose variance and period match the variance and energy period of a specified polychromatic sea state, will also have the same wave power.

NOTE 2 In accordance with IAHR, the spectral estimate of the energy period is preferred.

$T_e = \frac{m_{-1}}{m_0}$, where m_{-1} and m_0 are the minus-one and zero spectral moments.

2.23
energy storage capacity
measure of the amount of energy a storage device can store and deliver, within established design limits and maintenance interval conditions

NOTE The energy storage capacity is specified in terms of energy units such as kJ, MJ, kWh or MWh (i.e. the kinetic energy stored in a flywheel, the hydraulic energy stored in accumulators or potential energy stored in a water reservoir).

2.24
excitation force (wave)
force which an incident wave exerts on a static body

2.25
extreme significant wave height
significant wave height (H_{m0}) of the most severe sea state expected at a site over a specific return period or design life

NOTE This definition provides for extreme wave heights to be defined in terms of a 50/100 year storm condition.

2.26
farm
group of similar marine energy converters of the same type (either WECs or TECs) sharing a connection to the electric grid

NOTE Farm spacing will normally be dictated by installation, mooring and access requirements.

2.27
fast tuning
adaptive control of a device over a typical wave period

NOTE Adaptive tuning, real-time control, or complex conjugate control is examples of fast tuning.

2.28
fetch
unobstructed distance of water surface over which the wind has acted

2.29
focusing absorber device
energy converter that uses a method to concentrate waves onto a central converter to enhance energy production

2.30
free surface
interface between the air and a body of water

2.31
group velocity (wave)
propagation velocity of water wave groups and the wave energy

NOTE The group velocity of a water wave is the velocity that the energy associated with the wave disturbance travels in the direction of wave propagation. In deep water using linear wave theory this is one half the wave phase velocity. In shallow water it is equal to the wave phase velocity.

2.32
harmonic analysis of tides
representation of tidal elevations and velocities by the summation of components whose amplitudes and periods describe astronomical processes

2.33
highest astronomical tide
HAT
highest sea level due to an astronomical tide that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions

NOTE The highest astronomical tide is not an extreme sea level, as certain meteorological conditions can cause a higher sea level. The sea level under these circumstances is known as a storm surge. HAT is determined by inspecting predicted sea levels over a number of years.

[National Oceanography Centre – Natural Environment Resource Council (NERC), 2011]

2.34
in-stream generation
capture and conversion of the energy of flowing water

NOTE In-stream generation includes tidal, ocean current, and flowing river environments.

2.35
intermediate depth water
spatial location where the kinematics properties of the waves are such that the water depth is less than half the wave length but equal to or greater than a twentieth of the wave length

NOTE In intermediate water, the dispersion equation is

$L = \frac{gT^2}{2\pi}\tanh\frac{2\pi d}{L}$, where L = wave length, d = water depth, T = period and g = gravitation acceleration

2.36
latching
restraining the motion of the primary interface at the extremes of its range of motion to improve power capture

NOTE Latching is sometimes referred to as phase control because latching is often used to align the excitation (force or pressure) and response (velocity or flow rate), and this can be understood as reducing the phase difference between the principal frequency components of these parameters.

2.37
lowest astronomical tide
LAT
lowest sea level due to an astronomical tide that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions

NOTE The lowest astronomical tide is not an extreme sea level, as certain meteorological conditions can cause a lower sea level. The sea level under these circumstances is known as a negative surge. LAT is determined by inspecting predicted sea levels over a number of years. LAT is commonly used as the datum point from which sea level is measured.

[National Oceanography Centre – NERC, 2011]

2.38
maintainability
probability that a given active maintenance action, for an item under given conditions of use, can be carried out within a given duration, when the maintenance is performed under stated conditions and using stated procedures and resources

[IEC 60050-191:1990, 191-13-01, modified]

2.39
marine current
persistent flow of seawater produced by natural physical processes, including the gravitational pull of celestial bodies

2.40
maximum average power
time-averaged power produced by a device under peak operating conditions over a given interval

NOTE 1 For a wave device, peak operating conditions represent the maximum operating sea conditions.

NOTE 2 For a tidal device, peak operating conditions would be the maximum flow rates.

2.41
maximum individual wave height
$\boldsymbol{H}_{\mathbf{max}}$
statistical measure of the largest individual wave heights which can be observed or expected in a given sea state for a stated probability of exceedance

NOTE Maximum individual wave height is normally calculated from a Rayleigh distribution for wave heights in deep water for an exceedance probability of one per thousand, for which a H_{max} = 1,86 H_{m0}.

2.42
mean annual wave power
long-term average of the directionally unresolved wave energy flux per unit width, calculated as an arithmetic mean over all sea states occurring at a given location

NOTE Typically mean annual wave power units are expressed in kilowatts per metre.

2.43
mean high water neaps
MHWN
annual average height (when the average maximum declination of the moon is 23,5 degrees) of two successive high waters during those time intervals of 24 h when the range of the astronomical tide is at its least

NOTE The values of mean high water neaps vary from year to year with a cycle of approximately 18,6 years.

[National Oceanography Centre – NERC, 2011, modified]

2.44
mean high water springs
MHWS
annual average height (when the average maximum declination of the moon is 23,5 degrees) of two successive high waters during those time intervals of 24 h when the range of the astronomical tide is at its greatest

NOTE The values of mean high water springs vary from year to year with a cycle of approximately 18,6 years.

[National Oceanography Centre – NERC, 2011, modified]

2.45
mean low water neaps
MLWN
annual average height (when the average maximum declination of the moon is 23,5 degrees) of two successive low waters during those time intervals of 24 h when the range of the astronomical tide is at its least

NOTE The values of mean low water neaps vary from year to year with a cycle of approximately 18,6 years.

[National Oceanography Centre – NERC, 2011, modified]

2.46
mean low water springs
MLWS
annual average height (when the average maximum declination of the moon is 23,5 degrees) of two successive low waters during those time intervals of 24 h when the range of the astronomical tide is at its greatest

NOTE The values of mean low water springs vary from year to year with a cycle of approximately 18,6 years.

[National Oceanography Centre – NERC, 2011, modified]

2.47
mean neap range
difference between mean high water neaps (MHWN) and mean low water neaps (MLWN)

[National Oceanography Centre – NERC, 2011]

2.48
mean spring peak velocity
Vmsp
annual average (when the average maximum declination of the moon is 23,5 degrees) of four successive maximum flow speeds during those time intervals of 24 h when the range of the astronomical tide is at its greatest

NOTE Mean spring peak velocity should be calculated at a depth 5 m below the surface as the average over 30 min of the four peak speeds occurring during the two ebb and the two flood tides, associated with the largest spring tide.

2.49
mean spring range
difference between mean high water springs (MHWS) and mean low water springs (MLWS)

[National Oceanography Centre – NERC, 2011]

2.50
mean water level
surface level of a body of water with motions such as wind waves and/or changes due to the tides averaged out

NOTE When considering tides, the mean water level is normally measured at a tidal gauging station over a period of several years. When considering waves, the sea level is generally averaged over a much shorter time period (e.g. 1 h).

2.51
mean zero crossing period (see Figure 3)
average time interval between down crossings of the mean water level during a given sea state

NOTE The spectral estimate of the mean zero crossing period, T_{02}, is calculated as

$$T_{02} = \sqrt{\frac{m_0}{m_2}}$$

2.52
met-ocean
meteorological and oceanographic environment typically described using wind, wave, tidal characteristics, etc.

2.53
mixed tides
occurrence of relatively large diurnal inequality in the high or low waters or both

2.54
ocean current
large scale and persistent flow of seawater produced by mechanisms other than the gravitational forces of celestial bodies

NOTE Ocean currents result from processes such as wind, density gradients, salinity gradients, Coriolis forces, etc.

2.55
oscillating hydrofoil
energy converter in which force is induced due to a pressure difference on the foil section caused by the relative motion of the fluid over the foil inducing oscillatory motion

[University of Strathclyde, Energy Systems Research Unit, 2011, modified]

2.56
oscillating water column device
OWC
energy converter with an enclosed air volume excited by waves causing reciprocating air to flow through a turbine

2.57
oscillating wave surge converter
OWSC
device which responds to the predominantly horizontal fluid motions in shallow and intermediate depth water

2.58
overtopping device
energy converter with a reservoir filled by wave overtopping, which typically discharges through a low head turbine

2.59
park (marine energy)
designated geographical region containing one or more marine energy farms

2.60
peak operating conditions
met-ocean and/or river conditions under which a machine operates so as to generate its maximum power output

2.61
peak period (wave)
$\boldsymbol{T}_{\mathbf{p}}$
inverse of the peak frequency (wave), $T_{\mathrm{p}} = 1 / f_{\mathrm{p}}$

2.62
peak frequency (wave)
$f_{\mathbf{p}}$
frequency corresponding to the maximum value of the omni-directional wave spectrum

2.63
phase velocity (water wave)
celerity
speed at which the shape of the wave propagates

2.64
point absorber device
WEC that is small relative to the wave length and typically absorbs wave energy independent of the direction of wave incidence

2.65
power matrix
tabular description of power capture as a function of relevant met-ocean parameters

NOTE 1 For a wave energy converter, the power matrix should be described using at least wave height and energy period.

NOTE 2 For a tidal energy converter, the power matrix should be described using at least flow speed and direction.

2.66
power curve
power surface
graphical description of the power capture as a continuous function of relevant met-ocean parameters

NOTE 1 For a wave energy converter, the power curve should be described using at least wave height and energy period.

NOTE 2 For a tidal energy converter, the power curve should be described using at least the flow speed.

2.67
power take-off
PTO
mechanism that converts the motion of the prime mover into a useful form of energy such as electricity

2.68
prime mover
physical component that acts as the interface between the marine resource and the energy converter from which energy is captured

NOTE For wave energy converters the prime mover may be a heaving buoy, a hinged flap, an OWC runner, etc., and for tidal energy converters the prime mover is typically the runner.

2.69
rated capacity (system)
designated power output of a marine energy converter

NOTE The term capacity can refer to the output of a single device, an array of devices, or an entire marine farm.

2.70
reliability
probability that an item can perform a necessary function under given conditions for a given time interval

[IEC 60050-191:1990,191-12-01, modified]

2.71
resource assessment (marine energy)
collection and processing of met-ocean data required for determining the performance of a marine energy converter or farm

NOTE Resource assessment may be conducted in three distinct stages including theoretical resource assessment, technical resource assessment, and practical resource assessment.

2.71.1
practical resource assessment
proportion of the technical resource that is available after consideration of external constraints

NOTE 1 External constraints may include grid accessibility, competing use, environmental sensitivity, etc.

NOTE 2 Practical resource assessment is one of three distinct stages in a resource assessment. The remaining two stages include theoretical resource assessment and technical resource assessment. The value of the theoretical resource assessment is greater than the technical resource assessment, which in turn is greater than the practical resource assessment.

[Legrand, 2009, modified]

2.71.2
technical resource assessment
proportion of the theoretical resource that can be captured using existing technology options without consideration of external constraints

NOTE Technical resource assessment is one of three distinct stages in a resource assessment. The remaining two stages include practical resource assessment and theoretical resource assessment. The value of the theoretical resource assessment is greater than the technical resource assessment, which in turn is greater than the practical resource assessment.

[Legrand, 2009, modified]

2.71.3
theoretical resource assessment
energy contained in the entire resource

NOTE Theoretical resource assessment is one of three distinct stages in a resource assessment. The remaining two stages include practical resource assessment and technical resource assessment. The value of the theoretical resource assessment is greater than the technical resource assessment, which in turn is greater than the practical resource assessment.

[Legrand, 2009, modified]

2.72
resource characterization
parameterization of met-ocean data to enable determination of the performance of a marine energy converter or farm

2.73
scatter diagram
tabular representation of the frequency of occurrence for given met-ocean conditions at a specific site

NOTE 1 For wave energy converters, the met-ocean conditions typically used are significant wave height and a characteristic wave period.

NOTE 2 A scatter diagram is sometimes referred to as a joint occurrence table.

2.74
sea state
stationary condition of the wind waves and swell at a site, characterized by relevant parameters such as the significant wave height and energy period (wave)

2.75
sea trial
evaluation of a device’s performance and properties in the natural environment

2.76
semi-diurnal tides
occurrence of two high waters and two low waters of approximately equal height each tidal day

NOTE A tidal day is equal to 24,8 h.

2.77
shallow water
spatial location defined by the kinematic properties of waves where the water depth is less than a twentieth of the wave length

NOTE In shallow water, the dispersion equation is

$$L = \frac{gT^2}{2\pi} \tanh \frac{2\pi d}{L}$$

where

L is the wave length;

d is the water depth;

T is the period;

g is the gravitation acceleration.

In shallow water, the dispersion equation may be simplified to $L = T\sqrt{gd}$.

2.78
significant wave height
statistical measure of the average of the largest one-third of wave heights in an irregular sea state

NOTE 1 From time domain analysis the significant wave height, H_s, is calculated based on zero down crossing analysis.

NOTE 2 The spectral estimate of the significant wave height is to be preferred and is estimated by $H_{m_0} = 4\sqrt{m_0}$ where m_0 is the zeroth spectral moment of the wave energy spectrum. m_0 is the variance of the sea state and can be calculated directly from the surface elevation time series. If the individual wave heights are Rayleigh distributed then $H_s = H_{m0}$. In most realistic sea states this is not completely true and H_{m0} is therefore often slightly larger than H_s.

2.79
spectral density
limit of the variance of the free surface elevation as the frequency bin width tends to zero

2.80
spectral moment
n^{th} spectral moment, m_n, about zero frequency, is given by

$$m_n = \int_0^{\infty} f^n S(f) \mathrm{d} f$$

where $S(f)$ is the spectral density.

NOTE For discrete data the following estimate may be used

$$m_n = \sum_i f_i^n S_i \Delta f_i$$

2.81
submerged pressure differential device
immersed WEC which converts pressure variations into some other form of energy, typically electricity

2.82
survivability (functional)
probability that a converter will continue to operate without a forced outage over the stated operational life

[Legrand, 2009, modified]

2.83
survivability (safety)
probability that a converter will remain as installed over the stated operational life

[Legrand, 2009, modified]

2.84
survival mode
operation mode for a device that reduces the likelihood of damage being sustained during extreme/uncommon environmental conditions such as storms

2.85
tank testing
evaluation of device performance and properties under controlled hydrodynamic conditions

NOTE Tank tests may be performed in wave flumes, towing tanks, wave basins, and other types of facilities.

2.86
terminator device
energy converter which is aligned perpendicular to the predominant direction of wave incidence

2.87
tidal current
tidal stream
flow of water induced by the gravitational forces of celestial bodies

2.88
tidal current constituents
complex amplitudes and phases of the components of the harmonic description of tidal velocities at a specified location

2.89
tidal current ellipse
polar plot of the tidal velocities at spring and neap tide

NOTE Typically the depth averaged velocities are used to create the plot.

2.90
tidal current turbulence
unsteady fluctuation of the flow velocity in a tidally induced current

2.91
tidal eddy
circular movement of water present in a tidally induced current

2.92
tidal energy
energy present in the movement of water created by the gravitational forces of celestial bodies

2.93
tidal energy converter
TEC
device which captures energy from tidal currents and converts it into another form

2.94
tidal height constituents
amplitudes and phases of the components of the harmonic description of tidal elevations at a specified location

2.95
tidal range
difference between consecutive high and low tides

2.96
turbine
rotating device that converts kinetic energy of flowing fluid to mechanical energy

2.96.1
axial flow turbine
kinetic energy conversion device in which the fluid moves in a direction parallel to the axis of rotation

[IEC 60050-811:1991, 811-22-04, modified]

2.96.2
bulb turbine
hydraulic reaction type kinetic energy conversion device set with its casing containing the generator and turbine immersed in the water flow

[IEC 60050-602:1983, 602-02-16]

2.96.3
counter-rotating turbine; contra-rotating turbine
set of kinetic energy conversion devices placed close together with their blades rotating in opposite directions

2.96.4
cross-flow turbine
kinetic energy conversion device in which the fluid moves in a direction perpendicular to the axis of rotation

2.96.5
Darrieus turbine
type of cross-flow turbine with non-helical blades in line with the axis of rotation

2.96.6
Francis turbine
hydraulic reaction type kinetic energy conversion device with fixed runner blades usually operating from a medium or low head source with medium flow rate

[IEC 60050-602:1983, 602-02-14, modified]

2.96.7
Gorlov turbine
type of cross-flow turbine with helical blades

2.96.8
horizontal axis tidal turbine
kinetic energy conversion device whose rotor axis is substantially parallel to the fluid flow

[IEC 60050-415:1999, 415-01-04, modified]

2.96.9
Kaplan turbine
axial hydraulic reaction type kinetic energy conversion device with adjustable runner blades operated with a high flow rate

[IEC 60050-602:1983, 602-02-15, modified]

2.96.10
Pelton turbine
hydraulic impulse type kinetic energy conversion device usually operated from a high head source with small flow rate

[IEC 60050-602:1983, 602-02-13, modified]

2.96.11
propeller turbine
kinetic energy conversion device with non-adjustable runner blades suitable for non-varying head sources

[IEC 60050-602:1983, 602-02-17, modified]

2.96.12
pit turbine
type of bulb type kinetic energy conversion device in which the gearbox is used to reduce the size of the generator and the bulb

2.96.13
rim turbine
type of axial flow type kinetic energy conversion device in which the power take-off is taken from the perimeter of the turbine

2.96.14
Savonius turbine
type of cross-flow kinetic energy conversion device with S-shaped scoops, which have an offset against each other so that a part of the fluid is diverted to the other concave blade

2.96.15
tubular turbine
type of axial flow kinetic energy conversion device in which the power take-off is taken from a long shaft connected to the runner

[Wave Energy Centre, 2007]

2.96.16
Turgo turbine
hydraulic impulse type kinetic energy converter operated from a medium head source in which the head range is where Pelton and Francis turbines overlap

2.96.17
vertical axis tidal turbine
kinetic energy conversion device whose rotor axis is vertical and perpendicular to the flow of water

[IEC 60050-415:1999, 415-01-05, modified]

2.96.18
Wells turbine
kinetic energy conversion device with symmetric fixed-pitch blades that rotates in a single direction regardless of the direction of fluid flow

[Carbon Trust, 2005, modified]

2.97
Venturi device
convergent-divergent duct section used to create a pressure difference that drives a turbine

2.98
water current measuring instrument
device used to measure water current properties

2.98.1
Doppler current meter
acoustic device which measures water current at only one level in the water column

2.98.2
Doppler current profiler
DCP
acoustic device which measures current speed and direction in multiple layers throughout the water column

2.98.3
Doppler velocimeter
acoustic device which produces high resolution measurement of the current speed and direction at a single point

2.99
wave climate
long-term statistical characterization of the wave properties at a location

NOTE Wave climate is a subset of met-ocean.

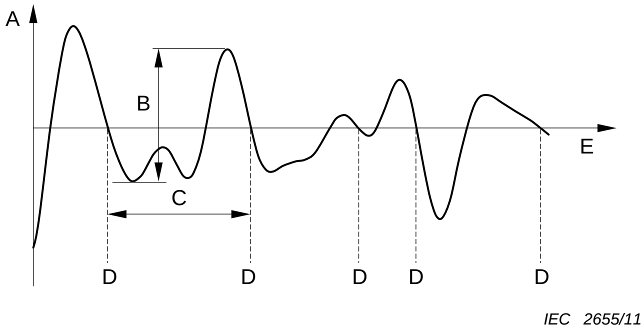
2.100
wave energy
total kinetic and potential energy associated with the propagation of surface waves, integrated from the sea floor to the surface

2.101
wave energy converter
WEC
device which captures energy from surface waves and converts it into another form

2.102
wave energy spectrum
wave energy per unit area as a function of frequency, expressed as $\rho g S(f)$, where $S(f)$ is the spectral density

NOTE The wave energy spectrum may be expressed as a function of frequency and direction, and other parameters.

2.103
wave height
vertical distance between a consecutive wave trough and wave crest (see Figure 3)



Key

A	Surface elevation η	D	Zero downcrossing
B	Wave height H	E	Time t
C	Wave period T		

Figure 3 – Wave height and wave period

2.104
wave measuring instrument
WMI
device used to measure wave properties

2.104.1
acoustic wave profiler
AWP
inverted sonar device which uses the reflection of sound waves at the water surface to measure surface displacement

NOTE Acoustic wave profilers are often integrated into Doppler current profilers.

2.104.2
capacitance gauge
wavestaff constructed from a wire with a dielectric sheath to measure surface elevation

2.104.3
electromechanical probe
wave measuring instrument or staff constructed from a rigid insulated rod with a capacitance probe on the end which measures surface elevation by adjusting the vertical position of the rod to ensure the probe measures a constant capacitance

NOTE Electromechanical probes can only be used at small scale in laboratories.

2.104.4
laser wave gauge
laser system which uses an offset camera to measure the changing position of scattered light

NOTE Laser wave gauges have a high degree of accuracy but can only be used in laboratories and are unsuited for taking measurements where there are breaking waves.

2.104.5
optical altimeter
laser radar (lidar) system used to measure the distance between the instrument and the water surface

NOTE Optical altimeters are only useable for field measurements and are unreliable when there is significant wave breaking or spray.

2.104.6
resistance gauge
wavestaff constructed from two parallel wires, energized with an AC current, to measure surface elevation

2.104.7
shipborne wave recorder
device mounted within the hull of a ship, which accurately follows the rise and fall of each wave, combining the principles of the pressure recorder and the surface following buoy

2.104.8
sub-surface pressure recorder
pressure sensor placed at a fixed point below the water surface used to derive the surface displacement

2.104.9
surface following buoy
floating device using accelerometers to measure wave motions

2.104.10
wavestaff
surface piercing sensor that measures its own immersion depth

2.105
wave period
time between two consecutive zero down crossings of surface elevation

NOTE Refer to Figure 3 for a depiction of wave period.

2.106
wave phase velocity
velocity at which the phase of the wave is propagating

NOTE 1 The wave phase velocity is calculated in terms of the ratio between wave length and period.

NOTE 2 As water waves are dispersive, the wave phase velocity varies with period and is not necessarily the same as the group velocity of the wave.

2.107
wave power
wave energy flux per unit width
wave energy transport rate per unit width from the sea floor to the surface, calculated as the product of the group velocity and the wave energy

NOTE Unless otherwise specified, wave power should be understood as omnidirectional, or directionally unresolved.

2.108
wave spectrum
distribution of the spectral density as a function of frequency

2.108.1
Bretschneider spectrum
theoretical two parameter spectrum for long fetch (oceanic) waves

NOTE Various parameterizations of the Bretschneider spectrum exist giving the spectrum as functions of typically H_{m0} and T_p.

2.108.2
JONSWAP spectrum
theoretical two parameter spectrum developed for the North Sea (fetch limited conditions), by the Joint North Sea Wave Project (JONSWAP) given as a function of wind speed and fetch length

NOTE 1 The JONSWAP spectrum is the Pierson-Moskowitz spectrum modified with a term involving a peak enhancement factor.

NOTE 2 Various parameterizations of the JONSWAP spectrum exist giving the spectrum as functions of typically H_{m0} and T_p.

[Hasselman, Dunckel, & Ewing, 1980]

2.108.3
Pierson-Moskowitz spectrum
theoretical one parameter spectrum for fully developed sea states given as a function of wind speed

NOTE Various parameterizations of the Pierson-Moskowitz spectrum exist giving the spectrum as functions of typically H_{m0} and T_p.

2.109
wave steepness
ratio of wave height to wave length

NOTE Wave steepness is normally expressed as a percentage.

2.110
wave tank; wave flume; wave basin
facility that is able to reproduce controlled hydrodynamic conditions primarily waves and/or currents

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