

PD IEC/TS 62600-10:2015



BSI Standards Publication

Marine energy — Wave, tidal and other water current converters

Part 10: Assessment of mooring system for marine energy converters (MECs)

bsi.

...making excellence a habit.™

National foreword

This Published Document is the UK implementation of IEC/TS 62600-10:2015.

The UK participation in its preparation was entrusted to Technical Committee PEL/114, Marine energy — Wave, tidal and other water current converters.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2015.

Published by BSI Standards Limited 2015

ISBN 978 0 580 83342 7

ICS 27.140

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2015.

Amendments/corrigenda issued since publication

Date	Text affected
-------------	----------------------



TECHNICAL SPECIFICATION



Marine energy – Wave, tidal and other water current converters – Part 10: Assessment of mooring system for marine energy converters (MECs)

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.140

ISBN 978-2-8322-2431-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	9
4 Abbreviated terms	11
5 Principal element.....	12
5.1 General.....	12
5.2 Mooring and anchor systems	12
5.3 Design considerations	12
5.4 Safety and risk consideration.....	13
5.5 Analysis procedure.....	13
5.6 Inspection and maintenance requirements	13
6 Types of moorings and anchoring systems	13
6.1 General.....	13
6.2 Mooring systems.....	13
6.2.1 General	13
6.2.2 Spread moorings (catenary, taut-line and semi-taut-line).....	13
6.2.3 Single point moorings (SPM)	14
6.3 Mooring line components.....	15
6.3.1 General	15
6.3.2 Chain.....	15
6.3.3 Wire rope.....	16
6.3.4 Synthetic rope.....	17
6.3.5 Clump weights	17
6.3.6 Buoyancy aids	17
6.3.7 Connectors and accessories.....	17
6.4 Anchors types	18
6.4.1 General	18
6.4.2 Drag embedment anchor	18
6.4.3 Pile anchor	19
6.4.4 Suction anchor.....	19
6.4.5 Gravity installed anchor.....	20
6.4.6 Gravity anchor	20
6.4.7 Plate anchor	21
6.4.8 Screw anchor.....	21
7 Design consideration	22
7.1 General.....	22
7.2 Limit states	22
7.2.1 Ultimate limit state (ULS)	22
7.2.2 Accidental limit state (ALS)	22
7.2.3 Serviceability limit state (SLS).....	22
7.2.4 Fatigue limit state (FLS).....	22
7.3 External conditions.....	23
7.3.1 General	23
7.3.2 Metocean conditions	23

7.3.3	Marine growth	23
7.3.4	Marine life.....	23
7.3.5	Environmentally sensitive and protected areas and marine animals.....	23
7.3.6	Nearshore impact.....	23
7.3.7	Vandalism and misuse	23
7.3.8	Marine traffic.....	24
7.4	Assorted loading	24
7.4.1	General	24
7.4.2	Low frequency loads	24
7.4.3	Wave frequency loads on mooring components	24
7.4.4	Wave frequency loads on MEC.....	25
7.4.5	High frequency loading.....	25
7.5	Mooring line components.....	25
7.5.1	Component strength.....	25
7.5.2	Component fatigue life	25
7.5.3	Redundancy.....	25
7.5.4	Clearance	25
7.6	Umbilical considerations.....	26
7.6.1	Umbilical response.....	26
7.6.2	Umbilical strength	26
7.6.3	Umbilical offset and clearance limits	26
7.7	Anchors	26
7.7.1	Type selection	26
7.7.2	Holding capacity	26
7.7.3	Sediment and rock conditions.....	26
7.7.4	Fluke setting	27
7.7.5	Installation	27
7.7.6	Proof loading	27
7.7.7	Directional anchor loading.....	27
7.7.8	Failure mode.....	27
7.7.9	Environmental loading.....	27
8	Safety and risk considerations	27
8.1	Overview	27
8.2	Risk.....	27
8.2.1	General	27
8.2.2	Definition	28
8.2.3	Consequence types.....	28
8.2.4	General risk mitigation	28
8.2.5	ALARP principle.....	28
8.3	Risk assessment methodology.....	28
8.3.1	General	28
8.3.2	Methodology flowchart	29
8.3.3	Basic considerations	30
8.3.4	Probability assessment	31
8.3.5	Consequence classification assessment	31
8.4	Consequence considerations for mooring failure	31
8.5	Consequence classification	31
8.5.1	General	31
8.5.2	Consequence impact considerations.....	32

8.5.3	Waterway navigation impacts	33
8.5.4	Environmentally sensitive and protected sites	33
8.5.5	Archaeological sites	33
8.6	Risk mitigation considerations	33
8.6.1	Mitigation overview	33
8.6.2	Probability reduction	33
8.6.3	Consequence reduction.....	33
8.7	Risk acceptance.....	34
8.7.1	Acceptance overview	34
8.7.2	Documentation.....	34
9	Analysis procedure	34
9.1	General.....	34
9.2	Basic considerations	34
9.3	Analysis procedure overview	35
9.4	Modelling consideration.....	36
9.4.1	General	36
9.4.2	Mooring and umbilical models	36
9.4.3	Floating unit numerical models	36
9.4.4	Coupled and uncoupled analysis	37
9.5	Analysis procedure considerations.....	37
9.5.1	Metoccean directionality	37
9.5.2	Resonant response	37
9.5.3	Dynamic mooring analysis.....	37
9.5.4	Design situations of ULS	38
9.5.5	Design situations of ALS	38
9.5.6	Design situations of FLS	38
9.5.7	Design situations of SLS	38
9.6	Mooring design criteria	38
9.6.1	Design return period	38
9.6.2	Consequence class design factor	38
9.6.3	Mooring line component failure.....	39
9.6.4	Anchor holding capacity	39
10	In-service inspection, monitoring, testing, and maintenance.....	40
10.1	General.....	40
10.2	Mooring system proof loading	41
10.3	Component replacement.....	41
10.4	In air and splash zone mooring line sections	41
10.5	Submerged mooring line sections	41
10.6	Commissioning and decommissioning procedures.....	42
Annex A	(informative) Sample mooring design.....	43
A.1	General.....	43
A.2	Problem layout.....	43
A.3	Consequence class identification.....	44
A.4	Mooring design process	47
Bibliography	50
Figure 1	– Spread mooring configuration	14
Figure 2	– Catenary anchor leg mooring configuration	14

Figure 3 – Single anchor leg mooring configuration	15
Figure 4 – Turret mooring configuration	15
Figure 5 – Studless and studlink chain	16
Figure 6 – Typical wire rope construction	16
Figure 7 – Types of connectors	18
Figure 8 – HHP drag embedment anchor	19
Figure 9 – Pile anchor	19
Figure 10 – Suction anchor	20
Figure 11 – Gravity installed anchor	20
Figure 12 – Gravity anchor	21
Figure 13 – Plate anchor	21
Figure 14 – Screw anchor	22
Figure 15 – General risk methodology flowchart	30
Figure 16 – Conceptual mooring analysis procedure	35
Figure A.1 – Potential tidal current MEC installation locations A, B; artificial reef C; fish farm D; marine traffic corridor E	43
Figure A.2 – Mooring line component minimum ASF for each return period environment 5, 10, 20, 50, and 100 plotted to determine mooring ULS return period	48
Figure A.3 – Anchor minimum ASF for each return period environment 5, 10, 20, 50, and 100 plotted to determine anchor ULS return period	48
Table 1 – Potential nearshore impacts	23
Table 2 – Consequence categories	31
Table 3 – Consequence class	32
Table 4 – Consequence class associated design factors	39
Table 5 – Safety factors for ULS and ALS conditions	39
Table 6 – Safety factors for holding capacity of drag anchors factors	40
Table 7 – Safety factors for holding capacity of anchor piles and suction piles	40
Table 8 – Safety factors for holding capacity of gravity and plate anchors	40
Table A.1 – Consequence classification matrix: location A	45
Table A.2 – Consequence classification matrix: location B	46

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARINE ENERGY –
WAVE, TIDAL AND OTHER WATER CURRENT CONVERTERS –****Part 10: Assessment of mooring system
for marine energy converters (MECs)**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

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

IEC TS 62600-10, 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
114/140/DTS	114/150A/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 website 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This technical specification defines rules and assessment procedures for the design, installation and maintenance of mooring system with respect to technical requirements for floating marine energy converters.

The proposed work will aim to bring together expert knowledge from the marine energy power and offshore engineering industries in order to formulate a guideline specification of the design, installation and maintenance requirements for mooring system of floating MECs.

In addition to safety and ocean environmental requirements, this technical specification focuses on the strength requirements of mooring systems for MECs.

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

Part 10: Assessment of mooring system for marine energy converters (MECs)

1 Scope

The purpose of this Technical Specification is to provide uniform methodologies for the design and assessment of mooring systems for floating MECs (as defined in TC114 scope). It is intended to be applied at various stages, from mooring system assessment to design, installation and maintenance of floating MEC plants.

This technical specification is applicable to mooring systems for floating MEC units of any size or type in any open water conditions. Some aspects of the mooring system design process are more detailed in existing and well-established mooring standards. The intent of this technical specification is to highlight the different requirements of MECs and not duplicate existing standards or processes.

While requirements for anchor holding capacity are indicated, detailed geotechnical analysis and design of anchors are beyond the scope of this technical specification.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 62600-1, *Marine energy – Wave, tidal and other water current converters – Part 1: Terminology*

ISO 17776:2000, *Petroleum and natural gas industries – Offshore production installations – Guidelines on tools and techniques for hazard identification and risk assessment*

ISO 19901-1:2005, *Petroleum and natural gas industries – Specific requirements for offshore structures – Part 1: Metocean design and operating considerations*

ISO 19901-7:2013, *Petroleum and natural gas industries – Specific requirements for offshore structures – Part 7: Stationkeeping systems for floating offshore structures and mobile offshore units*

API RP 2SK, *Design and Analysis of Station keeping Systems for Floating Structures*, 3rd Edition, October 2005

API RP 2I, *In-Service Inspection of Mooring Hardware for Floating Structures*, 3rd Edition, 2008

3 Terms and definitions

For the purposes of this document, the following terms and definitions as well as those given in IEC TS 62600-1 apply.