Classification and Certification of Ocean Thermal Energy Converter (OTEC) - Tentative Rules -

January 2018

Guidance Note
NI 637 DT R00 E

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MARINE & OFFSHORE - GENERAL CONDITIONS

1. INDEPENDENCY OF THE SOCIETY AND APPLICABLE TERMS

1.1. The Society shall remain at all times an independent contractor and neither the Society nor any of its officers, employees, servants, agents or subcontractors shall be or act as an employee, servant or agent of any other party hereto in the performance of the Services.

1.2. The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not, in any circumstances, involve monitoring or exhaustive verification.

1.3. The Society acts as a services provider. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty. The Society is not and may not be considered as an underwriter, broker in Unit's sale or chartering, expert in Unit's valuation, consulting engineer, controller, naval architect, manufacturer, shipbuilder, repair or conversion yard, charterer or shipowner; none of them above listed being relieved of any of their expressed or implied obligations as a result of the interventions of the Society.

1.4. The Services are carried out by the Society according to the applicable Rules and to the Bureau Veritas' Code of Ethics. The Society only is qualified to apply and interpret its Rules.

1.5. The Client acknowledges the latest versions of the Conditions and of the applicable Rules applying to the Services' performance.

1.6. Unless an express written agreement is made between the Parties on the applicable Rules, the applicable Rules shall be the rules applicable at the time of the Services' performance and con tract's execution.

1.7. The Services' performance is solely based on the Conditions. No other terms shall apply whether express or implied.

2. DEFINITIONS

2.1. "**Certificate(s)**" means class certificates, attestations and reports following the Society's intervention. The Certificates are an appraisement given by the Society to the Client, at a certain date, following surveys by its surveyors on the level of compliance of the Unit to the Society's Rules or to the documents of reference for the Services provided. They cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

2.2. "**Certification**" means the activity of certification in application of national and international regulations or standards, in particular by delegation from different governments that can result in the issuance of a certificate.

2.3. "**Classification**" means the classification of a Unit that can result or not in the issuance of a class certificate with reference to the Rules.

2.4. "**Client**" means the Party and/or its representative requesting the Services.

2.5. "**Conditions**" means the terms and conditions set out in the present document.

2.6. "**Industry Practice**" means International Maritime and/or Offshore industry practices.

2.7. "**Intellectual Property**" means all patents, rights to inventions, utility models, copyright and related rights, trade marks, logos, service marks, trade dress, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software, database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets), methods and proto cols for Services, and any other intellectual property rights, in each case whether capable of registration, registered or unregistered and including all applications for and renewals, reversions or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world.

2.8. "**Parties**" means the Society and Client together.

2.9. "**Party**" means the Society or the Client.

2.10. "**Register**" means the register published annually by the Society.

2.11. "**Rules**" means the Society's classification rules, guidance notes and other documents. The Rules, procedures and instructions of the Society take into account at the date of their preparation the state of currently available and proven technical minimum requirements but are not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.

2.12. "**Services**" means the services set out in clauses 2.2 and 2.3 but also other services related to Classification and Certification such as, but not limited to: ship and company safety management certification, ship and port security certification, training activities, all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board.

2.13. "**Society**" means the classification society '**Bureau Veritas Marine & Offshore SAS**', a company organized and existing under the laws of France, registered in Nanterre under the number 821 131 844, or any other legal entity of Bureau Veritas Group as may be specified in the relevant contract, and whose main activities are Classification and Certification of ships or offshore units.

2.14. "**Unit**" means any ship or vessel or offshore unit or structure of any type or part of it or system whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

3. SCOPE AND PERFORMANCE

3.1. The Society shall perform the Services according to the applicable national and international standards and Industry Practice and always on the assumption that the Client is aware of such standards and Industry Practice.

3.2. Subject to the Services performance and always by reference to the Rules, the Society shall:

- review the construction arrangements of the Unit as shown on the documents provided by the Client;
- conduct the Unit surveys at the place of the Unit construction;
- class the Unit and enters the Unit's class in the Society's Register;
- survey the Unit periodically in service to note that the requirements for the maintenance of class are met. The Client shall inform the Society without delay of any circumstances which may cause any changes on the conducted surveys or Services.

The Society will not:

- declare the acceptance or commissioning of a Unit, nor its construction in conformity with its design, such activities remaining under the exclusive responsibility of the Unit's owner or builder;
- engage in any work relating to the design, construction, production or repair checks, neither in the operation of the Unit or the Unit's trade, neither in any advisory services, and cannot be held liable on those accounts.

4. RESERVATION CLAUSE

4.1. The Client shall always: (i) maintain the Unit in good condition after surveys; (ii) present the Unit after surveys; (iii) present the Unit for surveys; and (iv) inform the Society in due course of any circumstances that may affect the given appraisement of the Unit or cause to modify the scope of the Services.

4.2. Certificates referring to the Society's Rules are only valid if issued by the Society.

4.3. The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.

5. ACCESS AND SAFETY

5.1. The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out. Any information, drawings, etc. required for the performance of the Services must be made available in due time.

5.2. The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

6. PAYMENT OF INVOICES

6.1. The provision of the Services by the Society, whether complete or not, involve, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.

6.2. Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interests equal to twelve (12) months LIBOR plus two (2) per cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold certificates and other documents and/or to suspend or revoke the validity of certificates.

6.3. In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to solve the dispute.

7. 7. LIABILITY

7.1. The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:

- Indirect or consequential loss;
- Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.

The Client shall save, indemnify, defend and hold harmless the Society from the Client's own consequential loss regardless of cause.

7.2. In any case, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cents (150%) of the price paid by the Client to the Society for the performance of the Services. This limit applies regardless of fault by the Society, including breach of contract, breach of warranty, tort, strict liability, breach of statute.

7.3. All claims shall be presented to the Society in writing within three (3) months of the Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

8. INDEMNITY CLAUSE

8.1. The Client agrees to release, indemnify and hold harmless the Society from and against any and all claims, demands, lawsuits or actions for damages, including legal fees, for harm or loss to persons and/or property tangible, intangible or otherwise which may be brought against the Society, incidental to, arising out of or in connection with the performance of the Services except for those claims caused solely and completely by the negligence of the Society, its officers, employees, servants, agents or subcontractors.

9. TERMINATION

9.1. The Parties shall have the right to terminate the Services (and the relevant contract) for convenience after giving the other Party thirty (30) days' written notice, and without prejudice to clause 6 above.

9.2. In such a case, the class granted to the concerned Unit and the previously issued certificates shall remain valid until the date of effect of the termination notice issued, subject to compliance with clause 4.1 and 6 above.

10. FORCE MAJEURE

10.1. Neither Party shall be responsible for any failure to fulfil any term or provision of the Conditions if and to the extent that fulfilment has been delayed or temporarily prevented by a force majeure occurrence without the fault or negligence of the Party affected and which, by the exercise of reasonable diligence, the said Party is unable to provide against.

10.2. For the purpose of this clause, force majeure shall mean any circumstance not being within a Party's reasonable control including, but not limited to: acts of God, natural disasters, epidemics or pandemics, wars, terrorist attacks, riots, sabotages, impositions of sanctions, embargoes, nuclear, chemical or biological contaminations, laws or action taken by a government or public authority, quotas or prohibition, expropriations, destructions of the worksite, explosions, fires, accidents, any labour or trade disputes, strikes or lockouts

11. CONFIDENTIALITY

11.1. The documents and data provided to or prepared by the Society in performing the Services, and the information made available to the Society, are treated as confidential except where the information:

- is already known by the receiving Party from another source and is properly and lawfully in the possession of the receiving Party prior to the date that it is disclosed;
- is already in possession of the public or has entered the public domain, otherwise than through a breach of this obligation;
- is acquired independently from a third party that has the right to disseminate such information;
- is required to be disclosed under applicable law or by a governmental order, decree, regulation or rule or by a stock exchange authority (provided that the receiving Party shall make all reasonable efforts to give prompt written notice to the disclosing Party prior to such disclosure.

11.2. The Society and the Client shall use the confidential information exclusively within the framework of their activity underlying these Conditions.

11.3. Confidential information shall only be provided to third parties with the prior written consent of the other Party. However, such prior consent shall not be required when the Society provides the confidential information to a subsidiary.

11.4. The Society shall have the right to disclose the confidential information if required to do so under regulations of the International Association of Classifications Societies (IACS) or any statutory obligations.

12. INTELLECTUAL PROPERTY

12.1. Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.

12.2. The Intellectual Property developed for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain exclusive property of the Society.

13. ASSIGNMENT

13.1. The contract resulting from to these Conditions cannot be assigned or transferred by any means by a Party to a third party without the prior written consent of the other Party.

13.2. The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

14. SEVERABILITY

14.1. Invalidity of one or more provisions does not affect the remaining provisions.

14.2. Definitions herein take precedence over other definitions which may appear in other documents issued by the Society.

14.3. In case of doubt as to the interpretation of the Conditions, the English text shall prevail.

15. GOVERNING LAW AND DISPUTE RESOLUTION

15.1. The Conditions shall be construed and governed by the laws of England and Wales.

15.2. The Society and the Client shall make every effort to settle any dispute amicably and in good faith by way of negotiation within thirty (30) days from the date of receipt by either one of the Parties of a written notice of such a dispute.

15.3. Failing that, the dispute shall finally be settled by arbitration under the LCIA rules, which rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three (3). The place of arbitration shall be London (UK).

16. PROFESSIONNAL ETHICS

16.1. Each Party shall conduct all activities in compliance with all laws, statutes, rules, and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption. Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official, or candidate.

16.2. In addition, the Client shall act consistently with the Society's Code of Ethics of Bureau Veritas. http://www.bureauveritas.com/home/about-us/ethics+and+compliance/

GUIDANCE NOTE NI 637

Classification and Certification of Ocean Thermal Energy Converter (OTEC) - Tentative Rules

January 2018

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SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 The present tentative rules purpose is to provide guidance for the classification/certification of Ocean Thermal Energy Converter (OTEC) floating unit.

The tentative requirements are intended to cover the floating platform supporting the OTEC plant. The renewable power generation pieces of equipment related to the OTEC plant are not included in the scope of the present note.

1.1.2 Attention is essentially to be paid on the characteristics of the unit, such as:

- manned or unmanned unit

Note 1: In the present note, OTEC unit is considered unmanned when no personnel are on board in normal working condition, even if some personnel are on board for short time period (e.g. maintenance operation).

- presence or not of dangerous gas/liquid (working fluid).

1.1.3 Rules

Particular provisions of the present tentative rules are complementary to provisions of the following rules, which remain applicable, when relevant:

- NR216 Rules on Material and Welding for the Classification of Marine Units
- NI 423 Corrosion Protection of Steel Offshore Units and Installations
- NR426 Construction survey of steel structures of offshore units and installations
- NR445 Rules for the Classification of Offshore Units
- NR493 Classification of Mooring Systems for Permanent Offshore Units
- NR494 Rules for the Classification of Offshore Loading and Offloading Buoys
- NR526 Rules for the classification of lifting appliances onboard ships and offshore units
- NR595 Classification of Offshore Handling Systems
- NI 605 Geotechnical and Foundation Design
- NI 621 Guidelines for Moonpool Assessment.

1.1.4 Other standards

Standards other than those mentioned in the present note may be used on a case by case basis, upon the acceptance of the Society.

1.1.5 The full list of standards which are specified and used for a given project are to be submitted to the Society before the review of documents is started.

1.2 Definition

1.2.1 Certification

Certification is a formal procedure by which an accredited or authorized third party assesses and attests in writing by issuing a certificate, that the characteristics, quality, qualification, or status of individuals or organizations, goods or services, procedures or processes, events or situations, are in accordance with specified requirements, standards or national and international regulations (in particular by delegation from different governments).

1.2.2 Classification

Classification consists of a representation of the level of compliance of a ship, vessel or offshore structure to the rules set up by a classification society. This is established following plan approval and surveys carried out by the society's experts, as provided for in the rules. Unit classification provides a point of reference on unit safety and reliability to builders, repairers, brokers, charterers, Flag Administrations, insurers and the financial community. It is represented by a class, entered on classification certificates and transcribed in the register published periodically by the society.

The Society establishes and applies rules in relation to the design and construction of a unit, and assesses the structural strength of the unit as well as reliability of the machinery on board during its life.

1.2.3 Dangerous goods

Dangerous goods are substances or articles which can pose a threat to people, property and/or the environment, as listed in the IMO International Maritime Dangerous Goods Code (IMDG Code).

1.2.4 Hazardous area

Hazardous areas are all those areas where, due to the possible presence of a flammable atmosphere, the use without proper consideration of machinery or electrical equipment may lead to fire hazard or explosion.

1.2.5 Moonpool

A moonpool is a vertical well extending through the unit from deck to bottom, providing a direct access to the sea and allowing safe and easy deployment of equipment used for sea water pumping or any other subsea operation.

1.2.6 Pressure equipment

Pressure equipment means pressure vessels, piping, safety accessories and pressure accessories.

1.2.7 Pressure vessel

Pressure vessel means pressure retaining item designed and built to contain fluids under pressure including its direct attachments up to the coupling point connecting it to other equipment. A vessel may be composed of more than one chamber.

1.2.8 Subsea power cable system

The subsea power cable system connects the floating unit to the shore or substation for transmission of electrical power and information.

1.2.9 Water intake and discharge pipe system

Water intake and discharge pipe system includes the cold water pipes (CWP), the warm water pipes (WWP) and the seawater discharge pipes (SDP), their supports and all integrated pipes components.

1.2.10 Working fluid

The working fluid means the gas or liquid heat transfer medium which drives the turbine. Closed cycle OTEC systems generally use cryogenic fluid. Open cycle OTEC systems generally use vapor from the flash evaporation of warm sea water producing low pressure steam.

1.2.11 Cryogenic fluid, refrigerated fluid

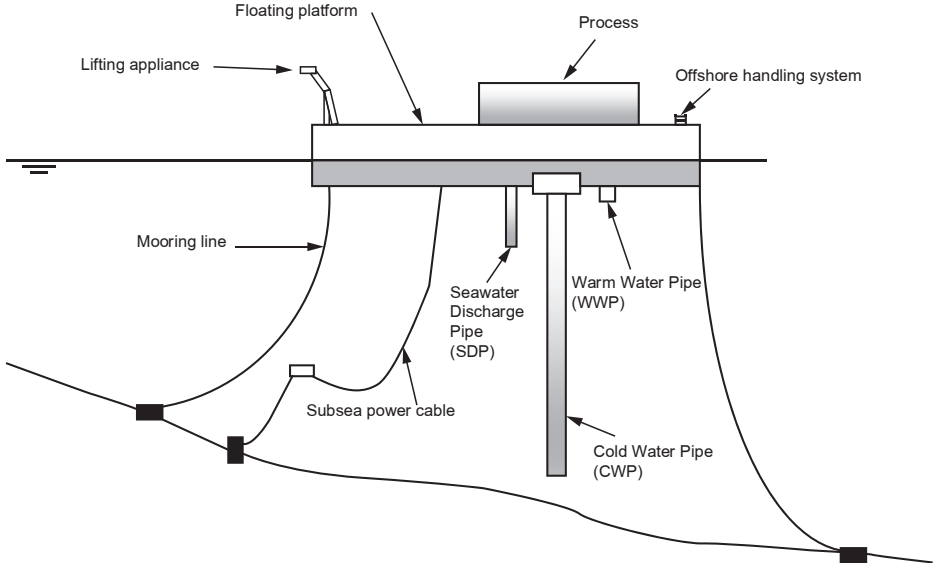
Cryogenic fluids and refrigerated fluids are gases which are partially liquid because of their low temperature. Cryogenic fluids have boiling points below –238° F (–150° C).

In the context of this document, the refrigerated fluids are referred to as cryogenic fluids (independently of their boiling point temperature).

1.2.12 Technology qualification

A technology qualification is a confirmation by examination that a new technology meets the specified requirements for the intended use. The qualification process is carried out through a set of documented activities to prove that the technology is fit for service.

Figure 1 : OTEC



2 Principles of classification and certification

2.1 Certification

2.1.1 Certification results in issuance of certificates attesting the compliance of the unit and/or its components with Rules or standards. The certification activity consists of review of plans and calculations, surveys, checks and tests intended to demonstrate that standards/ national Regulations are met.

2.1.2 Certification in compliance with special national rules

It is reminded that certification in compliance with specific national regulations can be delivered by the Society only when it is authorized to do so by the competent National Authority.

2.1.3 Detailed boundaries for certification

For each project, the detailed boundaries for certification are defined by the Society on case-by-case basis and with reference to the applicable rules, standards or regulations.

2.2 Classification

2.2.1 Classification is the expression of confidence given by the Classification Society to a unit, for a particular use or service and for a certain period of time, by reference to its Rules, Rule or Guidance Notes and other documents.

2.2.2 Classification work

The classification of a unit includes, in accordance with the Rule notes:

- review of design drawings and documents
- surveys of materials and equipment
- survey during construction of the unit
- attendance to trials alongside and at sea
- issuance of Classification documents
- in service surveys.

2.2.3 The unit, the construction and condition of which satisfy the applicable Rule requirements, is registered with the corresponding classification symbols, marks and notations.

2.2.4 Scope of classification

The scope of classification of OTEC unit is based on appraisal of the integrated unit covering (see Tab 1), in general:

a) hull, accommodation, helideck and hull attachments and appurtenances including:
   - water pipe support structure

Note 1: In principle, for water intake and discharge pipes, the limit of classification is the connector of the pipes with the manifold.

   - subsea power cable support structure
   - structure to which the moorings are attached, and supports for mooring equipment
   - foundations for the support of topsides modules and the hull mounted equipment.
   - support structure for life saving appliances
   - passive fire protection and cathodic protection.

b) moonpool arrangement, if applicable

c) intact and damage stability

d) accommodation quarter, if applicable

e) mooring system:
   - for the additional service feature **POSA**:
     mooring line components (anchors, chains, wire and accessories) and hull mounted equipment (fairleads, stoppers...)
   - for the additional class notation **OHS**:
     mooring lie handling equipment (winch, sheaves,...).

f) lifting appliance, when additional class notation **ALM** is requested.

Classification covers the crane pedestal and its foundation welded to the hull or to a classed topside structure, considering the loads specified by the designer.

Note 2: In case the pedestal is connected to the topside structure not covered by class and extended over the hull, only the part of pedestal connected to the hull is classed for the specific loads.

g) equipment and systems necessary for the safe operation of the hull and to the safety of personnel on board

h) equipment and systems installed in the hull, the failure of which may jeopardise the safety of the floating unit

i) fire and gas detection system for the hull as well as the definition of hazardous area of the hull, when relevant

j) fire water and foam system for the protection of the hull

k) propulsion plant, if applicable

l) renewable power generation equipment and installations may be covered upon specific request of the Owner, or should be certified according to recognized standard.

2.2.5 Detailed boundaries for classification

For each project, the detailed boundaries for the classification of units are defined by the Society on case-by-case basis and with reference to the requested structural type and service notations, additional class notations and additional service feature.

2.2.6 Classification of renewable power generation equipment requested

When classification of the renewable power generation equipment is requested, the equipment in relation to renewable power generation is included in the scope of the classification. Structural elements supporting or housing this equipment, and related facilities (topsides structures), are to be designed and built in accordance with the relevant requirements.

Subject to initial agreement, topsides structures may be designed following other recognized standards, provided due consideration is given to inertial loads, overall deformations of the unit, differential displacements of supports points and other relevant loadings.

2.2.7 Classification of renewable power generation equipment not requested

When the classification of the renewable power generation equipment is not requested, the equipment only necessary to the operation of the renewable power generation systems and the related topsides structures are not included in the scope of the classification.

However, the Society will include in the scope of the classification items relating to renewable power generation equipment and installations affecting the general safety of the unit, such as:

- structural safety and loads generated by renewable power generation equipment on the hull or other classed parts of the unit
- definition of hazardous areas, when applicable
- venting system, when applicable
- interface to the fire fighting and fire prevention systems
- arrangement of emergency escapes.

Supports and foundations of renewable power generation equipment which are welded to the hull or other classed part of the unit will be included in the scope of the classification. Classification limits will be defined on a case-by-case basis, after examination of submitted drawings and documentation.

Table 1 : OTEC Classification and certification

Equipment/system	Comments
Hull	Classification
Mooring	Classification (**POSA** additional notation according to NR493)
Marine systems	Classification
Offshore handling systems	Classification (**OHS** additional notation according to NR595) or certification
Lifting appliances	Classification or certification (see NR 526)
Renewable power generation equipment	Certification or classification
Subsea power cable	Certification
Cold water pipes Warm water pipes	Certification Qualification of new technologies, (see NI 525 **(1)**)
(1) NI 525 Risk Based Qualification of New Technology - Methodological Guidelines	

2.3 Classifications notations

2.3.1 When classification is requested, the classification notations give the scope according to which the class of the unit has been based and refer to the specific rule requirements which are to be complied with for their assignment.

2.3.2 Structural type notations

At least one structural type notation is to be assigned to every classed unit as given in NR445, Pt A, Ch 1, Sec 2. For example, the following structural type notation may be granted:

- **offshore service barge**
- **offshore buoy**
- **column stabilized unit.**

2.3.3 Service notations

The service notation defines the type/service of the unit which have been considered for its classification. At least one service notation is to be assigned to every classed unit as given in NR445, Pt A, Ch 1, Sec 2. The following service notation may be granted to OTEC unit:

- **special service (OTEC)**.

2.3.4 Additional service features

A service notation may be completed by one or more additional service features, giving further precision regarding the type of service of the unit, for which specific rule requirements are applied, as given in NR445, Pt A, Ch 1, Sec 2. For example, the following additional service features may be granted to an OTEC unit:

- **POSA**: station keeping systems, mandatory for permanent unit.

2.3.5 Additional class notations

An additional class notation expresses the classification of additional equipment or specific arrangement which has been requested, see NR445, Pt A, Ch 1, Sec 2. For example, the following additional class notations may be granted to an OTEC unit:

- **ALM**: lifting appliances
- **HEL**: helideck
- **INWATERSURVEY**: for units provided with suitable arrangements to facilitate the in-water surveys, mandatory for permanent installation
- **OHS**: offshore handling systems
- **LSA**: life saving appliances
- **Spectral Fatigue**: fatigue check of structural details performed though spectral fatigue techniques
- **COMF HEALTH-NOISE/VIB**: comfort and health on board related to level of noise/vibration.

2.3.6 Site notation

A site notation consists in the name of geographical area and/or the most unfavourable sea condition where the unit is intended to operate.

Data, limitations and assumptions used for the assessment of the unit on site are to be stated in the Design Criteria Statement, (see NR445, PtA, Ch1, Sec1, [1.6]) which is referred to on a memorandum.

2.3.7 Transit notation

Units involved in towing or sailing by means of own propulsion system between construction shipyard and the intended site, or between different operation sites, are to be granted with the notation **transit**.

Note 1: Dry towing is not covered by the notation **transit**.

SECTION 2 DESIGN, STRUCTURE AND STATION KEEPING

1 Application

1.1 General

1.1.1 The list of references to the applicable requirements of the NR445, when relevant, is given in Tab 1.

2 Design conditions and loads

2.1 Design conditions

2.1.1 Operating conditions

a) Production conditions:
Production conditions are conditions wherein unit is on location and performs electricity production within design limits.
Production conditions are associated to normal external conditions.

b) Parked conditions:
Parked conditions are conditions wherein unit is on location but no electricity production is performed.

c) Transit, Installation and Maintenance conditions:
Transit, Installation and Maintenance conditions are conditions assumed for the transportation, assembly, maintenance and repair on site of the unit.

2.1.2 Environmental conditions

Environmental conditions are subdivided into normal and extreme categories. Normal conditions are expected to occur frequently during the unit life. Extreme conditions have a low probability of being exceeded during the unit life.

For the purpose of this document, the minimum return period, Rp, are to be considered:

- Rp = 1 year for normal conditions
- Rp = 100 years for extreme conditions.

Note 1: For units without dangerous goods, return periods may be reduced according to the Society.

3 Structure

3.1 General

3.1.1 Structure of the OTEC unit should consider provisions of NR445, Part B according to its structural type (surface unit, buoy...).

3.1.2 Materials

The selected materials are to have mechanical properties satisfying the structural design of the unit and are to be of a type suitable for use in a marine environment.

Table 1 : Applicable rules

Scope		Rules	Comments
Structure	General	NR445, Part B NR445, Part D	According to the structural type
	Moonpool	NI 621	Guidance to be considered for any vessel fitted with a moonpool
Station keeping		NR493	Permanent unit equipped with position anchoring equipment is to comply with the applicable requirements of NR493. (Additional service feature **POSA** is to be assigned to classed permanent unit)
Foundation		NI 605	Anchor and its foundation is to be designed in accordance with NI 605

3.1.3 Unit areas

Following analysis of the stress level in the structure and design environment, the Society may categorize some of the areas as "ship areas" or as "offshore areas", as given in NR445, Pt D, Ch 1, Sec 3.

In this context, the foundations of the water intake and discharge pipes are considered to belong to offshore area.

3.2 Structure strength requirements

3.2.1 General

The structure is to have adequate strength to resist overall and local failure of its components. Relevant modes of failure to be considered include excessive deformations and yielding, general and local instability, fatigue, brittle failure, corrosion damage and occurrence of excessive vibrations.

Strength requirements are to be considered together with:

- loading conditions
- construction with materials properties and workmanship
- testing.

3.2.2 Design life

The design of primary structural elements is to take into account the design life of the unit and for all of its conditions of operation. The design life of the structure is to be specified by the party applying for classification. It is normally to be taken not less than 20 years.

Note 1: The design life of the structure is to be indicated in the Design Criteria Statement.

4 Station keeping

4.1 General

4.1.1 Permanent unit equipped with position anchoring equipment should comply with the applicable requirements of NR493.

Note 1: Additional service feature **POSA** is to be assigned to classed permanent unit.

Attention is to be paid on interaction between station keeping and water intake pipes. Design is to be appropriate to avoid clashing between mooring lines and water pipes.

4.2 Environmental conditions

4.2.1 Attention is drawn on the fact that for mooring analysis in extreme conditions, all possible combinations of wave, wind and current are to be studied, with the appropriate intensity (see NR493, Appendix 2).

4.3 Fatigue

4.3.1 The mooring lines fatigue analysis is to be carried out with detailed environmental fatigue conditions. The methodology and assumptions used in the fatigue study should be in line with the requirements of NR493.

5 Foundation

5.1 General

5.1.1 Anchor and its foundation should be designed in accordance with NI 605. Special attention is to be paid on:

- installation and removal conditions
- scouring
- vertical bearing
- overturning capacity
- horizontal bearing capacity
- settlements.

SECTION 3 STABILITY

1 General

1.1 Application

1.1.1 Unit stability is to comply with the applicable requirements of the present article, or subject to a preliminary agreement, in accordance with other particular specifications based on the same principles or relevant National or International Regulations.

1.1.2 The information given in this Note is subject to specific requirements by National and Local Authorities and the Society reserves the right to modify its own requirements and to ask for additional information when judged necessary.

1.1.3 In addition to the stability requirements given in the present note, general reference is made to the general rules corresponding to the structural type of the unit, when applicable (see Tab 1).

2 Inclining test and lightweight survey

2.1 General

2.1.1 Any unit for which a stability investigation is requested is to be initially subjected to an inclining test permitting the evaluation of the position of the lightship centre of gravity, or a lightweight check of the lightship displacement, so that the stability data can be determined. Cases for which the inclining test and/or lightweight check are required are given in the different Rule Notes corresponding to the structural type of the unit (see Tab 1).

2.1.2 Unit of same design

For successive units of a same design or for units undergoing only minor alterations, the Society may, at its discretion, waive the requirements of [2.3.1] and accept the light unit data of the first unit of the series in lieu of an inclining test, provided that, notwithstanding minor differences in machinery, outfitting or equipment, both following conditions are fulfilled:

- the lightweight survey indicates a change from the lightweight displacement calculated for the first of the series less than 1% of the displacement in working condition, and
- this survey indicates a change from the horizontal position of the unit centre of gravity as determined for the first of the series less than 1% of the unit's principal horizontal dimensions.

The applicant is required to submit detailed calculations showing the differences of weights and centres of gravity.

Note 1: An extra care is to be given in the case of a series of column stabilized units as these, even though identical by design, are recognised as being unlikely to attain an acceptable similarity of weight or centre of gravity to warrant a waiver of the inclining test.

2.2 Lightweight survey

2.2.1 A lightweight survey is to be carried out on each unit at the time of construction or after substantial modifications.

Note 1: The lightweight condition means that the unit is complete in all respects, but without consumable, stores, cargo, crew and their effects, and without any liquids on board except for machinery and piping fluids, such as lubricants and hydraulics, which are at operating levels.

2.3 Inclining test

2.3.1 An inclining test is to be carried out on each unit at the time of construction to determine accurately the lightweight data (weight and position of centre of gravity).

Alternative for units of same design are given in [2.1.2].

Note 1: The inclining test is a procedure which involves moving a series of known weights, normally in the transverse direction, and then measuring the resulting change in the equilibrium heel angle of the unit. By using this information and applying basic naval architecture principles, the unit's vertical centre of gravity (VCG or KG) is determined.

Table 1 : Stability Rules

Structural type	Rules	Comments
Offshore unit	NR445, Part B, Chapter 1	General rules for offshore units
Ship	NR467, Part B, Chapter 3	General rules for ships
Buoy	NR494, Section 3	Rules for buoys

3 Stability calculations

3.1 General

3.1.1 For the purpose of stability calculations, general reference is made to NR445, Pt B, Ch 1, Sec 2.

3.1.2 Moonpool

The volume of moonpools, when fitted within the hull in open communication with the sea, is not to be included in calculation of hydrostatic properties.

3.2 Unit's conditions for calculations

3.2.1 Stability calculations are to be carried out for all relevant conditions of the unit:

- Lightship condition

  Fixed loads are to be considered. It includes the weight of the complete floating platform with all permanently attached machineries, equipment and other items of outfit. Weight of all permanent liquids (including renewable power generation system liquids) is to be considered.

  (Subsea power cable, water intake and discharge pipes and mooring lines not connected)
- Towing condition, if applicable

Note 1: The assessment of the stability under tow with the heeling moment due to the tow line is excluded from the scope of classification

- Installation conditions, if applicable

  Loads due to partially installed mooring lines, subsea cables and/or water pipes are considered.

  The most unfavourable loading condition as regard to the stability is to be assessed among the installation procedure. As a minimum, one mooring line connected is to be considered.
- Production condition considering the deepest and the lightest draught.
- Parked condition, if relevant

  Loads due to parked procedures are to be considered, such as disconnection of equipment liable to be disconnected (cold water pipe) and/or necessary ballast adjustments to place the unit in the survival draught configuration.
- Maintenance conditions, if relevant

  Loads due to maintenance procedures are to be considered (such as temporary tanks on decks,...)

The loading conditions are summarized in Tab 4 for intact stability calculations and in Tab 5 for damaged stability.

3.3 Righting moments and heeling moment curves

3.3.1 The curves of righting moments and the curves of heeling moments are to be calculated in the most critical axis of the OTEC unit.

3.3.2 Effect of mooring lines, water intake and discharge pipes, subsea power cable

The water intake and discharge pipes, subsea power cable and mooring lines are to be considered as weight, i.e. displacement and KG values are to account for the vertical components of mooring forces, the water pipes and the subsea power cable tensions.

The necessary data are to be submitted for the range of applicable water depth. At least, the Highest Astronomical Tide (LAT) and the Lowest Astronomical Tide (LAT) with 50 years return period are to be considered.

3.3.3 Current heeling

a) The current heeling force on the floating platform, $F_{current}$, in Newton, is to be calculated by the following formula:

$$F_{current} = \frac{1}{2}\rho_{water}\sum[C_D S\cos\theta]U_{current}^2$$

where:

$U_{current}$: Current speed, in m/s

C_D : Drag coefficient, when no data are available C_D is to be taken equal to 1

S : Projected area of the exposed surface of the structural member in upright condition, in m^2

θ : Heel, in degree

ρ_{water} : Sea water specific mass, in kg/m^3

b) The current force on water intake and discharge pipes is to be considered depending on the current profile and may be calculated by the following formula:

$$F_{pipe} = \frac{1}{2}\rho_{water} C_D \sum_{pipe} D \int_0^L z \cdot U_{current}^2(z)dz$$

where:

z : water depth, in m

D : water pipe diameter, in m

L : water pipe length, in m.

The levers for the current heeling moments, $\ell_{current}$ in m, is to be taken vertically from the centre of lateral resistance of the underwater body (or the mooring lines' fairleads barycentre if the mooring lines are considered) to the centre of pressure of areas subjected to current loadings.

3.3.4 Wind heeling

The wind force, F_{wind}, in Newton, is to be calculated by the following formula:

$$F_{wind} = \frac{1}{2}\rho_{air} \sum [C_s S \cos\theta] V_{wind}^2$$

where:

V_{wind} : Wind speed at the considered elevation, in m/s, see Tab 2

C_s : Shape coefficient, see Tab 3

S : Projected area of the exposed surface of the structural member in upright condition, in m^2

θ : Heel, in degree

ρ_{air} : Air specific mass, equal to 1,222 kg/m^3.

The wind heeling lever, in m, ℓ_{wind}, is to be taken vertically from the centre of lateral resistance of the underwater body (or the mooring lines' fairleads barycentre if the mooring lines are considered) to the centre of pressure of areas subjected to wind loading.

3.3.5 Seastate

Seastate (e.g. waves) effect may have to be considered when deemed relevant.

Table 2 : Wind speeds, V_{wind}

Wind condition	Wind speeds, V_{wind}	
	Site conditions available	Site conditions non available, or mobile unit **(1)**
Normal	V_{10min}, rp = 1yr	25,8 m/s (50 knots) for sheltered waters
		36,0 m/s (70 knots)
Extreme	V_{10min}, rp = 100 yrs	51,5 m/s (100 knots)

(1) Reference wind speeds taken at 10m above the mean water level

Note 1: V_{10min}, rp= X yrs : 10 minutes mean wind speed corresponding to a X years return period

Table 3 : Shape coefficient, C_s

Shape	C_s
Spherical	0,40
Cylindrical	0,50
Large flat surface	1,00
Exposed beams and girders under deck	1,30
Small part	1,40
Isolated shapes (crane, beam,...)	1,50
Clustered deckhouses or similar structures	1,10

4 Intact stability criteria

4.1 General

4.1.1 Intact stability loading conditions

The loading conditions and associated system conditions are given in Tab 4.

4.1.2 Intact stability criteria under environmental conditions

The following intact stability criteria are to be verified when applying the heeling moment due to wind and current:

- the angle of inclination is to be less than that giving interference between water intake pipes and the hull
- initial metacentric height GM_0 is not to be less than 0,15 m
- freeboard is to remain positive
- area under the righting moment curve to the second intercept or downflooding angle, whichever is less, is not to be less than 40% in excess of the area under the heeling moment curve to the same limiting angle (see Fig 1):

$$\frac{A + C}{B + C} \geq 1,4$$

Figure 1 : Stability criteria under heeling moment due to wind and current

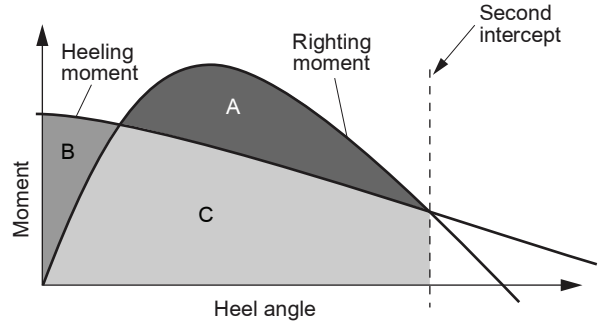


Table 4 : Loading conditions - Intact stability

#	Loading condition	Description	Environmental conditions	
			Wind	Current
1	Lightship	Free floating	Normal	NA
2	Transit (towing)	Free floating Transit draught	Normal, or specified limiting parameters	NA
3.1	Installation	Free floating	Normal, or specified limiting parameters	NA
3.2		Partially installed mooring lines, subsea cables and/or water risers **(1)**	Normal, or specified limiting parameters	NA
4	Maintenance **(2)**	Moored Maintenance load	Normal, or specified limiting parameters	Normal, or specified limiting parameters
5.1	Operation	Full load	Normal	Normal
5.2		Minimum draught	Normal	Normal
5.3		One mooring line failure	Normal	Normal
6.1	Parked	Full load	Extreme	Extreme
6.2		Minimum draught	Extreme	Extreme
6.3		One mooring line failure	Extreme	Extreme

(1) According to installation procedures.
(2) Required if specific loads are to be considered during maintenance (such as tools, transit containers,...).
NA: Not applicable

Table 5 : Loading conditions - Damaged stability

#	Loading condition	Description	Environmental conditions	
			Wind	Current
14.1	Maintenance **(1)**	2 compartments flooded	NA	NA
14.2		2 compartments flooded	Normal, or specified limiting parameters	Normal, or specified limiting parameters
15.1	Operation	2 compartments flooded	NA	NA
16.1	Parked	2 compartments flooded	Extreme	Extreme
(1) Required if specific loads are stored during maintenance (such as tools, transit containers,...). NA: Not applicable				

4.1.3 Intact stability criteria during towing and installation

The following intact stability criteria are to be verified during towing and installation conditions:

- the initial metacentric height GM_0 is not to be less than 0,15 m
- maximum angle of positive stability is not to be less than 35°
- area under the righting moment curve to the second intercept or downflooding angle, whichever is less, is not to be less than 40% in excess of the area under the heeling moment curve to the same limiting angle:

$$\frac{A + C}{B + C} \geq 1,4$$

Note 1: The assessment of the stability with the external loads due to the tow line is not in the scope of the classification.

5 Damage stability

5.1 General

5.1.1 The measure of the ability of a unit to survive flooding accidents caused by collision, grounding or others accidental conditions, is called “damage stability”. This stability is generally attained by installing a number of watertight compartments. If one of these compartments is breached, then the watertight bulkheads surrounding it will prevent the inrush of sea water from spreading to the rest of the unit.

There are two significant factors to take into account when assessing the damage stability of a unit:

- a maximum extent of damage is assumed in the design calculation
- the margin of safety remaining after damage (residual stability).

5.1.2 Watertight compartments

The subdivision into watertight compartments should be such that after damage to the hull, the unit will remain afloat and stable. Requirements for watertight integrity and bilge pumping arrangement are also laid down.

The unit is to have sufficient freeboard and be subdivided by means of watertight decks and bulkheads to provide sufficient buoyancy and stability to withstand in general, the flooding of any one compartment in any condition consistent with the damage assumptions set out in [5.2].

5.1.3 Flooding

The progressive flooding analysis is to consider flooding due to failure of water pipe in the energy converter room.

5.2 Extent of damage

5.2.1 Dimension of damage

For the purpose of the damage cases, the following extent of damage is assumed to occur:

- transverse penetration of 1,5 m normal to the side shell
- vertical extent of 4 m between 2 m above the seawater level and 2 m below the seawater level.

Two compartments are assumed to be flooded.

5.3 Damage stability criteria

5.3.1 General

The damage stability criteria are to be verified according to the structural type of the unit. Calculations are to take into account the arrangement and configuration of damaged compartments.

5.3.2 No environmental conditions

At least, the following damage stability criteria are to be considered:

- the angle of inclination is to be less than that giving contact between CWP and the hull side.
- the angle of inclination after flooding is not to be greater than 25°
- the range of positive stability beyond the angle of inclination after flooding is not to be less than 7°.

Note 1: Additional criteria may be required according to the structural type of the unit. Reference is to be made to the corresponding Note.

5.3.3 With environmental conditions

When the unit has downflooding points on the deck, considering a heeling moment induced by environmental conditions, the final waterline is to be below the lower edge of any opening through which progressive flooding of intact buoyant compartment may take place.

SECTION 4 MACHINERY AND PIPING

1 Application

1.1 General

1.1.1 The following considerations apply to the design, construction, installation, tests and trials of machinery systems associated pieces of equipment and piping systems.

1.1.2 General reference is made to the applicable requirements of the NR445, Pt C, Ch 1, when relevant.

1.1.3 Distance to the side shell

It is recommended to install the renewable power generation equipment or piping at a distance not less than 1,5 m normal to the side shell.

2 Pressure equipment

2.1 General

2.1.1 Pressure vessels, associated piping systems and fittings are to be of a design and construction adequate for the service for which they are intended. They are to be so installed and protected as to reduce to a minimum any danger to persons on board, due regard being paid to moving parts, hot surfaces and other hazards.

The design is to have regard to materials used in construction, the purpose for which the equipment is intended, the working conditions to which it will be subjected and the environmental conditions on board.

2.1.2 Pressure vessels such as boiler, thermal oil heater, heat exchanger or steam generator may consider provisions of NR445, Pt C, Ch 1, Sec 3. For other pressure vessels, recognized standards should be considered (EN, ISO, ASME code, API,...).

2.1.3 Overpressure risk

Where pressure vessels are subjected to internal pressure and may be subject to dangerous overpressure, means are to be provided, where practicable, to protect against excessive pressure.

3 Piping

3.1 General

3.1.1 Material

Materials to be used in piping systems are to be suitable for the medium and the service for which the piping is intended.

3.1.2 Separation of systems

Piping systems carrying non-hazardous fluids are generally to be separate from piping systems which may contain hazardous fluids. Cross connection of the piping systems may be permitted where means for avoiding possible contamination of the non-hazardous fluid system by the hazardous medium are provided.

3.1.3 Overflow

Overflow pipes of dangerous goods tanks are to be led to a specific tank dedicated for one kind of product. If several dangerous goods tanks exist for a same product, overflow tank may be common.

3.1.4 Protection against shocks

Pipes passing through storage compartments other than those containing liquid are to be protected against shocks by means of strong casings.

3.1.5 Protection against overpressure

Pipes likely to be subjected to a pressure exceeding their normal working pressure are to be provided with safety valves or equivalent overpressure protecting devices.

3.2 Flexible hoses

3.2.1 General

Flexible hoses and expansion joints are to be of a type approved by the Society or to be approved on a case by case basis.

3.2.2 Flexible hose assembly

Flexible hose assembly of metallic or non-metallic hose normally with prefabricated end fittings is ready for installation.

3.2.3 Installation

The installation of a flexible hose assembly or an expansion joint is to be in accordance with the manufacturer's instructions and use limitations, with particular attention to the following:

- type
- orientation
- end connection support (where necessary)
- avoidance of hose contact that could cause rubbing and abrasion
- minimum bend radii.

Flexible hose assemblies or expansion joints are not to be installed where they may be subjected to torsion deformation (twisting) under normal operating conditions.

Where they are likely to suffer external damage, flexible hoses and expansion joints of the bellows type are to be provided with adequate protection.

3.2.4 Isolation

Isolating valves are to be provided enabling the isolation of flexible hoses intended to convey flammable oil or compressed air.

3.3 Valves

3.3.1 General

Valves and accessories are normally to be built in accordance with recognized standard or codes (e.g. EN, ISO, API, ASME,...).

Cocks, valves and other accessories are generally to be arranged so that they are easily visible and accessible for manoeuvring, control and maintenance. They are to be installed in such a way as to operate properly.

3.3.2 Isolation

Shut-off valves are to be provided where necessary to isolate pumps, heat exchangers, pressure vessels, etc., from the rest of the piping system when necessary, and in particular:

- to allow the isolation of duplicate components without interrupting the fluid circulation
- for survey or repair purposes.

Where two or more pressure vessels are interconnected by a piping system of adequate size so that no branch of piping may be shut off, it is sufficient to provide them with one safety valve and one pressure gauge only.

3.3.3 Toxic or flammable product isolation

Toxic or flammable product pipes, which, if damaged, would allow the product to escape from a tank, are to be fitted with a quick closing valve directly on the tank, capable of being closed from a safe position outside the compartment involved.

3.4 Prevention of pollution

3.4.1 Prevention of pollution by oil

The discharge of oily effluents associated with offshore activities and the discharge of contaminated water and displacement water are subject to national or regional regulation as applicable.

Piping systems intended for machinery oily effluents are to be completely independent from any piping system intended for other oily effluents.

4 Exhaust system and ventilation discharges

4.1 General

4.1.1 Exhaust systems should be designed according to NR445, Pt C, Ch 1, Sec 7, [18].

4.1.2 Air outlet

Air outlet from hazardous areas should be designed according to NR445, Pt C, Ch 4, Sec 3, [5].

5 Tanks

5.1 General

5.1.1 Storage of flammable liquids

Tanks used for storage of flammable liquids together with their fittings are to be so arranged as to prevent spillages due to leakage or overfilling.

5.1.2 Sounding

Sounding devices are to be fitted to tanks intended to contain liquids as well as to all compartments which are not readily accessible at all times.

5.1.3 Level

Void compartments adjacent to the sea or tanks containing liquids are to be fitted with separate sounding pipes or means to determine the liquid level in the tank.

5.1.4 Isolation

Every tanks containing dangerous goods, and their piping system should be fitted with manually, and remote (for unmanned unit), operated valves for isolation purposes.

5.2 Protection against overpressure

5.2.1 Provisions are to be made to prevent overpressure in any oil tank or in any part of the fuel oil system. Any relief valve is to discharge to a safe position.

5.2.2 Air pipes

Air pipes are to be fitted to all tanks, double bottoms, cofferdams, tunnels and other compartments which are not fitted with alternative ventilation arrangements, in order to allow the passage of air or liquid so as to prevent excessive pressure or vacuum in the tanks or compartments, in particular in those which are fitted with piping installations. Their open ends are to be so arranged as to prevent the free entry of sea water in the compartments.

6 Refrigerating installations

6.1 General

6.1.1 Installations related to the cryogenic installation may have to comply with safety requirements for refrigerating installations, such ones given in NR445, Pt C, Ch 1,Sec 9, as applicable.

6.2 Cryogenic machinery compartment with ammonia

6.2.1 Arrangement

The cryogenic machinery compartment and the compartments where ammonia is stored, are to be separated by gastight bulkheads from the accommodation spaces, the engine room (including the shaft tunnel when applicable) and other machinery spaces intended for essential services. This requirement does not apply to plants using less than 25 kg of ammonia.

6.2.2 Ventilation system

The space is to be arranged with a ventilation system, distinct from that of other spaces, having a capacity of at least 30 changes per hour. Provision is to be made for starting and stopping the ventilation fans from outside the cryogenic space.

Note 1: For unmanned unit, lower capacity of air changes may be considered on a case by case basis.

6.2.3 Access

At least two access doors are to be provided. One of these doors is to be used for emergency and is to lead directly to an open space. The doors are to open outwards and are to be self-closing.

Note 1: Escape routes that pass only through stairways and/or corridors that have protection equivalent to machinery spaces are considered as providing a direct access to the open space.

Where the access to a cryogenic machinery space is through an accommodation or machinery space, the ventilation of the former is to be such as to keep it under negative pressure with respect to the adjacent space, or, alternatively, the access is to be provided with an air lock.

6.2.4 Bilge system

An independent bilge system is to be provided for the water contaminated with ammonia.

6.2.5 Electrical equipment

All electrical equipment and apparatus in the space is to be arranged such that it may be shut off by a central switch located outside the space. This switch is not to control the ventilation system.

6.2.6 Piping

Ammonia piping is not to pass through accommodation space.

SECTION 5 ELECTRICAL INSTALLATIONS

1 Application

1.1 General

1.1.1 The considerations of this Section apply to electrical installations of the OTEC unit. In, particular, they apply to the components of the electrical installations for:

- essential services to be maintained under various emergency conditions
- safety of crew, contractors, visitors and unit
- essential services for special purposes connected with unit specifically intended for such purposes (e.g. propulsion on mobile units, ballast system,...)
- services for habitability, if applicable.

The other parts of the installation are to be so designed as not to introduce any risks or malfuntions to the above services.

1.1.2 The present section considers electrical installation for the unit including the export panel. Electrical subsea cables and onshore installation are excluded from the present section, except for control systems and essential services. Subsea cables requirements are given in Sec 9.

1.1.3 Tab 1 lists the electrical sources of power to be considered in the scope of classification, depending on the characteristics of the unit (unmanned or manned).

1.1.4 Risk analysis

For electrical items not covered by the NR445 nor the present note, a risk analysis is to be performed based on single failure principle.

1.1.5 Applicable references

The list of references to the applicable requirements of the NR445, Pt C, Ch 2, when relevant, is given in Tab 2.

1.2 Documentation to be submitted

1.2.1 The documents listed in Tab 3 are to be submitted. The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if deemed necessary for the evaluation of the system, equipment or components.

1.3 Definitions

1.3.1 Essential services

Essential services mean services necessary for a unit to operate at site, be steered or manoeuvred, or undertake activities connected with its operation, and for the safety of life, as far as class is concerned. Examples of equipment for essential services are given in Tab 4. This list is not exhaustive and other services may be defined.

All services necessary for the operation of the renewable power system are not to be considered as essential services except if the renewable power generation equipment and installations are included in the scope of classification according to Sec 1.

Services for habitability are those intended for minimum comfort conditions for people onboard. Examples of equipment for maintaining conditions of habitability are listed in Tab 5. When there is no accommodation, this list is not applicable.

1.3.2 Emergency services

The emergency services are the services essential for the safety which need to be operable during emergencies. The services listed in Tab 6 are to be considered as emergency ones.

Table 1 : Applicable references of NR445

Requirements		NR445, Part C, Chapter 2	Comments
General		Section 1	For definition of essential services and emergency services, see [1.3]
General design requirements		Section 2	
System design	Sources of electrical power	Section 3	For sources of electrical power, see Article [2]
	Distribution	Section 3	
	Signal lights	Section 3	Units are to be provided with signal lights in accordance with National Authorities requirements.
Rotating machines		Section 4	When renewable power generation turbogenerators are considered as a main source of electrical power, they are to be marine certified by the Society.
Transformers		Section 5	When the shore grid is considered as a main source of electrical power, the export transformer is to be marine certified by the Society.
Semiconductor convertors		Section 6	
Storage batteries and chargers		Section 7	
Switchgear and controlgear assemblies		Section 8	
Cables		Section 9	Electrical subsea cables are adressed in Sec 9.
Miscellaneous equipment		Section 10	
Location		Section 11	
Installation		Section 12	
High voltage installations		Section 13	Nominal voltage exceeding 35 kV should be considered on a case by case basis.
Communications, safeties and alarms		Section 14	
Specific requirements for electrical installations in hazardous areas		Section 15	
Testing		Section 17	
Indirect test method for synchronous machines		Appendix 1	
Indirect test method for induction machines		Appendix 2	

Table 2 : Electrical sources of power covered by classification

Unit	Electrical power source	
	Emergency	Main source **(2)**
Manned **(1)**	X	X
Unmanned **(1)**	X	

(1) If renewable power generation equipment and installations are included in the scope of classification, the main renewable electrical power source is to be considered.

(2) Main source other than the main renewable electrical power source.

Table 3 : Documents to be submitted

No.	I/A **(1)**	Documents to be submitted
1	A	General arrangement of electrical installation
2	A	Single line diagram of main and emergency power and lighting systems
3	A	Electrical generation system philosophy
4	I	Electrical power balance (main and emergency supply)
5	A	Calculation of short-circuit currents for each installation in which the sum of rated power of the energy sources which may be connected contemporaneously to the network is greater than 500 kV A
6	A	List of circuits including, for each supply and distribution circuit, data concerning the nominal current, the cable type, length and cross-section, nominal and setting values of the protective and control devices.
7	A	Single line diagram and detailed diagram of the main switchboard
8	A	Single line diagram and detailed diagram of the emergency switchboard
9	A	Diagram of the most important section boards and motor control centres (above 100 kW)
10	A	Diagram of the supply for monitoring and control systems of generator prime movers
11	A	Diagram of the general emergency alarm system, of the public address system and other intercommunication systems
12	A	Detailed diagram of the navigation-light switchboard (where required)
13	A	Diagram of the remote stop system (ventilation, fuel pump, fuel valves, etc.)
14	A	List of batteries including type and manufacturer, voltage and capacity, location and equipment and/or system(s) served (when used for essential and emergency services)
15	A	General arrangement of electrical equipment with regards to hazardous areas
16	A	Justification of safety character of electrical equipment located in hazardous areas
17	I	Principal cable routing diagram
18	A	Selectivity and coordination of electrical protections (for high voltage installations)

(1) A = to be submitted for approval
I = to be submitted for information

Table 4 : Essential services

No.	Description of service
1	Electric generators and associated power sources
2	Auxiliary services supplying the above equipment (fuel oil supply pumps, lubricating oil pumps and cooling water pumps...)
3	Sea water pumps (not associated to the sea water used by OTEC plant)
4	Forced draught fans, feed water pumps, water circulating pumps, condensate pumps, oil burning installations, for auxiliary boilers on units where steam is used for equipment supplying primary essential services
5	Control, monitoring and safety devices/systems for primary essential services
6	Starting equipment of diesel engines and gas turbines
7	The main lighting system for those parts of the unit normally accessible to and used by personnel
8	Ventilation of hazardous areas and those areas maintained at an overpressure to exclude the ingress of dangerous gases
9	Lubrication oil transfer pumps and lubrication oil treatment equipment
10	Fuel oil transfer pumps and fuel oil treatment equipment
11	Preheaters and viscosity control equipment for heavy fuel oil
12	Bilge, ballast and heeling pump
13	Fire pumps and other fire-extinguishing medium pumps

(1) Units granted with **POSA** notation

No.	Description of service
14	Ventilation fans for engine and boiler rooms
15	Any signalling lights aids and sound signals which may be required for navigation or marking of offshore structures
16	Internal safety communication equipment
17	Fire and gas detection and alarm systems
18	Electrical equipment for watertight closing appliances
19	Control, monitoring and safety devices/systems for equipment for secondary essential services
20	Emergency shutdown systems having an impact on essential services
21	Cooling system of environmentally controlled spaces
27	Mooring system **(1)**
(1) Units granted with **POSA** notation	

Table 5 : Services for maintaining habitability conditions

No.	Description of service
1	Cooking
2	Heating
3	Domestic refrigeration
4	Mechanical ventilation
5	Sanitary and fresh water
6	Electric generators and associated power sources supplying the above equipment

Table 6 : Emergency services

No.	Description of emergency services
1	Emergency lighting
2	Signalling lights and sound signals (for navigation or for the marking of offshore structures, including helicopter perimeter lights)
3	Fire and gas detection and alarm systems
4	Fire fighting systems
5	All power-operated watertight door systems
6	General alarm and public address system
7	Emergency shutdown systems having an impact on emergency services
8	Ventilation of hazardous areas and those areas maintained at en overpressure to exclude the ingress of dangerous gases
9	Equipment, operating on electric power, at life-saving stations serving platform disembarkation
10	Indoor and outdoor communication systems required in emergency conditions

2 Sources of electrical power

2.1 Main source of electrical power

2.1.1 *A main source of electrical power is to be provided, of sufficient capability to supply all electrical auxiliary services necessary for maintaining the unit in normal operational and habitable conditions without recourse to the emergency source of electrical power.*

2.1.2 The main source of electrical power may be one or a combination of the following means:

- main renewable power generation system (including. renewable energy converter)
- supply from shore by fixed cables
- auxiliary generator

Note 1: For manned units, main source of electrical power other than renewable energy converters is to be considered.

The capacity of these electrical power sources is to be sufficient to start the largest motor without causing any other motor to stop or having any adverse effect on other equipment in operation.

2.2 Emergency power sources and circuits

2.2.1 A self-contained emergency source of electrical power is to be provided.

2.2.2 *The emergency source of electrical power may be either a generator or an accumulator battery which shall comply with the requirements of* [2.2.10] *or* [2.2.12]*, respectively.*

2.2.3 *Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits.*

Exceptionally is understood to mean conditions, while the unit is at sea, such as:

a) blackout situation

b) routine use for testing

c) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

2.2.4 *The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously.*

2.2.5 The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services listed in Tab 7, for a period of time specified in the operating manual of the unit, in order to secure the unit and evacuate the personnel.

This period of time is not to be less than 12 hours, except for structure marking, for which the duration is 96 hours minimum.

Note 1: Period of time may be reduced depending on the distance from the coast and depending on agreement of competent Authority.

2.2.6 Failure of convertor

If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor convertors, means are to be provided for supplying such services also in the event of failure of the convertor (e.g. providing a bypass feeder or a duplication of convertor).

2.2.7 Periodic testing

Provision is to be made for the periodic testing of the complete emergency system and is to include the testing of automatic starting arrangements. If running unattended during tests, normal prime mover and generator protections are to be provided.

2.2.8 Starting arrangements

For starting arrangements for emergency generating sets, see NR445, Pt C, Ch 1, Sec 2, [3.1].

2.2.9 Inclination

The emergency generator and its prime mover and any emergency accumulator battery should be designed to function at full rated power when upright and when inclined up to the maximum angle of heel in the intact and damaged condition, as determined in accordance with Sec 3. In no case need the equipment be designed to operate when inclined more than the values indicated in NR445, Pt C, Ch 1, Sec 1, Tab 1 to Tab 3.

2.2.10 Generator as emergency source

Where the emergency source of electrical power is a generator, it shall be:

a) driven by a suitable prime mover with an independent supply of fuel, having a flashpoint (closed cup test) of not less than 43°C

b) started automatically upon failure of the main source of electrical power supply to the emergency switchboard unless a transitional source of emergency electrical power in accordance with item c) below is provided; where the emergency generator is automatically started, it shall be automatically connected to the emergency switchboard; those services referred to in [2.3.1] shall then be connected automatically to the emergency generator; see also NR445, Pt C, Ch 1, Sec 2, [3.1.3]

c) provided with a transitional source of emergency electrical power as specified in [2.3.1] *unless an emergency generator is provided capable both of supplying the services mentioned in that paragraph and of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 s.*

2.2.11 The availability of the emergency generator is to be maintained as far as possible. Shutdown or inhibition of emergency generator starting may be accepted for ultimate safety reasons, such as confirmed gas detection at air entrance of emergency generator room or fire detection inside emergency generator room.

2.2.12 Accumulator battery as emergency source

Where the emergency source of electrical power is an accumulator battery it shall be capable of:

a) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage

b) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and immediately supplying at least those services specified in [2.3.2].

2.2.13 Batteries indicator

An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in [2.2.12] and [2.3.1] are being discharged.

2.3 Transitional source of electrical power

2.3.1 *The transitional source of emergency electrical power where required by [2.2.10], shall consist of an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the services in [2.3.2] if they depend upon an electrical source for their operation.*

2.3.2 The transitional source of emergency electrical power, where required, is to supply the services listed in Tab 7 when a duration of transitional power is indicated.

2.3.3 Where the emergency and/or transitional emergency loads are supplied from a battery via an electronic converter or inverter, the maximum permitted d.c. voltage variations are to be taken as those on the load side of the converter or inverter.

Where the d.c. is converted into a.c. the maximum variations are not exceed those given in NR445, Pt C, Ch 2, Sec 2, Tab 5.

3 Lightning protection

3.1 Steel units

3.1.1 For metallic hull unit, if there is electrical continuity between hull and lightning protective masts or other metallic superstructures of adequate height, no additional lightning protection is required.

3.1.2 Metallic hull structure units fitted with non-metallic masts

In metallic hull structure units fitted with non-metallic masts, a lightning conductor should be provided. The lower end of the lightning conductor is to be earthed to the hull.

3.2 Non metallic hull units

3.2.1 Non metallic hull units should be provided with lightning conductors. The lower end of the lightning conductor is to be connected to an earthing plate of copper or other conducting material compatible with sea water, not less than 0,25 m2 in surface area, secured to the outside of the hull in an area reserved for this purpose and located below the light-load water line so that it is immersed under all conditions of heel. The earthing plate for the lightning conductor is to be additional to, and separate from the electrical earthing plate.

3.3 Lightning conductors

3.3.1 Lightning conductors should to be made of copper (strip or stranded) and should not to be less than 70 mm^2 in cross-section.

Table 7 : Duration services and duration of services to be supplied by emergency and a transitional source

Service	Emergency power consumers	Duration, in hours, of:	
		Emergency power	Transitional power
Emergency lighting	At every muster and embarkation station on deck and over sides	12	0,5 **(1)**
	In all service and accommodation alleyways, stairways and exits, personnel lift cars and personnel lift trunks	12	0,5 **(1)**
	In the machinery spaces and main generating stations including their control positions	12	0,5 **(1)**
	In all control stations **(3)**, machinery control rooms, and at each main and emergency switchboard	12	0,5 **(1)**
	At the stowage positions for firemen's outfits	12	0,5 **(1)**
	At the fire pump, at the sprinkler pump, if any, at the emergency bilge pump, if any, and at the starting positions of their motors	12	0,5 **(1)**
	On helideck, including landing area perimeter and obstacle lighting	12	0,5 **(1)**
Machinery and safety equipment	Fans and other equipment deemed necessary to avoid accumulation of dangerous or explosive gases	12	
	One of the fire pumps required by the Society's Rules for Classification applicable to the unit or installation considered if dependent upon the emergency generator for its source of power	12	
	Automatic sprinkler pump (if any)	12	
	The fire and gas detection and their alarm systems	12	0,5 **(2)**
Structure marking **(4)**	Any signalling lights or sound signals which may be required for marking of offshore structures	96	
Communications	All internal communication equipment required in an emergency	12	0,5 **(2)**
	Internal/External safety telecommunication systems	12	0,5
Doors and hatches	Power to operate watertight doors, remote controlled doors and hatch covers, together with corresponding alarms and controls, but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided	12	

(1) The required emergency lighting, in respect of the machinery space and accommodation and service areas, may be provided by permanently fixed, individual accumulator lamps which are automatically charged and operated

(2) Transitional source required unless these services have an independent supply from an accumulator battery suitably located for use in an emergency and sufficient for the period specified

(3) Control station located on shore not included in above requirements

(4) Navigation lights not covered during towing

Note 1: For services other than structure marking, duration indicated is considered to be a minimum, subject to modification according to operating condition of the unit

SECTION 6 CONTROL SYSTEMS AND AUTOMATION

1 Application

1.1 General

1.1.1 The following considerations apply to automation systems installed onboard, intended for essential services as defined in Sec 5. They also apply to system required by Sec 4 and Sec 5, installed on the unit.

1.1.2 The list of references to the applicable requirements of the NR445, Pt C, Ch 3 when relevant is given in Tab 1.

1.2 Documentation to be submitted

1.2.1 The documents listed in Tab 2 are to be submitted. The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if is deemed necessary for the evaluation of the system, equipment or components.

1.2.2 For computer based systems, the documents listed in Tab 3 are to be submitted.

Table 1 : Applicable rules

Scope	NR445, Part C, Chapter 3	Comments
General requirements	Section 1	
Design requirements	Section 2	The consequence of failure of power supply of the onshore control system is to be considered in view to define the needed redundancy. Priority of the different control stations is to be considered.
Computer based systems	Section 3	
Constructional requirements	Section 4	
Installation requirements	Section 5	
Testing	Section 6	For equipment located onshore: vibration, inclination and salt mist tests may be not required.
Unattended machinery spaces	Section 7	For manned unit, additional class notation AUTO may not be required. Nevertheless, the followings are applicable: • for fire detection system: NR445, Pt C, Ch 3, Sec 7, [3.2] • for fire fighting: NR445, Pt C, Ch 3, Sec 7, [3.3] • for protection against flooding: NR445, Pt C, Ch 3, Sec 7, [3.4].

Table 2 : Documentation to be submitted

No.	I/A **(1)**	Documentation
1	I	The general specification for the automation of the unit
2	A	The detailed specification of the essential service systems
3	A	The list of components used in the automation circuits, and references (Manufacturer, type, etc.)
4	I	Instruction manuals
5	I	Test procedures for control, alarm and safety systems
6	A	A general diagram showing the monitoring and/or control positions for the various installations, with an indication of the means of access and the means of communication between the positions as well as with the engineers
7	A	The diagrams of the supply circuits of automation systems, identifying the power source
8	A	The list of monitored parameters for alarm/monitoring and safety systems
9	A	Diagram of the engineers' alarm system
(1) A = to be submitted for approval I = to be submitted for information.		

Table 3 : Computer based system documentation

No.	I/A **(1)**	Documentation
1	I	System description, computer software
2	A	System description, computer hardware
3	I	System reliability analysis
4	I	User interface description
5	I	Test programs
6	I	Method of tests and required tests results
7	A	For wireless data communication: a) details of manufacturers recommended installation and maintenance practices b) network plan with arrangement and type of antennas and identification of location c) specification of wireless communication system protocols and management functions d) details of radio frequency and power levels e) evidence of type testing f) on-board test schedule
(1) A = to be submitted for approval I = to be submitted for information.		

2 Control stations

2.1 Manned units

2.1.1 For manned unit, adequate monitoring and alarms are to be made available in a Central Control Room onboard the unit.

2.2 Unmanned units

2.2.1 For unmanned unit, adequate monitoring and alarms are to be made available in a Control station located onboard the unit, and in a Control Room located onshore.

Note 1: When located onshore, the control system is also included in the scope of classification

3 Alarm

3.1 General

3.1.1 General emergency alarm system

Each unit is to be provided with a general alarm system, so installed as to be clearly perceptible in all part of the unit, including open decks.

3.1.2 Fire detection alarm

Fire detection system provides output signals to the navigation bridge (if any), continuously manned central control station or onboard safety centre to notify the crew of fire and fault conditions.

3.1.3 Gas detection alarm

Gas detection system are to be connected to an audible and visual alarm system with indicators in the main control station.

3.2 Alarm activation

3.2.1 Alarm activation

Alarms are to be activated when abnormal conditions appear in the machinery, which need the intervention of personnel on duty, and on the automatic change-over, when standby machines are installed.

An existing alarm is not to prevent the indication of any further fault.

4 Control and monitoring

4.1 General

4.1.1 Monitoring

For unattended unit, the main operating parameters (pressure, temperature, rpm, etc.) are to be adequately monitored or controlled and displayed at the control console (see NR445, Pt C, Ch 3, Sec 7).

For parameters monitored in order to identify faults and associated safeguards, alarms are required (see NR445, Pt C, Ch 3, Sec 7, [4.3.3]).

4.1.2 Local indicators

Local indicators are to be provided for at least the following parameters:

- pressure in pressure vessels, at pump or compressor discharge, at the inlet of the equipment served, on the low pressure side of pressure reducing valves
- temperatures, in tanks and vessels, at heat exchangers inlet and outlet
- levels, in tanks and vessels containing liquids.

5 Safety system

5.1 General

5.1.1 Safety functions are to be independent of control and monitoring functions.

5.1.2 The safety and alarm systems are to be designed to `fail safe'. The characteristics of the `fail safe' operation are to be evaluated on the basis not only of the system and its associated machinery, but also the complete installation, as well as the unit.

5.1.3 System failures

A safety system is to be designed so as to limit the consequence of failures. It is to be constructed on the fail-to-safety principle.

6 Automation

6.1 General

6.1.1 Environmental conditions

The automation system is to be designed to operate satisfactorily in the environment in which it is located. Attention is to be paid on humidity, salt mist, inclinations, vibrations, etc.

6.1.2 System reliability analysis

The reliability of the automation system is to demonstrated by means of appropriate analysis, such as indicated in NR445, Pt C, Ch 3, Sec 1, [2.3.4].

6.2 Power supply of automation systems

6.2.1 Uninterruptible power supply (UPS)

During changeover from the main source of electrical power to the stand-by source of electrical power, an uninterruptible power supply (UPS) system is to ensure uninterrupted duty for consumers which require continuous power supply, and for consumers which may malfunction upon voltage transients.

6.2.2 Capacity of the stand-by power supply

The capacity of the stand-by power supply is to be sufficient to allow the normal operation of the automation systems for at least half an hour.

SECTION 7 SAFETY FEATURES

1 Application

1.1 General

1.1.1 The following considerations apply to safety features of the OTEC unit.

NR445 has been developed to cover drilling unit and platform for the storage and/or production of hydrocarbon. NR445 is to be adapted to consider the storage of different flammable gas such as ammonia.

1.1.2 Unmanned unit

OTEC unit may be unmanned. As most of marine rules and standards consider that in case of incident, someone onboard is available to act, attention is to be paid on the correct application of these marine rules and standards on unit without personnel onboard.

Note 1: When a risk analysis is performed, typically at preliminary design stage, this particularity is to be taken into account in order to define the risk mitigation measures for the final design.

Even if the unit is unmanned during normal operation, personnel safety is to be considered where personnel are onboard for maintenance operation.

1.1.3 Applicable rules

The list of references to the applicable requirements of the NR445, Pt C, Ch 4 when relevant is given in Tab 1.

1.1.4 Documentation to be submitted

The relevant documentation required in NR445, Pt A, Ch 1, Sec 4 is to be submitted, including the fire plans. The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if is deemed necessary for the evaluation of the system, equipment or components.

Table 1 : Applicable rules

Scope	NR445, Part C, Chapter 4	Comments
General	Section 1	
Arrangement of unit or installation	Section 2	
Hazardous areas	Section 3	
Structural fire protection	Section 4	
Detection, controls, communications and alarms	Section 5	Portable gas monitoring devices: On units where flammable gas are stored, at least two portable flammable gas monitoring devices are to be provided, each capable of an accurate measurement of gas concentration. In addition, at least two portable oxygen analysers are to be provided.
Fire fighting	Section 6	NR445, Pt D, Ch 1, Sec 11, [7.3.2] is applicable
Structural integrity	Section 7	
Escape	Section 8	
Fire plan	Section 9	
Helicopter facilities	Section 10	
Fire safety systems	Section 11	
Additional notation LSA	Section 12	NR445, Pt C, Ch 4, Sec 12 is not recommended For French area, Division 229 may be applied
Noise and vibration	NR636	Requirements for Comfort and Health on-board Offshore Units

2 Arrangement of unit or installation

2.1 General

2.1.1 The layout of the unit or installation is to be designed giving due consideration to safety of personnel, prevention of pollution and protection of industrial properties.

2.2 Manned unit

2.2.1 Living quarter

For manned unit, the general orientation of the unit or installation is to be as far as practicable, such as the living quarter is not located under the prevailing wind of process area or cold vent.

2.2.2 Accommodation

For manned unit, the general orientation with regard to current is to be as far as practicable such as dangerous goods leaks will not be pushed towards accommodation.

2.3 Access

2.3.1 Means of escape

Generally, at least two widely separated and ready means of escape are to be provided from all spaces or groups of spaces.

Embarkation areas are to be adequately protected to ensure safe access to the evacuation means during an accidental event and for a period of time sufficient for evacuation operations.

2.3.2 Walkways, ladders and handrails

Walkways, ladders and handrails are to be fitted to all raised areas requiring access for maintenance and operation personnel.

3 Detection and alarms

3.1 Fire detection

3.1.1 General

In principle, spaces having a fire risk should be provided with an automatic fire detection and alarm system.

3.1.2 The fire detection main indicator board is to be at a manned control station and is to clearly indicate where fire has been detected.

3.1.3 Unattended units

Fire detectors are to be of such type and so located that they will rapidly detect the onset of fire in conditions normally present in the protected space. Consideration is to be given to avoiding false alarms. The type and location of detectors are to be approved by the Society and a combination of detector types is recommended in order to enable the system to react to more than one type of fire symptom.

3.1.4 Position of detectors

Position of detectors are to be located for optimum performance.

3.1.5 Visual and audible fire signals

Activation of any detector or manually operated call point is to initiate visual and audible fire detection alarm signal at the control unit and indicating units.

3.2 Gas detection

3.2.1 General

A fixed automatic gas detection and alarm system is to be provided to the satisfaction of the Society, so arranged as to monitor continuously all enclosed areas of the unit in which the accumulation of flammable gas may be expected to occur.

3.2.2 Gas detection equipment should be designed, installed and tested in accordance with recognized standards.

Note 1: IEC 60079-29-1 - Explosive atmospheres - Gas detectors - Performance requirements of detectors for flammable gases.

3.2.3 Portable gas monitoring devices

On units where flammable gas are stored, at least two portable flammable gas monitoring devices are to be provided, each capable of an accurate measurement of gas concentration. In addition, at least two portable oxygen analysers are to be provided.

3.2.4 In the case of toxic products or both toxic and flammable products, portable equipment may be used for the detection of toxic products as an alternative to a permanently installed system.

3.2.5 Visual and audible signal

Gas detectors are to be connected to an audible and visual alarm system with indicators on the main control station. The alarm system is to clearly indicate the location and concentration of the gas hazard.

Any alarms status within a gas detection system shall initiate an audible and visible alarm:

- on the navigation bridge, when applicable
- at the relevant control station(s) where continuous monitoring of the gas levels is recorded, and
- at the gas detector readout location.

3.2.6 Ammonia in unattended machinery spaces

Where the cryogenic machinery spaces are not permanently attended, a gas detection system with an audible and visual alarm is to be arranged in a suitable location. This system is also to stop the compressor when a flammable gas concentration is reached.

3.2.7 Personnel protection for ammonia installation

At least two sets of breathing apparatus and protective clothing are to be available outside and in the vicinity of the ammonia machinery space.

4 Fire protection

4.1 Structural fire protection

4.1.1 The principle of the passive fire protection is to separate the potentially aggressed spaces from the potential aggressors by partitioning in order to prevent against the propagation of the fire through the unit and allow a safe evacuation of persons (tenability criteria).

The spaces to be protected (aggressed) are for example: control stations, spaces where the means of control of the active fire protection are located, escape routes (corridors, muster stations, shelters and refuges,...), accommodation spaces, if relevant.

4.1.2 Bulkheads and decks (divisions) should resist a certain time, according to their required fire classification, in order to:

- prevent passage of flames
- prevent passage of smoke
- prevent radiation / conduction – temperature on unexposed face to fire.

4.1.3 Fire categories

For determining the appropriate fire integrity standards to be applied to divisions between adjacent spaces, such spaces are classified according their fire risk as shown in categories defined in NR445, Pt C, Ch 4, Sec 4.

4.2 Smoke and gas spread

4.2.1 Principle

The control of smoke spread is intended to maintain practicable the escapes for evacuation, by extraction of smoke and combustion gases at the beginning of fire.

4.2.2 Openings

Suitable arrangements are to be made to allow the release of smoke in the event of a fire in the space to be protected.

4.2.3 Ventilation

a) the ventilation is to be so arranged as to prevent any accumulation of flammable gases or vapours.

b) the main inlets and outlets of all ventilation systems are to be capable of being closed from outside the spaces being ventilated.

c) ventilation of compartments where dangerous goods are stored or used somehow is to be separated from any other ventilation systems. It has to be provided with mechanical means of ventilation. Acceptance of common ventilation with other compartments may be accepted on case by case basis subject to risk assessment.

d) spaces containing thermal oil heaters are to be suitably mechanically ventilated. Ventilation is to be capable of being stopped from outside these spaces.

5 Fire fighting

5.1 General

5.1.1 OTEC units are to be provided with fire fighting systems of appropriate type.

5.1.2 Water supply

At least two water supply sources (sea chests, valves, strainers and pipes) should to be provided and so arranged that one supply source failure will not put all supply sources out of action.

5.1.3 Fire fighting system flow

System flow calculations is to be performed using a calculation technique acceptable to the Society.

5.2 Fire mains

5.2.1 Diameter of fire mains

The diameter of the fire main and water service pipes are to be sufficient for the effective distribution of the maximum required discharge from the required fire pumps operating simultaneously.

5.2.2 Pressure of fire mains

The pressure maintained in the fire mains should be adequate for the safe and efficient operation of all equipment supplied there-from.

5.2.3 Isolating

The fire main is not to have connections other than those necessary for fire-fighting purposes

5.2.4 Storage area of flammable goods

Within storage area of flammable or explosive goods, isolation valves are to be fitted in the fire main at intervals of not more than 40 m to preserve the integrity of the fire main system in case of fire or explosion.

5.3 Hydrants, hoses and nozzles

5.3.1 General

In general, the number and position of the hydrants is to be such that at least two jets of water, not emaning from the same hydrant, may reach any part of the unit normally accessible to those on board while the unit is operating.

5.4 Fire extinguishing system

5.4.1 Type approval

All fire extinguishers are to be of approved types and designs, or approved by Authorities.

5.4.2 Where a fire hazard exists in any machinery space for which no specific provision for fire extinguishing appliances are prescribed in NR445, Pt C, Ch 4, there is to be provided in or adjacent to that space, such a number of approved portable fire extinguishers or other means of fire extinction.

6 Hazardous areas

6.1 General

6.1.1 Applicable requirements for hazardous areas are given in NR445, Pt C, Ch 4, Sec 3.

SECTION 8 SUBSEA POWER CABLE SYSTEM

1 Application

1.1 General

1.1.1 The following considerations apply to structural part of subsea power cable system.

1.1.2 Recognised standards

The main relevant standards for subsea power cable system are:

- ISO 13628-5 Petroleum and Natural Gas Industries – Design and Operation of Subsea Production Systems - Part 5: Subsea Umbilicals
- API17E Specification for Subsea Umbilicals.

Other general standards, as listed in Tab 1 may be used for failure mode verification and qualification tests definition of the subsea power cable system, as applicable.

1.2 Definitions

1.2.1 Subsea power cable system

The subsea power cable system includes the subsea power cable itself, its supports and all integrated subsea power cable components.

1.2.2 Subsea power cable

Subsea power cable is used for electrical power transmission between the OTEC unit and electrical substation. It is composed of:

- a dynamic section from the floating platform to the sea bed
- and static section along the seabed to shore or another electrical substation.

The subsea power cable cross section may contain:

- electrical conductors
- electrical signal cables
- optical fibers, for communication between the shore and the unit.

1.2.3 Subsea power cable components

Subsea power cable components are all the equipment associated with the subsea power cable such as connectors.

1.2.4 Subsea power cable supports

The subsea power cable supports are the ancillary structures giving to the subsea power cable adequate global configuration to the dynamic section and on-bottom stabilization and protection methods to the static section.

2 Umbilical supports

2.1 Ancillary equipment

2.1.1 Recognised standards

The Tab 2 lists the relevant standards for ancillary equipment.

Table 1 : Standards for subsea power umbilical

Title	Domain
ISO 13628-5 Petroleum and Natural Gas Industries - Design and Operation of Subsea Production Systems - Part 5: Subsea Umbilicals	Subsea power umbilical
API 17E Specification for Subsea Umbilicals	Subsea power umbilical
BS EN 10257-2 Zinc or zinc alloy coated non-alloy steel wire for armouring either power cables or telecommunication cables. Submarine cables	Submarine cable
ISO 13628-11 Design and operation of subsea production systems - Part 11: Flexible pipe systems for subsea and marine applications	Flexible pipe
API RP 17B Recommended Practice for Flexible Pipe	Flexible Pipe
ISO 13628-2 Design and operation of subsea production systems- Part 2: Unbonded flexible pipe systems for subsea and marine applications	Unbonded flexible pipe
API 17J Specification for Unbonded Flexible Pipe	Unbonded Flexible Pipe
CIGRE - Green books	Electric system

Table 2 : Relevant standards for ancillary equipment

Title	Domain
API 17 L1 Specification for Flexible Pipe Ancillary Equipment	Flexible Pipe
API 17 L2 Recommended Practice for Flexible Pipe Ancillary Equipment	Flexible Pipe

SECTION 9 WATER INTAKE AND DISCHARGE PIPE SYSTEM

1 General

1.1 Principle

1.1.1 Application

The following considerations apply to the water intake and discharge pipe system of OTEC unit. It includes:

- cold water intake pipe system
- warm water intake pipe system
- seawater discharge pipe system.

Note 1: The associated pumps stations are not covered by the present Section.

1.1.2 Environmental impact

Discharge of production water and displacement water are subjected to national or regional regulation as applicable.

Note 1: Attention is to be paid on depth of seawater discharge. It may be observed that in the surface, the layer of warm seawater, nutrient levels are low. Whereas in deep, the layer of cold water presents higher levels of nutrient. Introducing deep nutrients into surface layer could potentially increase growth of plankton or algal blooms.

1.2 Definitions

1.2.1 Water pipe system

The water pipe system includes the water pipe itself, its supports and all integrated pipe components. Typically, the water pipe system of a floating OTEC unit includes the followings:

- Cold Water Pipe (CWP), Warm Water Pipe (WWP) or Seawater Discharge Pipe (SDP)
- connection to the floating unit (such as Flex joint, sealed Gimbal, Flex-hose or other mechanism) that allows to carry the pipe and also to decouple the pipe rotations from the unit motions, or to limit the pipe curvature at the upper connection
- strainer or other similar system as protection for the seawater system (ingress of living species, large particles …)
- sinkers (lumped mass) at the pipe lower end to improve the pipe global behavior and limit lateral offsets.

1.2.2 Pipe components

Pipe components are all the equipment associated with the pipe such as clamps, connectors, joints, end fitted, bend stiffeners.

1.2.3 Pipe supports

The pipe supports are the ancillary structures giving the pipe its configuration and securing it, such as buoyancy modules and sinkers.

1.3 Standards

1.3.1 The Tab 1 lists recognized standards for water intake and discharge pipe system.

2 Design

2.1 General

2.1.1 Qualification of new technology

It is suggested to undertake a process of qualification of new technology, from which a qualification program on the water intake and discharge system could be derived.

Guidance for performing such new technology qualification process is included in NI 525 (Risk Based Qualification of New Technology) or API 17N.

Table 1 : Relevant standards for water intake riser

Title	Description
ISO 13628-11 Design and operation of subsea production system	Flexible pipe
API 17 L1 Specification for Flexible Pipe Ancillary Equipment	Flexible Pipe
API 17 L2 Recommended Practice for Flexible Pipe Ancillary Equipment	Flexible Pipe
API RP 17B Recommended practise for flexible pipe	Non-bonded and bonded flexible pipe
API 17J Specification for unbounded flexible pipe	Unbounded flexible pipe
API 17K Specification for bonded flexible pipe	Bonded flexible pipe
API RP 15S Recommended Practice for Qualification of Spoolable Reinforced Plastic Line Pipe	Plastic pipe
API 17Z Bonded Composite Pipe for Offshore Applications	Bonded composite pipe
EN 1474 Part 2 Installation and equipment for liquefied natural gas. Design and testing of marine transfer systems. Design and testing of transfer hoses	Bonded composite pipe

2.1.2 Documentation to be submitted

The documentation submitted is to include at least the followings:

- design data (metocean data, soil data, water depth,...)
- general arrangement
- description of interfaces with the floating platform (hang-off, connection system to the platform)
- description of ancillaries elements (bend stiffeners,...)
- material specifications
- design analysis for local pipe sections
- global dynamic analysis report including methodology description
- global fatigue analysis report including methodology description
- test report (specifications, calibration test report, experimental test report).

2.2 Water pipe system design

2.2.1 General

Water pipes are subjected to actions of currents and waves along the line, and primarily, to imposed displacements of pipe head attached to the unit. Design analyses are to be carried out in order to ascertain that the design configuration is appropriate and in order to verify that extreme tensions, curvatures, and cyclic actions are within the design limits of the specified product.

2.2.2 Water pipe is to be checked against strength and fatigue life. Additional considerations such as impact, tearing, minimum tension are also to be considered.

2.2.3 Load cases

The load cases selected for analysis are to be verified as being the most unfavourable combinations of unit offsets, current and wave loadings.

2.2.4 Design loads

Water pipe is to withstand the static and dynamic loads due to:

- self-weight:
  - static longitudinal loads.
- relative motion between pipe and floating platform (related to wave and current):
  - static bending loads due to steady current
  - dynamic bending loads induced by floating platform motion (roll, pitch, yaw, heave, surge and sway)
  - dynamic bending loads induced by unsteady currents and waves
  - angle due to balance force between lateral moments imposed by the current and the restoring force of the water intake riser.

- internal pressure induced by water flow:
  - dynamic pressure coupling with plateform movements
  - water hammer
  - start and stop of pumping station
  - static normal pressure loads
  - ovalling.

2.2.5 Sea water inlets

Sea water inlets are to be protected against ingestion of large particles.

Sea water suction lines should to be fitted with strainers.

2.2.6 Coupled analysis

When dynamic response of the water pipe may affect the dynamic response of the platform, coupled seakeeping and structural analysis may be required.

2.2.7 Interference

An analysis of interference is to be performed in order to verify that all the pipes, umbilical and anchor lines remain at an acceptable distance from each other (and from the unit) during operation.

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