भारतीय मानक
Indian Standard

IEC TS 62600-1 : 2020

समुद्री ऊर्जा — तरंग, ज्वार और अन्य जल धारा परिवर्तक

भाग 1 शब्दावली

Marine Energy — Wave, Tidal and Other Water Current Converters

Part 1 Vocabulary

ICS 27.140

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

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Marine Energy Conversion Systems Sectional Committee, ETD 54

NATIONAL FOREWORD

This Standard (Part 1) which is identical to IEC TS 62600-1 : 2020 ‘Marine energy — Wave, tidal and other current converters: Part 1 Vocabulary’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Marine Energy Conversion Systems Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appears referring to this standard, they should be read as ‘Indian Standard’; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

CONTENTS

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 document defining the terms used within the sector was required. The aim of this document is to present clear and consistent language that will aid the development of programs, projects, and future standards.

This document lists the terms that the marine energy industry 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. The document does not constitute a full glossary of terms used in the marine energy community.

Indian Standard

MARINE ENERGY — WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS

PART 1 VOCABULARY

1 Scope

This part of IEC 62600 defines the terms relevant to marine energy. For the purposes of this document, sources of ocean and marine renewable energy are taken to include primarily devices that convert wave, tidal and other water current energy into electrical energy, although other conversion methods, systems and products are included.

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

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

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
annual energy production
estimate of the total energy production of a device during a one-year period obtained by applying the device’s power performance characteristics to a relevant energy resource characterization, assuming 100 % availability

Note 1 to entry: Actual annual energy production is unlikely to exceed this estimate.

[SOURCE: IEC 60050-415:1999, 415-05-09, modified – The definition has been revised to be generic by replacing "wind turbine generator system" by "device", and by replacing "the power curve to different reference wind speed frequency distributions at hub height" by "the device’s power performance characteristics to a relevant energy resource characterization". For clarity, "obtained" has been added before "by applying". Note 1 to entry has been added.]

3.2
array
<in marine energy> one or more groups of marine energy converters

Note 1 to entry: Array spacing is dictated by hydrodynamic considerations and can be very closely packed so as to constitute a single platform or an arrangement of identical devices.

3.3
availability, <of an item>
See IEV 192-01-23

3.4
capture width
capture length
<of a wave energy converter> power captured by the **wave energy converter** divided by the **wave power** of the incident wave field

3.5
current energy converter
CEC
device that converts energy from water currents to electricity or other useful forms of energy

3.6
cut-in water speed
cut-in water velocity
<of a current energy converter> water speed above which there is power production

Note 1 to entry: The term "cut-in water velocity" is sometimes used in industry, although the concept is in fact a speed.

3.7
cut-out water speed
cut-out water velocity
<of a current energy converter> water speed above which there is no power production

Note 1 to entry: The term "cut-in water velocity" is sometimes used in industry, although the concept is in fact a speed.

3.8
degrees of freedom, pl
independent displacements and/or rotations that specify the orientation of a body or system

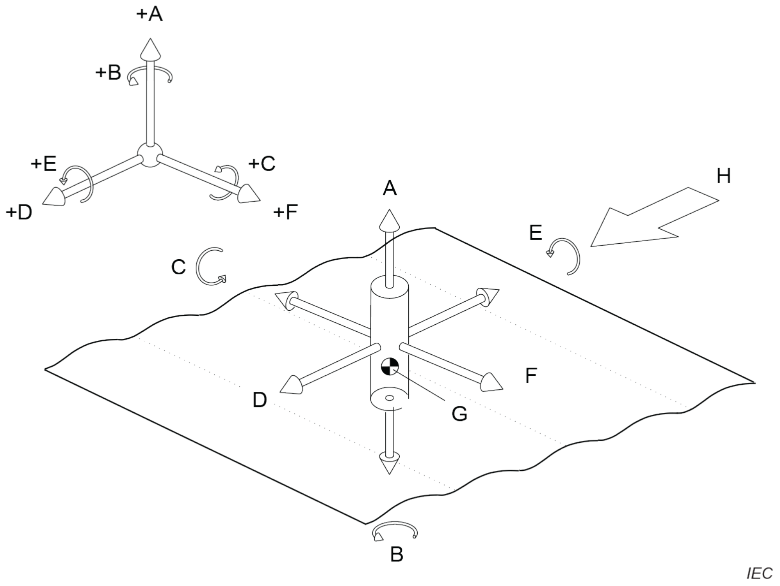
Note 1 to entry: A marine body can experience three linear and three rotational motions as depicted in Figure 1 and A Heave D Surge G Centre of gravity

B Yaw E Roll H Incident energy at zero-degree heading

C Pitch F Sway I Seabed

Figure 2.

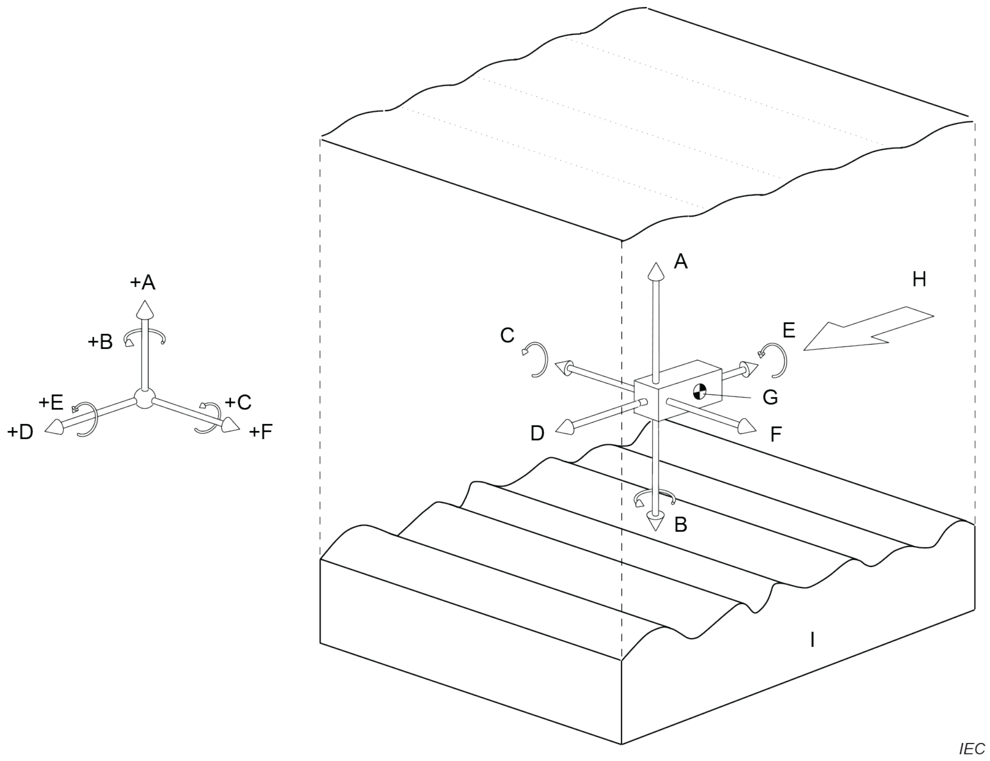
Note 2 to entry: The principal axis is parallel to the mean water surface and aligned with the longest, plan form, dimension of the device. The principal axis for a symmetric device will be parallel to the mean water surface and aligned with a chosen direction of interest. The direction of incident energy will be through the centre of gravity and may be at an angle to the principal axis.



Key

A Heave
B Yaw
C Pitch
D Surge
E Roll
F Sway
G Centre of gravity
H Incident energy at zero-degree heading

Figure 1 – Six degrees of freedom – Floating device



Key

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

Figure 2 – Six degrees of freedom – Submerged device

3.8.1
heave
motion in a direction perpendicular to the mean water surface

3.8.2
pitch
rotation about the **sway** axis

3.8.3
roll
rotation about the **surge** axis

3.8.4
surge
motion parallel to the principal axis

3.8.5
sway
motion perpendicular to the principal axis and parallel to the mean water surface

3.8.6
yaw
rotation about the **heave** axis

3.9
directional spreading function
<of a water wave> normalized distribution of **wave energy**, D, for a given frequency, f, over the angle of incidence, θ

Note 1 to entry: Since $\int_0^{2\pi} D(\theta, f)\,\mathrm{d}\theta = 1$ the **directional spreading function** can be considered to be a probability density function over direction.

3.10
directional wave spectrum
<of a water wave> distribution of the wave elevation variance density as a function of incident wave frequency and direction

Note 1 to entry: The **directional wave spectrum** is calculated as the product of the **wave spectrum** multiplied with the directional spreading function.

3.11
directionally resolved power
<of a water wave> sum of all **wave power** components propagating in a specified direction in a given sea state

3.12
energy extraction plane
<of a current energy converter> plane that is perpendicular to the **principal axis of energy capture** where device rotation or energy conversion nominally occurs

Note 1 to entry: Refer to Figure 4 for a simplified illustration of the energy extraction plane.

Note 2 to entry: For a **tidal energy converter** device with multiple extraction planes, an appropriate upstream energy extraction plane on both ebb and flood tides should be identified.

3.13
energy period
$\boldsymbol{T}_{\mathrm{e}}$
<of a water wave> characteristic wave period associated with energy propagation expressed as the **group velocity** weighted mean period of the **wave spectrum**

Note 1 to entry: It is numerically equivalent to the period of a monochromatic wave in deep water with wave elevation variance and energy flux equal to a polychromatic sea state.

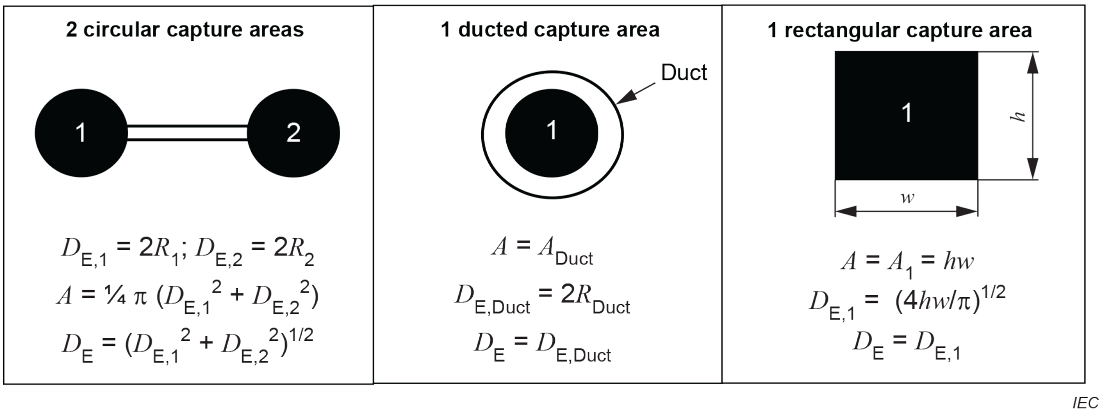
Note 2 to entry: In accordance with International Association for Hydraulic Research the spectral estimate of the energy period is preferred.

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

3.14
equivalent diameter
$\boldsymbol{D}_{\mathrm{E}}$
diameter of a circle with area equal to the device **projected capture area**

Note 1 to entry: The equivalent diameter is generally calculated as:

$De = \sqrt{\frac{4A}{\pi}} D_{\mathrm{E}} = \sqrt{\frac{4A}{\pi}}$, where A is the projected capture area as illustrated in Figure 3.



Key

A projected capture area	h height
D_E equivalent diameter	w width
R radius	

Figure 3 – Equivalent diameter calculations for various projected capture areas

3.15
free-stream condition
<of a current energy converter> boundary condition description for a **current energy converter** such that its performance is equivalent to that of a **current energy converter** operating in a channel with infinite cross-section

3.16
functional survivability
probability that a device will continue to operate without a forced outage over the stated operational life

3.17
group velocity
<of a water wave> propagation velocity of water wave groups and the wave energy

Note 1 to entry: The **group velocity** of a water wave is the velocity at which the energy associated with the wave disturbance travels in the direction of wave propagation. In deep water using linear wave theory the **group velocity** is one half the **wave phase velocity**. In shallow water the **group velocity** is equal to the **wave phase velocity**.

3.18
hub height
<of a current energy converter> distance from the centroid of a **current energy converter**'s **projected capture area** to the sea floor

3.19
instantaneous availability
See IEV 192-08-01

3.20
low cut-out water speed
low cut-out water velocity
<of a current energy converter> water speed during the decelerating part of the current cycle below which a **tidal energy converter** does not produce power

Note 1 to entry: The term "cut-out water velocity" is sometimes used in industry, although the concept is in fact a speed.

3.21
maintainability, <of an item>
See IEV 192-01-27

3.22
marine current
persistent flow of seawater produced by natural physical processes, including the gravitational pull of celestial bodies

3.23
marine energy converter
MEC
device that converts energy from oceans or other natural bodies of water to electricity or other useful forms of energy

3.24
maximum individual wave height
$H_{\max}$
<of a water wave> 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 1 to entry: 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 $H_{\max}$ = 1,86 times the significant wave height.

3.25
mean annual wave power
<of a water wave> yearly average of the directionally unresolved **wave power** calculated as an arithmetic mean over all sea states occurring at a given location

Note 1 to entry: Typically **mean annual wave power** is expressed in kilowatts per metre.

3.26
mean zero crossing period
<of a water wave> average time interval between downcrossings of the mean water level during a given sea state

Note 1 to entry: The spectral estimate of the mean zero crossing period, T_{02}, is calculated as

$T_{02} = \sqrt{\frac{m_0}{m_2}}$, where m_0 and m_2 are the zero and second spectral moments.

3.27
metocean
met-ocean
meteorological and oceanographic environment typically described using wind, wave, tidal and other characteristics

3.28
ocean current
large scale and persistent flow of seawater other than **tidal current**

3.29
ocean current energy converter
OCEC
device that converts energy from an **ocean current** to electricity or other useful forms of energy

3.30
ocean thermal energy converter
OTEC
device that converts thermal energy from the ocean to electricity or other useful forms of energy

3.31
power curve
power surface
<of a current energy converter> representation of the power capture as a function of current parameters

3.32
power matrix
tabular description of the power capture as a function of relevant meteorological and oceanographic parameters

3.33
power take-off
PTO
mechanism that converts the motion of the **prime mover** into a useful form of energy such as electricity

3.34
power weighted speed
<of a current energy converter> magnitude of current velocity derived with a weighted function corresponding to the kinetic energy flux through the **projected capture area**

3.35
power weighted velocity
<of a current energy converter> current velocity derived with a weighted function corresponding to the kinetic energy flux through the **projected capture area**

3.36
prime mover
marine energy converter component that interfaces with a resource from which energy is converted

3.37
principal axis of energy capture
<of a current energy converter> axis parallel to the design orientation or heading of a **current energy converter** passing through the centroid of the **projected capture area**

Note 1 to entry: Figure 4 illustrates a simplified example of the principal axis of energy capture.

3.38
principal flow direction
<of a current energy converter> primary orientation or heading of the water current

Note 1 to entry: Figure 4 illustrates a simplified example of the principal flow directions.

Note 2 to entry: For tidal energy converters, it is common to introduce two primary flow directions, one defining the primary flood flow, and one defining the primary ebb flow.

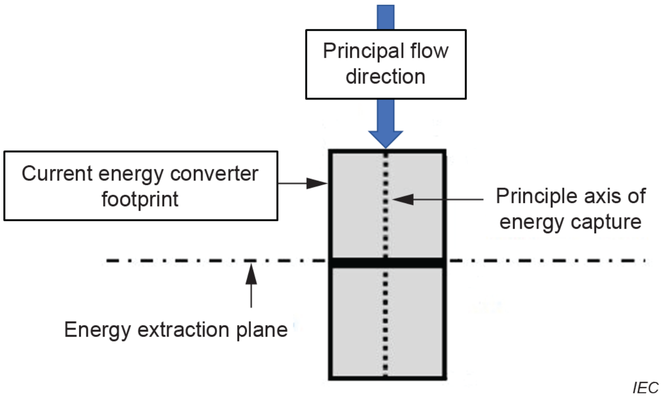


Figure 4 – Principal flow direction

3.39
projected capture area
<of a current energy converter> frontal area perpendicular to the **principal flow direction** of the **current energy converter** components hydrodynamically utilized in energy conversion

3.40
rated power
rated capacity
maximum continuous electric output power which a device's generator system is designed to achieve under normal operating conditions

Note 1 to entry: The term "rated power" can refer to the output of a single device or an **array.**

[SOURCE: IEC 60050-415:1999, 415-04-03, modified **–** The definition has been revised to be generic by replacing "wind turbine" by "devices'". Note 1 to entry has been added.]

3.41
rated water speed
rated water velocity
<of a current energy converter> lowest mean flow speed at which the **rated power** of a **current energy converter** is delivered

Note 1 to entry: The term "rated water velocity" is sometimes used in industry, although the concept is in fact a speed.

3.42
reliability, <of an item>
See IEV 192-01-24

3.43
resource assessment
<in marine energy> collection and processing of meteorological and oceanographic data required for determining the performance of a **marine energy converter** or **array**

Note 1 to entry: Resource assessments are conducted in three distinct stages comprising theoretical resource assessment, technical resource assessment, and practical resource assessment.

3.43.1
practical resource
proportion of the **technical resource** that is available after consideration of external constraints

Note 1 to entry: External constraints can include grid accessibility, competing use, environmental sensitivity, etc.

3.43.2
technical resource
proportion of the **theoretical resource** that can be captured using existing technology options without consideration of external constraints

3.43.3
theoretical resource
energy available in the resource

3.44
resource characterization
parameterization of meteorological and oceanographic data to enable determination of the performance of a **marine energy converter** or **array**

3.45
river current
flow of water in an open channel other than **tidal current**

3.46
river energy
energy present in a **river current**

3.47
river energy converter
REC
device that converts energy from a **river current** to electricity or other useful forms of energy

3.48
survivability
<of an item> ability to continue to operate without a failure over the stated operational life

3.49
survival mode
<of a device> operational configuration that improves **survivability** during extreme conditions

3.50
test availability
ratio of the total number of hours during a test period where all test conditions are met, to the total number of hours of the **test period**

3.51
test period
period between the first data collection and the last data collection, for the purpose of power performance assessment

3.52
tidal current
tidal stream
flow of water induced by the gravitational forces of celestial bodies

3.53
tidal energy
energy present in a **tidal current**

3.54
tidal energy converter
TEC
device that converts energy from a **tidal current** to electricity or other useful forms of energy

3.55
wave climate
long-term statistical characterization of the wave properties at a location

Note 1 to entry: Wave climate is a subset of the metocean.

3.56
wave energy
energy present in surface waves

3.57
wave energy converter
WEC
device that converts energy from surface waves to electricity or other useful forms of energy

3.58
wave height
<of a water wave> vertical distance between a consecutive wave trough and wave crest

3.59
wave phase velocity
<of a water wave> velocity at which the phase of the wave is propagating

Note 1 to entry: The **wave phase velocity** is calculated in terms of the ratio between wave length and period.

Note 2 to entry: As water waves are dispersive, the wave phase velocity varies with period and is not necessarily the same as the **group velocity**.

3.60
wave power
wave energy flux per unit width
wave energy transport rate per unit width from the sea floor to the surface

Note 1 to entry: Unless otherwise specified, wave power should be understood as omnidirectional, or directionally unresolved.

3.61
wave spectrum
<of a water wave> distribution of the wave elevation variance density as a function of frequency

3.62
wave steepness
<of a water wave> ratio of **wave height** to wave length

Bibliography

IEC 60050-192:2015, *International Electrotechnical Vocabulary (IEV) – Part 192: Dependability*

IEC 60050-415:1999, *International Electrotechnical Vocabulary (IEV) – Part 415: Wind turbine generator systems*

ISO 19901-1, 2015 *Petroleum and natural gas industries — Specific requirements for offshore structures – Part 1: Metocean design and operating considerations*

Dean, R.G., Dalrymple, R.A., 1991, *Water wave mechanics for engineers and scientists. World Scientific, Advanced Series on Ocean Engineering, 2*

Frigaard, P., Helm-Petersen, J., Harford, C., Klopman, G., Stanberg, C., Benoit, M., Briggs, M., Miles, M., Santas, J., Schaffer, H., & Hawker, P., 1997, *International Association for Hydraulic Research (IAHR) List of sea state parameters – an update for multidirectional waves,* Paper presented at the IAHR Conference in San Francisco, California

International Association for Hydraulic Research (IAHR), working group on wave generation and analysis, 1989, *List of sea state parameters,* Journal of Waterway, Port, Coastal and Ocean Engineering 115 (6), 793–808

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
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