China Classification Society

Rules for Classification of Offshore Single Point Moorings

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Contents

Chapter 1 Scope and Conditions of Classification

Section 1 General Provisions

1.1.1 Rules for classification

1.1.1.1 CCS shall handle the classification business of offshore single point moorings according to the Rules and relevant regulations.

1.1.1.2 Classification means that CCS considers according to the Rules that the structural strength and integrity of the primary structural members of the main body and appendages of the single point moorings, as well as the reliability and function of other facilities or auxiliary systems assembled on the single point moorings, can maintain the basic services of the single point moorings, and are identified with different symbols and signs.

1.1.2 Classification process

1.1.2.1 The classification process consists of the following stages:

(1) Formulation of norms;

(2) Confirm that the single point moorings meet the requirements of the Rules through plan approval and construction inspection;

(3) When compliance is confirmed, the single point moorings class shall be assigned and the classification certificate shall be issued;

(4) Through surveys after construction, confirm that the single point moorings meet the requirements of the Rules, and sign or issue the classification certificate;

(5) Application of information.

1.1.3 Definitions

1.1.3.1 Unless otherwise specified in the Rules, the relevant definitions are as follows:

(1) Classification: refers to the technical services provided by CCS to customers according to the Rules issued by CCS;

(2) Classified single point moorings: Refer to the single point moorings of which classification certificate is issued by CCS according to the Rules;

(3) Floating structures: Refer to floating structures such as ships, units and devices used for oil and gas production, processing, storage, cargo transfer or other purposes;

(4) Offshore single point moorings: Refer to a mooring and transfer device, which provides a connection between submarine pipelines and mooring floating structures, and can be used to transport fluid substances such as oil or natural gas when necessary, as well as provide power, signal transmission and other functions. Under the action of environmental conditions, mooring floating structures can rotate around mooring points.

Common offshore single point moorings include offshore single point mooring transport terminal system and offshore floating structure single point moorings. Commonly used single point moorings include catenary buoy type, SALM, turret type, SYMS and so on;

(5) Offshore single point mooring transportation terminal system: refers to a set of system which connects its buoy with floating structure through mooring line and combines single point mooring with offshore transportation, which is mainly used for medium transportation between floating structure and shore-based storage. Offshore single point mooring terminal system mainly includes single point mooring, single point buoy and turntable, oil (gas and liquid) fluid swivel, floating hose, subsea hose, submarine manifold and submarine pipeline.

(6) Single point moorings for offshore floating structures: a device composed of permanent or disconnectable connection between floating structures such as oil storage vessels or floating devices and single point mooring;

(7) Floating single point moorings: refers to an offshore floating device, which is anchored to the seabed by mooring lines or supported by anchor pile, and the floating structure can be tied to it, and the attached floating structure can rotate around the mooring point under the action of environmental load;

(8) Fixed single point moorings: Refer to single point moorings composed of a space truss or cylindrical tower and foundation and fixed on the seabed;

(9) CALM single point moorings: Refer to single point moorings consisting of a large buoy and a plurality of catenary mooring lines anchored on the seabed, and the floating structure is connected to the buoy through flexible cables (multiple cables) or a rigid yoke arm;

(10) SALM single point moorings: Refer to single point moorings connected to a seabed infrastructure by a single mooring line or a buoy structure and anchor pile. Anchor piles can be mooring lines, steel structures or combinations thereof;

(11) Turret single point moorings: Refer to single point moorings comprising a turret structure anchored to the seabed by multiple mooring lines, which is connected with a floating structure by bearings, the floating structure can rotate freely around the turret, and a pipeline transmission system inside the turret realizes two-way flow of fluid medium between the floating structure and the seabed pipeline. According to the different positions of turrets on floating structures, turrets are divided into ITM and ETM;

(12) SYMS single point moorings: Refer to the single point moorings mainly including jacket foundation structure, kingpost, rotating platform, soft rigid arm (also called mooring arm), mooring frame, conduction system, etc. The foundation structure is fixed on the seabed, the kingpost is located at the upper end of the foundation, and the upper part of the foundation is equipped with a rotating platform. The mooring floating structure is connected with the rotating platform through a soft rigid arm and a mooring head, so as to realize rotation and positioning around the mooring point. The conduction system can transmit oil, water, electricity, gas and other transmission media between mooring floating structure and single point moorings in two directions. According to the different positions of soft rigid arm, it generally includes two forms: water SYMS and subsea SYMS;

(13) Authorities of the government of the coastal state: Refer to the government organs of the state that exercise the administrative power of the coastal state over the operation of single point moorings;

(14) Newly built single point moorings: Refer to the single point moorings signed with the construction contract on or after the effective date of the Rules;

(15) Existing single point moorings: Refer to single point moorings other than newly built single point moorings;

(16) Products: Refer to the general designation of materials, equipment and systems;

(17) The Rules: Refer to the rules for classification, special rules, guide and calculation software issued by CCS;

(18) Force majeure: Refer to damage to single point moorings, and the situation that the CCS surveyor is accidentally unable to board the single point moorings due to restrictions on entry or movement of personnel by port authorities; unexpected delay of single point moorings in port due to abnormal continuous bad weather, strike or civil unrest; war or other irresistible external force;

(19) Exceptions: one or more of the following:

① Unable to obtain repair equipment;

② Unable to obtain the required materials, equipment or spare parts;

③ Delay caused by avoiding bad weather conditions;

④ Special consideration by the competent government authorities of coastal states.

(20) Double-class single point moorings: Single point moorings are classified in two classification societies, and each classification society independently completes all inspections according to its own rules and inspection time;

(21) Double-class single point moorings: Single-point moorings are classified in two classification societies, the two classification societies have a written agreement, and work is shared;

(22) Single point moorings class conditions: The implementation requirements of specific measures, repairs, inspections, etc. that need to be dealt with within a time limit to maintain the single point moorings class;

(23) Anchoring: The connection between single point moorings and the seabed;

(24) Mooring: The connection between floating structures and single point moorings.

Section 2 Rules for Classification

1.2.1 Rules for classification

1.2.1.1 "Rules for classification" are provisions with complete contents, including conditions and scope of classification, matching technical requirements, aiming at controlling safety and quality to an appropriate level, which are widely recognized.

1.2.1.2 "Special rules" refer to the provisions that only have special contents and are used in conjunction with the rules for classification.

1.2.1.3 The rules issued by CCS are the base and sole basis for classification.

1.2.1.4 The rules issued by CCS specifies the dimensions of the main structure and important machinery of single point moorings, the quality of materials used, structural and mechanical construction standards, classification and test requirements, and the conditions under which they are kept in good condition.

1.2.1.5 CCS will develop guidelines for contents not included in the existing rule, or where there are principles in the rules that require further refinement, or where specific operability needs to be added, or where novel single point moorings or equipment or systems are required. It is convenient to classify by using the "Guide". Where the "Guide" is quoted in the rules, the contents related to classification in the "Guide" constitute the requirements of the rules.

1.2.2 Rules development

1.2.2.1 The main basis for formulating rules is:

(1) Use experience;

(2) Relevant theories and scientific research achievements;

(3) Relevant conventions, rules, resolutions, uniform requirements and other applicable parts adopted by the International Maritime Organization (IMO) and the International Association of Classification Societies (IACS).

1.2.2.2 The first draft of CCS rules or its revision notification shall be sent to the administration, designer, manufacture, inspection, owner, scientific research, institutions of higher learning and other units related to single point moorings and products for comments.

1.2.2.3 According to the safety situation involved in the use experience and accident investigation, or when the relevant new IMO resolutions and rules come into effect, and the classified parts need to be revised, or the unified requirements adopted by IACS are accepted, CCS will directly issue the revision notification.

1.2.3 Entry into force of the rules

1.2.3.1 Unless otherwise stated, the rules (including revision notification) will generally take effect three months after its promulgation. The effective date is indicated on Page 1 of the corresponding chapter or on the title page of the publication.

1.2.3.2 Unless otherwise specified, the rules apply to newly built single point moorings and newly manufactured products.

1.2.3.3 The requirements of the new rules may be applied to single point moorings under construction with the consent of the manufacturer and the owner.

1.2.3.4 The effective date of the rules is only related to the date of approval and promulgation of the rules, and is not affected by the effective date of other statutory requirements.

1.2.4 Scope of application

1.2.4.1 The Rules are applicable to classified unmanned offshore single point moorings.

1.2.4.2 The Rules applicable to newly built single point moorings. For single point moorings prior to the entry into force of the Rules, except as specified in 1.2.4.3, they shall continue to comply with the requirements of their original applicable rules.

For major reconstructed single point moorings, the reconstructed parts and related parts shall apply to the current rules.

1.2.4.3 Where applicable, the requirements of Chapters 1 and 2 may also apply to existing single point moorings.

1.2.4.4 The materials and welding of single point moorings shall meet the requirements of CCS *Rules for Materials and Welding* (2018).

1.2.4.5 The Rules apply to the following two types of single point moorings:

(1) Single point moorings for offshore floating structures;

Such single point moorings include all structures, equipment and systems from the subsea pipeline terminal manifold to the interface with the mooring floating structure. The relevant requirements of mooring floating structures are not involved;

(2) Offshore single point mooring transport terminal system.

1.2.5 Equivalence and exemption

1.2.5.1 With respect to any single point moorings with new construction and new characteristics, any requirement of the CCS rules may be waived with the consent of the CCS headquarters where the application of any of the provisions of the CCS rules would seriously impede the application of the characteristics of such single point moorings or the use of the single point moorings.

1.2.5.2 Any device, material, equipment and apparatus installed on single point moorings may replace those required by the CCS rules, provided that such device, material, equipment and apparatus are determined by tests and other means to be at least as effective as required by the CCS rules.

1.2.5.3 The calculation methods, evaluation criteria, manufacturing procedures, materials, inspection and test methods required by the rules can be accepted as substitutes and equivalents with the consent of CCS headquarters if they can provide corresponding tests, theoretical basis, use experience or valid recognized standards.

1.2.6 Application of risk assessment techniques

1.2.6.1 Where the owner or his/her agent wishes to design, manufacture or operate the entire single point moorings or a single point mooring system or unit through risk assessment techniques, the risk control scheme used in the risk assessment may replace all or part of the Rules after CCS has reviewed the risk assessment documents to the satisfaction.

1.2.7 Normative reference documents

1.2.7.1 The provisions of the relevant documents shall become provisions of the Rules by reference to the Rules. For undated reference documents, the latest version is applicable to the Rules.

Section 3 Classification Symbols and Additional Notations

1.3.1 Classification symbols

1.3.1.1 Classification symbol is the expression of the main characteristics of single point moorings, which is mandatory.

1.3.1.2 The main body (including equipment) and machinery (including electrical equipment) of the single point moorings shall comply with CCS rules, guidelines or equivalent regulations, and CCS shall assign corresponding classification symbols and additional notations.

1.3.1.3 Where the main body (including equipment) and machinery (including electrical equipment) of single point moorings are approved for classification by CCS, the following classification symbols will be assigned according to different circumstances:

★ CSA

or

★ CSA

The meaning of the classification symbol is as follows:

★ CSA - means that the product inspection, plan approval and surveys during construction of the main body of the

single point moorings and the auxiliary machinery for the important use of the single point moorings are conducted by CCS to comply with the provisions of CCS rules.

★ CSA - means that the product inspection, plan approval and surveys during construction of the main body of single point moorings and auxiliary machinery for important use of single point moorings are not conducted by CCS, but are subsequently inspected by CCS, and it is considered that they meet the requirements of CCS rules.

1.3.2 Additional notations

1.3.2.1 Additional notations are graded representations of the different characteristics of single point moorings, which are added behind the classification symbols. Additional notations can be divided into necessary and optional additional notations.

1.3.2.2 Optional additional notations shall be assigned by CCS upon application by the owner and after CCS review and inspection to confirm compliance with the corresponding provisions of CCS rules.

1.3.2.3 Additional notations include single point moorings anchoring system type and one or one group of marks with other meanings.

1.3.2.4 Upon the owner's application, for single point moorings constructed in accordance with the relevant rules issued by CCS or other standards accepted by CCS, CCS will assign appropriate additional notations as appropriate.

1.3.2.5 Table 1.3.2.6 is a list of additional notations for single point moorings, which can be filled in English only in the classification certificate. The table can be divided into the following categories:

A: Single point moorings type additional notations: All single point moorings shall be filled with type additional notations;

E: Additional notations for special performance: Units have special performance design in structure, and corresponding additional signs can be assigned respectively;

G: Additional notations for special equipment and systems: Special equipment and systems on single point moorings are designed and built according to relevant specifications and guidelines, and corresponding additional signs can be assigned respectively;

H: Additional notations for special survey: Alternative inspection methods or special survey requirements can be assigned with corresponding additional signs respectively;

I: Additional notations for environmental protection: Single point moorings conforming to the relevant provisions of CCS specifications can be assigned with corresponding additional notations respectively.

Table 1.3.2.6 Additional notations

Additional mark	Specification		Meet the technical requirements
A Offshore single point moorings mooring system type additional mark			
CALM	Catenary anchor pile mooring	CALM is the abbreviation of Catenary Anchor Pile Mooring, as defined in 1.1.3.1 (9).	Chapters 1 to 11 of the Rules
SALM	Single anchor pile mooring	SALM is the abbreviation of Single Anchor Pile Mooring, as defined in 1.1.3.1 (10).	
ETM	External turret mooring	ETM is the abbreviation of External Turret Mooring, as defined in 1.1.3.1 (11).	
ITM	Inner turret mooring	ITM is the abbreviation of Internal Turret Mooring, as defined in 1.1.3.1 (11).	
SYMS	Soft yoke mooring system	SYMS is the abbreviation of Soft Yoke Mooring System, as defined in 1.1.3.1 (12).	
E Additional notations for special performance			
PSPC	PSPC	Apparatus conforming to IMO performance	Relevant

Additional mark	Specification		Meet the technical requirements
		standards for protective coatings at specific locations, with the suffix V symbol, which means as follows: V: Protective coating applied to the empty compartment of the device.	requirements of *Guidelines for Anticorrosion Inspection of Hull Structure* (2009)
G Additional notations for special equipment and systems			
Lifting Appliance	Lifting appliance	This notation may be assigned to single point moorings equipped with lifting appliance	*Rules for Lifting Appliances of Ships and Offshore Installations* (2007)
H Additional notations for special survey			
In-Water Survey	In-water survey	This notation can be assigned to single point moorings with in-water survey conditions	*Rules for Classification of Sea-Going Steel Ships* (2018)
I Additional notations for environmental protection			
G-EP (AFS)	G-EP(AFS)	This notation can be assigned to single point moorings with G-EP(AFS) that does not contain organic compounds as biocides	*Rules for Green Eco-Ships* (2020)

1.3.2.6 Other additional notations

Additional notations other than those specified above can be assigned upon the application of the owner and with the consent of CCS headquarters, provided that they should meet the corresponding requirements and are satisfactory to CCS.

1.3.3 Combination of classification symbols and additional notations

1.3.3.1 Additional notations are added behind the classification symbol. Additional notations of single point moorings type are required additional signs and shall be assigned with the classification symbol.

1.3.3.2 Use ";" between two sets of additional notations for separation.

1.3.3.3 Unless otherwise specified, the additional notations shall generally be arranged in the order of A-F in 1.3.2.5, and shall be filled in the classification certificate. For example, the classification symbols and additional notations of floating CALM single point moorings with lifting appliance constructed under CCS inspection are as follows:

★ CSA CALM; Floating; Lifting Appliance.

Section 4 Application and Fees

1.4.1 Application

1.4.1.1 Applicants for CCS services must submit a written application or application form to CCS headquarters or CCS designated unit or local branch, and/or sign a contract/agreement with CCS.

1.4.1.2 The application or contract/agreement shall specify the responsibilities of both parties, classification symbols and additional notations, elements of single point moorings, etc. The applicant shall undertake not to object to and provide convenience for representatives of third-party independent audit bodies (including representatives of recognized certification bodies (ACB), IACS observers, etc.), representatives of European Commission (EC), boarding single point mooring or entering manufacturers and shipyards for audit or evaluation.

1.4.1.3 The applicant shall provide the drawings and technical documents required to perform the above services.

1.4.1.4 For drawings review of newly built single point moorings, the single point moorings designer or the owner or his/her agent or the single point moorings manufacturer shall submit an application to CCS headquarters or CCS designated single point moorings plan approval unit. For the construction inspection of single point moorings, the single point moorings manufacturer can directly submit an application to the inspection unit.

1.4.1.5 The owner or his/her agent shall submit an application for drawings review and initial inspection of existing single point moorings to CCS headquarters or the inspection unit.

1.4.1.6 Product plan approval and inspection shall be applied by the manufacturer to CCS headquarters or CCS designated product plan approval and inspection unit.

1.4.1.7 To ensure the occupational health and safety of CCS surveyors, CCS has established an occupational health and safety management system. Applicants applying for CCS classification and statutory inspection services mean respecting CCS occupational health and safety management system, and undertake to provide CCS surveyors entering facilities related to the survey services applied for with safety survey conditions that meet the safety technical requirements or equivalent technical standards[1] stipulated by the country where the surveyor's nationality is located, the country where the survey agency is located and/or the administration where the survey site is located, including permanent or temporary inspection channels and facilities, compartment environment and safety protection. CCS surveyors will confirm the safety of the survey conditions with the applicant and his/her designated responsible personnel before performing the specific survey work.

1.4.2 Fees

1.4.2.1 The applicant shall pay fees and transportation and other necessary expenses in accordance with CCS regulations and/or contract/agreement.

1.4.2.2 For services beyond the contract/agreement, or duplication of CCS services due to the client, CCS is entitled to charge the applicant additional fees.

Section 5 Drawing Submission and Plan Approval

1.5.1 Review of drawings

1.5.1.1 Before commencement, the owner or designer of the single point moorings shall apply to CCS for review of paper drawing or electronic drawing. In case of application for paper drawings review, the applicant shall submit the application together with the drawings and documents to the plan approval unit designated by CCS for review according to the relevant provisions of each chapter of the Rules. When submitting drawings in batches, at least the necessary main drawings and documents of the single point moorings shall be submitted first.

For the listed single point moorings or the single point moorings for continuous construction within one year according to the approved main structural drawings, according to different circumstances, the number of drawings submitted for review may be exempted or appropriately reduced.

1.5.1.2 Single point moorings inspection, test list and technical documents, such as welding process, NDT drawings, tightness test drawings, mechanical installation process, inclining test outline and mooring test outline, shall be submitted to CCS on-site surveyors for review.

1.5.1.3 Drawings materials submitted for review shall show the necessary dimensions and relevant documents

[1] See CCS *Customer Guide for Inspection Safety*.

required by the rules.

1.5.1.4 "Approval" means that the drawings or documents have been reviewed and meet the requirements of CCS rules. CCS approval of drawings and documents only includes items required by CCS rules, and does not involve items not required by CCS rules. If CCS undertakes statutory inspection at the same time, the "approval" of CCS shall also include the items required by relevant statutory rules.

1.5.1.5 If the drawings are considered to meet the requirements after examination, the approved drawings shall be stamped with the "approval" stamp. The conditions and restrictions of approval may be written on the drawings or stated in the letter of drawings withdrawal, but shall be indicated on the drawings.

1.5.1.6 If there is any modification or supplement in principle to the approved drawings, the applicant shall submit the modification or supplement to the original plan approval unit for re-examination.

1.5.1.7 "For future reference" means that the drawings are not audited and are only used as supporting documents in the process of reviewing the drawings subject to approval.

1.5.1.8 In addition to the drawings submitted in accordance with the relevant provisions of each chapter of the Rules, an operation manual shall be submitted for review:

(1) The single point moorings shall be provided with an operation manual readily available to all personnel as a guide for the safe operation of the single point moorings under normal conditions and emergency circumstances. In addition to describing the general situation of single point moorings, the manual shall also include all operating procedures, instructions and restrictions that are essential to single point moorings, so as to ensure that the loading conditions and environmental conditions on which classification is based are not exceeded during operation.

(2) The manual shall be concise and easy to understand. Each manual shall have a table of contents and an index. There shall be relevant details that can be referenced to each other and can be easily found on the single point moorings;

(3) The contents included in the operation manual shall at least comply with the relevant provisions of the administration;

(4) As far as classification is concerned, CCS will check the contents related to classification in the operation manual to ensure that the contents related to classification in the operation manual are consistent with the approved design conditions, restrictions and criteria as the basis for classification.

1.5.1.9 When necessary, CCS may request to expand the scope of drawings and documents review.

1.5.2 Validity period of approved drawings

1.5.2.1 Approved drawings are valid only to the extent of the manufacturer, number of construction works or number of constructions specified in the plan approval or the contract/agreement.

1.5.2.2 Approved drawings for the classification of single point moorings shall be self-invalidated in any of the following cases:

(1) 4 years from the date of approval;

(2) When the entry into force of CCS rules (including the revision notification of rules) or the laws, decrees and accepted international conventions, rules and their amendments of the competent authorities affects the validity of approved drawings, and the drawings have not been modified and re-approved accordingly;

(3) When all the project numbers or number filled in the application for plan approval or the contract/agreement are completed;

(4) When the number of approved manufacturers or construction works changes or exceeds the number of constructions;

(5) The surveys during construction is not carried out by CCS.

1.5.2.3 An approved statutory drawings of single point moorings shall automatically lapse when the validity of the approved drawings is affected by the entry into force of a statutory requirement of the administration or accepted international conventions, rules and amendments thereto.

Section 6 Classification Survey

1.6.1 General requirements

1.6.1.1 The designer of single point moorings and products shall establish an appropriate quality assurance system to ensure the design quality of single point moorings and products.

1.6.1.2 The manufacturer shall establish an appropriate quality assurance system to ensure the construction quality of single point moorings and products. The manufacturer shall also provide a list of its suppliers and its general documents (such as the builder's brief introduction and quality management system information).

1.6.1.3 Suppliers who provide important safety systems and measuring and test equipment for single point moorings, the results of which will be used as the basis for CCS survey, shall be approved by CCS (see Section 8 of this Chapter), otherwise such services shall be performed in the presence of surveyors.

1.6.2 Pre-commencement assessment and inspection

1.6.2.1 Before commencement of single point moorings, CCS will assign surveyors to evaluate the capacity of the builder and/or conduct pre-commencement inspections.

1.6.3 Inspection

1.6.3.1 For products such as materials, equipment and systems required by the rules, the manufacturer shall apply to CCS headquarters or CCS designated product plan approval and inspection unit for product inspection according to the requirements of Section 2 of Chapter 2.

1.6.3.2 Single point moorings to be classified at CCS shall apply to CCS for initial classification survey in accordance with the relevant requirements of Sections 3 and 4 of Chapter 2.

1.6.3.3 In order to maintain the validity of the classification, the manufacturer shall apply for surveys after construction of CCS as required by Section 4 of Chapter 2.

Section 7 Statutory Services

1.7.1 General requirements

1.7.1.1 The CCS shall undertake part or all of the statutory services for single point moorings under the authorization of the administration and upon the application or contract/agreement of the owner or the designer or manufacturer.

1.7.1.2 For authorized statutory services, CCS will issue/sign the corresponding statutory certificates and/or reports upon CCS plan approval, surveys during construction and surveys after construction to confirm that the classification parts meet the requirements of CCS Rules for Classification and meet the corresponding statutory requirements.

1.7.1.3 For single point moorings applied for CCS classification, which are concurrently authorized to perform statutory services or statutory requirements assessment, CCS will combine the classification of single point moorings with statutory services or statutory requirements assessment.

1.7.1.4 For single point moorings for which CCS provides classification services and statutory services, if the classification certificate is invalid and the issuance conditions of relevant statutory certificates are affected, the relevant statutory certificates or compliance certificates shall also be invalid.

1.7.2 Statutory service basis

1.7.2.1 Single point moorings shall comply with the relevant statutory requirements of the competent governmental authorities of the coastal state. In the absence of relevant regulations by the competent authorities, CCS will adopt the applicable parts of relevant international conventions or rules and their amendments as the basis for statutory services, mainly including:

(1) International Convention on Load Lines, 1966;

(2) International Convention for the Safety of Life at Sea, 1974;

(3) International Convention for the Prevention of Pollution from Ships, 1973, as amended by the Protocol of 1978;

(4) International Convention for the Control of Harmful Anti-fouling Bottom Systems on Ships, 2001;

(5) International Regulations for Preventing Collisions at Sea, 1972.

1.7.2.2 The applicable statutory requirements shall be specified in the application or contract/agreement.

1.7.3 Responsibilities of parties

1.7.3.1 The power of interpretation of statutory requirements shall be vested in the competent government authorities of the coastal states.

1.7.3.2 Equivalence and exemption in statutory requirements are the responsibility of the competent government authorities of coastal states.

1.7.3.3 CCS shall not be liable for any costs or losses incurred in the modification of single point moorings due to the retrofitting of the existing single point moorings as a result of the statutory requirements of the competent government authorities of the coastal states.

1.7.4 Assessment of statutory requirements based on customer application

1.7.4.1 CCS may also undertake the assessment of statutory requirements on the basis of a customer's application or contract/agreement for statutory requirements that have not been authorized by the competent government authority of the coastal state or that the customer has voluntarily requested to meet.

1.7.4.2 For assessment of statutory requirements applied by customers, CCS will issue the corresponding certificates of conformity and/or reports upon CCS plan approval, surveys during construction and surveys after construction to confirm that the classification parts meet the requirements of CCS Rules for Classification and meet the corresponding statutory requirements.

1.7.4.3 CCS issues corresponding certificates of conformity and/or reports in accordance with the statutory requirements provided by customers, but CCS does not guarantee acceptance by the competent government authorities of the coastal states.

1.7.4.4 1.7.1.3, 1.7.1.4, and 1.7.3.3 of this Section also apply to the assessment of statutory requirements.

1.7.5 Statutory certificates and documents

1.7.5.1 CCS surveyor shall issue or approve the corresponding statutory certificates and documents according to the authorized contents after single point moorings pass the statutory inspection. For example:

(1) Certificate of conformity of offshore single point moorings;

(2) International load line certificate;

(3) International oil pollution prevention certificate;

(4) G-EP(AFS) certificate/conformity certificate;

(5) Stability approval;

(6) Equipment safety certificate;

(7) Inspection record of lifting equipment and test certificate of lifting equipment;

(8) Other certificates or documents.

Section 8 Approval of Suppliers

1.8.1 General requirements

1.8.1.1 Suppliers representing the owner who provide services such as measurement, testing or maintenance of safety systems and equipment to CCS and whose results are used as the basis for CCS surveyors' surveys shall be approved by CCS to demonstrate their ability to provide approved services.

1.8.1.2 The supplier shall also be approved by CCS if the services provided affect CCS's decision to issue statutory certificates. CCS may also accept suppliers approved by the administration or its authorized institutions.

1.8.1.3 The supplier's actions do not represent CCS, and the supplier shall be responsible for the services it

provides and the results of its services.

1.8.2 Approval requirements

1.8.2.1 The supplier applying for approval shall meet the following conditions:

(1) Equipment with sufficient technical, operational, inspection and supervision personnel competent to provide approved services;

(2) Equipped with necessary and appropriate equipment and facilities;

(3) Establish and maintain an effective documented quality assurance system.

1.8.2.2 Supplier's approval scope and approval procedure requirements shall be implemented in accordance with Appendix 8 *Requirements for Procedures of Approval on Service Supplier* of Chapter 5 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018).

1.8.3 List of approved suppliers

1.8.3.1 CCS publishes and maintains a list of CCS-approved suppliers.

Section 9 Assignment, Maintenance, Suspension, Cancellation and Reinstatement of Classification Symbols

1.9.1 Assignment and maintenance of single point moorings class

1.9.1.1 After plan approval and inspection, if the main body (including equipment) and machinery (including electrical equipment) of single point moorings are confirmed to conform to the relevant provisions of CCS rules, and CCS will Assign classification symbols and corresponding additional notations, and issue classification certificates.

1.9.1.2 The main body (including equipment) and machinery (including electrical equipment) of single point moorings shall be well maintained and managed in accordance with the provisions of the classification symbols and additional notations assigned or the provisions of the validity of the certificate, including oil lifting and ballast, and operating requirements in severe weather conditions.

1.9.1.3 Single point moorings shall be operated in accordance with the conditions defined by additional notations to ensure that the operating and environmental conditions on which classification is based are not exceeded during operation.

1.9.1.4 Single point moorings that have been assigned CCS class shall continue to be valid upon surveys after construction in accordance with the Rules and compliance with the requirements of the Rules, and CCS will sign or issue a new classification certificate.

1.9.1.5 The operator shall promptly report to CCS any damage, malfunction, breakage, collision and repair that may affect the validity of the assigned grade symbols and additional notations or certificates; CCS will conduct evaluation and/or inspection, and make requirements and opinions.

1.9.1.6 When CCS has reasonable grounds to believe that single point moorings do not fully meet the various inspection requirements specified in the Rules for Classification, CCS reserves the right to conduct irregular inspections of single point moorings. CCS shall notify the owner in writing of the irregular inspection arrangement, and the owner shall make the irregular inspection arrangement in time and be obliged to pay the relevant expenses.

1.9.2 Suspension and cancellation of single point moorings class

1.9.2.1 Suspension of single point moorings:

(1) If single point moorings operate beyond the limits specified in the classification symbols and additional notations and other approved additional conditions, the single point moorings class will be suspended and the classification certificate will be invalid.

(2) Any damage, defect or failure to single point moorings that may render the assigned single point moorings class inoperative may result in suspension of the single point moorings class and invalidation of the classification certificate if it is not reported to CCS at the first reasonable time, or if CCS consent is not submitted before the anticipated repair commences.

(3) Suspension of the single point moorings class and invalidation of the classification certificate will be resulted in unless the surveyors have boarded the single point moorings for the completion of these surveys:

① If the left-over items of single point moorings or single point moorings class conditions given by CCS have not been eliminated within the specified time and have been extended without CCS consent;

② If the cycle inspection items have not been completed on the due date during the annual survey and are extended without CCS consent;

③ If the surveys after construction other than annual survey, intermediate survey or special survey has not completed on the expiration date and is extended without CCS consent;

④ If the repair of any damage, defect or fault is not completed and inspected as required;

⑤ The owner fails to arrange the irregular inspection required in 1.9.1.6.

(4) One of the following conditions will result in automatic suspension of single point moorings class and invalidation of classification certificate:

① The annual survey has been not be completed within 3 months after the annual expiration date, unless the single point moorings are undergoing the completion inspection of the annual survey;

② The intermediate survey has not be completed within 3 months after the expiration date of the third annual survey anniversary of the 5-year special survey cycle, unless the single point moorings are undergoing the completion inspection of the intermediate survey;

③ The single point moorings fail to undergo the special survey within the time limit specified by CCS or before the specified extension deadline, and is extended again without CCS's consent, unless the single point moorings have started to undergo the special survey before the expiration date (this inspection shall be completed before resuming operation).

a. In "exceptional circumstances", CCS may agree to assign a special survey extension (the extension period shall be determined by CCS according to the actual conditions of the single point moorings) if the surveyor has boarded the single point moorings to the satisfaction of the survey according to the following scope:

(a) Annual survey;

(b) Re-inspection of remaining item/single point moorings class conditions;

(c) The specially tested items are carried out as far as practicable;

(d) If the in-water survey has expired before the expiration date of the single point moorings class extension, a temporary in-water survey shall be conducted by an approved in-water survey company. If there are no remaining items/single point moorings class conditions in the subsea part of the single point moorings, and the expiration date of the extended in-water survey is no more than 36 months from the last in-water survey, temporary in-water survey may not be necessary.

b. Under "exceptional circumstances", if the special survey of single point moorings cannot be completed, the special survey may be extended according to the requirements of a above, but the expiration date of the extended special survey shall not exceed 3 months from the expiration date of the original special survey.

④ When it is confirmed that the single point moorings have been boarded by the surveyor before its inspection expires, but put into operation before the corresponding overdue inspection is satisfactorily completed.

(5) In case of force majeure beyond the normal control capacity of the owner or CCS, resulting in the failure of the single point moorings to complete the due inspection items in time, CCS may give special consideration upon the application of the owner and the authorization of the competent government authorities of coastal states.

The above-mentioned expired inspection shall be carried out according to the inspection requirements at the original expiration, rather than according to the requirements corresponding to the age of the single point moorings. The expiration date of the next relevant inspection shall still be calculated from the expiration date of the original corresponding inspection.

In this case, the single point moorings class can be restored if the single point moorings class which has been automatically suspended meets the above conditions.

1.9.2.2 Suspension of single point moorings class:

(1) The single point moorings class will be canceled if one of the following occurs:

① At the request of the owner;

② When the situation causing the suspension of the single point moorings class is not corrected within the specified time;

③ When the single point moorings class is suspended for 6 consecutive months due to expired annual survey, intermediate survey, special survey or other surveys after construction specified in the Rules and/or expired remaining items/single point moorings class conditions; for single-point moorings that are on hold, waiting for the disposal of their accidents or undergoing the inspection of restoring single-point moorings, it may be agreed to extend the suspension period of single point moorings;

④ When the main body (including equipment) and machinery (including electrical equipment) of the single point moorings suffer major damage or other circumstances, it is confirmed that they can no longer continue to operate, such as sinking and disassembly;

⑤ Failing to pay the inspection fee on time.

1.9.2.3 If only the inspection requirements related to the maintenance of special additional notations are not carried out as required, the suspension or cancellation is limited to the corresponding special additional notations.

1.9.2.4 Notice of suspension or cancellation of single point moorings class:

(1) Cancellation of single point moorings at single point moorings class will be announced accordingly in CCS register of unit or its supplementary record;

(2) CCS will notify the owner and the administration in writing of the suspension or cancellation of single point moorings at the single point moorings class, which will be posted on the CCS website for insurers and other interested parties to know.

1.9.3 Reinstatement of single point moorings

1.9.3.1 The single point moorings class can be restored under the following circumstances:

(1) The single point moorings class will be restored after the single point moorings satisfactorily pass the expired inspection. The expired inspection shall be carried out according to the inspection requirements at the original expiration, rather than according to the requirements corresponding to the age of the single point moorings. After the reinstatement of single point moorings class, the expiration date of the next relevant inspection shall still be calculated from the expiration date of the original corresponding inspection. The single point moorings do not have single point moorings class during the period from the suspension of the single point moorings class to the reinstatement of the single point moorings class;

(2) When the expired cycle inspection items are confirmed to be completed, the single point moorings class will be restored;

(3) When the expired remaining items are confirmed to be completed, the single point moorings class will be restored.

1.9.3.2 CCS will notify the owner and the administration in writing of the reinstatement of single point moorings at the single point moorings class, which will be posted on the CCS website for insurers and other interested parties to know.

Section 10 Certificates and Reports

1.10.1 Certificates

1.10.1.1 Classification certificate only indicates that the items covered by the certificate meet the requirements of CCS rules and are suitable for the intended purpose through plan approval and classification survey.

1.10.1.2 The equipment record attached to the classification certificate is a part of the classification certificate.

1.10.1.3 Classification certificates and reports are independently issued by CCS.

1.10.1.4 Classification certificates shall be accompanied by mutually agreed terms and conditions.

1.10.2 Validity period of certificate

1.10.2.1 Classification certificates of single point moorings are generally valid for no more than 5 years.

1.10.2.2 The validity period of the classification certificate shall be coordinated with the validity period of the statutory certificate of the single point moorings as possible.

1.10.2.3 If the special survey is completed within 3 months before the expiration date of the original certificate, the validity period of the new classification certificate shall not exceed 5 years from the expiration date of the original certificate.

1.10.3 Issuance and signing of classification certificate

1.10.3.1 After the classification survey is completed, the authorized personnel of the inspection unit shall issue the classification certificate, which shall be reviewed by the competent department of CCS headquarters and submitted to the classification committee for approval, and the final classification of single point moorings shall be confirmed by the president of CCS or the authorized personnel of CCS headquarters.

1.10.3.2 Upon completion of the surveys after construction in accordance with Section 4 of Chapter 2, the surveyor shall sign the classification certificate as required.

1.10.3.3 After the completion of the special survey, if a new classification certificate cannot be issued before the expiry date of the existing classification certificate, the surveyor may sign the existing classification certificate for a period not exceeding 5 months from the expiry date of the existing classification certificate.

1.10.3.4 After the special survey is completed, the authorized personnel of the inspection unit shall issue a new classification certificate.

1.10.3.5 Notwithstanding the provisions of 1.10.2.1, when CCS implements Article 1.10.3.4, based on the data/information about other safe operations of the single point moorings obtained by comprehensive consideration, such as safety inspection information of coastal states, and safety management status of single point moorings companies, CCS can decide the validity period of classification certificates less than 5 years and/or take other necessary restrictive measures, such as adding operational restrictions when issuing new classification certificates. If the validity period of the classification certificate is shortened, it should be coordinated with the interval of single point moorings class/statutory periodic inspection as possible, and should be reported to the classification committee regularly.

Section 11 Register of Units and Lists of Approved Marine Products

1.11.1 Register of Units

1.11.1.1 For single point moorings approved for classification by CCS, upon the assignment of classification symbols and additional notations, CCS will incorporate the main characteristic elements and details of single point moorings into the register of units published regularly by CCS to provide information for the parties involved in single point moorings, such as manufacturers, owners, insurers and charters.

1.11.1.2 In the event of a change in single point moorings or some of characteristic elements, CCS will publish a new register of unit or a supplement thereto in a timely manner.

1.11.2 Lists of Approved Marine Products

1.11.2.1 For CCS-approved factories and marine products, CCS will include the names of its products, their main performance elements and details, and details of their manufacturers in the lists of approved marine products published regularly by CCS to provide information for single point moorings designers, manufacturers, owners, traders and exporters.

1.11.2.2 In the event of additions or performance changes to approved marine products, CCS will publish a new list of approved marine products or additions thereto in a timely manner.

Section 12 Audit

1.12.1 Vertical contract review

1.12.1.1 When the vertical contract audit of CCS is conducted by representatives of third-party independent audit

bodies (including representatives of accredited certification bodies (ACB), IACS observers, etc.) and representatives of the European Commission (EC), accompanied by CCS representatives, the relevant owners, manufacturers and product manufacturers shall facilitate the work of the audit representatives so that their audit work can proceed smoothly.

1.12.1.2 Information requested by the audit representative during the audit process shall be provided by the owner, the builder and the manufacturer of the product concerned, provided that they do not in any way duplicate or transmit the information to other parties.

Section 13 Provision and Confidentiality of Information

1.13.1 Provision of information

1.13.1.1 The provider of information shall be responsible for the authenticity, timeliness and completeness of the information provided to CCS for the classification of single point moorings.

1.13.2 Confidentiality of information

1.13.2.1 CCS will not disclose the information obtained from the classification to parties other than those specified in the contract and table 1.13.2.2 except in the following cases:

(1) When the single point moorings class of the single point moorings is transferred from CCS to another IACS member, the relevant documents and inspection report of the single point moorings class shall be provided to the classification society of the other party;

(2) According to the working regulations of IACS, the updated data of register of units, the suspension and inspection status data of single point moorings and the fault accident information of single point moorings shall be transmitted to IACS;

(3) The owner and single point moorings operator shall authorize CCS to allow representatives of third-party independent audit bodies (including representatives of recognized certification bodies (ACB), IACS observers, etc.) and representatives of European Commission (EC) to consult relevant certificates, inspection reports, documents and other relevant information of CCS-class single point moorings during the audit or evaluation of CCS.

(4) Where the law of the administration specifically provides, the court with jurisdiction or the owner agrees in writing.

1.13.2.2 The parties entitled to relevant information are shown in table 1.13.2.2.

Table 1.13.2.2 Information Available to Relevant Parties

Information category	Information available to relevant parties				
	Owner	Flag state	Port state	Insurance company *	Manufacturer
1. General documents of CCS					
* Rules and guidelines (single point moorings class and statutory requirements)	1	1	1	1	1
* Notes to surveyors		1			
* Quality Manual	1	1	1	1	1
* Register of Unit	1	1	1	1	1
2. Information related to single point moorings					
A. New single point moorings					
* Approved drawings	6	1			7
* Formal letter of approval	1				7
* Critical equipment certificate	2				7
B. Operation of single point moorings					
* Single point moorings class service					
-- Date of all single point moorings class inspections (month, year)	7	1	1	1	
-- Expiration date of single point moorings class certificate	7	7**	1	1	
-- Certificates/Reports	7	1	6	5	
-- Expired inspection	7	7**	1	1	
-- Content of single point moorings class conditions/remaining items	7	1	1	5	
-- Expired single point moorings class conditions/remaining items	7	1	1	1	
-- Condition assessment report of single point moorings	7	3	3	3	
* Statutory services					
-- Legal inspection expiration date	7	7**	1	1	
-- Expiration date of legal certificate	7	7**	1	1	
-- Registered statutory remaining items	7	7**	1	5***	
-- Expired statutory remaining items	7	7**	1	1***	
3 Other information					

* Documentation of correspondence with the manufacturer and/or the owner	6	6		5&6	
* Quality system audit of CCS	4	4	4	4	
* Class transfer report	7	7	7	7	
* Single point moorings class cancellation information	7	7	7	7	

Note:

* = Insurance company refers the owner's Protection And Indemnity Club and principal insurer

** = If stated in the agreement

*** = Unless prevented by agreement with the flag state

1. Available when requested
2. Obtained from the manufacturer when handing over the single point moorings
3. Available when boarding single point moorings
4. Audit results are available when required
5. When the owner agrees or through special clauses in the insurance contract
6. When the owner or the manufacturer (if applicable) agrees
7. Automatic acquisition

1.13.2.3 CCS has a general responsibility for confidentiality of its customers in accordance with its specifications, however CCS customers should still accept CCS to participate in IACS early warning system. The system requires each IACS member and associate member to provide its member classification society with technical information related to the damage of the main structure and mechanical system defined by the early warning system (but excluding any drawings related to single point moorings that may be the property of the other party), so that these useful information can be shared and utilized, and the IACS early warning system can run normally. Such information sent by CCS to IACS members and associate members will be provided in writing to customers.

Section 14 Liability, Disagreement and Arbitration

1.14.1 Responsibilities of parties

1.14.1.1 CCS rules are the basis for the design, manufacture and testing of single point moorings and related products, but are not the only basis for design. The rules cannot replace the process control and quality control of the manufacturer, nor can they reduce or relieve the responsibility of the manufacturer.

1.14.1.2 CCS rules do not cover every structure or equipment on single point moorings, nor do they cover operational factors or activities outside the scope of application of classification, including design and manufacturing process, selection of types and powers of machines and certain equipment, number and qualification of operators, overall dimensions and bearing capacity and operational performance, material fastening, vibration of main body and equipment, noise, spare parts, life-saving equipment and maintenance equipment, etc.

1.14.1.3 CCS shall not be liable for the consequences arising from the use of CCS rules by third parties without CCS plan approval and inspection.

1.14.1.4 The classification of single point moorings undertaken by CCS is performed on the basis of the respective responsibilities of the designers, builders, owners, manufacturers, sellers, suppliers, repairers, operators and other parties involved. Nothing contained in any report, document or certificate issued by CCS shall be deemed to mitigate or relieve any of the responsibilities of any of the above parties.

1.14.1.5 Any documents issued by CCS in connection with the inspection shall reflect only the conditions at the time of the inspection.

1.14.1.6 The classification certificate (classification symbols and additional notations) only certifies that the single point moorings comply with the applicable CCS rules for classification and/or other standards agreed in writing between CCS and the applicant for CCS service. CCS reserves the right not to assign, or to suspend and cancel the classification symbols and additional notations if the single point moorings do not comply with the applicable

CCS rules and/or other standards agreed in writing between CCS and the applicant for CCS service.

1.14.1.7 Except for reports, statements, plan approval, inspection, certification or other services, CCS will not make any other statements except those related to the requirements of the rules. For whether it is up to the user to decide the information provided by CCS in documents other than the classification certificate and report, CCS is not responsible for the consequences of this behavior.

1.14.1.8 CCS shall provide services in accordance with the contract and in no event shall CCS be liable for any loss of any party to which it is not directly related.

1.14.1.9 Any problems found by the owner and/or the builder during the use of marine products shall be promptly fed back to the manufacturer and CCS to facilitate the improvement of the manufacturer.

1.14.1.10 Any negligence or error by CCS in accordance with any provision, condition or obligation to be performed or observed under the contract shall not constitute any claim against CCS nor shall it be deemed a breach of contract, provided that the cause of such negligence or error is beyond the reasonable control of CCS.

1.14.2 Divergence

1.14.2.1 The rules issued by CCS shall be interpreted by CCS headquarters. CCS rules are translated into English by CCS. In case of any discrepancy in the English version, the Chinese version of CCS rules shall prevail.

1.14.2.2 When the surveyor disagrees with the parties concerned in the performance of his/her tasks, which affects the progress of the work, the parties concerned shall promptly submit a written complaint to the service unit where the surveyor works; if the parties concerned are still dissatisfied with the handling of the complaint, they can appeal to CCS headquarters in writing together with detailed background materials, and the headquarters will make a final decision according to the circumstances.

1.14.2.3 If the CCS headquarters is requested to conduct a review, the costs arising from the review shall be borne by the complainant, unless the complainant's complaint is proved to be correct.

1.14.3 Arbitration

1.14.3.1 CCS is only liable for loss or damage directly caused by its own negligence, and in no case shall CCS be liable for indirect loss or subsequent additional loss or damage.

1.14.3.2 Notwithstanding the foregoing, CCS shall be liable and shall pay compensation for any loss or damage suffered by the parties to the contract if it is legally determined that the loss or damage is only caused by the negligence of CCS or its employees, agents or other representatives of CCS, but the amount of such compensation shall not exceed 5 times the charge for the service and shall not exceed RMB 2 million at the maximum. However, if the loss or damage is caused by the following acts, CCS will not assume any responsibility:

(1) Acts of CCS employees beyond their employment authority;

(2) Acts of agents or other representatives of CCS beyond the scope of written authorization assigned to them by CCS.

1.14.3.3 Claims for loss or damage for which CCS is liable shall be made in writing within 6 months of the initial discovery of the damage or the formation of the loss. Failure to do so shall be deemed to be a complete waiver of the claim.

1.14.3.4 Unless otherwise agreed with CCS, any dispute arising out of or in connection with services rendered in accordance with the Rules shall be submitted to the China Maritime Arbitration Commission for arbitration in accordance with its arbitration rules in force at the time of the application for arbitration. The arbitral award is final and binding on both parties.

1.14.4 Applicable laws

1.14.4.1 The laws of the People's Republic of China shall apply.

Chapter 2 Surveys and Certification

Section 1 General Provisions

2.1.1 General requirements

2.1.1.1 Where the owner or his/her agent of offshore single point moorings intends for CCS classification shall submit a written application for product inspection, surveys during construction and surveys after construction of the single point moorings to CCS headquarters or its local authority, CCS shall conduct plan approval and inspection in accordance with the relevant provisions of the Rules, and issue corresponding certificates upon satisfaction.

2.1.1.2 Materials, equipment and systems required by the Rules shall be subject to product inspection as required by Section 2 of this Chapter.

2.1.1.3 Single point moorings intended for CCS classification shall be subject to initial classification survey as required by Section 3 of this Chapter.

2.1.1.4 In order to maintain the effectiveness of the single point moorings classification, surveys after construction shall be carried out in accordance with the requirements of Section 4 of this Chapter.

2.1.1.5 CCS may refer to the Rules or other provisions for verification and inspection of offshore single point moorings.

Section 2 Product Inspection

2.2.1 General requirements

2.2.1.1 Product inspection is a part of the inspection of single point moorings, including classified product inspection and authorized legal product inspection. Through product inspection, confirm that products meet the requirements of rules for classifications or statutory requirements or requirements of entrusting parties respectively.

2.2.1.2 The inspection of products to be used for classification of single point moorings shall comply with Chapter 3 and related chapters of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018), the Rules and CCS *Rules for Materials and Welding* (2018).

2.2.1.3 The inspection of authorized legal products shall comply with the relevant provisions of the competent authorities and international conventions/rules.

2.2.1.4 The entrusted product inspection shall conform to the product standards provided by the entrusting party.

2.2.1.5 For products specified in the rules, corresponding standards can be accepted as substitutes. However, in any case, the equipment, components and systems shall undergo design evaluation, in-manufacture inspection, testing and functional testing to confirm whether they are equivalent to the rules.

2.2.1.6 Products covered by the CCS rules, in the absence of specific technical requirements, may be designed, manufactured and tested to applicable standards determined by the manufacturer. The inspection of such products generally includes the following contents:

(1) Product drawings;

(2) Service conditions on single point moorings;

(3) Material and welding requirements;

(4) Safety and performance related test items.

2.2.1.7 The manufacturer shall be responsible for whether the products it produces meet relevant laws, regulations, mandatory standards and customer requirements.

2.2.1.8 Additional notations of products shall be applied for by the applicant and assigned by CCS after they are confirmed according to relevant CCS regulations through CCS plan approval, approval test and on-site audit.

2.2.2 Product certification and inspection

2.2.2.1 The certification and inspection of classified products and products authorized for statutory inspection, including design approval, type approval and factory approval, shall comply with the relevant provisions of Chapter 3 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018). The certification requirements for general classified products of single point moorings and authorized statutory inspection products shall meet the following requirements:

(1) The certification requirements for classified products shall comply with Appendix 1A of Chapter 3 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018);

(2) The certification requirements for authorized statutory inspection products shall comply with the relevant provisions of the administration. If there is no provision, please refer to Appendix 1B of Chapter 3 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018);

(3) The certification requirements of lifting appliance products shall comply with the relevant provisions of the administration. If there is no provision, please refer to Appendix 1C of Chapter 3 of Part One of the Rules for *Classification of Sea-Going Steel Ships* (2018);

(4) The certification requirements for classified product parts shall comply with Appendix 2A of Chapter 3 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018);

(5) The certification requirements for authorized statutory inspection product parts shall comply with the relevant provisions of the administration. If there is no provision, please refer to Appendix 2B of Chapter 3 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018);

(6) The certification requirements of lifting appliance product parts shall comply with the relevant provisions of the administration. If there is no provision, please refer to Appendix 2C of Chapter 3 of Part One of the *Rules for Classification of Sea-Going Steel Ships* (2018).

2.2.2.2 The certification requirements for the main classified products and authorized statutory inspection products of single point moorings shall meet the following requirements:

(1) The certification requirements for the main classified products of single point moorings shall comply with Appendix 1 of this Chapter;

(2) The certification requirements of the main authorized statutory inspection products of single point moorings shall comply with the relevant provisions of the administration. If there is no such provision, please refer to Appendix 2 of this Chapter;

(3) The certification requirements of the main lifting appliance products of single point moorings shall comply with the relevant provisions of the administration. If there is no provision, please refer to Appendix 1 of this Chapter.

2.2.2.3 Products in Appendix 2 with respect to the classification requirements shall also meet the relevant classification requirements.

Appendix 1 List of Certification Requirements for Main Classified Products of Single Point Moorings

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
1	**Turret equipment**							
1.1	Slip ring	X	—	X	O	O	—	
1.2	Bearing	X	—	—	—	—	X	
1.3	SDV shutdown device	X	—	O	X	O	—	
1.4	Hydraulic power unit (HPU)	X	—	O	O	O	—	
2	**SYMS equipment**							
2.1	Rotating bearing	X	—	—	—	—	X	
2.2	Turntable	X	—	—	—	—	X	
2.3	Hose cradle	X	—	—	—	—	X	
2.4	Universal joint (including axial thrust bearings)	X	—	—	—	—	X	
2.5	Bearing connecting flange	X	—	—	—	—	X	
2.6	Bolt	X	—	—	—	—	X	Raw materials and finishing need to be inspected
3	**Anchoring equipment and mooring equipment**							
3.1	Mooring line and its accessories	X	—	—	—	—	—	
3.2	Anchor and its accessories	X	—	—	—	—	—	
3.3	Mooring line stopper	X	—	—	—	—	—	
3.4	Windlass	X	—	—	—	—	—	
3.5	Winch	X	—	—	—	—	—	
3.6	Lifting appliance (crane/rail crane/hoist crane/crown block)	X	—	X	O	O	—	
3.7	Towing and mooring cables (fiber ropes and steel wire ropes)	X	—	—	—	—	X	
3.8	Guide device	X	—	—	—	—	—	
3.9	Mooring line buoyancy element	X	—	—	—	—	—	
4	**Cargo transfer system**							
4.1	Riser system	X	—	O	O	—	—	
4.2	Hose	O	X	O	X	—	—	
4.3	Subsea pipeline terminal manifold	X	—	—	—	—	—	
4.4	Flange (standard type)	X	—	—	X	O	—	
4.5	Fluid swivel	X	—	—	—	—	—	
5	**Outfitting equipment**							

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
5.1	Hatch cover	X	—	O	O	O	—	
5.2	Hydraulic device	X	—	O	O	O	—	
5.3	Storm cover	X	—	—	O	O	—	
5.4	Towing hook	X	—	X	O	O	—	
5.5	Towing winch	X	—	X	O	O	—	
5.6	Watertight door	X	—	O	O	O	—	
5.7	Weathertight door	X	—	O	O	O	—	
5.8	Mobile inspection channel	O	X	—	X	—	—	Type approval certificate shall be provided with W
6	**Pumps and piping system**							
6.1	Valves (50mm diameter and above in Class I and II piping systems, 300mm diameter and above in Class III piping systems; Cargo (crude) oil valves, safety valves, wave-proof valves, subsea valves, outboard valves, pressure vacuum valves)	X	—	O	X	O	—	
6.2	Class I and II piping systems	X	—	—	—	—	X	
6.3	Class III piping system	X	—	—	X	O	—	
	Valves and accessories other than those of 5.1	O	X	—	X	O	—	Type approval certificate shall be provided with W
6.4	Pump	X	—	—	X	O	—	
6.5	Mechanical joint of pipe	O	X	—	X	O	—	Type approval certificate shall be provided with W
6.6	Air pipe closing device	O	X	—	X	O	—	Type approval certificate shall be provided with W
6.7	Hydraulic cylinder, hydraulic motor, hydraulic pump	X	—	O	O	O	—	
7	**Electrical equipment and automation**							
7.1	Solar power panels	O	X	—	X	O	O	Type approval certificate shall be provided with W
7.2	Distribution board	X	—	—	—	—	—	
7.3a	Transformer (50kVA and above)	X	—	O	X	O	—	
7.3b	Transformer (below 50kVA)	O	X	—	X	O	—	Type approval certificate shall be provided with W

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
7.4	Battery	O	X	—	X	O	O	Type approval certificate shall be provided with W
7.5a	Explosion-proof switch and junction box	O	X	—	X	O	—	Type approval certificate shall be provided with W
7.5b	Explosion-proof lamp	O	X	—	X	O	—	Type approval certificate shall be provided with W
7.6	Power, control and communication cables and wires	X	—	—	—	—	X	
7.7	Motor (50kW and above)	X	—	—	X	O	—	Extra-large motors and special motors are considered separately
	Motor (below 50kW)	O	X	—	X	—	—	Type approval certificate shall be provided with W
7.8	Explosion-proof motor	X	—	—	X	O	—	
7.9	Electrical control box (for important equipment)	X	—	—	—	—	—	
7.10	Power supply charging and discharging panel	X	—	—	—	—	—	
7.11a	Safety system (including sensors)	O	X	—	X	O	—	Type approval certificate shall be provided with W
7.11b	Monitoring and alarm system	O	X	—	X	O	—	Type approval certificate shall be provided with W
7.12	Liquid level measuring system (including sensors)	—	X	—	X	O	O	Type approval certificate shall be provided with W
7.13	Temperature monitoring system (including sensors)	—	X	—	X	O	O	Type approval certificate shall be provided with W
7.14	Circuit breaker (main switch)	X	—	—	X	O	—	
	Circuit breaker (shunt switch)	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.15	Uninterruptible power supply (UPS)	O	X	—	X	O	—	Type approval certificate shall be provided with W
7.16	Additional emergency lighting	X	—	—	X	O	—	
7.17	Distribution box	X	—	—	—	—	—	
7.18	Disconnecting switch	—	X	—	X	—	—	Type approval certificate shall be

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
								provided with W
7.19	Compartment bilge alarm system (including sensors)	X	—	—	X	O	—	
7.20	Contactor	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.21	Insulation monitor	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.22	Soft start system	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.23	Fuse	O	X	—	X	O	—	Type approval certificate shall be provided with W
7.24	Lighting fixture	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.25	Combined acousto-optic alarm lamp board (box)	X	—	—	—	—	—	
7.26	Relay and its accessories	—	X	—	O	O	—	
7.27	Fixed combustible gas detection and alarm system	X	—	—	X	—	—	
7.28	Combined startup monitoring screen/cabinet	X	—	—	—	—	—	
7.29	Temperature transmitter	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.30	Pressure transmitter	—	X	—	X	O	—	Type approval certificate shall be provided with W
7.31	Liquid level transmitter	—	X	—	X	O	—	Type approval certificate shall be provided with W
8	**Nonmetallic material**							
8.1	Resins and fibers for fiber reinforced plastics	O	X	—	—	—	X	Factory approval certificate shall be provided with W
8.2	Plastic pipe	O	X	—	—	—	X	Factory approval certificate shall be provided with W
8.3	Resin	O	X	—	—	—	X	Factory approval certificate shall be provided with W
8.4	Rubber	O	X	—	—	—	X	Factory approval

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
								certificate shall be provided with W
8.5	Synthetic (bearing) material	O	X	—	—	\—	X	Factory approval certificate shall be provided with W
9	**Others**							
9.1	Oil spatter protection belt	X	—	—	O	O	—	
9.2	Flexible hose assembly	X	—	—	X	O	—	
9.3	Elastic shock absorber	X	—	—	X	O	—	
9.4	Mooring tension measuring device	X	—	—	—	—	X	
9.5	Distance measuring device	X	—	—	—	—	X	

Symbol description: 1) C-marine product certificate; E-equivalent certificate; W-manufacturer's certificate; X-applicable; O-optional.

2) DA-design approval; TA-B-type approval B; TA-A-type approval A; WA-factory approval.

3) Factory approval of parts refers to the approval of the manufacturer of its blank.

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
1	**Fireproof materials and equipment***							
1.1	Refractory material	X	—	—	—	—	X	
1.2	Fire door or window	X	—	—	X	—	—	
1.3	Fire brake or fire bar	X	—	—	X	—	—	
1.4	Deck dressing	O	X	—	—	—	X	Factory approval certificate shall be provided with W
1.5	Penetration of deck or bulkhead	O	X	—	X	—	—	Type approval certificate shall be provided with W
1.6	Cable sealing packing	O	X	—	X	—	—	Type approval certificate shall be provided with W
1.7	Class A deck separation	O	X	—	X	O	—	Type approval certificate shall be provided with W
1.8	Class A bulkhead partition	O	X	—	X	O	—	Type approval certificate shall be provided with W
1.9	Class B bulkhead partition	X	—	—	X	O	—	
2	**Fire extinguishing systems and equipment***							
2.1	Fixed fire extinguishing system	X	—	O	X	O	—	
2.2	Fire extinguishing agent (foam)	O	X	—	—	—	X	Factory approval certificate shall be provided with W
2.3	Fire extinguishers (foam, dry powder and gas and other fire extinguishers)	X	—	—	X	O	—	
2.4	Fire hose (including foam and dry powder hoses)	O	X	—	X	O	—	Type approval certificate shall be provided with W
2.5	Fire water guns, fire water cannons, foam guns and dry powder guns	X	—	—	X	O	—	
2.6	Spray nozzles (including open and closed nozzles)	O	X	—	X	O	—	Type approval certificate shall be provided with W
2.7	Fixed local water-based fire extinguishing device	X	—	—	X	O	—	
2.8	Portable foam gun device	X	—	—	X	O	—	
2.9	Fire pump and emergency fire pump	X	—	—	X	O	—	
3	**Fire detector and alarm system ***							
3.1	Fire detector	O	X	—	X	O	—	Type approval certificate

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
								shall be provided with W
3.2	Detectors for combustible gas and hydrogen sulfide gas	—	X	—	X	O	—	Type approval certificate shall be provided with W
3.3	Fire detection and fire alarm device	X	—	—	X	O	—	
3.4	Alarm devices for combustible gas and hydrogen sulfide gas	X	—	—	X	O	—	
3.5	Light sign of escape passage	O	X	—	X	O	—	Type approval certificate shall be provided with W
3.6	Fire extinguishing agent release alarm system	X	—	X	—	O	—	
3.7	Portable combustible gas detector	—	X	—	—	—	—	
4	**Life-saving equipment and devices**							
4.1	Free floating equipment	X	—	—	X	O	—	
4.2	Survival suit and anti-exposure suit	X	—	—	X	O	—	
4.3	Life jacket	X	—	—	X	O	—	
4.4	Life buoy	X	—	—	X	O	—	
4.5	Self-lighting floating lamp (including life jacket and life buoy)	X	—	—	X	O	—	
4.6	Heat preservation appliance	—	X	—	X	O	—	Type approval certificate shall be provided with W
4.7	Pyrotechnic signal	X	—	—	X	O	—	
4.8	Rope throwing equipment	X	—	—	X	O	—	
4.9	Boarding ladder	X	—	—	—	—	—	
5	**Environmental protection equipment and materials**							
5.1	15ppm bilge water oil-water separation device	X	—	—	X	O	—	
5.2	15ppm bilge water alarm device	X	—	—	X	O	—	
6	**Conduction and signaling equipment**							
6.1	Navigation lights and signal lights	O	X	—	X	O	—	Type approval certificate shall be provided with W
6.1a	Navigation light control panel	X	—	—	X	O	—	
6.2	Sound signal sending equipment	O	X	—	X	O	—	Type approval certificate shall be provided with W

S/N	Product name	Certificate type		Approval mode				Remark
		C/E	W	DA	TA-B	TA-A	WA	
6.2a	Horn	X	—	—	X	O	—	
6.2b	Horn control panel	X	—	—	X	O	—	
6.3	Night vision device	O	X	—	X	O	—	Type approval certificate shall be provided with W
6.4	Navigation aid sign lamp	X	—	—	X	O	—	
6.5	Aviation obstruction beacon	X	—	—	X	O	—	

Note: * means that this kind of product is also a classified product required in the Rules, and shall meet the relevant classification requirements.

Symbol description: 1) **C**-marine product certificate; **E**-equivalent certificate; **W**-manufacturer's certificate; **X**-applicable; **O**-optional.

2) DA-design approval; TA-B-type approval B; TA-A-type approval A; WA-factory approval.

Section 3 Surveys during Construction

2.3.1 General requirements

2.3.1.1 Application

For single point moorings applied for CCS construction inspection, the applicant shall submit a written application for construction inspection of single point moorings CCS headquarters or its local authority before construction.

2.3.1.2 Evaluation on manufacturer

For the manufacturer applying for the construction of CCS-class single point moorings for the first time or the manufacturer building CCS-class new single point moorings for the first time, the surveyors shall evaluate the production capacity of the manufacturer, including the quality assurance system of the production site, facilities and manufacturer, the general qualification of the construction personnel, subcontractors, etc., and the applicability and effectiveness of the single point moorings to be constructed.

2.3.1.3 Pre-commencement inspection

Before commencement, the surveyors shall check and confirm the relevant preparations for commencement of construction and inspection of the manufacturer (or equipment integration and assembly plant). Including:

(1) Approved drawings necessary before commencement;

(2) Technical specifications of single point moorings manufacturers;

(3) Table of detail standards adopted for construction;

(4) Precision control plan for construction and installation;

(5) Inspection and test plan;

(6) Welding procedure and evaluation;

(7) NDT process documents;

(8) Qualification of welder/NDT personnel;

(9) Certificate list of mooring system equipment products;

(10) Relevant materials (steel plates, welding materials, etc.);

(11) Welding specification list;

(12) NDT diagram;

(13) Tightness test diagram;

(14) Subcontractors.

2.3.1.4 Verification of other test/inspection documents

(1) If the single point moorings manufacturer adopts the production mode that important components (slip ring, main bearing, winch, ESD valve, etc.) are prefabricated and produced by the subcontractor, and finally the components are assembled in a third-party manufacturer for final assembly. The surveyors shall review or confirm the inspection/test related documents provided by the manufacturer or its subcontractors, such as the installation process documents of machinery, equipment and systems, the machining scheme of bearings, the surface treatment scheme of materials, and the assembly and installation scheme of parts.

(2) The surveyors shall confirm that the explosion-proof electrical equipment of single point moorings in dangerous area are equipped with the product certificate or certificate meeting the requirements of the rules.

(3) The single point moorings shall be constructed according to the approved drawings. The materials, process, equipment and layout used shall conform to the requirements of the Rules and be to the satisfaction of CCS surveyors, and the quality assurance system implemented by the manufacturer shall be approved by CCS. Any item that does not conform to the Rules or to the approved drawings, or any material, process, equipment or arrangement is not to the satisfaction of the CCS Surveyors, they shall be corrected.

2.3.2 Inspection and testing

2.3.2.1 Inspection requirements

(1) The surveyors shall carry out inspection according to the approved drawings (including plan approval opinions) and implement and confirm the measures taken by the manufacturer; different opinions on the implementation of approved drawings and their opinions on drawings review by the manufacturer shall be fed back to the drawings review department in time;

(2) According to the requirements of the Rules, the manufacturer shall prepare a certification list of products related to the proposed single point moorings in combination with Appendixes 1 and 2 of Section 2 of this Chapter, and submit it to the on-site surveyors of the units for confirmation;

(3) With effect from January 1, 2012, new asbestos-containing materials shall be prohibited for all single point moorings.

2.3.2.2 Structural inspection and test items:

(1) Welding control during construction

The control of welding materials, welding environment and welding process during construction shall meet the requirements of CCS *Rules for Materials and Welding* (2018);

(2) Precision control during construction

① Review of construction process flow and sectional installation closure sequence scheme;

② The dimensions and levelness of the supporting structures of main bearings and rotating bearings after machining;

③ The size and levelness of mooring line support structure;

④ Precision control of the closing position of the turntable and its connection structure;

⑤ Measurement and alignment of the diameter of upper clasp structure and lower clasp structure of moon pool of single point moorings;

⑥ Precision control of longitudinal verticality in moon pool of single point moorings;

⑦ Procession control such as levelness of turntable and its connection structure (or components);

⑧ Scale measurement and control of structure and components of specific type single point moorings;

⑨ Base installation and positioning inspection of locking mechanism;

⑩ Installation and positioning precision of hatch cover and false float;

⑪ Installation and positioning inspection of slip ring guide rail support and top guide rail winch support;

⑫ Levelness of mooring head rotating bearing installation;

⑬ Precision control of installation and closure position of turntable and rotating bearing;

⑭ Levelness of kingpost and slip ring of rotating platform of single point moorings.

(3) Components of single point moorings such as turrets are generally applied for product inspection by single point moorings suppliers. Check its product certificate before installation;

(4) Turrets are usually welded with high-strength steel plates and casting and forging bearings. Welding evaluation and welding process shall be strictly done, and dimensional accuracy and quality density shall be ensured;

(5) The tightness and strength of single point moorings compartment shall not only meet the requirements of single point moorings suppliers, but also be tested according to the relevant requirements of CCS *Rules for Classification of Offshore Floating Devices* (2020);

(6) The inspection of ventilation, air, measurement, drain outlet, sewage trap, watertight and weathertight doors and windows of single point moorings area shall be carried out in accordance with the relevant requirements of

Rules for Classification of Offshore Floating Devices (2020).

2.3.2.3 Inspection and test items of anchoring equipment and mooring equipment:

All suitable parts requiring product inspection at the manufacturer shall be confirmed by the surveyors before installation. All anchoring and mooring parts shall be inspected for transport damage before installation. Any damage found should be repaired to the satisfaction of the surveyors.

2.3 2.4 Inspection and test items of fire resistance, fire detection and fire extinguishing devices:

(1) The inspection of fire-resistant separation, fire detection and fire alarm system and fire extinguishing device shall refer to the relevant requirements of fire prevention and explosion prevention safety in the *Rules for Classification of Offshore Floating Devices* (2020);

(2) Check the arrangement of fire pumps and fire mains and check independent operation of each fire pump (including emergency fire pump) to ensure that the fire mains at any part of the floating structure can obtain the required pressure;

(3) Check the stationary fire extinguishing system, special arrangement of machine places, mechanical ventilation and exhaust fan, and remote control stop device.

2.3.2.5 Inspection and test items of piping and electromechanical equipment:

(1) The machinery, equipment, devices and systems required in the rules shall be confirmed, and the product certificates or certification documents required in the rules shall be provided;

(2) The electrical equipment and systems required in the rules shall be confirmed, and the product certificates or certification documents required in the rules shall be provided;

(3) All aspects of machinery, equipment, devices and systems, such as layout, installation and process, shall be inspected to conform to approved drawings, diagrams, specifications, calculations and other technical documents;

(4) The layout, installation and process of electrical equipment such as motors, cables and switchboards, shall be checked for compliance with approved drawings, data, calculations and other technical documents;

(5) The manufacture, installation and test of pipelines shall be checked, including confirming the strength test in workshop and the tightness test after installing floating structure;

(6) Pump systems and piping systems such as fuel oil, lubricating oil, cooling, heating, compressed air, inert gas, bilge, ballast, firefighting, ventilation, measurement, ventilation, crude oil and hydraulic pressure as well as integrity utility shall be checked;

(7) Machinery, equipment, devices and systems, such as generator sets, pressure vessels, windlasses, air compressors and heat exchangers shall be inspected and utility tested after installation;

(8) Test the remote control operation and manual operation function of the air duct fire brake;

(9) Carry out visual inspection and utility test on open and closed discharge systems;

(10) Check the integrity of auxiliary piping of hydraulic system, and carry out cross-oil inspection and utility test;

(11) Check the installation of nitrogen and miscellaneous air systems, and carry out airtight test on the air system;

(12) Carry out installation inspection and utility test on emergency facilities of single point compartment (quick-closing valve of submarine riser, emergency drainage of single point compartment cut off by fan, etc.);

(13) Check the installation of Kingston valve and side valve and confirm the consistency between their positions and approved drawings, and conduct opening and closing utility test;

(14) Check the correctness of the number and installation position of liquid level detectors in the bilge water level detection system of single point cabin;

(15) Carry out utility test on the effectiveness of mooring line inclinometer;

(16) Check and test the effectiveness of remote control shutoff devices, such as fuel tank emergency shutoff device, ventilation system and opening shutoff after installation;

(17) Carry out inspection and utility test on electrical equipment (including motor, charging and discharging and

substation switchboard, cable, transformer, power supply, etc.) according to the rules.

2.3.2.6 Inspection and test items of communication system and alarm system:

(1) Check the lighting facilities (signal lights, explosion-proof lights and other special lighting fixtures) of the turret system of the single point moorings, and check the arrangement and installation of the lighting fixtures and their effectiveness;

(2) Check the laying of high-voltage cables and power grids, check the installation of cable stuffing boxes used for cables passing through watertight or refractory bulkheads or decks, and carry out withstand voltage test on high-voltage cables;

(3) Check and test the communication and signal device between the single point moorings area and the central control of floating structure.

2.3.2.7 Inspection and test items of proprietary equipment for turret of single point moorings:

(1) Slip ring

① Fluid swivel

a The pressure parts of the fluid swivel shall be designed and manufactured according to the relevant pressure vessel rules of the Rules;

b The fluid swivel and the structural load caused by the anchoring system shall not affect each other;

c The pipe load on slip rings shall be minimized (e.g., compensated by expansion joints);

d The material of the fluid swivel body and seal shall be compatible with the transmission medium;

e Bearings shall not be damaged due to internal circulation media and marine environment;

f If necessary, the pressure seal shall be protected against mechanical damage;

g Flammable and toxic materials shall be sealed with at least double seals to prevent leakage to the outside or between different media (multi-medium slip rings). A method for checking seal integrity with slip rings in operation shall be provided and a leak monitoring and alarm system shall be provided;

h When flammable fluid leaks, there shall be methods for collecting and safely disposing of the leakage;

i Hydrostatic pressure test: The fluid swivel shall undergo corresponding hydrostatic pressure test according to the design requirements;

j Dynamic test: Perform rotation and vibration tests under design pressure and record the start-up and running time of slip rings. Rotation test shall be carried out in at least two directions: clockwise and counterclockwise.

② Electric slip ring

a In a dangerous area, the electric slip ring shall meet the relevant fire and explosion safety requirements of the *Rules for Classification of Offshore Floating Devices* (2020);

b Dielectric and insulation resistance tests shall be performed;

c The electrical slip ring shall be tested for rotational continuity.

(2) Other field tests

① Load test of lifting winch;

② Test of bearing lubrication system;

③ Utility test of hydraulic power unit (HPU);

④ Utility test of inlet and drainage system;

⑤ Torque arm function test.

2.3.2.8 Inspection and test items of proprietary equipment of CALM single point moorings:

(1) Function test of chain stopper;

(2) Functional test of turntable locking system;

(3) Functional test of lifting equipment and working padeye;

(4) Function test of power system;

(5) Function test of navigation auxiliary system;

(6) Function test of control and detection system;

(7) Function test of hydraulic system;

(8) Function test of bilge pump;

(9) Sacrificial anode protection function test;

(10) Rotation test;

(11) Weighing test;

(12) Floating test.

2.3.2.9 Test requirements

(1) The compartment tightness test shall refer to the relevant provisions of Section 3 of Chapter 4 of Part One of CCS *Rules for Classification of Offshore Floating Devices* (2020);

(2) After installation of mechanical equipment, pressure vessels and piping systems, tightness test shall be carried out. The test pressure shall be in accordance with the relevant requirements of Chapter 6 of the Rules, and the test time shall generally be not less than 3 to 5 minutes;

(3) See the relevant requirements in Chapter 3 of the Rules for the requirements of inclining test;

(4) The mooring test shall be carried out according to the approved test outline;

(5) The NDT of structural welds shall refer to the relevant provisions of Section 4 of Chapter 4 of Part One of CCS *Rules for Classification of Offshore Floating Devices* (2020);

(6) The necessary operation manual shall be submitted for future reference before the final assembly and test of the single point moorings;

(7) Installation procedures, start-up and commissioning procedures for single point moorings as well as offshore tieback and release procedures shall be submitted to CCS surveyors for review and approval.

2.3.3 Documentation

2.3.3.1 Report

(1) The manufacturer shall submit to the surveyor and the owner reports and records of inspections, tests, measurements, etc. relate to single point moorings;

(2) The surveyors shall participate in the inspection and test of the specified items, review the reports and records related to the inspection, test and measurement of the units submitted by the manufacturer, issue various inspection reports, records, data and corresponding certificates of the main body of the single point moorings and equipment, mechanical and electrical equipment to the applicant according to the format specified by CCS headquarters, and report to the headquarters;

(3) The manufacturer shall submit to the surveyors the finished drawings of the single point moorings referred to in 2.3.3.2 (2) of this Section to confirm its compliance with 2.3.3.2 (1).

2.3.3.2 Data

(1) The relevant drawings, charts, instructions, calculations and other completion documents of the single point moorings shall be consistent with the actual situation of the single point moorings;

(2) At least one set of the following construction completion drawings shall be kept on the single point moorings and shore-based management department:

① Main drawings

a General layout;

b Hold capacity diagram;

c Hydrostatic curve;

d Deck load instructions and drawings;

e Anti-corrosion control, including coating and cathodic protection;

f Fire control chart;

g Hazard zoning map.

② Structure drawings of single point moorings

a Basic structure drawings;

b Main sectional views;

c Deck structure drawings;

d Expanded drawings of outer plate;

e Lifting, bilge, firefighting and ballast piping drawings.

(3) The following single point mooring completion data and documents shall be kept on the single point moorings and the owner and/or shore-based management department:

① Technical documents of moorings

a Instructions, calculations and related charts of single point moorings;

b Operation manual of single point moorings;

c Stability data;

d Other guidance documents such as equipment operation manual.

② Single point moorings and their equipment include device and system certificates, classification certificates of single point moorings, inspection reports and records and other specific certificates.

(4) Normally, the date of completion of construction inspection is used as the date of completion of construction of single point moorings. Other important dates of the single point mooring, such as the date of signing of the contract for the construction of the single point moorings, the commencement date of construction, the date of installation of the keel, the date of launching and the date of delivery of the single point moorings, shall also be recorded;

(5) All parties concerned, such as the owner or manager of single point moorings, shall keep the documents mentioned in (2), (3) and (4) (if any) of 2.3.3.2 above, and the subsequent documents and materials for a long time during the life cycle of the single point moorings;

(6) CCS shall maintain at least single point moorings drawings and documentation related to the single point moorings classification management described in (1) to (4) of 2.3.3.2 for the period during which CCS single point moorings class is maintained.

Section 4 Surveys after Construction

2.4.1 General requirements

2.4.1.1 Single point moorings that have been CCS-classed shall undergo various tests (where applicable) in accordance with this Section, so as to maintain the validity of the certificate. CCS surveyors may expand the scope of survey according to their professional judgment, and the owner shall provide corresponding survey conditions and arrangements.

2.4.1.2 In the inspection, the owner or his/her agent shall notify CCS on his/her own initiative if any damage or

defect to the single point moorings is found by and it necessary to deal with the damage or defect immediately.

2.4.1.3 The owner shall be responsible for applying to CCS for various inspections to maintain the validity of the certificate, and preparing the inspection items and providing safety measures for the inspection according to the rules.

2.4.2 Inspection of damage and repair

2.4.2.1 The owner of the single point moorings or his/her agent shall be responsible for timely reporting to CCS any damage, defect or failure that may invalidate the state of the single point moorings, so that CCS may appoint surveyors to inspect the single point moorings immediately. When surveyors deems it necessary, all repairs must meet the requirements.

2.4.2.2 Before repairing structures, equipment or mooring chains that affect or are likely to affect the classification of single point moorings, a complete repair procedure including the scope of repair and the participation of surveyors required shall be submitted to CCS and agreed by CCS before the repair begins. Failure to notify CCS prior to repairs may result in suspension of single point moorings class until repairs are resumed or sufficient evidence is submitted to the surveyors to prove that repairs have been properly completed.

2.4.2.3 The above requirements do not include maintenance and overhaul of structures and equipment, etc. in accordance with manufacturer's recommended procedures and established shipping regulations without CCS approval; if the result of such maintenance and overhaul affects or is likely to affect the classification of single point moorings, the repair shall be indicated in the maintenance log and submitted to the surveyors.

2.4.3 Retrofitting or service inspection beyond design life

2.4.3.1 When retrofitting the important parts (such as buoys and turrets) of the classified single point moorings, the scheme and relevant drawings shall be submitted to CCS for review and approval before retrofitting. Retrofitting and related parts shall generally comply with the current CCS rules or at least meet the requirements of the original applicable rules. Retrofitting shall be carried out according to approved schemes and drawings, and shall be inspected by experienced surveyors to meet CCS specification rules.

2.4.3.2 When replacing the important components of the classified single point moorings and applying for service inspection beyond the design life, the life extension evaluation report shall be submitted to CCS for review according to the requirements of current rules, the on-site surveyors shall conduct on-site inspection (including in-water survey and verification) of the replaced parts according to the evaluation and review opinions of the CCS drawings review department, and collect feedback inspection results. The plan approval department shall confirm whether to accept the use of single point moorings beyond the design life according to the submitted evaluation report for use beyond the design life and the feedback results of on-site inspection.

2.4.4 Type and cycle of inspection

2.4.4.1 The single point moorings constructed and put into operation must undergo the following tests in accordance with the provisions of this Chapter:

(1) Annual survey: The annual survey shall be carried out within 3 months before and after the date of the first classification survey or the date of the last special survey;

(2) Intermediate survey: The intermediate survey shall be carried out at the time of the second or third annual survey. Items other than the annual survey requirements can be carried out at the time of the second or third annual survey or between the two inspections;

(3) Inspection of the exterior of single point moorings and related items: During the special survey cycle every five years, at least two inspections of the exterior of single point moorings and related items shall be carried out, but one of them shall be carried out simultaneously with the special survey, and in all cases the interval between any two inspections shall not exceed 36 months;

(4) Special survey: The first special survey shall be completed within 5 years from the date of the first classification survey, and the subsequent special survey shall be completed within 5 years from the last special survey.

The surveyors may expand the scope of the inspection and test when he deeming it necessary.

2.4.5 Annual survey

All single point moorings shall be inspected annually.

2.4.5.1 Annual survey items:

(1) Record reports

① Check the operation records of positioning equipment, the angle measurement of mooring line on floating structure and the offset records of the center position of single point moorings (when applicable);

② Review the maintenance records of the swivel stack, and confirm whether the crew have carried out maintenance according to the manufacturer's technical instruction manual.

(2) Structure and equipment

During each annual survey, the structure and equipment of the single point moorings shall be thoroughly inspected within the visual range as possible, and they shall be in a satisfactory condition.

Check all structures above the water surface by means of appearance inspection, paying special attention to the supporting structure of mooring system and the connecting structure of mooring system components, as well as the collision of floating structures and floating objects on structures in splash areas or damage caused by corrosion. When necessary, local components shall be inspected by nondestructive testing.

① Anti-corrosive coating or other protective layers in splash area;

② Potential readings of subsea cathodic protection;

③ Changes of structure or load that may affect the overall performance of the structure;

④ Safety facilities such as railings, steps and lifts of decks, passages and stairways;

⑤ Watertight or non-watertight closing facilities of floating single point moorings;

⑥ Hatch cover, manhole, drain hole, ventilation hole and air pipe;

⑦ Conduct visual inspection of the structural layout of the chain stopper, including the supporting structure of all chain stoppers or brackets;

⑧ Check the angle measurement records of each mooring line to verify that the mooring line tension is within the design tension range (when applicable);

⑨ Visually inspect the mooring lines above the water surface as possible to confirm its wear;

⑩ In order to ensure the continuous effectiveness of the lubrication system, the state of the bearing shall be verified;

⑪ Conduct an overall inspection of the structure of the single point moorings on water to confirm whether there are signs of damage, coating fracture and excessive corrosion. The inspection scope includes all turret structures, hydraulic calipers and all structures supporting the release operation of mooring system, etc. (if applicable).

(3) Cargo transfer systems and components and anti-pollution systems

① Conduct visual inspection of cargo transfer system pipelines, risers, hoses and their connections to determine their mechanical damage status, coating damage, anode consumption and condition, leakage, etc.;

② Expansion joint and fluid swivel;

③ Seals and valves;

④ Emergency procedures for oil pollution prevention;

⑤ Emergency shutdown device.

(4) Mooring and anchoring equipment

① Conduct visual inspection of mooring line, yoke structure and connecting parts. If necessary, nondestructive testing shall be adopted for local components;

② Conduct visual inspection of mooring line or steel wire rope at the following parts to determine the wear and corrosion of mooring line, the falling or loosening of rung, the wear and flattening of steel wire rope and the fracture of steel wire:

a Anchoring parts near winches or windlasses;

b Anchoring parts in direct contact with guide holes/wheels, guide elbows and chain detectors;

c Anchoring parts in areas where severe corrosion splashes occur;

d Connect chain rings and cable joints;

e On the basis of the above survey results, the surveyors may request an extension of the scope of the survey.

③ For guide holes/wheels and guide elbows, especially check the wear or degradation of the gasket material in the guide elbows.

(5) Fire safety equipment

① Confirm whether there is any significant change in the layout of structural fire prevention;

② Operation test of manual and/or automatic fire door;

③ Whether the fire control chart is posted as required;

④ Test the automatic fire alarm and fire detection system, and combustible gas detection and alarm system;

⑤ Check the water fire protection system to confirm that each fire pump and its piping is in an effective state;

⑥ Check the closing devices of ventilation duct, surrounding space of chimney, skylight, doorway, etc.;

⑦ Check whether hoses, water guns, foam spray guns, gun ejectors, fire extinguishers and firefighters' equipment are in working condition;

⑧ Check the control devices, piping and signs of the fixed fire extinguishing system, and confirm the normal maintenance of each system and the last test date; check portable fire extinguishers and other fire extinguishing devices to make sure they are in good working condition and stored in specified positions;

⑨ Check whether the fire extinguishing dose of the fixed fire extinguishing system, piping unblocked test and pressure test are carried out on schedule.

(6) Electromechanical equipment

① Confirm that the ventilation system is operating well;

② Confirm that the installation and protection of machines and pressure vessels, as well as their piping and accessories, fully consider their moving parts, hot surfaces and other dangerous conditions, and the minimize danger to the safety of personnel on single point moorings;

③ Check the remote control turn-off device, and check the wind and oil turn-off device boiler in the compartment of single point moorings as practically possible. All hydraulic, pneumatic and emergency turn-off devices and other systems and their related accessories shall be inspected as a whole, and the surveyors shall conduct utility test when deeming it necessary;

④ Confirm that the bilge water system and sewage trap in the machinery places, including the operation of bilge pump and water level alarm, etc., and inspect them as possible;

⑤ Conduct visual inspection of slip ring and its attached instruments and safety equipment to confirm that they are in good working condition;

⑥ The electrical equipment of single point moorings in dangerous areas shall meet the inspection requirements of fire and explosion-proof safety equipment in CCS *Rules for Classification of Offshore Floating Devices* (2020);

⑦ Check the sealing system of the turret of the single point moorings to confirm that it is in good working condition;

⑧ Test the slip ring stack protection device to confirm that it is in good working condition;

⑨ Check the insulation resistance of electrical equipment and cable lines in the compartment of single point moorings to confirm that they are in good working condition;

⑩ Verify the protection function of the incoming switch of the switchboard;

⑪ The satisfactory operation of the power supply device, including the starting device of the power supply, shall be verified. If the power supply is equipped with an automatic power supply device, the test shall be carried out in an automatic way;

⑫ Check and measure the insulation resistance of electrical equipment and cable lines;

⑬ Check the lighting of machine places, escalators, corridors and escape exits;

⑭ Conduct general understanding and inspection of other electrical equipment; if necessary, conduct utility test:

a Transformer;

b AC/DC conversion system;

c Explosion-proof electrical equipment;

d Control equipment;

e Supply slip ring.

2.4.6 Intermediate survey

2.4.6.1 All single point moorings shall be subject to intermediate survey.

2.4.6.2 In addition to the following items, the intermediate survey shall also include annual survey items, and the inspection items may be added according to the results of previous inspection, service maintenance and service life.

2.4.6.3 A full inspection of the single point moorings shall be carried out by visual method or other means. To determine the integrity of the entire single point moorings, e.g., to confirm that the corrosion protection system works properly, to confirm that the pre-tension or angle above the water surface of each mooring line meets the requirements, and to confirm that the chain switch works properly. Visually inspect the structure close to the chain stopper as possible.

2.4.7 Special survey

2.4.7.1 All single point moorings shall undergo special survey, which may begin one year before the expiration date and be completed before the expiration date. If the special survey starts earlier than one year before the expiration date, all special survey shall be completed within 15 months after the start of the special survey. In this case, the items carried out at the beginning of the special survey can be used as an integral part of the special survey. For single point moorings with unconventional design, shelved state or abnormal environment, special survey shall be determined according to specific conditions.

2.4.7.2 In exceptional circumstances, if the owner fails to arrange a special survey of the single point moorings on the expiration date of the special survey, it may be extended according to the corresponding contents of the Rules according to the written application of the owner before the expiration date. In this case, the date of the next special survey will be calculated from the expiration date of the special survey before the extension.

2.4.7.3 If the special survey is completed 3 months before the expiration date, the date of the next special survey shall be counted from the date of completion of the special survey. If the special survey is completed within 3 months before the expiration date, the date of the next special survey shall be counted from the expiration date of the original special survey.

2.4.7.4 Special survey items

In addition to the following items, the special survey shall also include annual and intermediate survey items, and

the inspection items may be added according to the results of previous inspection, service maintenance and service life. The inspection shall include the inspection of the whole structure, protective coating, cathodic protection system, chain brake and its locking mechanism of the single point moorings.

(1) Structure and equipment

① Comprehensively check the appearance of the structure above the water surface. Carry out nondestructive testing on some representative nodes, conduits and risers in the splash area;

② Thickness measurement shall be carried out in any suspicious area where significant corrosion is found. Conduct close visual inspection of all mooring parts and accessible members bearing mooring load. These structures include chain stopper, anchor cable base, cable support and its attachment structure. These structures shall be thoroughly cleaned and inspected, and any suspicious areas shall undergo NDT;

③ Test the main bearing of single point moorings. The test includes visual inspection of the main bearings as possible for bilging, corrosion, pitting and excessive wear. For main bearings that cannot be visually inspected, at least find out the wear of main bearings and verify the sealing of main bearings;

④ Internal inspection shall be carried out on the liquid tank, and hydrostatic test shall be carried out at the maximum pressure that may be encountered during operation; however, if the operation record proves that the liquid tank has been tested, the inspection can be exempted with the consent of the experienced ship surveyors;

⑤ During the internal inspection of all compartments, if obvious corrosion is found, thickness measurement inspection shall be carried out, and the new criterion shall refer to Section 6 of Chapter 13 of Part Two of CCS *Rules for Classification of Offshore Floating Devices* (2020);

⑥ Check the closing devices of watertight doors and windows and deck openings, as well as the tightness of compartment pipe fittings, and conduct tightness tests if necessary;

⑦ Carry out flushing test on hatch cover and other weathertight closing equipment;

⑧ In the second special survey or later special survey, some compartment structures shall be selected for representative thickness measurement, and special attention shall be paid to the structure of splash area;

⑨ For inaccessible structural areas, special alternative inspection methods or procedures shall be recognized and approved by CCS;

⑩ If the tension force of mooring line does not meet the requirements of technical specifications, it shall be adjusted accordingly.

(2) Cargo transfer systems and components and anti-pollution systems

① Cargo hoses with service life exceeding two years shall be disassembled and inspected, and pressure (the test pressure shall be between 1.5 times the maximum working pressure and 2/5 burst pressure) and vacuum test shall be carried out;

② Pressure test shall be carried out for cargo pipelines, hoses, fluid swivels and valves under design pressure;

③ Carry out utility test on the whole cargo transfer system (including emergency cut-off device);

④ When it is necessary to inspect the subsea joint, it shall be fully cleaned for inspection.

(3) Fire safety equipment

In addition to the annual survey items, the following items shall also be inspected:

① Carry out the utility test of water fire control system to confirm that each fire control pump (including emergency fire control pump) and its piping is in an effective state;

② Carry out the utility test on each fire pump (including emergency fire pump);

③ Check the corrosion status of pipelines and accessories of fixed fire extinguishing system, and carry out hydrostatic test if the surveyors deem it necessary;

④ Check whether there is any change in the scope of dangerous areas.

(4) Electromechanical equipment

① Auxiliary machines, air compressors and their intercoolers, filters, oil-water separators and safety devices should be inspected;

② Air bottles for important purposes, together with their accessories, valves and safety devices, shall be cleaned internally and inspected internally and externally. If the air bottles cannot undergo internal inspection, the internal inspection shall be replaced by hydraulic test, and the safety valves shall be verified;

③ The connection and disconnection facilities of fuel oil, lubricating oil, cooling water, feed water and ballast systems shall be inspected or tested, and if necessary, the fuel oil, lubricating oil and cooling water systems of important machines shall be opened for inspection;

④ Valves, cocks and filters of bilge system, together with their piping, shall be tested under working pressure;

⑤ The utility experiment shall be carried out for the remote control shutdown device;

⑥ Check the steam piping. If the surveyors deem it necessary, the local insulation can be removed for inspection, or some main steam piping can be removed for hydrostatic test;

⑦ Check the ventilation pipe system, pressure, vacuum valve and fire net of oil storage tank, fuel tank and cargo oil pump station, and check the valves, accessories and control devices on the fuel tank;

⑧ The main generator shall be tested for single machine and parallel operation under the working load condition to test its load distribution; confirm that the motors and their control devices of generators and important equipment are in normal condition;

⑨ Overcurrent, undervoltage, reverse current or reverse power protection devices and automatic switches of switchboards shall be tested for utility, and air circuit breakers of generators shall be tested to verify that their protection devices, including operation and delay, are satisfactory;

⑩ All cables shall be inspected to ensure that the fixture and protective cover are not loose;

⑪ The motor for important purposes, together with its auxiliary control and operating mechanism, shall be inspected, and if necessary, the operation test shall be carried out under working conditions;

⑫ If the transformer used for power supply for important purposes is wet, the owner shall send the liquid sample to the authority to determine its breakdown voltage, acidity and moisture, and the test result report shall be submitted to the surveyors;

⑬ The automatic and remote control systems shall be inspected and tested when the surveyors deem it necessary;

⑭ Check and measure the insulation resistance of electrical equipment and cable lines;

⑮ Verify that there is no potential fire source in the hazardous place, confirm that all electrical equipment in the hazardous area is suitable for service in the place, in good condition and properly maintained, and check the explosion-proof reliability of electrical equipment in the hazardous area.

2.4.8 Survey of the exterior of single point moorings and related items

2.4.8.1 Survey of the exterior of single point moorings and related items may be carried out either in a dry dock or in a floating state. The survey in dry dock is called in-dock survey, and the survey in floating state is called in-water survey. For single point moorings with an age of 15 years or less, in-water survey can be used instead of in-dock survey. For single point moorings over 15 years, when the owner puts forward an application for in-water survey instead of in-dock survey, CCS will consider whether to accept the application according to the specific conditions of mooring system and the last survey status.

2.4.8.2 The dock or subsea survey plan shall be submitted for approval prior to the commencement of the survey of the exterior of the single point moorings and related items, and a pre-survey meeting shall be held before the commencement of the survey and the on-site surveyors shall be notified to attend.

2.4.8.3 In-dock survey or in-water survey:

(1) Before the in-water survey begins, the in-water survey plan (including the cleaning, survey scope and method of mooring parts) shall be submitted to CCS for approval;

(2) All mooring parts (mooring line, steel wire rope, shackle, etc.) such as mooring line and yoke structure shall be inspected within the whole length range, and representative nodes can be selected for nondestructive testing if necessary;

(3) Check mooring line joints and connecting links comprehensively, and pay special attention to the wear and corrosion of steel cables near joints. During the survey of mooring line, pay attention to its wear, corrosion and flattening and the fracture of steel wire. Potential measurement shall be carried out on joints equipped with anodes; magnetic particle or ultrasonic survey can be carried out on some or all connecting links according to specific conditions;

(4) Pay attention to wear, crack, bending and torsion deformation, loosening and falling off of chain ring rung when inspecting mooring line;

(5) Check the corrosion, wear and bending of the connecting shackle and loosening of the transverse pin;

(6) The buoys of single point moorings shall be cleaned and inspected (when applicable);

(7) When checking whether all mooring lines have excessive corrosion and loss, pay attention that the key survey area is the area with the largest relative movement between chain rings. These areas are usually the mooring line parts in contact with the seabed. Focus on checking whether the chain ring is corroded, worn or broken. For the mooring line close to the seabed, focus on confirming the excessive wear of the mooring line in the seabed touchdown area;

(8) For mooring lines of single point moorings that have been used for more than 5 years, mooring line diameter measurement shall be carried out during special survey, and the survey scope and standard of mooring line diameter measurement shall be implemented in accordance with the relevant requirements of Section 4.6.2 of the Rules;

(9) If the surveyors deem it necessary, the high stress and high wear areas of mooring lines shall be inspected and non-destructive flaw detection shall be carried out. These areas include contact areas between chain detectors and the seabed;

(10) Carry out a comprehensive survey of the erosion or exposure degree of suction anchor or anchor pile to ensure that these components are not overexposed;

(11) Check the tension force and mooring line angle of each mooring line. If it is found that it does not meet the requirements of technical specifications, it shall be adjusted accordingly;

(12) Select representative positions on the whole subsea structure of the mooring system and obtain cathodic potential readings at these positions to confirm the normal operation of the cathodic protection system within the design range;

(13) For mooring lines with armor or sheath, the armor and sheath shall be checked. Pay attention to the cracks, tears and wear of the sheath during survey;

(14) When the mooring line is a steel wire rope, if the steel wire rope is protected by a shell, the overall appearance survey shall be carried out. If the steel wire rope is not protected by a shell, the diameter of the steel wire rope shall be measured;

(15) For disconnectable mooring systems, the connection of the mooring system and the disconnectable system can be tested when the surveyors deem it necessary. In addition, the record of connection/release operations between the effective date of the last special periodic survey and the current expiration date may be reviewed and, the record is satisfactory, it meets the requirement.

2.4.9 Initial classification survey of single point moorings without CCS inspection

2.4.9.1 If the single point moorings not constructed under the supervision of the CCS surveyors are intended for CCS classification, a written application shall be submitted to CCS. Periodic inspections to maintain single point moorings class after classification of such single point moorings shall be treated in the same way as single point moorings constructed under the supervision of CCS surveyors. For single point moorings that have been classified by other classification societies accepted by CCS, the scope of inspection will be given special consideration by CCS when classification is intended in CCS.

2.4.9.2 The owner of single point moorings or his/her agent shall submit a set of drawings required in each chapter to CCS for review. If it is difficult to submit drawings for plan approval within the scope specified above, it may

be reduced as appropriate with the consent of CCS.

2.4.9.3 The owner of the single point moorings or his/her agent shall submit relevant information and supporting documents of the single point moorings during construction and repair, as well as single point moorings certificates and technical documents issued by other classification societies.

2.4.9.4 For existing single point moorings applied for initial classification survey, the scope of drawings submitted for plan approval of safety facilities shall be determined according to the relevant regulations of the competent department.

Chapter 3 Stability and Watertight/Weathertight Integrity

Section 1 General Provisions

3.1.1 General requirements

3.1.1.1 The requirements of this Chapter apply to independent floating single point moorings.

3.1.1.2 Floating single point moorings shall consist of multiple watertight compartments separated by watertight bulkheads, and watertight manhole devices shall be provided for compartments that are flooded due to possible factors such as external impact and internal leakage.

3.1.1.3 The intact and damage stability of floating single point moorings shall be checked in accordance with the requirements of this Chapter, and the calculation and analysis shall cover the corresponding working conditions of all design loading modes, generally including but not limited to possible conditions such as towing, installation and in-place, and the cable chain and its possible pretensioning force shall be considered according to the facts.

3.1.1.4 The inclining test of floating single point moorings can be carried out with reference to the relevant provisions of self-elevating units in Chapter 2 of Part Three of CCS *Rules for Classification of Mobile Offshore Units* (2020).

3.1.1.5 When the requirements of this Chapter are not applicable due to special design, it can be evaluated according to the actual situation of floating single point moorings.

3.1.1.6 In the design of installation operation, various states such as floating on water surface and floating under water that may be experienced by single point moorings shall be fully considered, and its stability and floatability can meet the requirements of installation operation, so as to ensure the smooth completion of installation operation.

3.1.1.7 For wind force calculation related to stability analysis, please refer to the requirements of Section 2 of Chapter 2 of Part 3 of CCS *Rules for Classification of Mobile Offshore Units* (2020).

3.1.2 Drawings and documents

3.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval:

(1) Intact stability calculation sheet;

(2) Calculation sheet of damage stability;

(3) Calculation sheet and graph of allowable center of gravity height;

(4) Drawings of watertight and weathertight closure devices for watertight, weathertight doors and windows and other openings;

(5) External watertight and weathertight integrity range drawings (when applicable);

(6) Drawings and documents for future reference:

① Lines plan;

② Hydrostatic curves;

③ Capacity plan;

④ Plan of watertight boundaries of spaces.

Section 2 Stability

3.2.1 Intact stability

3.2.1.1 The smaller of the area under the righting moment curve of the single point moorings to the second intersection or water inlet angle shown in Figure 3.2.1.1 under the action of wind forces corresponding to different operating conditions as described in 3.1.1.7 of this Chapter shall be at least 40% larger than the area under the wind tilt moment curve at the same limited angle, the righting moment in all angle ranges from positive float to

the second intersection point shall be positive, it shall be ensured that the single point moorings are within the whole draft range of all floating conditions, and the initial stability height after free surface correction shall not be less than 0.15m.

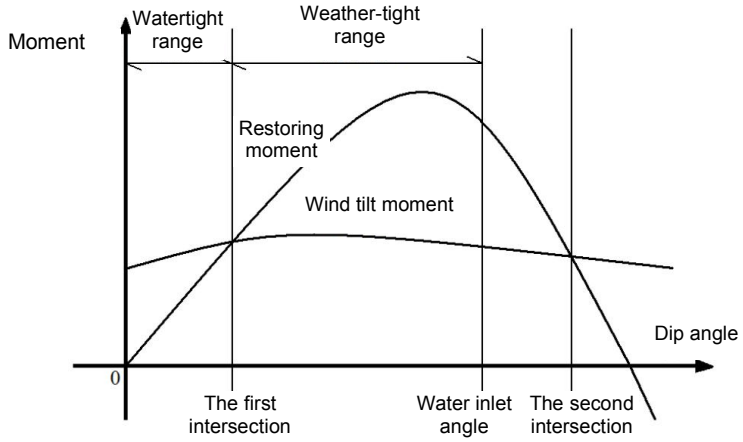


Figure 3.2.1.1 Typical Hydrostatic Curve for Intact Condition

3.2.2 Damage stability

3.2.2.1 Damage range:

(1) For damage not caused by collision, consider flooding in any cabin;

(2) For damage caused by collision, the scope of damage includes:

① Horizontal penetration 1.5m;

② Vertical direction is unlimited from the bottom plate upward;

③ The effective watertight bulkhead spacing or the spacing of adjacent step parts within the above assumed horizontal penetration range shall not be less than 2.3m, otherwise one or several adjacent bulkheads shall be assumed not to exist; however, for the outer wall of the cylinder, the effective spacing can be the smaller of the radius of the cylinder and 2.3m.

3.2.2.2 Stability criteria

The floating single point moorings shall have sufficient reserve buoyancy to remain unsinkable and the lower edges of all openings where continued flooding is likely to occur shall be above the damage equilibrium waterline corresponding to the first intersection point after the floating single point moorings withstand the following:

(1) Withstand the damage specified in 3.2.2.1;

(2) Withstand a wind force of at least 25.8m/s from any direction;

(3) Withstand the combined effects of sinking, trim and heel.

Section 3 Watertight and Weathertight Integrity

3.3.1 Watertight integrity

3.3.1.1 The number of openings in the watertight bulkheads and decks of single point moorings shall be kept to a minimum in normal operation. Measures shall be taken to maintain the watertight integrity of these watertight bulkheads if openings are necessary for the passage of entrances, pipes, ventilation, cables, etc.

3.3.2 Weathertight integrity

3.3.2.1 The external weathertight integrity of single point moorings can refer to the applicable requirements of Section 3 of Chapter 4 of Part Three of CCS *Rules for Classification of Mobile Offshore Units* (2020).

Chapter 4 Analysis of Mooring Systems

Section 1 General Provisions

4.1.1 General requirements

4.1.1.1 In addition to meeting the requirements of this Chapter, the analysis of mooring systems shall also comply with other applicable requirements of the Rules and relevant requirements of the administration.

4.1.1.2 The analysis results of mooring systems can be obtained by calculation analysis or model test method.

4.1.1.3 Where environmental loads are calculated using an analytical method different from that specified in this Chapter, sufficient model test or measured results shall be provided to account for it.

4.1.2 Drawings and documents

4.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval or reference:

(1) Site chart (for future reference);

(2) Environmental condition documents (for future reference);

(3) General layout of single point moorings;

(4) Instructions of single point moorings (for future reference);

(5) Layout of mooring systems;

(6) Analysis and calculation of mooring systems;

(7) Operation manual for mooring or reconnection, offloading, release and disembarkation;

(8) Environmental load analysis, motion and strength analysis of floating structures and buoys (for future reference);

(9) Physical model test report of single point moorings (for future reference);

(10) Main parameters of floating structure (for future reference);

(11) Main parameters of transporting goods (for future reference);

(12) Cargo transfer system layout and instructions.

Section 2 Environmental Conditions and Environmental Loads

4.2.1 General requirements

4.2.1.1 The owner/designer shall specify the environmental conditions of the single point moorings. Environmental conditions shall usually be adapted to the design environmental conditions of the main structure of the single point moorings, including wind, wave, current, tide and water depth, seabed soil parameters, air temperature and water temperature.

4.2.1.2 When model tests are used to determine environmental loads and mooring floating structure movements, the above-water and under-water shapes of the test models shall characterize the actual floating structure, taking into account the effects of propellers (where applicable), bilge keels and other accessories. The fluid characteristics of the model test shall be the same as those of the actual floating structure, and the procedure and method of the model test shall be decided through consultation with CCS.

4.2.2 Environmental conditions

4.2.2.1 When designing the positioning and mooring system, the environmental conditions of survival condition and maximum operating condition shall generally be considered for environmental load, and only the environmental conditions of survival condition can be considered for permanent mooring.

4.2.2.2 Survival environmental conditions refer to the combination of the worst wind, wave, current and other environmental conditions allowed by the design of single point mooring system. The positioning and mooring

system shall be designed according to the combination of wind, wave and current which cause extreme load in the design environment. In practical design, it is generally obtained by the combined approximation of multiple design criteria. The combination of the worst wind, wave, current and other environmental conditions when the single point moorings with quick release function are connected shall be regarded as survival condition.

For example, for the design environment conditions with a return period of N years, the following three design criteria are usually studied:

(1) Wave with a return period of N years, plus corresponding winds and currents;

(2) Wind with a return period of N years, plus corresponding waves and currents;

(3) Current with return period of N years, plus corresponding waves and winds.

4.2.2.3 The design criteria with a return period of at least 100 years shall be adopted for the survival environmental conditions of the permanent positioning mooring system. If the design life of the positioning and mooring system is actually less than 20 years, a shorter return period can be selected. In this case, the return period shall be determined by risk analysis taking into account the failure consequences of the positioning and mooring system, but it shall not be less than 50 years.

4.2.2.4 For permanent positioning and mooring systems with quick release design, besides the mooring system itself (not mooring floating structures) shall be able to resist the environmental conditions of survival conditions of permanent mooring, the worst environmental conditions of mooring floating structures shall also be checked with reference to relevant requirements of survival conditions.

4.2. 2.5 If floating structures and other ships are moored at single point moorings at the same time (such as oil tanker berthing and export operation), the worst environmental conditions during common mooring shall be checked with reference to the relevant requirements of survival conditions.

4.2.2.6 For single point mooring systems constructed for non-oil and gas production purposes, it is advisable to determine the return period by taking into account the risk analysis of failure consequences of single point mooring systems, and the risk analysis and design return period shall be reviewed and approved by CCS.

4.2.2.7 In the design of single point moorings, the possible influence of different wave periods on low-frequency motion and mooring load shall be considered. The wave peak lifting factor can be determined by reference to the statistical data of the actual environment. If there is no reliable data, the influence of the peak lifting factor on the motion of floating structures and wave loads shall be considered in the design of single point moorings.

4.2.2.8 For single point moorings operating in shallow water, the effect of shallow water on wave load and motion of floating structures shall be considered. The change of tidal level will affect the pre-tension and mooring stiffness of single point mooring system to a certain extent. In the design of single point mooring system, the influence of extreme water level on the design of shallow water single point mooring system shall be fully evaluated.

4.2.2.9 In the design of single point moorings, the seabed soil conditions and seabed shape in the working sea area shall be investigated in detail to provide reliable basic data for the design of anchor/anchor pile/fixed tower.

4.2.3 Action direction of environmental load relative to floating structure

4.2.3.1 Analysis shall be carried out using field applicable data of wind, wave and current direction distribution. In case of lack of reliable data, the following two environmental direction combination methods can be used instead in the initial design:

(1) Under the same environmental conditions, wind, wave and current act in the same direction, and the included angle between different action directions should not be greater than 15º;

(2) Under different environmental conditions, the angle between the wave action direction and the heading of the floating structure is 0º, the angle between wind and wave is 30º, and the angle between current and wave is 45º, and the wind and current are on the same side of the floating structure.

4.2.3.2 When the floating structure is connected to the single point moorings through the rigid arm, it is advisable to increase the working condition that the environmental load acts from the stern direction of the floating structure in the design.

4.2.4 Wind load

4.2.4.1 There are usually two methods for considering wind loads: One is to consider only the steady wind force acting on mooring floating structures, and the other is to consider the low-frequency wind force caused by superimposing wind fluctuation components on the steady wind force. In the final design stage of permanent positioning and mooring system, the method of adding steady wind force to low-frequency wind force shall be adopted, unless it is proved that it is safer to consider only steady wind force. Wind load can be obtained by model test or calculation.

4.2.4.2 When only the steady wind force is calculated, the design wind speed is the average wind speed with a time interval of 1 minute at 10m above the average sea level. In addition to the steady wind, the steady wind speed is generally calculated as the average wind speed with a time interval of 1 hour at 10m above the average sea level, and its fluctuating wind speed is considered as a suitable empirical gust spectrum. The time interval of steady wind speed shall be consistent with the average wind speed used in determining wind spectrum.

4.2.4.3 The calculation of wind load acting on floating structures can refer to the relevant requirements in CCS *Rules for Classification of Offshore Floating Devices* (2020).

4.2.4.4 When calculating the wind speed of components at different heights from sea level, it can be determined by referring to the relevant requirements in *Rules for Classification of Offshore Floating Devices* (2020) or by means of wind profile. If the wind profile is used for determination, the following requirements can be referred to.

Calculation formula of NPD wind profile for 1 hour average wind speed at Z meters above sea level:

$$U(z) = U_0\left[1 + C\ln\left(\frac{z}{10}\right)\right] \qquad \text{m/s}$$

Calculation formula of API wind profile for 1 hour average wind speed at Z meters above sea level:

$$U(z) = U_0\left(\frac{z}{10}\right)^{0125} \qquad \text{m/s}$$

Where: $U(z)$ is the 1h average wind speed z meters above sea level;

U_0 is the one-hour average wind speed at 10 meters above sea level, m/s.

$$C = 0.0573\sqrt{1+0.15U_0}$$

4.2.5 Current load

4.2.5.1 Current loads are normally considered as steady forces. Ocean current load can be obtained by model test or calculation analysis.

4.2.5.2 For the calculation method of current load, please refer to the relevant provisions of Section 3 of Chapter 5 of Part Two of CCS *Rules for Classification of Offshore Floating Devices* (2020).

4.2.5.3 In some sea areas, the current force may be the design control load, so careful consideration shall be given to selecting the appropriate current profile. For each relevant sea state, the total current applied to the site shall be considered as the vector sum of all currents.

4.2.5.4 Attention shall be paid to the interaction between currents and waves, and the calculation method refers to the relevant provisions of Section 3 of Chapter 5 of Part Two of the "Floating Regulations".

4.2.6 Wave load

4.2.6.1 For large-scale objects, the diffraction theory is generally used to calculate the wave load on the object. When waves act on floating structures, three kinds of forces acting on mooring floating structures are generally considered:

(1) The first-order force oscillating in wave frequency, which will cause the first-order motion of floating structure, and if necessary, the higher-order force above the second order can be predicted;

(2) The second-order force oscillating below wave frequency, which will cause the second-order motion (also called low-frequency motion) of the mooring floating structure;

(3) The steady part of the second-order force (also known as the mean drift force).

4.2.6.2 $D/L \leq 0.2$ (D: characteristic scale of member section, L: wavelength) is generally used as small-scale isolated pile, and the wave load of such members can be calculated by Morison formula.

4.2.6.3 Wave load can be determined by model tests or computational analysis. For the calculation method of wave load, please refer to the relevant provisions of Section 3 of Chapter 5 of Part Two of *CCS Rules for Classification of Offshore Floating Devices* (2020).

4.2.6.4 The relationship between wave height and wave period in the design sea state shall be accurately determined according to the marine environmental data in the operating sea area. Wave period has significant influence on wave drift force and floating structure motion, so a series of wave period data shall be considered in the design of single point mooring system. For fatigue calculation and analysis, the long-term joint distribution spectrum of wave height and period (wave scatter diagram) is also needed.

4.2.7 Oblique environmental load calculation

For oblique wind and flow environmental conditions, the following formulas can be used to estimate the wind and flow forces on floating structures in the absence of reliable data sources.

$$F_{\emptyset} = F_x\left(\frac{2cos^2\emptyset}{1+cos^2\emptyset}\right) + F_y\left(\frac{2sin^2\emptyset}{1+sin^2\emptyset}\right)$$

Where: F_ϕ - the environmental load of floating structure when the direction of environmental load is oblique;

F_x - the load of floating structure when the direction of environmental load is longitudinal;

F_y - the load of floating structure when the direction of environmental load is transverse;

ϕ - the angle with the bow direction.

4.2.8 Ice load

If there may be icing in the operating sea area, it shall be considered in the design of single point moorings, mainly including the increase of wind load caused by icing on water structure and the influence of icing on the whole ice load of floating structure.

4.2.9 Marine biological load

The type and accumulation velocity of marine organisms in the operation site of single point mooring system will affect the weight, hydrodynamic diameter and drag coefficient of floating structure members and mooring lines. All these factors shall be taken into account in design.

4.2.10 Drag force calculation

When marine organisms are not considered, the towing force per unit length of mooring parts shall be calculated according to the following formula:

$$f = \frac{1}{2}\rho C_d D V^2$$

Where: C_d - drag force coefficient, which can be determined with reference to table 4.2.10 if there is no reliable data source;

D - the nominal diameter of the mooring line;

V - velocity of water point relative to the mooring component.

Table 4.2.10 Drag Force Coefficient of Mooring Components

Mooring component	Transverse	Longitudinal
Stud link chain	2.6	1.4
Unstudded cable	2.4	1.15

Mooring component	Transverse	Longitudinal
Multi-strand steel wire rope	1.8	-
Single twist rope without plastic sheath	1.6	-
Single twist rope with plastic sheath	1.2	-
Fiber rope	1.6	-

4.2.11 Hydrodynamic loads on components such as counterweight and buoy

In the design of mooring system, if there are counterweight and buoy on the mooring line, besides gravity and buoyancy, the hydrodynamic load on it shall also be considered in the design.

4.2.12 Earthquake load

When the single point moorings are located in seismically active sea area, the action of earthquake load shall be considered. The basic earthquake intensity in the sea area where the single point moorings are located shall conform to the regulations of the national earthquake department.

Section 3 Offset and Mooring Line Tension

4.3.1 General requirements

4.3.1.1 The requirements in this Section relate only to motion offset and mooring line tension of single point moorings due to wind, wave and current action.

4.3.1.2 Motion offset and mooring line tension of single point moorings can be obtained by computational simulation analysis or model test method.

4.3.1.3 For the design of single point moorings, in the absence of model tests or other reliable data, the calculation formulas and parameters recommended in *Prediction of Wind and Current Loads for Supertankers* and *Effective Mooring* published by OCIMF may be used for estimating the wind and current loads of supertankers.

4.3.1.4 In the absence of model tests or other reliable data for the design of a single point mooring system, wind and current loads of liquefied natural gas (LNG) vessels connected to it may be estimated with reference to the formulas and parameters recommended in *Effective Mooring* published by OCIMF.

4.3.2 Mooring analysis method

4.3.2.1 The analysis method of a single point mooring system can be divided into:

(1) Quasi-static analysis method;

In the quasi-static analysis method, the wave dynamic load is considered by calculating the static displacement of floating structure caused by wave-induced motion, and the dynamic effects related to its mass, damping and fluid acceleration on mooring line are ignored. The accuracy of mooring line tension prediction based on this method is largely affected by the type of floating structure, water depth and mooring line arrangement.

(2) Dynamic analysis method can be divided into frequency domain method and time domain method.

The time-varying effects due to mass, damping and fluid acceleration are considered in dynamic analysis. This method calculates the time-varying fairlead motion from the surge, sway, heave, roll, pitch and yaw motions of the floating structure. The stretch of mooring line, the change of mooring line geometry, the fluid load on mooring line and the friction between mooring line and seabed all show nonlinear effects, which may have great influence on the characteristics of mooring line and shall be considered in dynamic analysis.

4.3.2.2 The quasi-static analysis method is applicable to the analysis of intact mooring system, and also to the analysis of damaged mooring system after any mooring line fails. However, the quasi-static analysis method is not suitable for transient motion analysis of damaged mooring system, and the dynamic analysis method shall be adopted.

4.3.2.3 For mooring system design, the analysis method shall be selected according to the analysis object and complexity, but the final design of permanent mooring system shall be dynamic analysis method.

4.3.3 Riser load

4.3.3.1 For single point moorings with a large number of risers, the load on the riser and the stiffness and damping of the interaction between the riser system and the floating structure shall be considered in the analysis of the mooring system.

4.3.4 Floating structure offset

4.3.4.1 Mean offset

Mean offset refers to the displacement of floating structures under the combined action of current force, wind force, mean wave drift force and other external steady components.

4.3.4.2 Maximum offset

When using frequency domain analysis method to simulate the dynamic characteristics of floating structures, the maximum offset is defined as the mean offset plus the combined displacement caused by wave frequency and low frequency floating structure motion. The maximum offset shall be calculated according to the following formula, and the larger value shall be taken:

$$X_{max} = X_{mean} + X_{lf\ max} + X_{wf\ sig}$$
$$X_{max} = X_{mean} + X_{wf\ max} + X_{lf\ sig}$$

Where: X_{max} - maximum offset;

X_{mean} - mean offset;

$X_{lf\ max}$ - maximum single amplitude of low-frequency motion of floating structures;

$X_{lf\ sig}$ - significant single amplitude of low-frequency motion of floating structures;

$X_{wf\ max}$ - maximum single amplitude of wave frequency motion of floating structure;

$X_{wf\ sig}$ - significant single amplitude of wave frequency motion of floating structure.

When the dynamic characteristics of floating structures are simulated by time domain analysis method, the maximum offset can be obtained by statistical processing of the corresponding maximum offset results. That is to say, by using different random seed numbers for calculation, taking the average value of the maximum offset obtained by each calculation or making statistics of the maximum offset value by extreme value distribution model, the statistical extreme value is obtained, which is regarded as the predicted value of the maximum offset response of floating structures. If other statistical methods are used, they shall be reviewed and approved by CCS. Usually, the number of seeds calculated and analyzed according to the average value statistics shall be no less than 5, and the number of seeds for statistical analysis according to extreme value shall be no less than 10.

4.3.5 Mooring system analysis simulation time

4.3.5.1 The duration of storm simulation during mooring system analysis shall be determined according to specific conditions, generally no less than 3h. For some single point moorings, if the period of low-frequency motion response reaches several minutes, it is advisable to take longer simulation time.

4.3.6 Mooring line tension

4.3.6.1 Mean tension

Mean tension refers to the mooring line tension corresponding to the mean offset of floating structure.

4.3.6.2 Maximum tension

When using frequency domain analysis method to simulate the dynamic characteristics of mooring lines, the maximum tension shall be calculated according to the following two formulas, and the larger of them shall be taken:

$$T_{max} = T_{mean} + T_{lf\ max} + T_{wf\ sig}$$
$$T_{max} = T_{mean} + T_{wf\ max} + T_{lf\ sig}$$

Where: T_{max} - maximum tension;

T_{mean} - average tension;

$T_{lf\,max}$ - maximum low-frequency tension;

$T_{lf\,sig}$ - meaningful low-frequency tension;

$T_{wf\,max}$ - maximum wave frequency tension;

$T_{wf\,sig}$ - meaningful wave frequency tension.

When the time domain analysis method is used to simulate the dynamic characteristics of mooring lines, the method of determining the maximum tension of mooring lines can refer to the method of determining the maximum offset of floating structures.

4.3.7 Statistical characteristics of random response

4.3.7.1 For wave frequency and low-frequency responses (motion, tension, etc.) that can be expressed as narrow-band Gaussian random processes with Rayleigh distribution, the maximum and meaningful values can be calculated as follows:

$$R_{\max} = \sqrt{2\ln N}\,RMS$$

$$R_{sig} = 2RMS$$

Where: *RMS* - root mean square of random process, when expressed as spectral order moment;

N - number of oscillations, $N = \dfrac{T}{T_a}$;

T - storm duration, s;

T_a - average zero-crossing period of wave, s, $T_a = 2\pi\sqrt{\dfrac{m_0}{m_2}}$;

m_i - the *i*th spectral moment, $m_i = \int_0^\infty w^i S_x(w)\,dw$;

$S_x(w)$- spectral density.

For low-frequency motion, T_a can be the natural period T_e of mooring floating structure, which can be calculated according to the following formula:

$$T_e = 2\pi\sqrt{m/c}$$

Where: *m* - the mass of floating structure and includes the low-frequency attachment mass, kg;

c - mooring system stiffness, taking the value when the mooring floating structure is at the average position, kN/m.

The duration of storm shall be determined according to specific conditions, generally no less than 3h.

4.3.8 Fiber rope

4.3.8.1 Unlike steel components, the stiffness of Fiber ropes generally increases with the increase of average load and decreases with the range of cyclic load and the release of load with time. The stiffness of fiber rope may also change with load frequency and load history. When fiber rope is used in single point mooring system, the characteristics of the selected fiber rope shall be considered.

4.3.8.2 In mooring system design, fiber rope stiffness *EA* is defined as follows

$$EA = \Delta T / \Delta\varepsilon$$

Where: ΔT - the change value of fiber rope tension, kN;

$\Delta\varepsilon$ - strain value in the length direction of fiber rope;

The dimensionless stiffness K_r of fiber rope is defined as follows

$$K_r = EA / P_B$$

Where: EA - stiffness of fiber rope, kN;

P_B - minimum breaking load of fiber rope, kN.

In the design of single point mooring system, because the stiffness of fiber rope is nonlinear and related to many factors such as load and material, two models are usually used to simulate: upper and lower boundary stiffness model and static and dynamic stiffness model.

(1) Upper and lower boundary model

In this method, the lower stiffness of fiber rope is used to evaluate the motion of floating structure, and the upper stiffness of fiber rope is used to evaluate the maximum tension of mooring line.

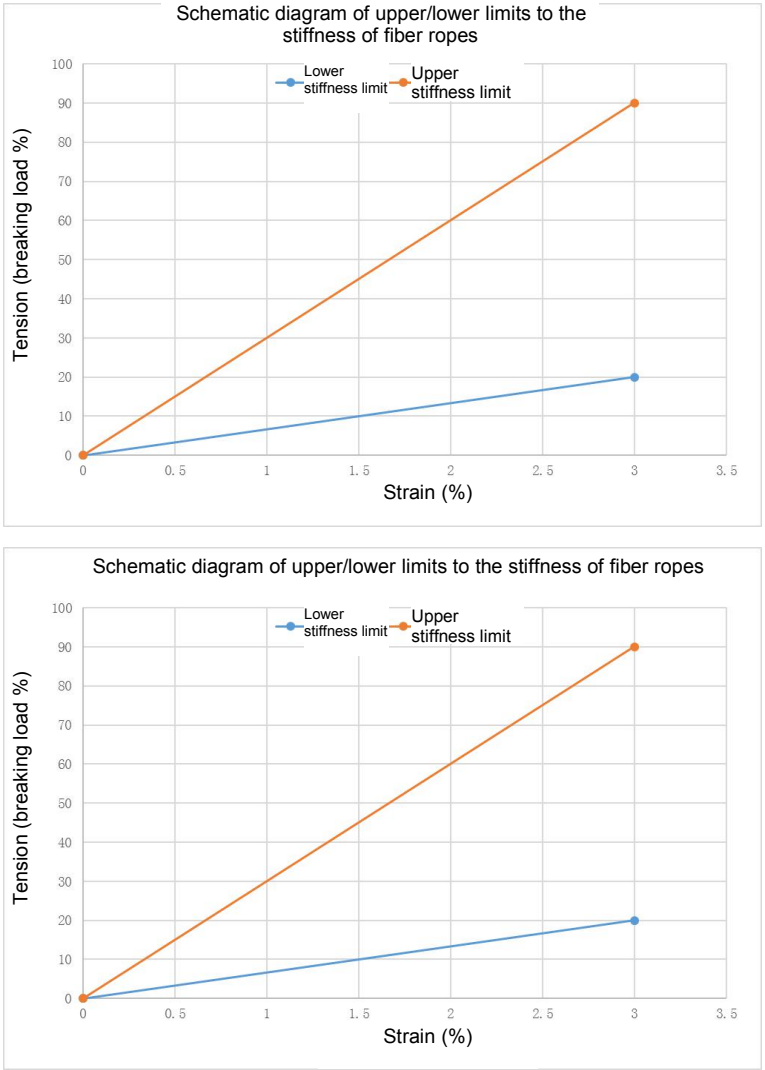


Figure 4.3.8.2 (a) Upper-lower Limit Diagram of Fiber Rope Stiffness

(2) Static-dynamic stiffness model

In this method, the mean response of floating structure is calculated by static stiffness, the dynamic stiffness is calculated by formula, and then the motion of floating structure and the maximum tension of mooring line are calculated by dynamic stiffness. The calculation formula of dynamic stiffness is as follows,

$$K_{rd} = \alpha + \beta T_m + \gamma T_A + \delta \log P$$

Where: T_m - mean tension, kN;

T_A - load amplitude, kN;

P - load cycle, s;

$\alpha, \beta, \gamma, \delta$ - corresponding coefficient.

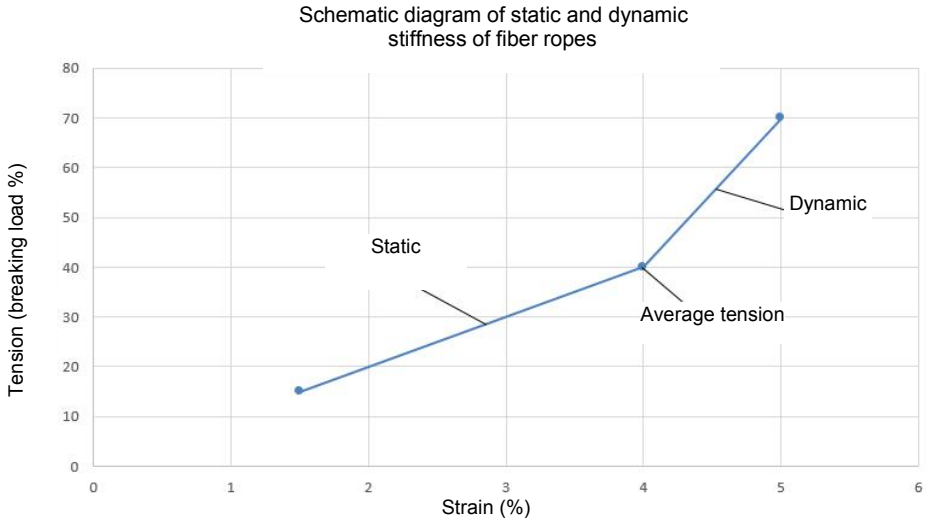


Figure 4.3.8.2 (b) Schematic Diagram of Static-Dynamic Stiffness of Fiber Rope

In fatigue design, a suitable nonlinear stiffness curve (such as piecewise linear curve or polynomial curve) can be used to simulate the stiffness of fiber rope, which shall be obtained based on the test parameters of fiber rope. If other methods are used to determine the stiffness, it shall be determined through consultation with CCS.

4.3.8.3 Creep

(1) Polyester ropes and aramid ropess usually do not undergo significant creep under load, and will not be damaged due to creep fracture. Therefore, creep or creep fracture analysis is not needed in mooring design. Because of its obvious creep property, the creep performance of high molecular weight polyethylene ropes shall be evaluated in design;

(2) During the design of service life, due to creep of fiber ropes, it may be necessary to adjust the length of mooring line, and it is advisable to keep enough upper chain length for future adjustment.

Section 4 Design Criteria for Mooring System

4.4.1 General requirements

4.4.1.1 This Section applies to single point moorings moored by mooring lines.

4.4.1.2 For single point moorings containing multiple mooring lines, it shall be ensured that the sudden failure of any mooring line will not lead to successive failure of other mooring lines. For the mooring system designed as a single mooring line, it shall be considered separately according to its failure consequences. If the failure condition of mooring line is not considered, the higher safety factor of mooring line shall usually be considered.

4.4.1.3 For the mooring analysis of single point moorings positioning system, the following design conditions shall be considered:

(1) Intact survival condition: Under the specified survival environment conditions, the calculated condition of all mooring lines with complete positioning and mooring system;

(2) Damaged survival condition: Under the specified survival environment conditions and the calculated condition when any mooring line in the positioning and mooring system fails, the damage of the mooring line bearing the maximum load in the intact state does not necessarily lead to the worst mooring state. For the positioning and mooring system with quick release function, this working condition cannot be calculated, but for the system with asymmetric mooring lines, it is generally necessary to calculate this working condition. For SALM single point moorings, water inflow in one compartment of cylindrical column can be considered as an alternative. For the

propeller-assisted positioning and mooring system, the failure of a propeller or mechanical device can be considered as a substitute, but the selection of specific failure components shall be analyzed separately according to the specific situation of each project;

(3) Transient survival condition: Transient motion caused by sudden failure of any mooring line under the specified survival environment conditions. This condition is applicable to the presence of other structures adjacent to the floating structure, and the analysis shall include the moving path, orientation and mooring line tension of the floating structure during the transient motion of the mooring floating structure before reaching the new equilibrium position.

4.4.2 Friction between mooring line and seabed

The friction between mooring line and seabed can be estimated according to the following formula;

$$F_C = fLW \qquad \text{kN}$$

Where: F_C - the friction between mooring line or steel wire rope and seabed, kN;

f - the friction coefficient between the mooring line or steel wire rope and the seabed depends on the actual seabed conditions at the mooring point. When there is no exact data available, it can be accessed according to Table 4.4.2;

L - the length of contact between the mooring line or steel wire rope and the seabed, m;

W - the weight of mooring line or steel wire rope in water per unit length, kN/m.

Table 4.4.2 Friction Coefficient between Mooring Line and Seabed

	Static friction coefficient	Dynamic friction coefficient
Mooring line	1.0	0.70
Steel wire rope	0.6	0.25

4.4.3 Maximum horizontal load on anchor end

In still water, if there is a mooring line at the bottom section, the maximum horizontal load borne by the anchor end can be determined according to the following formula:

$$P = T_{\max} - Wh - F_C \qquad \text{kN}$$

Where: P - maximum horizontal load on anchor end, kN;

T_{max} - maximum tension of mooring line obtained from mooring analysis, kN;

W - weight in water per unit length of mooring rope, kN/m;

h - water depth, m;

F_C - friction between mooring line or steel wire rope and seabed, kN.

4.4.4 Design criteria for single point mooring system

4.4.4.1 The following elements of a positioning mooring system shall be checked in accordance with the requirements of this article:

(1) Mean offset and maximum offset;

(2) Mooring line tension;

(3) Length of mooring line;

(4) Bearing capacity of anchor end.

4.4.4.2 Mean offset and maximum offset of floating structures are normally specified by the owner/designer in accordance with the design requirements of the equipment, riser or other facilities.

4.4.4.3 Mooring line tension

(1) Mooring line or steel wire rope

The tension safety factor of mooring lines depends on the design conditions and the mooring analysis method adopted, and the corrosion addition and wear of mooring lines shall be considered in the analysis.

When using quasi-static analysis and dynamic analysis, the safety factor of mooring line or steel wire rope tension shall not be less than the specified value in Table 4.4.4.3. The tension safety factor F is specified as

$$F = P_B / T_{\max}$$

Where: P_B - minimum fixed breaking load of mooring line, kN;

T_{max} - maximum tension of mooring lines calculated according to the requirements of this Chapter, kN.

Table 4.4.4.3 Table of Tension Safety Factors of Mooring Lines

	Quasi-static analysis method	Dynamic analysis method
Intact survival condition	2.00	1.67
Damage survival condition (equilibrium position)	1.43	1.25
Damage survival condition (transient)	1.18	1.05

Note: ① When the dynamic analysis method is used to calculate the intact survival condition, if the safety factor of mooring line is not less than 2.50, the damaged condition may not be required.

② If different analysis methods are adopted, they shall be examined and approved by CCS.

(2) Fiber rope

When using dynamic analysis method to check fiber rope in single point mooring system, the minimum safety factor shall be no less than 1.82, and the minimum safety factor under damaged condition shall be no less than 1.43.

(3) Mooring between single point moorings and floating structure

When the floating structure is moored with single point moorings through two mooring lines (through two fairleads), the safety factor of one single mooring line under intact survival condition shall not be less than 2.50 (dynamic analysis method); when the floating structure is moored with single point moorings through a mooring line (through a fairlead), the safety factor of the single mooring line under survival condition shall not be less than 1.67 (dynamic analysis method).

(4) Single point moorings with a single mooring line

When the floating structure and the anchor end are directly connected by a single mooring line, the safety factor of the mooring line shall be increased to 3.0 (dynamic analysis method) or 3.75 (quasi-static analysis method). When the diameter of the mooring line obtained by using the above safety factor is much larger than that of the commonly used mooring line, it is advisable to use two or three mooring lines with a small diameter instead, because the fatigue life of the mooring line with a too large diameter will be significantly reduced due to manufacturing defects and excessive semi-circular bending stress at the end of the chain ring.

4.4.4.4 Length of mooring line

In the case of large grip anchors, the mooring lines shall be of sufficient length to allow a section of the mooring lines to remain in contact with the seabed even when the maximum offset of the mooring system under breakage conditions is achieved, unless it is determined by design that the mooring lines can withstand vertical loads. For mooring systems with other anchoring foundations (such as pile anchors), shorter mooring lines can be used.

Considering that the fiber rope is easy to cause damage in the process of friction with the seabed, it shall be designed to ensure that the lower end of the fiber rope is at a certain distance from the seabed.

4.4.4.5 Bearing capacity of anchor end

The friction of mooring lines on the seabed shall be considered when calculating the bearing capacity of anchor ends. The friction coefficient depends on the actual conditions of the seabed at the anchoring position and the type of mooring lines. The owner/designer shall provide the analysis report of bearing capacity of anchor ends with set anchor types and seabed conditions to CCS for review. The safety system of bearing capacity of anchor ends can be determined according to table 4.4.4.5.

Table 4.4.4.5 Safety Factor of Bearing Capacity of Anchor End

	Intact survival condition	Damage survival condition
Large grip anchor	1.5	1.0
Suction anchor/pile anchor/gravity anchor (transverse)	1.6	1.2
Suction anchor/pile anchor/gravity anchor (axial)	2.0	1.5

4.4.4.6 Analysis of propeller-assisted positioning and mooring system

For floating structures with propeller assisted positioning, part or all of the net thrust effect can be considered under all design conditions, which depends on the propeller control system and design conditions. The propeller can be controlled manually or automatically, and the allowable thrust shall be selected according to Table 4.4.4.6.

Table 4.4.4.6 Permissible Values of Thrust Effect in Propeller-assisted Mooring System

Design condition	Propeller control system	
	Manual remote control	Automatic remote control
Intact survival condition	70% of the maximum usable thrust of propellers	100% of the maximum usable thrust of propellers
Damage survival condition	70% of the maximum usable thrust of all propellers	100% of the maximum usable thrust of all propellers

Note: (1) This table is applicable to propeller systems with standby power sources;

(2) If the thrust effect of propellers is different, one propeller with maximum thrust effect shall be deducted;

(3) The calculation of the maximum available thrust shall be based on the effective mooring thrust at zero speed, and the effects of any directional confinement, floating structure motion, ocean currents, interactions between propellers and floating structure shells, and between propellers shall been taken into account.

4.4.4.7 Dynamic positioning system design

For single point moorings equipped with dynamic positioning, the design of dynamic positioning system shall refer to the relevant requirements of Chapter 11 of Part Eight of CCS *Rules for Classification of Sea-Going Steel Ships* (2018).

4.4.5 Mooring equipment

4.4.5.1 The materials, design, manufacture and test of anchors, mooring lines and their accessories, guide devices and chain/cable stopers shall meet the applicable requirements of Chapter 10 of Part One of CCS *Rules for Materials and Welding* (2018), or the relevant requirements of recognized national or international standards.

4.4.5.2 The mooring equipment and corresponding materials shall be approved by CCS and shall have a product inspection certificate issued by CCS.

4.4.5.3 The structural design of a positioning mooring system connected by a yoke shall be calculated directly. Equipment connected to the piping of the single point moorings shall be easily connected and released, and the yoke mooring shall have the possibility of rapid release.

4.4.5.4 The mooring location with mooring line shall be provided with a quick release device. The control room of the floating structure shall be equipped with monitoring equipment to display the relative position of the floating structure and the single point moorings.

4.4.5.5 The design and safe working load of the emergency release device connected to the single point moorings shall be submitted to CCS for review and CCS product inspection certificate shall be obtained.

4.4.5.6 For mooring equipment on floating structures to which single point moorings are attached, refer to the relevant requirements in the *Recommendations for Equipment Used in Bow Mooring Conventional Tankers with*

Single Point Mooring published by OCIMF.

4.4.5.7 The structural design of the connection between the ITM single point moorings and the floating structure shall be calculated directly.

4.4.5.8 The number and grip of anchors or anchor piles used in a single point positioning mooring system shall be sufficient for their intended use, see 4.4.4.5 of this Chapter.

4.4.5.9 Mooring lines

(1) Mooring lines are usually mooring lines, steel wire ropes and synthetic fiber ropes or their combinations, and mooring lines and their accessories shall meet the requirements of CCS *Rules for Materials and Welding* (2018).

(2) The minimum breaking strength of mooring line accessories shall not be lower than the minimum breaking strength of mooring line itself.

4.4.5.10 Guide devices

(1) The design of guide devices such as guide holes and guide pulleys shall allow mooring lines to slide freely in all mooring modes without excessive bending and wear of mooring lines;

(2) The guide device and its supporting structure shall be able to bear the load applied to the mooring line when it reaches its tensile strength, and its allowable stress shall conform to the provisions of Chapter 5 on combined working conditions in structural strength analysis and verification;

(3) The mooring line guide pulley shall have at least 5 grooves. The diameter of the wire rope guide device is usually not less than 20 times the diameter of the steel wire rope.

4.4.5.11 Chain/Cable stopper

(1) According to the configuration of windlass/winch, chain/cable stopper may be required;

(2) The chain/cable stopper and its supporting structure shall be able to bear the load applied to the mooring line when it reaches its tensile strength, and its allowable stress shall conform to the provisions of Chapter 5 on combined working conditions in structural strength analysis and verification.

Section 5 Fatigue Strength of Mooring System

4.5.1 General requirements

4.5.1.1 This Section is applicable to fatigue check of mooring lines of single point mooring system by *T-N* curve method. *T-N* curve shall be obtained by test. When there is no valid test data available, the parameters of *T-N* curve of 4.5.4.1 can be used.

4.5.1.2 Dynamic analysis or model tests shall be used to determine the range of mooring cable tension.

4.5.2 Cumulative damage rate

4.5.2.1 For a mooring line, the tension response for each design condition shall be calculated and the cumulative fatigue damage rate D shall be calculated as follows:

$$D = \sum \frac{n_i}{N_i}$$

Where: n_i - the number of cycles in the tension range of i;

N_i - the permissible number of cycles given by the *T-N* curve in the first tension range of i.

4.5.3 Fatigue life

4.5.3.1 The fatigue safety factor of the positioning mooring system is related to the detectable conditions and position of the components, and the fatigue safety factor of each component of the mooring line shall not be less than the specified value in Table 4.5.3.1.

Table 4.5.3.1 Fatigue Safety Factor of Mooring Cable Components

	Detectable part	Undetectable and critical components
Ratio of fatigue life to design life	3	10

4.5.4 Tension-tension (*T-T*) fatigue

4.5.4.1 *T-N* curve

T-N curve can be used to calculate the nominal tension fatigue life of mooring parts.

$$NR^M = K$$

Where: *N* - the number of cycles;

R - the ratio of tension amplitude range (bilateral amplitude) to reference breaking strength (RBS). For the reference breaking strength of ORQ, R3, R4 and R4S ordinary or connecting mooring line rings (RBS), take the minimum breaking load of ORQ ordinary mooring line rings of the same size (P_B);

M - oblique moment of *T-N* curve;

K - *T-N* curve intercept.

M and *K* values of mooring line and steel wire rope can be obtained from the test of mooring line manufacturer. If there is no reliable source of parameters, refer to the values in Table 4.5.4.1.

Table 4.5.4.1 M and K Values

Mooring component	M	K
Common stud link	3.0	1000
Common studless link	3.0	316
Multi-strand steel wire rope	4.09	$10^{(3.20-2.79r)}$
Spiral strand (single twist) steel wire rope	5.05	$10^{(3.25-3.43r)}$

Note: r in the table is the ratio of the average tension of mooring line to the reference breaking strength.

4.5.4.2 The *T-N* curve parameters of fiber rope can be obtained by test.

4.5.5 Factors affecting the fatigue life of mooring lines

4.5.5.1 The formula for calculating the fatigue life of the stud link chain cannot be applied to the chain ring with a slack gear. The fatigue life of the studless link is usually lower than that of the stud link. Studless link does not have some fatigue problems caused by the existence of gear, such as slack of gear, welding cracks of gear, sharp angle of gear root, corrosion between gear and chain ring, and defects hidden behind gear that cannot be detected by inspection. All factors affecting fatigue life shall be considered when selecting mooring line types.

4.5.5.2 The *T-N* curve of steel wire ropes is only applicable to steel wire ropes with anti-corrosion measures, including galvanized, sleeved, shielded composite, and zinc filled steel wire ropes.

4.5.5.3 The average tension will significantly affect the fatigue life of steel wire ropes, so it shall be reflected in the design curve formula.

4.5.6 Fatigue of mooring equipment such as yoke and inner turret

4.5.6.1 For fatigue of mooring equipment such as yokes and inner turrets, refer to the relevant requirements in Chapter 5.

4.5.7 Distribution of long-term environmental conditions

4.5.7.1 The long-term environmental condition distribution is a collection of all environmental conditions expected to occur in the sea area where the single point moorings are located over a long period of time. Long-term environmental distribution can be characterized by some discrete design conditions. Each design

condition consists of a datum direction and a series of datum sea conditions. Usually, 8 -12 datum directions can well represent the directional distribution of long-term environmental distribution. The number of reference sea conditions required shall generally be greater than 10, which is generally determined by sensitivity analysis.

Section 6 Anti-corrosion Design of Mooring System

4.6.1 General requirements

4.6.1.1 This Section applies to the anti-corrosion design of single point mooring systems.

4.6.1.2 Generally, the method of increasing the diameter of mooring line is used to prevent the damage of mooring line due to corrosion and wear, but this part of the diameter increased due to corrosion and wear shall not be considered in the strength analysis of mooring system.

4.6.1.3 In the design of mooring system, if T-N curve is used for fatigue analysis of R3, R4 and R4S common mooring line rings and connecting links, half of the chain diameter deducted from corrosion and wear during service period shall be considered as the mooring line diameter for fatigue analysis.

4.6 2 Corrosion detection

4.6.2.1 A more comprehensive examination shall be carried out if the following typical injuries are found during the examination:

(1) Mooring line

① The chain diameter is reduced by more than 80% of the corrosion addition;

② The rung falls off;

③ The rung of mooring line above R4 is loose;

④ Wear of worn mooring line wheels (i.e., windlass drum) that will cause mooring line damage.

(2) Steel wire rope

① Obvious flattening or area reduction;

② Wear strand barrels that will cause wire rope damage;

③ Serious wear or corrosion;

④ Broken wire.

4.6.2.2 For special survey, the thickness (diameter) of about 1% of the chain rings shall be measured. The selected chain rings shall be roughly evenly distributed in the working section of mooring line. If the appearance inspection results show that the degree of deterioration is excessive or minimal, the above inspection ratio may be increased or decreased.

4.6.2.3 A plan for in-water survey (including cleaning of mooring parts, scope and method of inspection) shall be submitted to CCS for approval. Approval of equipment, submersibles or other applicable tools used in in-water survey shall be confirmed by the surveyors. Divers who perform in-water survey shall have qualification certificates, and diving companies shall be approved by CCS.

4.6.3 Mooring line replacement

4.6.3.1 The corrosion rate should be revised according to the previous inspection and measurement results, and the remaining corrosion life of mooring lines should be evaluated in combination with the corrosion addition of mooring lines.

4.6.3.2 The mooring lines of the single point mooring system shall be replaceable, and the test and replacement scheme of mooring lines shall be given in the operation manual.

4.6.3.3 When the reduction of chain ring diameter caused by wear and corrosion of mooring line rings reaches the corrosion allowance, the damaged chain rings shall be replaced. If it is found that the mooring line rung falls off or is loose during inspection, it shall be repaired or replaced.

4.6.3.4 In the event that a typical damage of the steel wire rope referred to in Article 4.6.2.1 of this Section is found during the inspection, the owner or operator of the single point mooring system shall evaluate the damaged steel wire rope to determine whether its performance meets the design requirements, and replace the steel wire rope that does not meet the requirements in time.

4.6.3.5 For existing single point mooring systems where corrosion allowance or replacement requirements are not specified at the time of design, the criteria for mooring line replacement can be determined with reference to the *Guide for Inspection of the Operation of Mooring lines in Offshore Engineering* (IACS Rec 38).

4.6.4 Corrosion addition

4.6.4.1 The corrosion of single point mooring system in different sea areas is quite different, so the designer shall study the corrosion of the sea area where the single point mooring system is located.

4.6.4.2 Different annual average corrosion amounts can usually be selected for different parts of mooring lines. If there is no clear design data, the annual average corrosion amount of mooring line in catenary section can be 0.3mm/year, and that in possible contact with seabed can be 0.4mm/year. The annual average corrosion amount of mooring line in splash area should be determined after field investigation, and the minimum shall not be less than 0.4mm/year and the maximum shall not exceed 1.0mm/year.

4.6.4.3 The corrosion addition of mooring line shall be determined by the annual average corrosion amount of mooring line, service life and protection efficiency of anti-corrosion system, and the corrosion addition shall not be less than the accumulated corrosion amount during service.

4.6.5 Mooring line strength after corrosion

4.6.5.1 If it is necessary to evaluate the residual strength of the corroded mooring line, the calculation can be made according to the following formula:

$$P_{corr} = P_B \cdot \left(\frac{D_{corr}}{D_{new}}\right)^2 \qquad \text{kN}$$

Where: P_{corr} - minimum breaking load of mooring line after corrosion, kN;

P_B - initial minimum breaking load of mooring line, kN;

D_{corr} - mooring line diameter after corrosion, mm;

D_{new} - initial diameter of mooring line, mm.

4.6.5.2 The residual strength of corroded mooring line can be determined by finite element analysis.

Chapter 5 Structure and Equipment

Section 1 General Provisions

5.1.1 General requirements

5.1.1.1 Unless otherwise specified, this Chapter applies to single point moorings with welded steel structures.

5.1.1.2 In addition to meeting the requirements of this Chapter, the structure and equipment of single point moorings shall also meet the relevant requirements of the flag state or coastal state.

5.1.2 Drawings and documents

5.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval or reference:

(1) General arrangement of single point moorings;

(2) Instructions of single point moorings (for reference);

(3) General layout of single point moorings;

(4) Operation manual for mooring, reconnection, offloading, release and disembarkation, including methods of connection and disassembly of hoses and floating structure manifolds;

(5) Structural design specification of single point moorings;

(6) External load summary of single point moorings structure (determined by hydrodynamic analysis and mooring analysis);

(7) Environmental load analysis, motion and strength analysis of mooring floating structures and buoys (for future reference);

(8) Basic structure drawings and main section drawings;

(9) Structural drawings of superstructure and deckhouse (if applicable);

(10) Connection drawings between main structures;

(11) The global strength analysis of the structure;

(12) Rule scantling of single point moorings (for future reference);

(13) Structural fatigue analysis;

(14) Anchor foundation structure drawings;

(15) Anchorage foundation strength calculation sheet;

(16) Drawings of anti-collision devices (if applicable);

(17) Drawings of rotary supporting structure (if applicable);

(18) Padeye structure drawings and strength calculation sheet;

(19) Strength analysis of main bearing supporting structure;

(20) Structural analysis and calculation sheet of chain stopper;

(21) Calculation sheet of falling objects and collisions (if applicable);

(22) Anti-corrosion system drawings and instructions, including coating and cathodic protection;

(23) Construction and welding procedure qualification report;

(24) Basic structure drawings of main bearings;

(25) Design calculation sheet of main bearing;

(26) Basic structure drawings of locking mechanism;

(27) Strength calculation sheet of locking mechanism;

(28) Fatigue strength calculation sheet of locking mechanism.

Section 2 Materials and Welding

5.2.1 General requirements

5.2.1.1 The manufacture, test and acceptance of materials and products used in the structure and equipment of single point moorings shall comply with the relevant provisions of CCS *Rules for Materials and Welding* (2018), except as otherwise provided in this Chapter.

5.2.1.2 All materials and products approved or inspected by CCS shall be marked with CCS stamp. Materials and products that do not bear CCS imprint shall not be used on single point moorings without CCS consent.

5.2.1.3 The chemical composition, mechanical properties and test methods of materials and products not covered in this Chapter may be accepted according to relevant national standards or international standards accepted by CCS.

5.2.2 Material and steel grade

5.2.2.1 The minimum design temperature is the temperature at which the steel grade of the member is selected by considering that the brittle failure of the single point moorings structure will not occur when it is at the lowest working environment temperature. The minimum design temperature shall be calculated according to the actual measurement records of air temperature and seawater temperature in the operating sea area by the national competent department, and the statistical calculation data shall be submitted to CCS for filing. The minimum design temperature of the structure shall be determined as specified in Table 5.2.2.1:

(1) The minimum design temperature of the part of the structure exposed to the water (atmospheric area and splash area) is 5℃ below the minimum monthly average temperature in the working sea area for ten years;

Table 5.2.2.1 Steel Grade Selection

Structural member	Minimum design temperature Td (℃)	Component thickness (mm)				
		< 12	12<t≤19	19<t≤25	25<t≤35	35<t≤50
Special structural member	$T_d \geq 0$	B	D	E	E	E
	$0 > T_d \geq -10$	D	E	E	F	F
	$-10 > T_d \geq -20$	E	E	E	F	F
	$-20 > T_d \geq -30$	E	F	F	△	△
Primary structural member	$T_d \geq 0$	B	B	B	D	E
	$0 > T_d \geq -10$	D	D	D	E	E
	$-10 > T_d \geq -20$	D	E	E	E	E
	$-20 > T_d \geq -30$	E	E	E	F	F
Secondary structural member	$T_d \geq 0$	A	A	A	B	B
	$0 > T_d \geq -10$	B	B	B	D	E
	$-10 > T_d \geq -20$	B	D	D	E	E
	$-20 > T_d \geq -30$	D	D	E	E	E

Note: ① The steel grade of general strength floating structure structural steel is listed in the table. If high strength floating structure steel is used, the letter A listed in the table shall be AH32, AH36 or AH40; D shall be DH32, DH36 or DH40; E shall be EH32, EH36 or EH40; F shall be FH32, FH36 or FH40

② "△" in the table means that steel with higher requirements than F or FH32, FH36 or FH40 grade steel for floating structure must be used, and its material and brittle resistance shall be specially approved by CCS;

③ When the thickness of the component is greater than 50mm or Td is less than -30℃, the steel grade shall be specially considered by CCS.

(2) The minimum design temperature of subsea structure is 5℃ below the minimum monthly average seawater temperature in the operation area for more than ten years.

5.2.2.2 In order to prevent lamellar tearing, for special members, the ductility of the whole thickness direction of the members shall be ensured, and Z-direction steel plates shall be considered. For the primary structural members, due to the welding of plates on the surface of the components, the members may be subjected to large tensile stress along the thickness direction, resulting in lamellar tearing. Z-direction steel plates can be used, which shall comply with the relevant provisions of CCS *Rules for Materials and Welding* (2018).

5.2.2.3 Unless otherwise specified in this article, methods for tensile, impact and Z-direction tensile testing of materials for single-point moorings structures, quantity and size of tests, direction and position of sample interception and preparation of samples shall comply with the relevant provisions of CCS *Rules for Materials and Welding* (2018).

5.2.2.4 Charpy V-notch test, fracture toughness test, fatigue test and strain aging test shall comply with the relevant provisions of Chapter 1 of Part Seven of CCS *Rules for Classification and Construction of Fixed Offshore Units (1992)*.

5.2.2.5 Steel (including Z-direction steel plate) for single point moorings structure shall comply with the relevant provisions of CCS *Rules for Materials and Welding* (2018) and Section 3 of Chapter 1 of Part Seven of *Rules for Classification and Construction of Fixed Offshore Units* (1992).

5.2.2.6 Steel castings and forged steel castings for single point moorings structure shall comply with the relevant provisions of CCS *Rules for Materials and Welding* (2018) and 1.6.1 of Part Seven of *Rules for Classification and Construction of Fixed Offshore Units* (1992).

5.2.2.7 The mooring lines used in the single point moorings structure include ordinary chain rings with gear or with no gear, ordinary replacement chain rings, enlargement chain rings, end chain rings, disconnectable connection chain rings (e.g., shackles), end shackles, subsea connectors, swivel rings, and swivel shackles. Unless otherwise specified in the Rules, the requirements of the materials used shall comply with the requirements of Section 3 of Chapter 10 of Part One of CCS *Rules for Materials and Welding* (2018).

5.2.2.8 The material and test requirements of large grip anchor shall meet the requirements of CCS *Rules for Materials and Welding* (2018).

5.2.3 Welding

5.2.3.1 Except as otherwise provided in this Section, the welding, inspection and nondestructive detection of structures shall also comply with the relevant provisions of Part Three of CCS *Rules for Materials and Welding* (2018)

5.2.3.2 Welders participating in structural welding construction shall hold the welder qualification certificate recognized in Part Three of CCS *Rules for Materials and Welding* (2018).

5.2.3.3 Effective supervision shall be provided to ensure that effective controls are in place at all stages of the assembly and welding operations.

5.2.4 Welding materials

5.2.4.1 Unless otherwise specified in this Section, the welding materials for the construction of single point moorings shall also comply with the relevant provisions of Chapter 2 of Part Three of CCS *Rules for Materials and Welding* (2018).

5.2.4.2 The storage, storage and use of welding materials and the test and inspection of welding materials for special structural members shall comply with the relevant requirements of 2.2.2 and 2.2.3 of Part Seven of CCS *Rules for Classification and Construction of Fixed Offshore Units* (1992).

5.2.5 Welding process approval

5.2.5.1 Before the construction of the single point moorings, the manufacturer shall formulate the welding process specification according to its structure, and conduct the welding process approval test according to the relevant provisions of Part Three of CCS *Rules for Materials and Welding* (2018).

5.2.5.2 The steel plate used for the welding process approval test and the steel plate used for the single point

moorings shall be of the same steel grade and shall be CCS qualified products.

5.2.5.3 The effective scope of welding process approval test shall comply with the relevant requirements of 2.3.2 of Part Seven of CCS *Rules for Classification and Construction of Fixed Offshore Units* (1992).

Section 3 General Principles of Design

5.3.1 General requirements

5.3.1.1 The requirements of this Chapter apply to all structural elements of single point moorings except the mooring system. See Chapter 4 for the requirements of mooring system equipment. The structure of fixed single point moorings shall comply with the relevant provision of CCS Rules for Classification and Construction of Fixed Offshore Units (1992).

5.3.1.2 The structure of mooring floating structures shall comply with the relevant requirements of CCS *Rules for Classification of Sea-Going Steel Ships* (2018), *Rules for Classification of Mobile Offshore Units* (2020) and *Rules for Classification of Offshore Floating Devices* (2020).

5.3.1.3 The mooring floating structure at the connection point of the single point moorings or fairlead and connecting link in the single point moorings shall be of sufficient strength and stiffness. They should be able to withstand the maximum mooring load and effectively transfer the mooring load and distribute it as evenly as possible among the relevant members.

5.3.2 Category of structural members

5.3.2.1 According to the severity of the impact on the structure of the single point moorings after the failure of the member, the member can be divided into:

(1) Secondary structural member: The failure of this kind of structural members will not affect the overall integrity of the structure;

(2) Primary structural members: This kind of structural members plays an important role in maintaining the overall integrity of the structure;

(3) Special structural members: This is a kind of structural members that transmit extreme load and may have high stress concentration, which is the most important to structural integrity.

5.3.3 Selection of steel

5.3.3.1 Steel grades for structural members shall be selected in accordance with Section 2 of Chapter 5.

5.3.4 Loading conditions

5.3.4.1 This article specifies the design load conditions for single point moorings during their service life, and the corresponding allowable stresses shall be selected in accordance with Sections 4 to 7 of this Chapter.

During the construction, transportation and installation stages, allowable stress shall be determined based on the probability of occurrence of the load concerned, the importance of the component and the possible consequences of failure, and shall be approved by CCS. The safety factor in the construction, transportation and installation stages should not be less than the requirements of static load conditions.

5.3.4.2 At least three design conditions shall be considered:

(1) Static load conditions: Including all dead loads such as gravity load, buoyancy and hydrostatic load, mooring load and riser load. The maximum variable load required for operation shall also be considered;

(2) Operational loading conditions: Including static load suitable for normal operation, environmental load within design limit and mooring load. If the static load is the same as the survival loading condition, the operational loading condition may not be considered;

(3) Survival loading conditions: Including the corresponding static load, environmental load and mooring load under the design extreme environmental conditions.

5.3.5 Design environmental conditions

5.3.5.1 The environmental conditions of the structural design shall be consistent with those of the mooring system and comply with the requirements of Section 2 of Chapter 4.

5.3.6 Rule scantling

5.3.6.1 For CALM single point structure, the watertight outer plate shall meet the following requirements:

(1) Side and bottom plate

The thickness *t* of the outer plate shall not be less than the value calculated according to the following formula:

$$t = 4sf\sqrt{Kh} + 2.5\text{mm, and no less than 9mm}$$

Where: s - spacing between stiffeners, m;

f - length-width ratio coefficient of the grid, $f = \frac{1}{\alpha}\left(1.21\sqrt{\alpha^2 + 0.33} - 0.69\right)$, which is not more than 1.0;

α - length-width ratio of grid, long side to short side;

K - for material coefficient, see 1.6.1.3 of Chapter 1 of Part Two of *Rules for Classification of Mobile Offshore Units* (2020);

h - vertical distance from the lower edge of the plate to 1.4 times the maximum working draft, m, not less than 6.0m.

(2) Stiffeners

The section modulus W of stiffeners shall not be less than the value calculated according to the following formula:

$$W = 8.2sKhl^2 \qquad \text{cm}^3$$

Where: s - spacing between stiffeners, m;

K - for material coefficient, see 1.6.1.3 of Chapter 1 of Part Two of Rules for Classification of Mobile Offshore Units (2020);

h - vertical distance from the midpoint of span of stiffeners to 1.4 times the maximum working draft, m, not less than 6.0m;

l - span of stiffeners, m.

The inertia moment I of stiffeners shall not be less than the value calculated according to the following formula:

$$I = \frac{2.3Wl}{K} \qquad \text{cm}^4$$

Where: W - section modulus of stiffeners;

l - span of stiffeners, m;

K - for material coefficient, see 1.6.1.3 of Chapter 1 of Part Two of *Rules for Classification of Mobile Offshore Units* (2020).

5.3.6.2 For CALM single point structure, the deck shall meet the following requirements:

(1) Deck plate

The plate thickness t shall be not less than the value calculated according to the following formula and not less than 7.0mm:

$$t = 4.5sf\sqrt{Kh} + t_0$$

$$t = 12s\sqrt{K}$$

Where: s - spacing between stiffeners, m;

t_0 - coefficient, 2.5 the deck forming the liquid tank boundary; 0 in other cases;

f - length-width ratio coefficient of the grid, $f = \frac{1}{\alpha}(1.21\sqrt{\alpha^2 + 0.33} - 0.69)$, which is not more than 1.0;

K - material coefficient, see 5.3.6.1;

h - calculation pressure head, m, equivalent to the pressure head of the design load, $h = 0.14p + 0.3$, where p is the design deck load, kN/m^2, and p shall be calculated according to the actual deck load in the calculation, and the value shall not be less than 4.5kN.

(2) Deck stiffeners

The section modulus W of stiffeners shall not be less than the value calculated according to the following formula:

$$W = 5sKhl^2 \qquad \text{cm}^3$$

Where: s - spacing between stiffeners, m;

K - material coefficient, see 5.3.6.1;

h - calculation pressure head, m; equivalent to the pressure head of the design load, $h = 0.14p + 0.3$, not less than (0.02L+0.76), where p is the design deck load, kN/m^2, L is the buoy length, m, and the value of p in the calculation is shown in (1) of this article;

l - span of stiffeners, m.

(3) Deck truss

The section modulus W of deck truss shall not be less than the value calculated according to the following formula:

$$W = 5bKhl^2 \qquad \text{cm}^3$$

Where: b - width of truss support area, m;

K - material coefficient, see 5.3.6.1;

h - calculation pressure head, m; equivalent to the pressure head of the design load, $h = 0.14p + 0.3$, not less than (0.02 L +0.76), where p is the design deck load, kN/m^2, L is the unit length, m, and the value of p in the calculation is shown in (1) of this article.

l - truss span, m.

5.3.6.3 For other types of single point structures, the component dimensions shall be determined based on the results of direct calculation, and the initial dimensions may refer to the provisions of this Section.

5.3.7 Check criteria

5.3.7.1 Structural analysis shall be carried out according to design conditions, and the yield failure criteria and buckling failure criteria of single point structures shall comply with the provisions of Section 4 of Chapter 3 of Part Two of *Rules for Classification of Mobile Offshore Units* (2020).

5.3.7.2 The fatigue check of single point structure shall comply with the provisions of Section 5 of Chapter 3 of Part Two of the *Rules for Classification of Mobile Offshore Units* (2020).

Section 4 CALM Single Point Structure

5.4.1 General requirements

5.4.1.1 In addition to the special requirements of this Section, the CALM single point structure shall also meet the applicable requirements of this Chapter and CCS *Rules for Classification of Offshore Floating Devices* (2020).

5.4.1.2 This Section is applicable to the design of CALM single point structure, which mainly includes turntable buoy single point structure and turret buoy single point structure.

5.4.1.3 The foundation shall be designed to meet the applicable requirements of Section 8 of this Chapter.

5.4.2 Loading conditions

5.4.2.1 In the strength analysis of buoy single point structure, at least typical load conditions such as operation condition, survival loading condition, transit loading condition and installation condition shall be considered. When necessary, special consideration shall be given to accident conditions. Special attention shall be paid to typical load conditions under survival conditions and accident conditions in design.

5.4.2.2 The environmental return period for survival conditions is generally not less than 100 years, and if the consent of the administration is obtained, a return period of no less than 50 years may be adopted. At the same time, it shall meet the applicable requirements of Chapter 2 and CCS *Rules for Classification of Offshore Floating Devices* (2020).

5.4.2.3 Accident conditions shall include load conditions in which one mooring line is broken.

5.4.2.4 Transit loading condition is the loading condition that transports the buoy single point structure from the construction site to the operation sea area to prepare for the subsequent installation of subsea mooring line. The return period of the sea area environment of the transit route for the transit loading condition is 10 years; for predetermined transit routes and window periods, if appropriate, design loads can be obtained based on seasonal environmental conditions.

5.4.2.5 Installation condition is the load condition of buoy single point structure for lifting operation or connecting mooring line and hose at construction site or operation sea area.

5.4.3 Design load

5.4.3.1 For each design condition, the static load condition and the combination of static load and environmental load shall be considered. The environmental load shall be calculated according to the applicable requirements of Chapter 4, and the corresponding calculation criteria for various design conditions shall be taken according to the requirements of Section 3 of this Chapter.

5.4.3.2 Operation conditions:

(1) The static load is the buoy single point structure weight, fixing device weight, hose weight, mooring line weight, ballast weight, operation load and buoyancy corresponding to the operation state;

(2) The environmental load shall be the maximum wind, wave and current elements or loads allowed for normal operation in the operation manual, the load of positioning mooring, the load of hose, and the load of cable and hose connecting floating structures.

5.4.3.3 Survival condition:

(1) The static load is the buoy single point structure weight, fixing device weight, hose weight, mooring line weight, ballast weight and buoyancy corresponding to the survival state;

(2) The environmental load shall be the maximum wind, wave and current elements or loads, positioning and anchoring loads and riser loads in the survival of structure in the operation manual.

5.4.3.4 A mooring line is damaged under accident conditions:

(1) The static load is the buoy single point structure weight, fixing device weight, hose weight, mooring line weight, ballast weight and buoyancy corresponding to the accident state;

(2) The environmental load shall be the maximum wind, wave and current elements or loads, positioning and anchoring loads and riser loads in the survival of structure in the operation manual.

5.4.3.5 Transit loading conditions:

(1) The static load is the weight of buoy single point structure, the weight of fixing device, etc.;

(2) If the buoy single point structure is dry towing, the environmental load is the load produced by the motion acceleration of the transport ship under a given environmental condition on the buoy single point structure.

(3) If the buoy single point structure is wet towing transit, the environmental load can refer to Appendix 1 of CCS *Maritime Towing Guide* (2011).

5.4.3.6 Installation conditions:

(1) The static load is the weight of buoy single point structure, the weight of fixing device, etc.;

(2) The dynamic amplification factor shall be considered when lifting the buoy single point structure. For details, please refer to Section 3.3 of Chapter 3 of CCS *Rules for Lifting Appliances of Ships and Offshore Installations* (2007).

5.4.3.7 The ice load shall be considered for CALM single point moorings operating in ice areas.

5.4.4 Fatigue check

5.4.4.1 Fatigue problems caused by cycling stress shall be considered in the design of connecting members.

5.4.4.2 Fatigue analysis and check shall generally be carried out in accordance with the stress range, and simplified methods and criteria may also be used, subject to CCS approval.

5.4.4.3 Fatigue analysis and verification of components can be carried out by *S-N* curve method or fracture mechanics method. Fatigue calculation can refer to the requirements of Chapter 5 of CCS *Guidelines for Fatigue Strength Assessment of Offshore Engineering Structures* (2013).

5.4.4.4 The fatigue safety factor can be selected according to Table 4.1.1 of Chapter 4 of CCS *Guidelines for Fatigue Strength Assessment of Offshore Engineering Structures* (2013).

5.4.4.5 The stress concentration factor and hot spot stress can be calculated according to the applicable requirements of Chapter 3 of CCS *Guidelines for Fatigue Strength Assessment of Offshore Engineering Structures* (2013).

5.4.4.6 The *S-N* curve can be calculated according to the applicable requirements of Section 5 of Chapter 2 of CCS *Guidelines for Fatigue Strength Assessment of Offshore Engineering Structures* (2013).

5.4.4.7 When a process causing cycling stress in structural hot spots includes wave frequency and low-frequency components (such as chain stopper structure, which bears mooring line load including wave frequency and low frequency components), fatigue calculation can be carried out according to the applicable requirements of Section 3 of Chapter 6 of CCS *Guidelines for Fatigue Strength Assessment of Offshore Engineering Structures* (2013). A more accurate method for calculating fatigue damage is to simulate the combined stress process in time domain, and calculate the number of stress cycles by rain flow counting method for each sea state. The cumulative fatigue damage of structural hot spots is calculated by summing up the damage caused by all sea states, and the occurrence probability of each sea state is given by the wave scatter diagram.

5.4.5 Buoy structure

5.4.5.1 Buoy structure means a buoyant watertight cylinder structure. The cylinder and internal components of the buoy shall be designed according to the requirements of 5.4.2 and 5.4.3, and the strength shall be checked according to 5.3.7 and 5.4.4. The dimensions of outer plate and stiffeners shall meet the requirements of 5.3.6. Members bearing hosing or mooring loads shall be specially strengthened to have sufficient strength and stiffness.

5.4.6 Rotary supporting structure

5.4.6.1 The rotary supporting structure for supporting bearings in fluid swivel for conveying goods shall meet the requirements of this article. The structural strength of the supporting structure shall meet the strength requirements of ordinary structural parts. Usually, a turntable type rotary supporting structure is adopted. The turntable is supported on the fixed part by rolling elements (rollers, cylinder, ball, etc.) and rotates together with bearings. Turntable rotary supporting structure can be roughly divided into two types: roller type and rolling bearing type.

5.4.6.2 The strength, fatigue, deformation and wear of rotary supporting structure shall be checked, and due consideration shall be given to the interaction between the supporting ring and its support.

5.4.6.3 In general, the strength shall be checked according to the maximum load of each design working condition and meet the requirements of 5.3.7. For each component or section to be checked, the most unfavorable combination of horizontal load F_H, vertical load F_V and overturning moment M acting simultaneously shall be considered according to the form of single point moorings.

Taking the roller supporting turntable on the buoy as an example, its simplified stress mode is shown in Figure 5.4.6.3. Horizontal load F_H, vertical load F_V and overturning moment M can be determined as follows:

$$F_H = F_M \cos\alpha \quad \text{kN}$$

$$F_V = G - F_M \sin\alpha \quad \text{kN}$$

$$M = F_M \cos\alpha \, h + G\, e \quad \text{kN.m}$$

Where: F_M - mooring line load, kN;

G - gravity of turntable (including inertia force caused by heaving motion of buoy), kN;

a - angle between mooring line load and horizontal direction;

h - vertical distance between the center of gravity of the turntable and the buoy, m;

e - eccentricity of the center of gravity of the turntable, m.

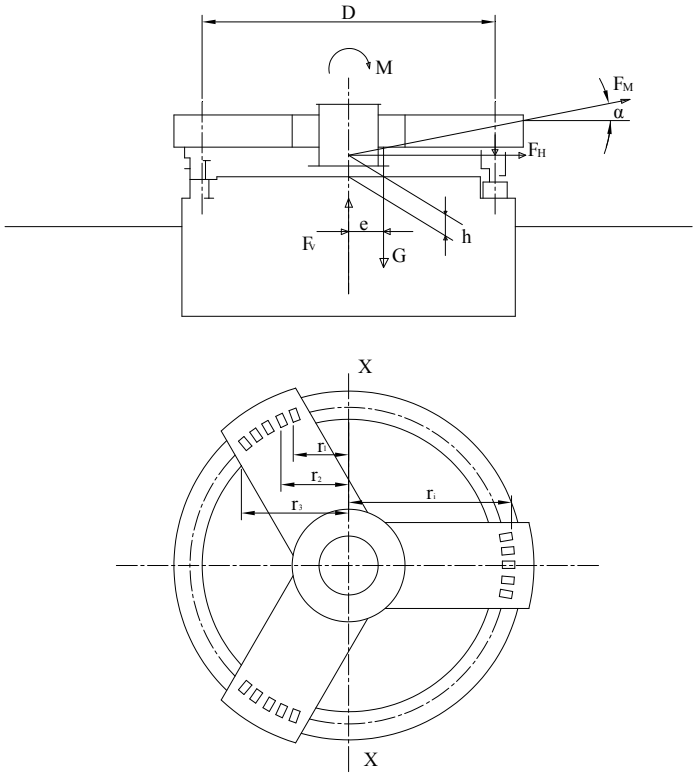


Figure 5.4.6.3 Bearing Force Mode of Roller Support

5.4.6.4 The roller pressure can be calculated as follows:

$$N_{\max} = \frac{Fv}{n} + \frac{MD}{2\sum r_i^2} \quad \text{kN}$$

$$N_{\min} = \frac{Fv}{n} - \frac{MD}{2\sum r_i^2} \quad \text{kN}$$

Where: N_{max}, N_{min} - maximum and minimum wheel pressures, respectively;

F_v, M - see 5.4.6.3;

n - the number of pressure-bearing rollers located on the circular orbit;

D - the diameter of the circular orbit, m;

$\sum r_i^2$ - the sum of the squares of the distance from the center of the loaded roller to the plane *X-X* (see Figure 5.4.6.3), m^2;

$$\sum r_i^2 = r_1^2 + r_2^2 + r_3^2 + \cdots$$

Its horizontal load shall be borne by the central shaft pivot, that is, by the bearing in the fluid swivel; or horizontal rollers shall be installed in the roller set to bear horizontal loads.

5.4.6.5 The bearing mode of rolling bearing type support is shown in Figure 5.4.6.3. There are two methods in the design and calculation of rolling bearing rotary supporting structure, one without considering the axial clearance, the other with considering the axial clearance. Different allowable stresses are taken respectively, and a simple algorithm without considering axial clearance can be adopted in preliminary design, see 5.4.6.6. When more accurate calculation results need to be obtained, the method of considering axial clearance can be adopted.

5.4.6.6 The load distribution on the rolling element is shown in Figure 5.4.6.6 (1). The maximum load on the rolling element can be determined by the following method:

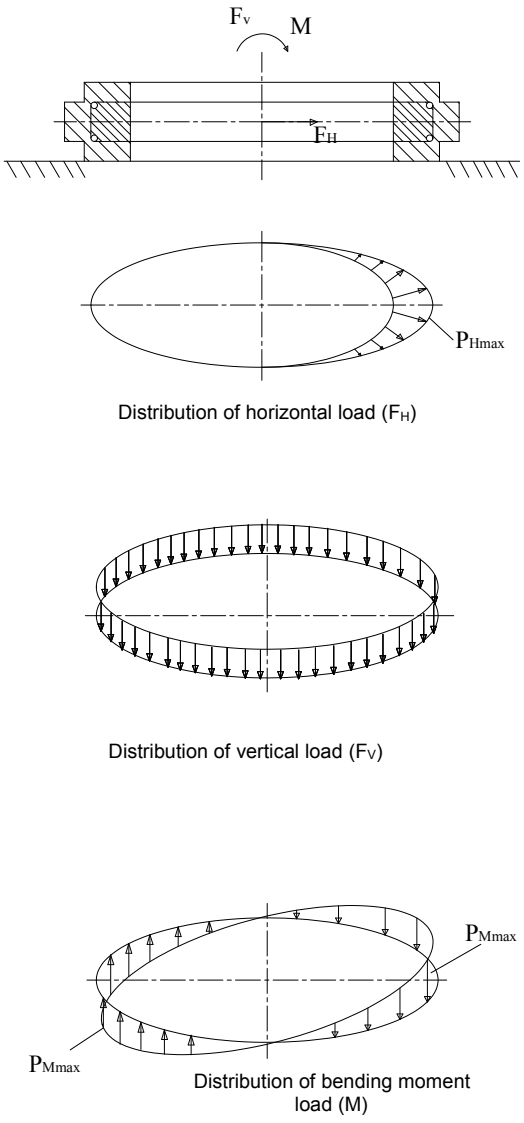


Figure 5.4.6.6 (1) Schematic Diagram of Load Distribution on Rolling Element

(1) The vertical counter-force P_V acting on each rolling element is determined by the following formula:

$$P_V = \frac{F_V}{Z} \quad \text{kN}$$

Where: F_v - the vertical force of the rotating support device, kN, see 5.4.6.3;

Z - the number of rolling elements in a row subjected to vertical forces.

(2) The maximum horizontal counter-force P_{Hmax} on the rolling element produced by the horizontal force F_H is determined by the following formula

$$P_{H\max} = \frac{KF_H}{iZ} \qquad \text{kN}$$

Where: i - the number of rows of rolling elements bearing horizontal forces;

F_H - horizontal force kN of the rotary supporting structure, see 5.4.6.3;

K - coefficient related to the shape of rolling element and roller path stiffness, K=4-4.5 for roller bearings; K=4.5-5 for ball bearings; when the roller path stiffness is small, small value is taken when the stiffness is large.

（3）Maximum vertical counter-force P_{Hmax} of rolling element caused by force distance M

$$P_{M\max} = \frac{KM}{ZD} \qquad \text{kN}$$

Where: D - diameter of the center circle of the rolling element, m;

M - torque of the rotating supporting structure, kN·m, see 5.4.6.3.

(4) Under the combined action of vertical force F_V, horizontal force F_H and moment M, the maximum normal force on the rolling element is determined by the following formula:

$$N_{\max} = \frac{P_V}{Sin\beta} + \frac{P_{H\max}}{\cos\beta} + \frac{P_{M\max}}{Sin\beta} \quad \text{kN}$$

Where: β - the angle between the normal of the contact point between the rolling element and the roller path and the horizontal line (contact angle), see Figure 5.4.6.6 (4).

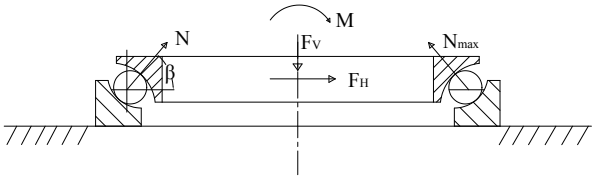


Figure 5.4.6.6 (4) Force Diagram When Contact Point Normal is Not Parallel to Bearing Axis

5.4.6.7 Generally, only the contact strength of roller path is checked. Roller bearing roller path shall be calculated according to line contact:

$$\sigma_{linear_{\max}} = 600\sqrt{\frac{N_{\max}}{lr_{conversion}}} < [\sigma_{linear}]_{\max} \qquad \text{N.mm}^{-2}$$

Ball bearing roller path shall be calculated according to point contact:

$$\sigma_{po\,\text{int}_{\max}} = 4000\sqrt[3]{\frac{N_{\max}}{r^2_{conversion}}} < [\sigma_{po\,\text{int}}]_{\max} \qquad \text{N.mm}^{-2}$$

Where: N_{max} - the maximum positive pressure between the rolling element and the roller path, kN, see 5.4.6.4;

l - length of contact line, cm;

$r_{conversion}$ - converted radius of curvature at the contact, which can be calculated according to the formula listed in Table 5.4.6.7;

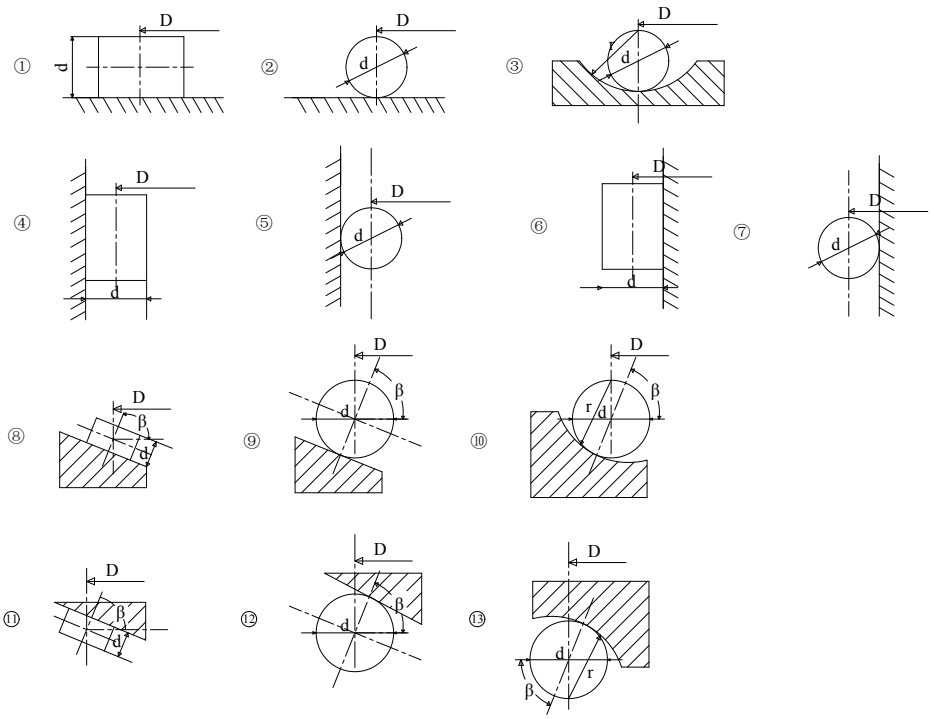
$[\sigma_{linear}]_{max}$, $[\sigma_{point}]_{max}$ - maximum allowable contact stress for line contact and point contact.

When HB < 300, take $[\sigma_{linear}]_{max}$ = (2-2.5) HB, $N \cdot mm^{-2}$;

When HRC > 30, take $[\sigma_{linear}]_{max}$ = (20-25) HRC, $N \cdot mm^{-2}$; take $[\sigma_{point}]$ max = (2-2.5) $[\sigma_{line}]_{max}$.

5.4.6.8 For bearings (without redundancy) that are subjected to overturning moment *M* by vertical counter-force, the strength of bearing races and fixing bolts shall be checked.

Table 5.4.6.7 Conversion Radius of Curvature between Rolling Element and Roller Path under Various Contact Conditions



Drawing No.	$\frac{1}{r_{conversion}}$	Drawing No.	$\frac{1}{r_{conversion}}$	Drawing No.	$\frac{1}{r_{conversion}}$	Drawing No.	$\frac{1}{r_{conversion}}$
1	$\frac{2}{d}$	4	$\frac{2}{d}-\frac{2}{D+d}$	8	$\frac{2}{d}-\frac{2\cos\beta}{D+d\cos\beta}$	11	$\frac{2}{d}+\frac{2\cos\beta}{D-d\cos\beta}$
2	$\frac{4}{d}$	5	$\frac{4}{d}-\frac{2}{D+d}$	9	$\frac{4}{d}-\frac{2\cos\beta}{D+d\cos\beta}$	12	$\frac{4}{d}+\frac{2\cos\beta}{D-d\cos\beta}$
3	$\frac{4}{d}-\frac{1}{r}$	6	$\frac{2}{d}+\frac{2}{D-d}$	10	$\frac{4}{d}-\frac{2\cos\beta}{D+d\cos\beta}-\frac{1}{r}$	13	$\frac{4}{d}+\frac{2\cos\beta}{D-d\cos\beta}-\frac{1}{r}$
		7	$\frac{4}{d}+\frac{2}{D-d}$				

5.4.6.9 The fatigue calculation shall meet the requirements of 5.4.4 of this Chapter.

5.4.6.10 For the support which bears the overturning moment *M* by vertical counter-force and has no redundancy, the fatigue strength of local section of bearing race and fixing bolts shall be checked.

5.4.6.11 The applicable fatigue criteria for the partial section of the bearing race shall be determined from the test results of the bearing, depending on the particular type of bearing.

5.4.6.12 For the fixing bolts connecting the bearing fixing race and the supporting part, the fatigue of the bolts shall be prevented by applying prestress to the bolts to reduce their stress changes. If there is no more accurate method, the required prestress can be determined according to the assumption that the stiffness of the race support is infinite. On this assumption, the prestress shall be sufficient to prevent the bearing race from being lifted off or rotated about the support under a load corresponding to the monthly average maximum bolt force. If prestress is

applied by tightening nuts, the maximum allowable bolt prestress is 70% of $\sigma_{0.2}$; if the prestress is applied by simply tensile bolts, it is 90% of $\sigma_{0.2}$.

5.4.6.13 The rotary supporting structure shall meet the durability requirements, and its durability mainly involves the wear and fatigue of rolling elements and roller paths, as well as the performance of support deformation.

5.4.6.14 Under normal use, the deformation of the bearing race shall not exceed a certain limit. If there is no precise method, the deformation can be checked by simply analyzing the following conditions:

(1) Rotation of the race section at the maximum stretch point (usually at the rear);

(2) Separation of the roller path at the maximum compression point (usually at the front). The criteria adopted can be negotiated with the bearing manufacturer and approved by CCS.

5.4.6.15 The hardness of rolling elements and roller paths as well as the number and size of rolling elements, shall be such that the contact deformation and subsurface shear stress do not exceed certain limits. The criteria adopted can be negotiated with the bearing manufacturer and approved by CCS.

5.4.6.16 The supporting structure of the bearing race shall be designed to minimize in-plane bending, out-of-plane bending and torsional deformation of the race itself.

5.4.6.17 The above deformation can be minimized by adjusting the difference between the force applied to the rolling element and the force applied to the supporting structure and by making the supporting structure sufficiently rigid. The supporting structure shall be of sufficient strength and stiffness to satisfy the calculation assumptions for bearing races and fixing bolts, see 5.4.6.6.

5.4.6.18 The force on the supporting structure shall be transmitted to the main structure as evenly and smoothly as possible to prevent fatigue of the supporting structure.

5.4.7 Universal joint

5.4.7.1 Universal joints used to hinge between single point moorings and the sea floor, or between parts of single point moorings, shall meet the requirements of this article.

5.4.7.2 The strength and durability of universal joints shall be checked.

5.4.7.3 In general, the strength shall be checked according to the maximum load of each design working condition and meet the requirements of 5.3.7.

5.4.7.4 The fatigue calculation shall meet the requirements of 5.4.4 of this Chapter. Fatigue of bolts shall be prevented by applying tensile prestress to supporting fixing bolts to reduce their stress changes. See 5.4.6.12 for the maximum allowable bolt prestress.

5.4.7.5 The rotation angle of the universal joint shall exceed at least 20% of the angle corresponding to the maximum movement of the single point moorings.

5.4.7.6 The abrasion resistance of the bearing surface shall be determined based on abrasion tests under appropriate conditions or effective engineering experience.

5.4.7.7 Sealing supports shall prevent seawater and impurities from penetrating. If it is necessary to update the sealing device on site, the update method shall be submitted to CCS for approval.

5.4.8 Anti-collision device

5.4.8.1 Light signal equipment shall be provided in accordance with the relevant provisions of the administration or as required by Chapter 9 to reduce the likelihood of collision. The following measures shall also be taken to reduce the consequences of collisions:

(1) The design of the shape and layout of the single point moorings shall make it move laterally or slide with the collision structure as much as possible. The shape of the collision-prone area shall be round and have a smooth surface, and the structure extending out of the main body shall not collide with the bow of the mooring floating structure;

(2) A fender shall be set in the collision-prone area, and the relevant main structure shall be locally strengthened;

(3) Watertight subdivision or other measures to prevent flooding in case of local damage (such as filling empty cabins with lightweight foam materials) shall be adopted.

5.4.8.2 The fender structure shall be of appropriate strength and stiffness. The energy absorbed by the fender shall be determined according to the specific situation, with due consideration for the following factors:

(1) The mass of single point moorings and mooring system characteristics;

(2) Energy absorption effect of surrounding water;

(3) Position of riser;

(4) Floating structure dimensions.

5.4.9 Padeye

5.4.9.1 Padeyes such as mooring line padeyes and lifting padeyes shall meet the requirements of this article. The strength and fatigue of padeyes shall be checked.

5.4.9.2 Strength check shall be carried out according to the maximum load that padeyes may bear. The force mode of padeyes is shown in Figure 5.4.9.2.

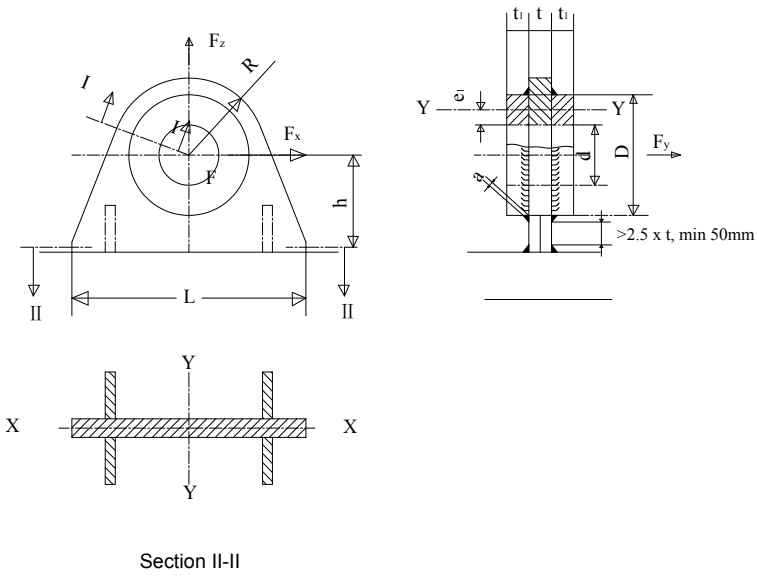


Figure 5.4.9.2 Force Mode of Padeyes

(1) I-I section: The converted stress σ_e shall be calculated according to the following formula and shall not exceed the allowable converted stress $[\sigma_e]$:

$$\sigma_e = \sqrt{F_z^2\left(\frac{1}{2A_1}+\frac{d+2e_1}{15W_{1y}}\right)^2+3\left(\frac{F_x}{2A_{s1}}\right)^2} \le [\sigma_e] \qquad \text{N.mm}^{-2}$$

$$[\sigma_e] = \frac{\sigma_s}{1.25} \qquad \text{N.mm}^{-2}$$

Where A_1 - area of section I-I, mm^2;

A_{s1} - shear area of section I-I (related to force F_x), mm^2, when $D/2R \ge 0.8$, $A_{s1} = A_1$;

W_{1y} - modulus of section I-I on y-y axis, mm^3;

e_1 - distance between the neutral axis and the orifice edge of padeye in section I-I, mm;

D - diameter of doubling plate, mm;

R - radius of padeye, mm;

d - opening diameter of the padeye, mm;

σ_s - material yield stress, N·mm^{-2};

F_x, F_y, F_z - force component in X, Y and Z directions on the padeye, N.

(2) Section II-II: Normal stress under the simultaneous action of axial tension and bending. It shall be calculated according to the following formula, which is not greater than the allowable normal stress [σ]:

$$\sigma = \frac{F_z}{A_2} + \frac{F_x h}{W_{2y}} + \frac{F_y h}{W_{2x}} \le [\sigma] \qquad \text{N.mm}^{-2}$$

$$[\sigma] = \frac{\sigma_s}{1.45} \qquad \text{N.mm}^{-2}$$

Where: A_2 - area of section II-II, mm^2;

h - vertical distance between the center of the padeye and section II-II, mm^2;

W_{2x}, W_{2y} - modulus of section II-I with respect to x-x and y-y *axes,* mm^3;

Shear stresses τ_x and τ_y shall be calculated according to the following formula and shall not exceed the allowable shear stress [τ]:

$$\tau_x = \frac{F_x}{A_{s2x}} \le [\tau] \qquad \text{N} \cdot \text{mm}^{-2}$$

$$\tau_y = \frac{Fy}{A_{s2Y}} \le [\tau] \qquad \text{N} \cdot \text{mm}^{-2}$$

$$[\tau] = \frac{\sigma_s}{2.16} \qquad \text{N} \cdot \text{mm}^{-2}$$

Where: A_{s2x}, A_{s2y}- shear area of section II-II (related to forces F_x and F_x, respectively), mm^2, A_{s2x}=A_{s2y}=A_2=tl for rectangular cross section (t x l).

(3) The welding connection between the padeye doubling plate and the padeye shall be checked according to the following formula:

$$\tau \approx \frac{\sqrt{F_x^2 + F_z^2}}{D\pi a} \frac{t_1}{t + 2t_1} \le [\tau]$$

$$[\tau] = \frac{\sigma_s}{1.77}$$

Where: a - throat thickness, mm, the minimum throat thickness shall be determined by the following formula and shall not be less than 3mm:

$$a_{\min} = 1.5\sqrt{\frac{t + t_1}{3}}$$

t, t_1 - is the thickness of the padeye and the doubling plate, respectively, in mm.

5.4.9.3 The fatigue calculation shall meet the requirements of 5.4.4 of this Chapter.

5.4.10 Yoke

5.4.10.1 Yoke means a hard-connected mooring element between a mooring floating structure and single point moorings. Yokes can usually be divided into buoyant container type and non-buoyant container type.

5.4.10.2 The yielding strength, buckling strength and fatigue of yokes shall be checked.

5.4.10.3 A three-dimensional (or two-dimensional, if applicable) structural model (including boundary conditions) equivalent to the actual structure shall be established, and the strength of structural members shall be checked according to the duration of mooring loads (including wave frequency and low frequency loads) under survival loading conditions, structural dead weight and buoyancy (for vessels with buoyancy), and the requirements of 5.3.7 shall be met.

When necessary, the influence of inertial force shall also be considered. The duration of mooring load shall be determined according to the results of model test in general, and can be determined according to the applicable calculation method in the preliminary design stage.

5.4.10.4 For the yoke of disconnectable single point moorings, when the mooring floating structure is released, it shall be considered that the yoke may be affected by wave impact and sea ice action.

5.4.10.5 The fatigue calculation shall meet the requirements of Section 5.4.4 of this Chapter.

5.4.10.6 Yoke connections to single point moorings and mooring floating structures are generally hinged. The hinge connection between yoke and buoy is complicated, which may be double-axis or three-axis rotating ring connection.

5.4.10.7 In addition to the mooring load, the influence of inertia force caused by the uncoordinated rolling of mooring floating structure, yoke and buoy shall also be considered for the hinge between yoke and mooring floating structure.

5.4.10.8 The strength and fatigue of hinge joints shall be checked according to approved standards.

Section 5 SALM Single Point Structure

5.5.1 General requirements

5.5.1.1 In addition to the special requirements of this Section, the SALM single point structure shall also meet the applicable requirements of this Chapter.

5.5.1.2 This Section is applicable to the design of SALM single point structure.

5.5.1.3 Subsea foundations shall be designed to meet the applicable requirements of Section 8 of this Chapter and the *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design* (API RP-2A-WSD).

5.5.1.4 For bearings, the applicable requirements of 5.4.6 of this Chapter shall be met.

5.5.1.5 For padeyes, the applicable requirements of 5.4.9 of this Chapter shall be met.

5.5.1.6 The mooring cable connection members shall be designed to meet the applicable requirements of 5.6.8.2 of this Chapter.

5.5.1.7 The buoy structure shall be designed to meet the applicable requirements of Section 3 of this Chapter.

5.5.1.8 Fatigue analysis of mooring line connection members and buoy structures shall meet the applicable requirements of 5.4.4 of this Chapter.

Section 6 Turret Single Point Structure

5.6.1 General requirements

5.6.1.1 In addition to the special requirements of this Section, the turret single point structure shall also meet the applicable requirements of this Chapter and/or CCS *Rules for Classification of Offshore Floating Devices*(2020).

5.6.1.2 This Section is applicable to the design of turret single point structure, which mainly includes disconnectable inner turret single point structure, permanent mooring inner turret single point structure and external turret single point structure.

5.6.1.3 The anchored foundations shall be designed to meet the applicable requirements of Section 8 of this Chapter.

5.6.1.4 The padeyes shall be designed to meet the applicable requirements of 5.4.9 of Section 4 of this Chapter.

5.6.1.5 For the rapid disconnectable single point structure, the typhoon exempt environmental conditions can be determined according to the operation sea area environment, and shall not be less than the 100 years return period environmental conditions of non-typhoon environment.

5.6.1.6 The design life of the turret single point structure shall be consistent with the design life of the connected floating structure.

5.6.1.7 The anti-corrosion design of turret single point structure shall meet the applicable requirements of Section 9 of this Chapter; for cathodic protection design, current loss from turret single point structure to connected floating structure shall be prevented.

5.6.1.8 Turret type single point structure shall meet the following functional requirements:

(1) Connecting with floating structures under design environment conditions, and keep structural integrity and weathervane effect;

(2) Providing connecting terminals for mooring lines and risers; bearing all loads of mooring lines and risers;

(3) Smoothly transferring the load of mooring lines and risers to floating structure through bearings;

(4) Supporting and bearing all loads in swivel operation;

(5) The turret type single point structure shall maintain structural integrity when a mooring line is broken or a locking mechanism fails; (if applicable)

(6) It includes multiple watertight compartments, and when one compartment is damaged, the turret type single point structure shall be able to maintain structural integrity (if applicable);

(7) During installation, the turret type single point structure shall be able to maintain stability and support the load of mooring lines and risers.

5.6.2 Loading conditions

5.6.2.1 In the strength analysis of turret single point structure, at least the following typical working conditions shall be considered:

(1) Operation conditions (connecting with floating structures);

(2) Survival conditions (connecting floating structures);

(3) Transit loading conditions;

(4) Installation conditions (lifting, connecting mooring lines and risers, free floating);

(5) Accidental conditions (connecting floating structure, one mooring line is broken);

(6) Accidental conditions (connecting floating structure, one locking mechanism fails);

(7) Accidental conditions (free floating, one compartment is damaged).

5.6.3 Design load

5.6.3.1 For each design condition, the static load condition and the combination of static load and environmental load shall be considered. The environmental load shall be calculated according to the applicable requirements of Chapter 4, and the corresponding strength criteria for various design conditions shall be taken according to the applicable requirements of Section 3 of this Chapter.

5.6.3.2 Refer to Table 5.6.3.2 for load information corresponding to each typical working condition.

Table 5.6.3.2 Load Information Corresponding to Typical Working Conditions

Basic load\ working condition *	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Self-weight	√	√	√	√	√	√	√
Pretension	√	√			√	√	
Mooring load	√	√		√**	√	√	√
Riser load	√	√		√**	√	√	√
Swivel load	√	√			√	√	
External hydrostatic pressure	√	√			√	√	√
Hydrostatic pressure of liquid tank				√			√
Additional weight load				√			√
Acceleration of transport barge			√				

Note: * Refer to 5.6.2.1 for working condition numbers;

** Turret is connected with mooring lines and risers.

5.6.4 Fatigue check

5.6.4.1 The fatigue calculation of turret single point structure shall meet the applicable requirements of 5.4.4 of this Chapter.

5.6. 5 Turret structure and buoy structure

5.6.5.1 The category of structural members shall meet the requirements of 5.3.2 of this Chapter. Components are specifically classified as:

(1) The special structural members include: bearing supporting structure, lifting point structure for lifting, and padeye structure for connecting mooring lines;

(2) Primary structural members include: swivel pedestal, bulkhead, outer plate, stiffener and guide tube;

(3) Secondary structural members include: protective structures such as turret fender.

5.6.5.2 Turret structure and buoy structure refer to buoyant watertight structure. The outer plate and internal components of the buoy shall be designed according to the requirements of 5.6.2 and 5.6.3, and the strength shall be checked according to 5.3.7 and 5.6.4. In addition, the dimensions of outer plates and stiffeners shall meet the requirements of Section 7 of Chapter 7 of Part Two of CCS *Rules for Classification of Offshore Floating Devices* (2020). Members bearing hosing or mooring loads shall be specially strengthened to have sufficient strength and stiffness.

5.6.5.3 In the finite element analysis of turret structure and buoy structure, all outer plates, bulkheads and stiffeners shall be simulated by shell element, thick plates and shells or bearing supporting structures (castings) shall be simulated by body element, and the coupling connection between shell element and body element shall be reasonably set to transmit bending moment load.

5.6.5.4 Pretension shall be applied to the structure connected to the locking mechanism, and the pretension value shall be provided by the equipment manufacturer.

5.6.5.5 The buckling calculation and analysis of turret structure and buoy structure shall meet the requirements of 5.3.7 of this Chapter and CCS *Guidelines for Buckling Strength Evaluation of Offshore Engineering Structures* (2015). For installation conditions, when the external water pressure is too high and the structural buckling analysis does not meet the requirements of CCS *Guidelines for Buckling Strength Evaluation of Offshore Engineering Structures* (2015), the finite element buckling analysis check can be carried out and submitted to

CCS for approval.

5.6.5.6 When the turret structure and buoy structure are hoisted and assembled on site, lifting analysis shall be carried out.

5.6.6 Main bearing

5.6.6.1 There are generally two types of main bearings: rolling bearings and self-lubricating bearings; rolling bearings shall be designed to meet the requirements of 5.4.6 of this Chapter, and self-lubricating bearings shall meet the requirements of this Section.

5.6.6.2 In the design of self-lubricating bearings, the following factors shall be considered:

(1) External load;

(2) Wear;

(3) Environmental conditions.

5.6.6.3 When the floating structure rotates around a single point, the sliding length of the self-lubricating bearing can be calculated as follows:

$$s = 4\sqrt{2} \cdot R \cdot \nu_z \cdot t \cdot \sigma_\gamma \cdot \Gamma\left(\frac{3}{2},\ \left(\frac{\alpha}{\sqrt{2}\sigma_\gamma}\right)^2\right)$$

Where: R - bearing radius;

ν_z - yaw motion zero-crossing frequency;

t - time period of yawing motion;

σ_γ - yawing standard variance;

α - effective yawing angle (3°) when the bearing starts to rotate;

$\Gamma(,)$ - incomplete gamma function.

$$\Gamma(a,\ z) = \int_z^\infty t^{a-1}e^{-t}dt$$

Before the floating structure starts to rotate around the turret single point moorings, the mooring system will rotate at an angle with the floating structure due to friction. If the friction coefficient of the bearing is 0.1, before the bearing starts to rotate, the single point moorings will rotate with the floating structure in the range of 5°-10°; with the increase of angle, the bearing pressure will increase and the mooring stiffness will increase.

In the formula of sliding length of self-lubricating bearing in this paragraph, the influence of initial rotation angle is filtered out. In the formula, the effective yawing angle (3°) of bearing rotation is between 1/3 and 1/2 of the actual operation value, which is relatively conservative.

In the South China Sea area, based on the sliding length formula of self-lubricating bearings, the annual sliding length can be 700 times the bearing circumference.

5.6.6.4 The wear thickness of bearing pressure surface can be calculated as follows:

$$w = Kps \cdot 10^{12}$$

Where: w - wear thickness, mm;

K - wear factor, m^3/Nm, to be determined by the equipment provider;

p - nominal bearing pressure, MPa;

s - slip length, km;

10^{12} - unit correction, $mm^3/(m^2.km)$.

5.6.7 Locking mechanism

5.6.7.1 The locking mechanism shall be used for fixing floating structures and turret structures, and the strength check shall meet the requirements of 5.3.7 of this Chapter.

5.6.7.2 The pre-tension value of the locking mechanism shall be determined by the equipment supplier.

5.6.7.3 The supporting structure of locking mechanism is an important stressed member and shall have sufficient structural strength. The vertical load and horizontal load of the supporting structure of the locking mechanism shall be accurately simulated for structural strength and fatigue analysis.

5.6.8 Chain stopper

5.6.8.1 This article applies to chain stopper structures or other connecting members for turrets and mooring lines, and the yield strength check shall meet the requirements of 5.3.7 of this Chapter.

5.6.8.2 The chain stopper structure or other connecting members (such as connecting link, shackles, fairlead, etc.) used for turrets and mooring lines shall be able to bear the breaking load of mooring lines; after the mooring line is broken, the connecting members shall be able to keep the structure integrity.

5.6.8.3 The structural fatigue analysis shall meet the requirements of 5.4.4 and 5.6.4 of this Chapter. The fatigue load spectrum is determined by rain flow counting method from the time series load of mooring line under different sea states.

5.6.9 Swivel pedestal

5.6.9.1 The swivel pedestal is located at the upper part of the turret structure, and its main function is to support the slip ring and the slip ring operating platform.

5.6.9.2 The check of yielding and buckling strength of swivel pedestal shall meet the requirements of 5.3.7 of this Chapter, and the following basic loads shall be considered in the analysis:

(1) Self-weight;

(2) Inertial load;

(3) Slip ring torque;

(4) Piping load;

(5) Variable load of slip ring operating platform;

(6) Explosion load, floating structure heeling 15° (if applicable).

5.6.9.3 The fatigue strength analysis of swivel pedestal shall meet the requirements of 5.4.4 and 5.6.4 of this Chapter. The following factors shall be considered in structural fatigue calculation:

(1) Horizontal acceleration of slip ring;

(2) Vertical acceleration of slip ring;

(3) Torque of slip ring torsion.

5.6.9.4 The swivel pedestal shall be bolted to connect the turret structure and slip ring, and the maximum pre-tightening force of the bolts shall meet the product requirements of the equipment manufacturer.

Section 7 SYMS Single Point Structure

5.7.1 General requirements

5.7.1.1 In addition to the special requirements of this Section, the SYMS single point structure shall also meet the applicable requirements of this Chapter.

5.7.1.2 This Section is applicable to the design of SYMS single point structure, which mainly includes overwater SYMS single point structure and subsea SYMS single point structure. SYMS single point structure is mainly composed of jacket foundation, mooring head, mooring arm, mooring leg and floating structure mooring frame.

5.7.1.3 The anchored foundations shall be designed to meet the applicable requirements of Section 8 of this Chapter.

5.7.1.4 For bearings, the applicable requirements of 5.4.6 of this Chapter shall be met.

5.7.1.5 For padeyes, the applicable requirements of 5.4.9 of this Chapter shall be met.

5.7.1.6 For SYMS single point structure working in ice area, ice load calculation and analysis shall be carried out.

5.7.1.7 SYMS single point structures operating in seismic active areas shall be subjected to seismic calculation and analysis.

5.7.2 Jacket foundation

5.7.2.1 The strength design of jacket foundation shall meet the applicable requirements of CCS *Standards for Construction and Inspection of Shallow Sea Fixed Units* (2004) and *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design* (API RP-2A-WSD).

5.7.2.2 The basic loads of jacket foundation include dead weight, wind load, wave and current load, mooring load, and mooring load and other basic loads, which are combined in the most unfavorable case for structural strength analysis.

5.7.2.3 The strength analysis criteria shall meet the requirements of 5.3.7 of this Chapter.

5.7.2.4 Fatigue calculations of jacket foundations shall meet the applicable requirements of 5.4.4 of this Chapter. In fatigue load, wave frequency and low frequency components in mooring load shall be considered.

5.7.3 Mooring head

5.7.3.1 The mooring head is located at the upper part of the jacket foundation and consists of a rotating bearing support, a rotating bearing, a turntable, a slip ring and a hose cradle.

5.7.3.2 The hose cradle of the mooring head shall protect the hose from the mooring arm and legs.

5.7.3.3 The basic load of mooring head includes dead weight, and variable load and wind load of piping and jumper hose, and the basic load is combined in the most unfavorable case for structural strength analysis.

5.7.3.4 The strength analysis criteria shall meet the requirements of 5.3.7 of this Chapter.

5.7.3.5 Fatigue calculation of mooring head structure shall meet the applicable requirements of 5.4.4 of this Chapter.

5.7.4 Mooring arm

5.7.4.1 The mooring arm is composed of rolling-pitching hinge and A-shaped steel pipe frame. The mooring arm is connected with the jacket through rolling-pitching hinge joint, and connected with the mooring leg through padeye and universal joint. There are ballast tanks on the components on both sides of the rear end, which can provide restorement load for the mooring system.

5.7.4.2 The basic loads of mooring arm and rolling-pitching joint include axial load, pitching direction load, pitching vertical load, bearing bending moment, pitching angle and rolling angle, and the basic loads are combined in the most unfavorable cases for structural strength analysis.

5.7.4.3 The strength analysis shall meet the requirements of 5.3.7 of this Chapter.

5.7.4.4 The fatigue load of the mooring arm shall be determined by the calculation and analysis of the mooring system, and the fatigue calculation shall meet the applicable requirements of 5.4.4 of this Chapter.

5.7.5 Mooring leg

5.7.5.1 The mooring leg is a steel pipe with axial bearings, the lower end of which is connected with the lifting lug of the mooring arm ballast tank by universal joints, and the upper end of which is connected with the lifting lug on the mooring frame of floating structure by universal joints with axial thrust bearings; the body of universal joint is made of cast steel and the shaft is made of forged steel.

5.7.5.2 The basic loads of mooring legs include dead weight and mooring load, and the basic loads are combined in the most unfavorable cases for structural strength analysis.

5.7.5.3 The strength analysis criteria shall meet the requirements of 5.3.7 of this Chapter.

5.7.5.4 The fatigue load of the mooring leg shall be determined by the calculation and analysis of the mooring system, and the fatigue calculation shall meet the applicable requirements of 5.4.4 of this Chapter.

5.7.6 Floating structure mooring frame

5.7.6.1 The floating structure mooring frame is a steel pipe space frame structure welded in the reinforced area of the floating structure; the frame suspends a certain distance from the bow of the floating structure, so that there is a certain gap between the floating structure and the mooring arm when the floating structure moves under heavy wind and waves.

5.7.6.2 The basic load of mooring frame of floating structure includes dead weight, motion acceleration and mooring load, and the basic loads are combined in the most unfavorable cases for structural strength analysis.

5.7.6.3 The strength analysis criteria shall meet the requirements of 5.3.7 of this Chapter.

5.7.6.4 The fatigue load of mooring frame of floating structure shall be determined by the calculation and analysis of mooring system, and the fatigue calculation shall meet the applicable requirements of 5.4.4 of this Chapter.

Section 8 Anchorage Foundation

5.8.1 General requirements

5.8.1.1 The basic forms of single point moorings can generally be divided into:

(1) Towing type;

(2) Pile type;

(3) Suction type;

(4) Gravity type.

5.8.1.2 In order to ensure that the single point moorings can work normally under the working environment and have a certain degree of safety under extreme environmental conditions, the strength and stability of the foundation structure and the bearing capacity of the foundation shall be analyzed and checked.

5.8.1.3 Possible remedial measures for failure to meet design requirements during construction of the infrastructure shall be studied and specified prior to construction.

5.8.1.4 The likelihood of relative displacement of the seabed relative to the foundation member shall be investigated and the forces resulting from such displacement shall be estimated and taken into account in the foundation design.

5.8.1.5 Seabed scour caused by current and wave action may cause the foundation to lose the corresponding supporting capacity. The seabed scour situation in the sea area where the single point moorings are located shall be investigated. If there is scour phenomenon, it shall be considered during design or necessary measures shall be taken to mitigate it.

5.8.1.6 The provisions of this Section also apply to the foundations of other installations (e.g., subsea pipeline terminal manifolds, etc.).

5.8.1.7 Prior to construction of single point moorings, the applicant shall submit a site survey report to CCS for review, including, if possible, information on geophysics, geomorphology and soil properties of similar areas in adjacent areas.

5.8.1.8 The foundation structure shall be designed to ensure that stress, displacement and fatigue in the anchor and surrounding soil do not exceed permissible limits during and after installation. The basic system above the mud surface shall include the parts required for inspection and maintenance. The testing range, testing time and maintenance requirements shall be appropriate to the redundancy required for overall safety and performance.

5.8.2 Towed foundation

5.8.2.1 The grip force of towed embedded anchor is related to the type of anchor and the performance of anchor deployment.

5.8.2.2 Normally, empirical methods are used to estimate the grip of anchors.

5.8.2.3 The embedding and grip force of anchors in soft clay can be calculated by analytical method based on the principle of finite equilibrium.

5.8.2.4 Accurate grip is determined after anchoring and loading tests.

5.8.3 Pile foundation

5.8.3.1 The pile body design of steel pipe piles for single point moorings shall comply with the provisions of the Rules on strength, stability, materials, welding, anti-corrosion, etc. in addition to the provisions of this Section.

5.8.3.2 The uplift resistance and lateral displacement resistance of pile foundation are mainly related to the size of pile, the way of pile installation and loading, the type and stiffness of pile and the strength of soil near pile.

5.8.3.3 Special structures, such as aprons or wings, can be added to the top of the pile to increase the horizontal bearing capacity of the pile foundation.

5.8.3.4 The internal forces and deformation of piles under transverse loads can generally be obtained by solving differential equations of pile shaft deflection or by finite element method. The nonlinear characteristics of soil and the influence of scour, slip and pile sinking on soil disturbance should be considered in the calculation.

5.8.3.5 The axial bearing capacity of piles is determined by the following methods:

(1) Field test;

(2) Static formula;

(3) Dynamic formula of pile (formula based on wave propagation theory);

(4) Regional semi-empirical formula.

For pile foundation design, the bearing capacity can be determined by the above method, but the dynamic formula cannot be used alone. It is best to use several kinds of methods to determine comprehensively.

5.8.3.6 For pile group in cohesive soil, when the pile spacing is less than 8 times the pile diameter, the influence of pile group effect on bearing capacity and deformation characteristics shall be considered. In sandy soil, the influence of pile group effect on bearing capacity may not be considered.

5.8.4 Suction foundations

5.8.4.1 Suction foundations are generally of all-steel cylindrical structure.

5.8.4.2 Suction foundation design includes penetration and recovery, bearing capacity, analysis of soil response or soil-structure interaction in structural design.

5.8.4.3 Suction foundations shall be designed to withstand the maximum loads on the anchors due to the following factors: mooring line load, maximum negative pressure for anchor penetration, maximum internal pressure for anchor pulling out, and load during anchor lifting, loading, launching, sinking and recovery. It is necessary to determine the fatigue life of key components and high stress areas of anchors and check whether they meet the minimum fatigue life requirements.

5.8.4.4 The influence of mooring cable geometry in soil on foundation load shall be considered.

5.8.5 Gravity foundation

5.8.5.1 Gravity foundations generally consist of concrete or steel blocks, scrap metal or other high-density materials.

5.8.5.2 The design of gravity foundation shall have sufficient safety degree. For a given failure mode, check its safety factor to prevent gravity foundation from being damaged under design load.

5.8.5.3 When considering the hydraulic stability of foundation, the following conditions shall be studied, and the influence of cyclic load shall be paid attention to:

(1) Softening of soil and reduction of bearing capacity due to seepage pressure;

(2) Piping formed with the internal erosion of soil;

(3) Surface erosion caused by deformation caused by environmental load in the partially exposed area of gravity foundation bottom.

5.8.5.4 Settlement and movement of the structure due to deformation and vibration of the gravity foundation shall not hinder the normal operation of the single point moorings. The influence of dynamic response of gravity foundation shall be considered. The natural frequency or stiffness of the combined system of structure and gravity foundation shall be checked and adjusted if necessary to avoid resonance or excessive vibration caused by periodic loads such as wave force.

5.8.5.5 Counter-force resisting all structural soil reactions placed or inserted into the seabed shall be included in the design loads of structural members. The distribution of soil counter-force shall be determined according to the strength distribution and deformation characteristics of foundation soil, and the seabed topography and foundation shape shall be considered.

Section 9 Structural Anti-corrosion

5.9.1 Scope of application

5.9.1.1 The anti-corrosion protection described in this Chapter applies to single point moorings.

5.9.1.2 All steel structures shall be effectively protected against overall damage due to corrosion. Effective protection systems generally include coatings, metallic coatings, cathodic protection, corrosion addition or other approved methods and are approved by CCS. For single point moorings, multiple protection methods can be adopted at the same time. When designing an anti-corrosion protection system, pay special attention to the design life of the device and the maintainability of protection.

5.9.1.3 In addition to the explicit requirements of this Section, the anti-corrosion protection system shall also meet the applicable requirements of CCS *Guidelines for Anticorrosion Inspection of Hull Structure* (2009).

5.9.2 Definitions

5.9.2.1 Splash area: The outer area with alternation of wetting and drying under the action of draft changes and waves.

5.9.2.2 Atmospheric area: The outer area above the splash area.

5.9.2.3 Submerged area: The outer area below the splash area.

5.9.2.4 Corrosion addition: Increased thickness of components beyond design strength to compensate for corrosion loss.

5.9.2.5 Internal area: Ballast tanks, liquid tanks and other compartments.

5.9.3 External area protection

5.9.3.1 Recommended minimum protection requirements for steel structures outside single point moorings are:

(1) The protection of the main structure in the submerged area includes cathodic protection and coating product;

(2) The main structure in the splash area is protected by coating;

(3) All structures in the atmospheric area are protected by coating only.

5.9.4 Internal area

5.9.4.1 Ballast tanks can be protected by coating or both coating and cathode.

5.9.5 Corrosion addition

5.9.5.1 The structural corrosion addition shall be determined according to the service life of the single point moorings, the annual average corrosion amount of steel and the protection efficiency of the anti-corrosion system. If it is impossible to determine the annual average corrosion amount of steel and the protection efficiency of the anti-corrosion system, the corrosion addition of the submerged area structure of the single point moorings with a service life of 30 years shall not be less than 2mm; the corrosion addition of splash area structure is generally not less than 14mm in the South China Sea and not less than 10mm in other sea areas.

5.9.5.2 Component dimensions calculated and determined according to the provisions of this Chapter or other

structural design methods do not include corrosion addition. Therefore, corrosion allowance shall be considered in a unified manner in combination with the location, environmental conditions, working conditions and anti-corrosion measures of the components, and the corrosion allowance shall meet the requirements of CCS. However, the dimensions of buoy members determined according to the requirements of Section 3 of this Chapter have been included in a certain corrosion addition, and when effective corrosion control measures are adopted, the dimensions of members need not be increased.

Section 10 Accessories

5.10.1 General requirements

5.10.1.1 Accessory mechanical equipment such as hoists, winches, quick connection and release devices shall be designed in accordance with applicable industry standards, rules and published recommendations.

5.10.2 Connecting link

5.10.2.1 Connecting accessories such as shackles or detachable connecting link shall be made of cast or forged materials. They shall be adequately tested using NDT methods (magnetic particle testing, membrane permeation, eddy current testing, etc.) in accordance with recognized standards. For cast connecting link, X-ray or ultrasonic testing methods shall be used to check internal casting defects. In addition, casting and forging shall meet the energy requirement of 40 joules at-20 $^{\circ}$C for Charpy V-shaped cuts. Kent type connecting link shall meet the requirements of the *Rules for Mooring Chain* (API Specification 2F). Inspection, mechanical, verification and fracture tests for other types of connecting link shall meet similar requirements or other recognized standards.

5.10.3 Winch equipment

5.10.3.1 The winches shall meet the requirements of the Rules *Marine Structures - Mobile Offshore Units - Anchor Winches* (ISO 9089) and Section 4.11 of the IMO *Rules for Construction and Equipment of Mobile Offshore Drilling Units* (IMO MODU Code).

5.10.4 Monitoring equipment

5.10.4.1 Mooring line tension

(1) If mooring lines need to be adjusted during operation, the mooring floating structure shall be equipped with a calibrated mooring line tension measuring system, and the mooring line tension shall be continuously displayed on each winch. For floating structures that do not need to be installed with tension measuring devices, devices with failure of monitoring mooring installation shall be considered;

(2) For floating structures equipped with propellers to reduce mooring line tension, a method for indicating mooring line tension and/or floating structure offset shall be provided. This method shall have appropriate redundancy to cover single fault requirements.

5.10.4.2 Mooring line arrangement

Mooring floating structures that require mooring line adjustment during operation need to be equipped with a system to monitor mooring line arrangement.

5.10.4.3 Floating structure position

For mooring floating structures, if there is a limit to the offset of floating structures during operation, it is necessary to install a floating structure position monitoring system. If applicable, semi-rigid connections to fixed objects (such as trestles connecting supply ships and single point moorings) can be used to monitor the position of floating structures. For mobile drilling system operations, the positioning system shall be able to give the orientation and distance relative to the wellhead or riser connection point. For floating structures equipped with dynamic positioning, at least two methods shall be used for position measurement, and for floating structures with artificial thruster auxiliary system, at least one method shall be used for position measurement.

5.10.4.4 Heading angle of floating structure

Floating structures connected with single point moorings shall be equipped with heading angle monitoring devices. If the heading of the floating structure needs to be controlled, at least two sets of heading angle monitoring devices shall be installed. If the heading is automatically controlled, the accuracy and frequency of the two sets of heading angle monitoring devices shall meet the requirements of automatic control.

5.10.5 Mooring buoys

5.10.5.1 Typical mid-line buoys are made of steel or synthetic materials. The maximum immersion depth of the buoy shall be classified according to the analysis of the intact working condition of the mooring system and the broken working condition of one cable. Maximum safe working depths of intermediate buoys shall be based on analysis and/or tests using appropriate or recognized design and manufacturing standards.

5.10.5.2 Centerline buoys shall be designed to meet the following conditions:

(1) If the buoy is not a level that can maintain the maximum working water depth under any circumstances, the buoy shall remain floating on the water surface under the intact working condition and the one failure working condition;

(2) If the buoy and internal bulkhead are not at a level that can inhibit sinking when any compartment is flooded, the buoy shall be able to float on the water surface when the mooring system is intact but one compartment of the buoy is flooded, such as a hollow steel buoy;

(3) When the bulkhead is damaged, filling foam in the non-watertight compartment can prevent bilging. If the diving depth of foam can resist hydrostatic pressure under the maximum design, the design of water inflow in one compartment can be ignored;

(4) When a certain amount of low-density foam is filled in the compartment of the buoy, the water bilging time of the compartment will be prolonged. In this case, the percentage of bilging of the compartment shall be considered when designing the buoy;

(5) Under the maximum design environment, the buoy shall be able to resist storm waves without turning over;

(6) The buoys shall be fitted with draft marker lines or other suitable means shall be used to monitor whether the buoys are bilged.

5.10.5.3 Any buoy used for safe separation between mooring lines and other critical systems, such as piping and other mooring legs, shall be designed with sufficient clearance under all possible conditions, such as integrity, broking of one cable and bilging of one cabin, and shall be graded according to the maximum working water depth in all conditions.

5.10.5.4 For hollow buoys that are not adjacent to other structures, the consequences of their failure shall be analyzed as possible. For example, for the hollow middle buoy, bilging will cause its diving depth to be lower than its own level, which will cause the whole buoy to be completely destroyed, which shall be considered and analyzed in the design of mooring system. The following conditions shall be analyzed, including but not limited to: mooring line dynamics and mooring equipment loads caused by internal damage and rapid descent of buoys; rapid change of impact on the position of floating structure caused by buoy failure; repair of damaged buoys and mooring lines, etc.

5.10.5.5 Hardware connecting the mid-section buoys and mooring lines shall be designed in accordance with appropriate and recognized design and manufacturing specifications and in accordance with maximum hydrostatic and dynamic loads. At the same time, the wear and relaxation of the connecting link and its locking system due to buoy movement during the expected service shall be considered in the design. Buoys moving at high speed shall be inspected regularly to ensure the integrity of the connection between buoys and mooring lines. Attention shall be paid to the failure of the connection between buoy and mooring line during the expected service period or inspection week. In the design of mooring system, it shall be regarded as a damage working condition to study the result caused by the loss of buoy. In this case, the standard of damage state shall be met.

5.10.6 Counterweight block/chain

5.10.6.1 The material, shape, size, weight and connection form of the counterweight block/chain shall be configured according to the installation position of the counterweight and the parameters such as water force and wave force.

5.10.6.2 The spacing of counterweight blocks/chains shall be designed according to the requirements of operation and convenient operation.

5.10.6.3 The counterweight block shall be able to withstand impact load to avoid breakage or falling off.

5.10.6.4 The counterweight block/chain shall be designed for anti-corrosion.

5.10.6.5 When using the counterweight in the design of the mooring system, the potential adverse effects, such as increased connection hardware, installation complexity, undesired mooring line dynamic response, and the counterweight block sinking into the seabed, shall be considered.

Chapter 6 Mechanical Equipment and Systems

Section 1 General Provisions

6.1.1 General requirements

6.1.1.1 Hydraulic, pneumatic, fuel, ballast, telemetry, control and other systems installed on single point moorings shall meet the applicable requirements of CCS *Rules for Classification of Offshore Floating Devices* (2020) in addition to the provisions of this Chapter.

6.1.1.2 Pumps, compressors, pressure vessels and other marine machinery and equipment shall not only meet the requirements of this Chapter, but also meet the relevant requirements of CCS *Rules for Classification of Sea-Going Steel Ships* (2018).

6.1.1.3 Auxiliary machinery and components, such as cranes, winches, quick joints and disconnect devices, shall be designed in accordance with applicable standards and rules.

6.1.2 Drawings and documents

6.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval or reference:

(1) Mechanical equipment and system instructions;

(2) Schedule of mechanical equipment

(3) Calculation sheet of mechanical equipment;

(4) Layout of mechanical equipment;

(5) System piping and instrument drawings;

(6) Layout of sounding pipe system;

(7) Layout of ventilation device;

(8) Ventilation calculation sheet;

(9) Mechanical equipment and system test outline.

Section 2 Layout

6.2.1 Installation

6.2.1.1 Safety-related equipment such as control centers, emergency power supplies and emergency fire pumps shall not be located in the cargo transport area.

6.2.1.2 The control center, emergency power supply, associated distribution equipment and fuel tanks shall be separated from their surroundings. They shall be separated from each other by A-60 fire separation.

6.2.2 Ventilation

6.2.2.1 The machinery places shall be adequately ventilated. Air for ventilation system shall be supplied from non-hazardous areas.

6.2.2.2 The exhaust pipe of the ventilation system shall lead to the open space and shall prevent the discharged dirty air from being sucked into this system or other systems.

6.2.2.3 Ventilation systems for hazardous and non-hazardous areas shall be independent of each other.

6.2.3 Escape route

6.2.3.1 The machine places shall be provided with at least two clearly marked escape routes as far apart as possible.

6.2.3.2 Escape routes shall not be obstructed by equipment or other fixtures, and all exit doors on the access shall be easily opened.

6.2.4 Protective facilities

6.2.4.1 Handrail or other protective means shall be provided in all unenclosed platform and deck areas, in all opening areas and in places where mechanical equipment and piping may be dangerous to staff when they are working.

6.2.4.2 All mechanical equipment of which surface temperature may exceed 220℃ or may encounter combustible liquids shall be effectively protected for the purpose of fire prevention and personnel protection. If the surface of the insulation layer is oil-absorbing or may be penetrated by oil, it shall be properly wrapped with thin steel plate or similar material.

6.2.4.3 In order to avoid errors in operation and conversion of mechanical equipment and systems, safety operation instruction signs shall be provided.

6.2.4.4 The noise level of the machine places shall conform to the approved standards and if the noise cannot be sufficiently reduced, excessive noise sources shall be properly isolated or insulated. People who need to enter such places shall be equipped with ear protectors.

Section 3 General Piping and Mechanical Equipment

6.3.1 General requirements

6.3.1.1 All piping shall be welded or flanged.

6.3.1.2 For the installation and fixation of pipelines, the internal pressure and flow guarantee as well as the force generated by the conveying riser shall be fully considered.

6.3.1.3 For the design of piping system, the demand of expansion shall be fully considered. For the design pressure of piping system, the influence of hydraulic impact produced by the system shall be considered.

6.3.2 Materials

6.3.2.1 Materials shall be selected in accordance with CCS approved codes, rules and standards. The selected materials shall have sufficient strength, ductility, toughness and uniformity.

6.3.2.2 Equipment shall effectively prevent internal and external corrosion.

6.3.3 Design, manufacture and installation

6.3.3.1 Equipment subjected to pressure, such as pressure vessels, pumps and piping, shall be designed, manufactured and installed in accordance with CCS approved rules, standards and guidance documents.

6.3.4 Test

6.3.4.1 All piping shall be tested at 1.5 times the design pressure before being installed to single point moorings. For manifolds or pry blocks that have been subjected to strength tests prior to installation, a tightness test shall be carried out after installation on the single point moorings, and the test pressure shall generally not be less than 1.0 times the design pressure unless otherwise specified.

6.3.5 Inspection

6.3.5.1 Mechanical equipment shall be inspected according to the design standards used.

6.3.6 Bilge water system

6.3.6.1 Bilge water systems shall be provided for cabins and empty cabins where liquid may leak from single point moorings. Portable manual pumps can be used instead of fixed bilge systems for drainage.

6.3.7 Liquid level measurement

6.3.7.1 Manual sounding devices shall be provided for all liquid tanks and empty tanks. The sounding pipe shall have a reliable closing device.

6.3.8 Ventilation system

6.3.8.1 All liquid tanks filled or emptied by fixed pumping devices and empty tanks and pipe tunnels through which pressure piping passes shall be provided with ventilation pipes.

6.3.8.2 The ventilation pipes shall be arranged to ensure the free flow of gas in the compartment or pipe tunnel under normal operational conditions.

6.3.8.3 Termination of ventilation pipes: Ventilation openings on the open deck shall be able to prevent direct bilging of rainwater and seawater, and shall be provided with closure devices by means of reliable permanent connection.

6.3.8.4 Where a tank is pumped, the total cross-sectional area of the air pipe shall not be less than 1.25 times the effective flow area of the tank injection pipe. In any case, the inner diameter of the air pipe shall not be less than 38mm for the fresh water tank, 51mm for the ballast tank and 63mm for the oil tank. When multiple cabinets share an air pipe, the cross-sectional area of the shared air pipe shall be at least the sum of the maximum required air pipe cross-sectional areas of two tanks.

6.3.8.5 The height of the ventilation pipe on the open deck shall be such as to prevent the bilging of upwelling seawater and shall be at least 760mm above the deck. If this altitude interferes with the operation of the single point moorings, a lower altitude can be accepted upon CCS approval.

Chapter 7 Electrical Installations

Section 1 General Provisions

7.1.1 General requirements

7.1.1.1 All electrical devices related to the safety of single point moorings shall comply with the provisions of this Chapter and the applicable provisions of CCS *Rules for Classification of Offshore Floating Devices* (2020).

7.1.1.2 Other electrical equipment on the single point moorings shall be designed and installed so as not to cause fire in case of failure, and shall conform to national or international standards.

7.1.1.3 For electrical installations:

(1) Ensure power supply to all electrical equipment for normal operation of single point moorings;

(2) For CALM and single SALM single point moorings, supply power to electrical equipment necessary for safety in case of failure of solar cell or power supply subsea cable;

(3) For turret type and SYMS single point moorings, ensure to supply power to electrical equipment necessary for safety in case of failure of main power supply;

(4) Ensure the safety of personnel and single point moorings and avoid the harm of electrical accidents.

7.1.2 Drawings and documents

7.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval or reference:

(1) Electrical instructions (for future reference);

(2) Schedule of electrical equipment (including radio communication equipment) (for future reference);

(3) Power load calculation sheet;

(4) Single line drawings of switchboard, which shall be marked:

① Model, specification and setting value of protective electrical appliances;

② Measuring instrument;

③ Grounding fault monitoring and alarm;

④ Interlocking.

(5) Single line drawings of solar panel and battery charging and discharging panel, which shall be marked:

① Model, specification and setting value of protective electrical appliances;

② Measuring instrument;

③ Monitoring and alarming of grounding faults (if equipped);

④ Interlocking.

(6) Power system drawings, which shall be indicated:

① Main rated parameters of motors, solar panels, batteries and electrical equipment;

② All feeders from the distribution board;

③ Distribution plate (if equipped);

④ Model, cross-sectional area and load current of cable;

⑤ Type and main rated parameters of circuit breakers and fuses;

⑥ Transformer.

(7) Lighting (including emergency lighting and signal lights) system drawings;

(8) System drawings of safety system (if provided);

(9) System drawings of fixedly installed communication equipment (if provided);

(10) Comprehensive layout of electrical equipment (including radio communication equipment and its antenna);

(11) Automatic fire alarm and fire detection system drawings;

(12) Detection and alarm system drawings of combustible gas and hydrogen sulfide (this system must be equipped for crude oil or primary treated crude oil, but not necessarily for finished oil and non-oil and gas single point moorings).

7.1.3 Tests

7.1.3.1 Upon completion of installation of the electrical device on the single point moorings, the test shall be carried out according to the test outline approved by CCS.

7.1.4 Working and environmental conditions

7.1.4.1 Electrical equipment shall be able to work normally under the environmental conditions and working conditions specified in 1.2.1 of Part Five of CCS *Rules for Classification of Offshore Floating Devices* (2020).

Section 2 Distribution System

7.2.1 Distribution system

7.2.1.1 The following distribution systems can be used:

(1) DC: double-wire insulation system;

(2) AC: single-phase double-wire insulation system; three-phase three-wire insulation system.

Section 3 Power Supply

7.3.1 General requirements

7.3.1.1 All single point moorings shall be provided with a power supply system in accordance with 7.3.2 of this Chapter.

7.3.1.2 When external power supply is used and electric energy is transmitted through slip ring device, the rated current of electric slip ring shall meet all current loads required by transmission equipment.

7.3.2 Different forms of single point moorings

7.3.2.1 The main power supply and emergency power supply on turret and SYMS single point moorings shall come from the main power supply and emergency power supply on mooring floating structures respectively. The quota of power supply cable and slip ring device shall be sufficient to deliver electric energy meeting the power supply requirements. Without relying on the main power supply, the sound and light signals required by offshore structures shall be supplied for at least 96 hours, and automatic charging devices shall be provided.

7.3.2.2 For CALM single point moorings and SALM single point moorings, the power supply shall be two sets of battery packs which are mutually standby, and the charging power supply can come from one set of solar panels. The capacity of any set of battery packs shall at least meet the power supply capacity required for normal operation and safe operation of single point moorings. Any battery pack shall also supply sound and light signals required by offshore structures for at least 96 hours, and shall be equipped with automatic charging devices.

Section 4 Electrical Equipment in Hazardous Areas

7.4.1 General requirements

7.4.1.1 Hazardous areas are divided in Chapter 8 Fire and Explosion Safety.

7.4.1.2 Electrical equipment and wiring installed in hazardous areas shall be limited to those necessary for operational purposes. Cables and specified types of equipment described in this Chapter can be installed. The selection and installation of equipment and cables in hazardous areas shall be in accordance with international standards.

7.4.1.3 Sockets shall not normally be installed in hazardous areas or places. When sockets must be installed, the selected sockets shall meet the relevant requirements of qualified explosion-proof electrical equipment allowed to be used in corresponding dangerous areas.

7.4.1.4 The selected socket shall be interlocked with its switch so that the plug cannot be inserted and pulled out when the switch in the ON position. The switch shall be able to break all poles or phases of the circuit.

7.4.1.5 The power switches and protective devices of qualified explosion-proof electrical equipment allowed to be installed in dangerous areas or places shall be able to break all poles or phases. Equipment, switches and protective devices shall be clearly and durably marked for easy identification.

7.4.1.6 Explosion-proof lamps of the appropriate grade shall be installed in hazardous places where lighting is necessary, to provide adequate lighting for normal and safe operation. The lighting in these places shall be controlled by separate control boxes installed in non-hazardous areas or places, and each shunt shall be provided with an ON indicator light. For easy identification, lamp switches and protective appliances shall be properly marked. For turret type and SYMS single point moorings, they shall be divided into at least two independent shunts for power supply; the light points of the two shunts shall be staggered so that when one shunt is overhauled, the other shunt can still maintain sufficient lighting.

7.4.1.7 There shall be a device for continuously monitoring the insulation resistance and giving an alarm when the insulation resistance is abnormally low. In particular, the monitoring scope of this device shall include all circuits connected to electrical equipment installed in dangerous places or passing through dangerous places, except intrinsically safe circuits.

7.4.1.8 If electrical slip rings are installed in hazardous areas, special laboratory tests shall be carried out to prove that these electrical slip rings are suitable for installation in hazardous areas specified in 7.4.1.1 of this Chapter.

7.4.2 Types and laying of cables in hazardous areas

7.4.2.1 In addition to cables in intrinsically safe circuits, cables laid in hazardous areas shall have at least one of the following protective coatings:

(1) Non-metallic impermeable sheath, plus metal braided layer or other metal covering layer;

(2) Mineral insulated cables shall have copper or stainless steel sheaths. For special purposes, mineral insulated cables with aluminum sheath can be considered.

7.4.2.2 Cables for intrinsically safe circuits shall be metallic shielded with at least a nonmetallic impermeable sheath.

7.4.2.3 Only cables related to intrinsically safe "ia" equipment shall be used in the category 0 hazard area.

For fixed lines in Class 2 hazardous areas, thermoplastic armored cables, thermosetting armored cables or elastic armored cables shall be used.

Flexible cables and portable cables used in Class 1 and Class 2 areas shall be used to the satisfaction of the administration if necessary.

Fixed cables permanently installed through Class 1 hazardous areas shall be fitted with conductive coverings, braids or armor for ground detection.

Chapter 8 Fire and Explosion Safety

Section 1 General Provisions

8.1.1 Scope of application

8.1.1.1 The requirements of this Chapter are applicable to the fire and explosion safety design of single point moorings, as well as the configuration and inspection of fire and explosion related systems and equipment.

8.1.2 General requirements

8.1.2.1 Movable firefighting equipment and devices shall be effectively fixed and shall not affect the ready-to-use of firefighting equipment.

8.1.2.2 All fire protection systems and equipment shall be sufficiently resistant to corrosion in the marine environment.

8.1.2.3 The arrangement of single point moorings within offshore floating structures shall be subject to risk analysis.

8.1.3 Layout requirements

8.1.3.1 The arrangement of single point moorings shall ensure qualified ventilation, and shall comply with the provisions of 1.2.12 of Chapter 1 and Chapter 3 of Part Eight of CCS *Rules for Classification of Offshore Floating Devices* (2020).

8.1.3.2 In turret single point moorings, if the anchor winch is on the lower deck of the riser terminal and shut-off valve, the deck separating the riser terminal, shut-off valve and the anchor winch shall be an airtight solid deck.

8.1.3.3 The piping arrangement of turret single point moorings shall reduce the risk of spraying fire towards the compartment roof.

8.1.4 Drawings and documents

8.1.4.1 The following applicable drawings and documents shall be submitted to CCS for approval:

(1) Fire control chart;

(2) Fire protection system drawings;

(3) Dangerous area map;

(4) Risk analysis report;

(5) Fire and explosion analysis report.

Section 2 Fire Safety

8.2.1 General requirements

8.2.1.1 The fire protection design and configuration of single point moorings shall not only comply with the provisions of 8.2.2 and 8.2.3 of this Section, but also comply with the relevant requirements of Part Eight of CCS *Rules for Classification of Offshore Floating Devices* (2020).

8.2.2 Provisions for oil and gas single point moorings

8.2.2.1 Provisions for turret single point moorings

(1) Turret single point moorings shall be equipped with temperature-sensing or flame-sensing fire detectors;

(2) The turret area shall be equipped with a water spraying system, and the water spraying rate shall not be less than 20 (1/min)/m^2;

(3) A foam fire extinguishing system shall be set in the turret area according to the provisions of 6.12.18.2 of Chapter 6 of Part Eight of CCS *Rules for Classification of Offshore Floating Devices* (2020).

8.2.2.2 Provisions for non-turret single point moorings

(1) The single point moorings shall be provided with at least 2 portable fire extinguishers. These fire extinguishers shall be foam fire extinguishers or dry powder fire extinguishers suitable for extinguishing oil and gas fires. Among them, the capacity of a single foam fire extinguisher shall not be less than 9L, and the capacity of a single dry powder fire extinguisher shall not be less than 5kg;;

(2) For single point moorings with electrical fire hazard, there shall be at least one fire extinguisher suitable for extinguishing electrical fire in addition to the fire extinguisher required by 8.2.2.2 (1). Among them, the capacity of dry powder fire extinguisher shall not be less than 5kg, and the capacity of gas fire extinguisher shall not be less than 5kg.

8.2.3 Provisions for non-oil and gas single point moorings

8.2.3.1 At least 2 portable fire extinguishers shall be provided for single point moorings that require personnel boarding during normal operation and maintenance. The type and capacity of these fire extinguishers shall match the type and scale of possible fire.

8.2.3.2 For single point moorings that do not require personnel boarding during normal operation and maintenance, part or all of the firefighting equipment may be exempted upon written application by the owner of the single point moorings and with the consent of CCS according to the instructions and risk assessment report in the design documents for the single point moorings that do not require personnel boarding during normal operation and maintenance.

Section 3 Explosion Safety

8.3.1 Division of hazardous areas

8.3.1.1 Types of hazardous areas

(1) Class 0 hazardous area: refers to the hazardous area where the ignition concentration of flammable gas or vapor exists continuously or for a long time;

(2) Class 1 hazardous area: refers to the hazardous area where the ignition concentration of flammable gas or steam may occur during normal operation;

(3) Class 2 hazardous area: refers to the hazard area where the ignition concentration of flammable gas or vapor is unlikely to occur, or the mixed gas will only exist for a short time if it occurs.

8.3.1.2 Division of hazardous areas

(1) In an open place, the area within 3m around the outer contour of slip ring device shall be classified as Class 2 dangerous areas;

(2) Enclosures and semi-enclosures with slip ring devices shall be classified as Class 1 hazardous areas;

(3) Internal spaces of containers, tanks, pipelines and slip ring devices containing crude oil and/or natural gas shall be classified as Class 0 hazardous areas;

(4) The division of dangerous areas in other places shall meet the requirements of Part Eight of CCS *Rules for Classification of Offshore Floating Devices* (2020).

8.3.2 Electromechanical equipment in hazardous areas

8.3.2.1 The configuration of electromechanical equipment in the hazardous areas shall meet the requirements of Part Eight of CCS *Rules for Classification of Offshore Floating Devices* (2020).

Chapter 9 Safety and Communication Equipment

Section 1 General Provisions

9.1.1 General requirements

9.1.1.1 Safety equipment of single point moorings covered in this Chapter includes life-saving equipment, communication equipment and signaling equipment.

9.1.1.2 In addition to meeting the requirements of this Chapter, the safety equipment of single point moorings shall also meet the relevant regulations of the competent authorities of the countries in which it operates.

9.1.2 Drawings and documents

9.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval:

(1) Layout of life-saving equipment;

(2) Operating system drawings and layout drawings related to communication, alarm and control;

(3) Signal equipment layout.

Section 2 Life-saving Equipment

9.2.1 General requirements

9.2.1.1 Life-saving equipment for single point moorings shall comply with the relevant applicable provisions of the *Rules for International Life-saving Equipment* (hereinafter referred to as the "LSA Rules") and be approved by CCS.

9.2.1.2 Life-saving equipment shall be put into use immediately and effectively in case of emergency, can be stored without damage within the temperature range of the working sea area where the single point moorings are located, and can be used normally within the water temperature range of the sea area. In addition, life-saving equipment shall be equipped with reflective tape according to the requirements of "LSA Rules", and its service life or replacement date shall be indicated.

9.2.1.3 For operational readiness, maintenance and inspection of life-saving equipment, reference may be made to the applicable provisions of Chapter III of the "SOLAS Convention" and Chapter 10 of the "MODU Rules".

9.2.2 Life jackets

9.2.2.1 A sufficient number of life jackets shall be provided for the use of each boarding person.

9.2.2.2 Outdoor life jackets shall be stored in safe and dry storage cabinets, which shall be provided with readily identifiable markings and be placed in readily accessible locations.

9.2.3 Life suit

9.2.3.1 Where the sea area where the single point moorings work does not belong to a warm climate area with a water temperature greater than 10℃, a sufficient number of life suits complying with the requirements of 2.3 of "LSA Rule" shall be equipped and stored in an appropriate position for the use of each boarding person.

9.2.4 Lifebuoy

9.2.4.1 Single point moorings with the possibility of side release shall be equipped with an appropriate number of lifebuoys complying with Article 7 of Chapter III of the "SOLAS Convention" and 2.1 of "LSA Rules".

9.2.4.2 For the storage position of lifebuoy, the type, shape and structural characteristics of single point moorings shall be considered to ensure safe use in emergency; lifebuoys shall be stored in such a way that they can be removed and used quickly.

9.2.4.3 At least half of the total number of lifebuoys shall be provided with an approved battery-type self-igniting lamp in accordance with the "LSA rules", and at least half 2 of these lifebuoys shall be provided with spontaneous smoke signals. In addition, at least one lifebuoy with a buoyant lifeline shall be equipped, and the length of the buoyant lifeline shall be the larger of the following: at least 1.5 times of the distance from the storage position of

the lifebuoy to the lowest astronomical tide surface or 30m.

Section 3 Communication Equipment

9.3.1 General requirements

9.3.1.1 Communication equipment for single point moorings generally includes emergency shutdown system, fire detection, combustible gas detection, alarm system and external communication system.

9.3.1.2 The products and performance of each system shall meet the requirements of CCS Rules for Classification of Offshore Floating Devices (2020).

9.3.1.3 All systems shall meet explosion-proof requirements.

9.3.2 Emergency shutdown system

9.3.2.1 The emergency shutdown system shall meet the requirements of Chapter 4 of Part Seven of CCS *Rules for Classification of Offshore Floating Devices* (2020).

9.3.3 Fire detection system

9.3.3.1 The fire detection system shall meet the requirements of Chapter 5 of Part Seven of CCS *Rules for Classification of Offshore Floating Devices* (2020).

9.3.3.2 For single point moorings for oil transportation, the fire detection system can be set independently. In case of fire, the sound and light alarm device and fog whistle system on the single point moorings can be triggered to show the occurrence of fire.

9.3.3.3 The fire detection system on the single point moorings serving the floating production and oil storage unit shall be included in the fire detection system of the floating production and oil storage unit. In case of fire, it shall be able to give an audible and visual alarm in the fire control station.

9.3.4 Combustible and toxic gas detection system

9.3.4.1 The combustible gas detection system shall meet the requirements of Chapter 6 of Part Seven of CCS *Rules for Classification of Offshore Floating Devices* (2020).

9.3.4.2 For single point moorings for oil transportation, the combustible gas detection system can be set independently. In case of gas leakage, the sound and light alarm device and fog whistle system on the single point moorings can be triggered to show the occurrence of gas leakage.

9.3.4.3 The combustible gas detection system on the single point moorings serving the floating production and oil storage unit shall be included in the combustible gas detection system of the floating production and oil storage unit. In case of gas leakage, it shall be able to give an audible and visual alarm in the fire control station.

9.3.5 Alarm system

9.3.5.1 For single point moorings for oil transportation, the sound and light alarm system shall be able to observe and hear alarm signals in shore-based control stations under the working environmental conditions.

9.3.6 Preventing flooding

9.3.6.1 The flooding prevention system shall meet the requirements of Section 4 of Chapter 7 of Part Seven of CCS *Rules for Classification of Offshore Floating Devices* (2020).

Section 4 Signal and Communication

9.4.1 General requirements

9.4.1.1 The provisions of this Section apply to single point moorings operating independently.

9.4.2 Signaling equipment

9.4.2.1 The signal equipment of single point moorings shall comply with the relevant provisions of China's maritime traffic safety and the relevant applicable requirements of IMO *Convention on the International Regulations for Preventing Collisions at Sea, 1972*.

9.4.2.2 Single point moorings shall be equipped with all the signaling equipment required in this Section to

prevent collision with floating structures navigating at sea.

9.4.2.3 The signaling equipment required in this Section shall be approved by the certification inspection agency.

9.4.2.4 Single point moorings shall be displayed in the most visible place:

(1) A ring-illuminated white lamp or a sphere at the front of the device;

(2) A ring-illuminated white lamp at or near the tail of the device and below the line lamps required by item (1) of this paragraph.

For single-point moorings less than 50 meters in length, a ring-illuminated white light may be displayed at the most visible place in lieu of the line lamps specified above in this paragraph.

9.4.2.5 For single point moorings, the deck can also be illuminated with existing working lights or equivalent lights.

9.4.2.6 Fixed obstacles and permanent equipment on single point moorings that may cause danger to flying objects shall meet the following requirements:

(1) Fixed obstacles and permanent equipment that may cause danger to flying objects shall be easily visible from the air during the day. If necessary, color shall be painted so as to be easier to identified during the day. It is recommended to paint black and white, black and yellow, or red and white color bars with a width of no less than 0.5m but no more than 6m;

(2) Omni-directional red lights with light intensity of at least 10 cd shall be installed at appropriate positions, to provide visual information which may cause dangerous obstacles to flying objects for helicopter pilots. The lamps shall meet the following requirements:

① For the lighting of high-rise structures, the middle red lights can be replaced by strong light lamps, but the arrangement of strong light lamps shall illuminate the whole structure without interfering with the night vision of helicopter pilots;

② Alternative equivalent technology can be adopted according to the suggestion of ICAO to highlight the main obstacles near the helicopter deck.

(3) An omni-directional red lamp with light intensity of 25-200 cd shall be installed at the highest point of the single point moorings. If it is not feasible at the highest point, the lamp should be as close to the endpoint as possible.

9.4.3 External communication

9.4.3.1 For single point moorings for oil transportation, the external communication system shall be reliable and equipped with a backup power supply.

Chapter 10 Cargo Transfer Systems and Components

Section 1 General Provisions

10.1.1 General requirements

10.1.1.1 The provisions of this Chapter apply to cargo or product conveying systems and associated components of single point moorings. The cargo or product conveying system includes all system components from the subsea connecting flange to the first flange on the loading floating structure. If there is a subsea pipeline terminal manifold, it shall comply with the provisions of this Chapter.

10.1.1.2 Subsea pipeline terminal manifolds for single point moorings shall meet the requirements of CCS *Guidelines for Certification Issuing of Subsea Production Systems* (2016) in addition to the requirements of this Chapter.

10.1.1.3 All piping shall be welded or flanged or in approved form. The installation and fixation of pipelines shall be able to bear internal pressure, liquid impact, transportation riser and other loads.

10.1.1.4 Cargo delivery systems shall be capable of preventing pollution of the marine environment.

10.1.1.5 Pipes, hoses, fluid swivels, valves, etc. of the cargo transfer system shall be subjected to factory pressure tests at a pressure no less than that specified in the standards used.

10.1.1.6 The cargo transfer system shall be subjected to hydrostatic pressure test after installation. Generally, the test pressure shall not be less than 1.1 times the design pressure. When the design pressure exceeds 1.55 MPa (15.8 kgf/cm^2, 225 psi), the test pressure shall not be less than the design pressure.

10.1.1.7 In the design and test of cargo transfer system, normal and emergency situations shall be considered.

10.1.2 Pipeline connection

10.1.2.1 Subsea pipeline terminal manifolds or other connections connecting subsea pipelines to lower hoses/flexible risers:

(1) In order to resist waves, currents and loads caused by single point moorings and submarine pipelines, the terminal manifold or other connecting devices of subsea pipelines shall be firmly fixed on the seabed;

(2) An isolation measure shall be provided for the single point moorings from the submarine pipeline.

10.1.3 System design pressure

10.1.3.1 The design pressure of the system shall be greater under the following two working conditions:

(1) The system closing pressure after the floating structure delivery manifold is closed;

(2) Shock pressure caused by valve closure. In the calculation of impact pressure value, the calculation working condition and the closing time of relevant valves shall be considered.

10.1.4 System design temperature

10.1.4.1 When determining the design temperature of the export system, factors such as temperature requirements of oil flow and ambient temperature shall be comprehensively considered.

10.1.5 Drawings and documents

10.1.5.1 The following applicable drawings and documents shall be submitted to CCS for approval:

(1) Main bearing of single point moorings;

(2) Slip ring, including rotary drive mechanism, bearing and electric slip ring mechanism drawings;

(3) Schematic diagram of product or cargo system piping with material list;

(4) Design documents of equipment, pipes and related components, including minimum and maximum design pressures and temperatures;

(5) Schematic diagram of auxiliary piping system with material list;

(6) Hose/riser systems:

① Hose design basis;

② Hose specification;

③ Configuration diagram of hose;

④ Details of hose system and components;

⑤ Hose design report;

⑥ Analysis report of cathodic protection of hose;

⑦ Hose prototype test and test report;

⑧ Hose installation flow chart;

⑨ Hose debugging outline;

⑩ Specification for hose inspection, maintenance, repair and inspection requirements;

⑪ Riser design basis;

⑫ Specification of riser;

⑬ Configuration diagram of riser;

⑭ Details of riser system and components;

⑮ Riser design report;

⑯ Analysis report on cathodic protection of riser;

⑰ Prototype test and test report of riser;

⑱ Flow chart of riser installation;

⑲ Commissioning outline of riser;

⑳ Specification for riser inspection, maintenance, repair and inspection requirements.

(7) The following applicable drawings for the subsea pipeline terminal manifold:

① Technical standards applicable to products;

② General product description;

③ Product design drawings, including component drawings, list of parts and material, etc.;

④ Design calculation sheet (including but not limited to calculation and analysis of structure and piping strength, anti-corrosion, flow guarantee and lifting calculation sheet);

⑤ Risk assessment/analysis report (applicable to new products);

⑥ Main process drawings and documents;

⑦ Control logic drawings (including safety monitoring and control);

⑧ Anti-corrosion layout;

⑨ Appearance marks and instructions;

⑩ Test procedures and acceptance criteria (including factory acceptance test, system integrity test, factory test, newly developed products, and engineering environment test procedures);

⑪ Operating interface of subsea vehicle (ROV) and related documents.

Section 2 Hose

10.2.1 General requirements

10.2.1.1 This section specifies the design, manufacture and test requirements for hoses of single point moorings.

10.2.1.2 For CALM single point moorings and SALM single point moorings, generally, hoses are used to transport media from seabed to floating structures, mainly including subsea hoses and floating hoses. For the tower SYMS single point moorings, the water jumper hose is usually used to connect the soft rigid arm system with the floating structure.

10.2.1.3 The design, manufacture, testing, etc. of hoses shall, in addition to the provisions of the Rules, meet the corresponding requirements of the OCIMF *Guidelines for the Acquisition and Manufacture of Hose for Offshore Mooring Facilities*. Where the requirements of the operating conditions differ from the above guidelines, they shall be considered and explained according to specific conditions.

10.2.1.4 Accessory components such as connecting bolts and sealing washers shall meet the requirements of predetermined functions and CCS acceptance standards.

10.2.1.5 Each section of hose shall be subjected to hydrostatic, vacuum and other factory acceptance tests in accordance with CCS acceptance standards.

10.2.1.6 The hose shall be approved by CCS and shall have a CCS-issued product certificate.

10.2.2 System design

10.2.2.1 The material of the hose shall be adapted to the requirements of the composition, temperature, pressure and their changes of the conveying medium during service.

10.2.2.2 The hose shall be designed to meet the internal and external pressure requirements, as well as the requirements of maximum axial load and minimum bending radius under the action of environmental load and floating structure motion.

10.2.2.3 The hose shall be designed to meet the load requirements of the hose in case of reel, emergency release, etc.

10.2.2.4 The end of the hose shall meet the design requirements for fatigue.

10.2.2.5 The hose shall not bear any mooring load.

10.2.2.6 The hose shall be properly shaped and supported to limit curvature variations during loading and release for safe use.

10.2.2.7 For hose length, factors such as maximum offset of connected single point moorings, acceptable dimension of floating structure, external load, internal medium weight and installation tolerance shall be considered.

10.2.2.8 In order to prevent the risk of arc due to potential differences between floating structures and single point mooring terminals, electrical insulation measures, such as insulated flanges or insulated hoses, shall be used at the hose ends. All flanges shall be connected to the other end and seawater through electrically connected hoses. Electrically connected hoses can be used to connect buoys, subsea pipelines and subsea pipeline terminal manifolds and provide them with electrical continuity required for cathodic protection.

10.2.2.9 Hoses shall be properly protected against mechanical damage caused by dirt and friction.

10.2.3 Subsea hose

10.2.3.1 Subsea hoses shall be designed in general to avoid friction damage resulting from interference with single point mooring floats, mooring lines, seabed or other rigid objects. Try to avoid interference between hoses or risers and other soft objects. If interference is unavoidable, it is necessary to evaluate the possible contact behavior in interference analysis to ensure the safety and reliability of the conveying system during service. Special consideration shall be given to the wear protection of subsea hoses and seabed.

10.2.3.2 Specially reinforced risers or hoses shall be used for minimum bends of subsea hoses.

10.2.4 Floating hose

10.2.4.1 Consideration shall be given to installing fluid swivels or specially reinforced hoses, or both, at joints between floating hoses and single point mooring components.

10.2.4.2 When the conveyor system is designed to load/unload oil to a floating structure, for the hose at the end away from the moorings, the special requirements for bending deformation when crossing the railings of floating structures shall be considered.

10.2.4.3 To avoid contamination of seawater, a blind flange shall be installed at the end of the floating hose away from the moorings.

10.2.4.4 Considering that water hammer and excessive axial load may cause damage to the floating hoses, separation joints with shut-off valves may be provided in series for each floating hose.

10.2.5 Other auxiliary equipment

10.2.5.1 The end of the floating hose shall be provided with lifting aids and meet the requirements of the predetermined function and CCS acceptance standards.

Section 3 Riser System

10.3.1 General requirements

10.3.1.1 ITM single point moorings and ETM single point moorings, riser systems are usually used to transport media from seabed to floating structures, and the types of risers mainly include flexible risers and hybrid risers. For ITM single point moorings in deep water applications, steel compliant risers can also be used.

10.3.1.2 For CALM single point moorings, flexible risers can be used instead of subsea hoses for medium transportation from seabed to floating body.

10.3.1.3 For tower SYMS single point moorings, rigid risers fixed to jackets are usually used for medium transport between seabed and water rotating joints.

10.3.1.4 For single point moorings with novel design forms, other types of riser systems may also be used if the corresponding design requirements are met.

10.3.2 Riser systems for floating single point moorings

10.3.2.1 Riser systems of floating single point moorings shall comply with the relevant provisions of CCS *Guidelines for Inspection of Marine Riser Systems* (2020) and the applicable requirements of *Design of Risers for Floating Production Systems (FPs) and Tension-leg Platforms* (TLPs) (API RP 2RD), *Specification for Unbonded Flexible Pipe* (API SPEC 17J) and *Recommended Practice for Flexible Pipes* (API RP 17B).

10.3.3 Rigid risers for fixed single point moorings

10.3.3.1 Rigid risers for fixed single point moorings shall comply with the corresponding requirements of CCS *Rules for Submarine Pipeline System* (1992).

Section 4 Fluid swivel

10.4.1 General requirements

10.4.1.1 In this Section, a fluid swivel is defined as a passageway device for the conveyance of fluid between the stationary and rotating parts of single point moorings.

10.4.1.2 The materials used for the manufacture of fluid swivels shall be approved by CCS or CCS-recognized bodies, and the fluid swivels and their accessories shall have certificates issued by CCS or CCS-recognized bodies.

10.4.1.3 Any attachment and structure shall not affect the free rotation of the fluid swivel at 360° in the horizontal direction.

10.4.1.4 Primary structural members shall meet the requirements of anti-corrosion and wear resistance.

10.4.1.5 Fluid swivels shall not be subjected to forces other than those caused by the pressure and temperature of the piped fluid.

10.4.1.6 Bearings of fluid swivels shall be provided with lubricating devices as required.

10.4.1.7 Leak collection devices with detection and alarm functions shall be provided. A pressure balance or overpressure isolation seal shall be used between the main seal and the fluid swivel containing gas fluid.

10.4.1.8 Fluid swivel test

The fluid swivel shall be tested in the presence of the surveyors in accordance with the approved test procedure and at least the following tests shall be completed:

(1) The fluid swivel shall be subjected to hydrostatic pressure test, the test pressure shall be at least 1.5 times the design pressure, and there shall be no leakage and no pressure change that is difficult to explain for at least 2h;

(2) The fluid swivel shall be able to rotate around without leakage under the design pressure. The first cycle is clockwise and the last cycle is counterclockwise. The rotation of 30° is a step, the rotation speed is 30°/30s, and the interval of the rotation of 30° is 30s. During the rotation of 30°, record the starting torque and rotating torque. When the fluid assembly rotates with the mooring fluid swivel, the test will be carried out on the combined system;

(3) The fluid swivel and supporting structure shall be tested for rotary utility under design pressure. It is required to rotate at a speed of 10min per cycle, and rotate for two cycles in both positive and negative directions without leakage.

Section 5 Piping and Components

10.5.1 General requirements

10.5.1.1 Pipelines installed on single point moorings shall be welded or flanged steel tubes.

10.5.1.2 The selection of piping materials, anti-corrosion coating and insulation layer materials can adapt to the changes of conveying medium and ambient temperature.

10.5.1.3 The piping shall be provided with at least a device at the inlet and outlet that can correctly indicate the pressure and temperature of the medium transported in the piping.

10.5.1.4 Piping shall be effectively secured to structural members.

10.5.1.5 The piping support shall allow the expansion and contraction deformation of pipelines caused by temperature change within a certain range, and elastic support and unidirectional sliding support can be used.

10.5.1.6 Materials of other parts welded to the piping shall be of the same grade of material as the piping.

10.5.1.7 The installed piping and accessories shall be arranged in such a way that the personnel on the single point moorings shall not be prevented from operating under normal conditions or escaping from danger in case of emergency.

10.5.1.8 The piping shall undergo factory test after completion of manufacture with a minimum test pressure of 1.5 times the design pressure.

10.5.1.9 Flanges and accessories shall be manufactured and tested to the standards accepted by CCS. Non-standard flanges and accessories shall be manufactured according to CCS approved drawings.

10.5.1.10 For the design of piping system, please refer to the relevant requirements in Chapter 2 of Part Four of the *Rules for Classification of Mobile Offshore Units* (2020).

Section 6 Emergency Shutdown Device

10.6.1 General requirements

10.6.1.1 When a hydraulically or electrically driven disconnecting valve is used, the source of power shall have an energy reserve that causes the valve to open and close at least three times.

10.6.1.2 Before the hose quick release device works, sound and light alarm shall be given as possible, and the disconnecting valve shall be automatically closed in advance.

Section 7 Valves

10.7.1 General requirements

10.7.1.1 Valve pressure and temperature classes shall be determined according to the design pressure and design temperature of the piping.

10.7.1.2 Suitable cast or forged steel ball valves shall be selected as the main valves according to the design pressure.

10.7.1.3 Manual valves shall have splash protection to avoid injury to operators.

10.7.1.4 The reduction ratio of valves shall be easily opened and closed by individual operators.

10.7.1.5 The reduction box of the valve shall be lubricated and sealed. Sealing material shall be suitable for the medium it conveys.

10.7.1.6 Remote control valves and isolation valves shall be driven by hydraulic or electric devices with limited position switches.

10.7.1.7 At least one manual valve shall be installed in front of remote control valve, and shall remain normally open under normal operation.

10.7.1.8 Easy-to-wear parts of valves shall be made of corrosion-resistant materials and be suitable for their intended use.

10.7.1.9 The closing direction of valves shall be clockwise and the opening direction shall be counterclockwise.

10.7.1.10 Valves shall have nameplates, switch direction indicators, switch status indicators, flow signs, etc.

10.7.1.11 Valves shall be manufactured and tested according to the standards accepted by CCS. Non-standard valves shall be manufactured according to CCS approved drawings.

10.7.1.12 Valves shall be hydraulically tested at a pressure of 1.5 times the design pressure prior to assembly.

Section 8 Subsea Pipeline Terminal Manifold

10.8.1 General requirements

10.8.1.1 Subsea manifolds in this Section mainly refer to transmission manifolds used in combination with CALM and SALM single point moorings, and the commonly used type is subsea pipeline terminal manifolds.

10.8.1.2 Other similar types of subsea pipeline terminal manifolds may also be implemented with reference to this Section, except for subsea manifolds and subsea pipeline terminal manifolds which are part of subsea production systems.

10.8.1.3 In addition to the requirements of this Section, manifolds shall be designed, manufactured and tested to meet the applicable requirements of CCS *Guidelines for Certification Issuing of Subsea Production Systems* (2016).

10.8.2 Design

10.8.2.1 The design life of the manifolds shall, in principle, not be less than the design life of the single point moorings.

10.8.2.2 For the connection between manifold and its foundation, during maintenance and repair, supporting infrastructure shall not be affected.

10.8.2.3 The protection structure of the subsea pipeline terminal manifolds shall be designed as required. The design and manufacture of protection structures shall meet the relevant requirements of CCS *Guidelines for Certification Issuing of Subsea Production Systems* (2016).

10.8.2.4 In the design of manifolds, the need for riser cleaning operation shall be considered.

10.8.2.5 In the design of subsea pipeline terminal manifolds, the installation needs shall be fully considered. Normally, a confined space shall be formed by means of pre-filling ethylene glycol or similar liquid for convenient installation, which is convenient to connect (whether connector or flange) subsea pipe and riser during

installation, so as not to cause a large amount of seawater to enter.

10.8.2.6 In the design of subsea pipeline terminal manifolds, the pigging needs for subsea pipeline during operation shall be considered. If the subsea pig traps which require subsea connection is used, appropriate shut-off valves or isolation valves shall be set in the design of the terminal manifolds of subsea pipeline to prevent a large amount of subsea pipeline from entering seawater during subsea connection operation.

10.8.2.7 In the design of manifold, for its preset function, it is not necessary to consider the pigging operation of submarine pipeline during operation, and it is not necessary to connect or open the joint (flange or connector) between manifold and riser subsea for operation, and the installation process design of preset pigging can be accepted.

10.8.2.8 Each branch pipe of the manifold shall be provided with a shut-off valve or isolation valve. For the design pressure of shut-off valve, the liquid column pressure shall be considered, and the liquid column impact force caused by valve shut-off shall be considered according to the actual situation.

10.8.2.9 When the terminal manifold of the subsea pipeline is operated remotely, the closing time of the valve shall be calculated or determined according to engineering experience to prevent the occurrence of water hammer effect.

10.8.3 Connection between manifold and foundation

10.8.3.1 The manifolds, foundations and their connections shall be able to withstand forces generated by waves, currents and single point moorings and subsea pipelines.

10.8.3.2 The connection foundation design of manifolds shall meet the relevant requirements of CCS *Guidelines for Certification Issuing of Subsea Production Systems* (2016).

Chapter 11 Offshore Installation

Section 1 General Provisions

11.1.1 General requirements

11.1.1.1 Offshore installation operations shall be carried out in accordance with documents and procedures approved by CCS, and the loads borne in each stage of the installation process shall be analyzed, calculated and checked, so that the loads borne by each component of the single point moorings during installation operations shall be kept within the design allowable range.

11.1.1.2 During the offshore installation of single point moorings, various safety regulations of the waters and areas where the single point moorings are located shall be observed, and various obvious signs shall be set according to the regulations of relevant state departments.

11.1.1.3 Installation procedures shall be submitted for CCS review prior to installation. The allowable offset value for installation shall be clearly defined in the installation procedure and properly considered in the design calculation.

11.1.1.4 Before installation, the diver or subsea robot shall conduct a survey of the installation site and its vicinity to verify the seabed condition of the installation site to confirm that there are no obstacles or debris affecting the installation at sea. Emergency procedures for clearing obstacles on site shall be provided.

11.1.1.5 Installation process inspection, including but not limited to foundation and mooring line installation, mooring system tension and verification load test, mooring system post-installation inspection, buoy placement and mooring tie-back, riser and submarine cable installation, floating production and storage unit and single point moorings tie-back, inlet and outlet system installation, separation system inspection, system and equipment start-up and commissioning.

11.1.2 Drawings and documents

11.1.2.1 The following applicable drawings and documents shall be submitted to CCS for approval:

(1) Anchorage foundation installation analysis report;

(2) Calculation report of anchorage foundation structure;

(3) Calculation report of anchorage capacity of anchorage foundation;

(4) Mooring line installation and tension analysis report;

(5) Fixed design report for shipment;

(6) Installation procedures for anchorage foundation and mooring line;

(7) Tension and verification load test procedures;

(8) Installation procedure of tie-back mooring line system;

(9) Installation procedures for inlet and outlet systems;

(10) Separation procedures;

(11) Start-up and debugging procedures for system equipment;

(12) Other drawings required by CCS (where applicable).

Section 2 Offshore Installation

11.2.1 Pre-installation procedure review

11.2.1.1 Installation procedures for anchor pile and mooring line

Installation procedures for anchor pile and mooring line include but are not limited to the following:

(1) Rigging arrangement of anchor pile, pile feeder and pile hammer;

(2) Expected pile driving resistance;

(3) Acceptance standard of anchor pile penetration;

(4) The procedure of positioning pile facing the center of positioning mooring system and the standard of allowable offset of position and direction;

(5) Mooring line installation procedure;

(6) Anchor pile installation procedure;

(7) Tension test procedures for anchor piles or anchor and mooring line systems shall include the following:

① Rigging arrangement for mooring line, anchor or pile system to verify load tension test;

② Tension procedure;

③ Acceptance standards for anchor pile penetration.

(8) Installation procedures for soft steel arm single point moorings (where applicable) shall include the following:

① Relative parameters of the soft steel arm single point moorings;

② Mooring head installation procedure;

③ Installation procedure of soft steel boom;

④ Connection procedure between floating device and soft steel arm;

⑤ Connection procedure of jumper hose of single point moorings.

11.2.1.2 Installation procedures for tie-back chain system

The procedure for connecting the mooring line system to the floating installation shall include:

(1) Positioning and towing procedure for connection between mooring system and floating structure;

(2) Mooring line tie-back procedure;

(3) Procedure for chain tensioning through ballast buoyant structures (if applicable);

(4) Debugging and testing procedures for mooring line fault detection equipment (if applicable).

11.2.1.3 Inlet and outlet system installation procedures

Inlet and outlet system installation procedures shall be submitted to CCS for review, to verify that all appropriate installation loads have been considered. An instruction manual for the installation of inlet and outlet systems shall be available. When necessary, disposal procedures, recycling procedures and repair procedures shall be provided.

(1) Installation procedures for connection between inlet and outlet risers and floating units shall include the following (if applicable):

① Lifting procedures for rigid or flexible risers;

② Installation procedures for floating box, arched bracket and counterweight block;

③ Riser hydrostatic test procedures, hydrostatic test pressure and test duration shall conform to API or other recognized standards.

(2) The installation procedure for the output system shall include the following items (if applicable):

① Assembly and handling of outlet hose system;

② All necessary accessories and navigational aids;

③ Hose pressure test procedure.

11.2.1.4 Release procedure

For releasable mooring systems, release and tieback procedures for floating device mooring systems shall be submitted.

11.2.2 Installation inspection of mooring system

11.2.2.1 Foundation and mooring line installation

(1) Foundation installation

The foundation forms mainly include towing anchor, normal bearing anchor, suction penetration anchor and dynamic penetration anchor. During foundation installation, the following shall be verified (where applicable):

① Correctly lock all shackles from mooring line to steel pile (or anchor pile) and between mooring lines;

② Size, length and number of mooring line accessories;

③ Installation position and direction of anchor pile or anchor;

④ Self-settlement depth, piling depth and penetration depth;

⑤ Inclination angle.

(2) Mooring line installation

Normally, during the installation of mooring lines, the following shall be verified (where applicable):

① Cross tension;

② Mooring line twisting and untwisting;

③ After installation, verify whether the chain tension conforms to the design specification and offset by measuring the catenary angle.

11.2.2.2 Connection and installation of soft steel arm with rotating mechanism

(1) Mooring mechanism

① Confirm that the rotating part will be locked at the designated position;

② Confirm that the slip ring rotary driving mechanism and external piping are separated from the slip ring;

③ After the mooring mechanism insertion tip is completely inserted into the jacket, the rotation test shall be carried out;

(2) Connection between soft steel arm and rotating mechanism

① For the weight of the boom, in addition to estimation, it is necessary to weigh it during construction;

② Confirm whether the angles of the boom nose end, the boom arm positioning hook on the mooring head and the hose cradle are in the same straight line;

③ Confirm that the stop on the rolling hinge shaft at the boom nose end is completely in place to install the guide device;

④ Ensure that the slip ring is disconnected from the driving mechanism of the turntable, and limit the friction torque of the mooring head within the allowable friction torque range of the turntable bearing.

11.2.2.3 Field testing

(1) After the suction anchor arrives at the installation site, moving point test, subsea robot humidity test, ultra-short baseline positioning system positioning calibration, suction pump humidity test under different water depths, etc. shall be conducted;

(2) After the mooring system is laid, pre-tension test shall be carried out on each mooring line;

(3) According to the scope of geotechnical engineering investigation, load size, analysis method used in geotechnical engineering design and soil experience in relevant areas, the necessity of maximum complete design

tensile test shall be determined. For suction anchors, the pile installation records shall be reviewed to verify the consistency between the calculated suction pressure and the suction pressure used to install the suction anchor. For conventional anchor piles, the anchor pile installation records shall be reviewed to verify the consistency between the calculated number of hammering and the actual number of hammering required to drive the pile to the designed penetration depth. For normal bearing anchors, check the critical load and if the anchor rotation calculated for the critical load is different from the anchor rotation in the field, check the anchor structure for any resulting out-of-line load to ensure that its integrity is not affected. For dynamic penetration anchor, it shall be examined whether the final penetration depth and pile inclination angle are within the allowable range;

(4) If the maximum design tensile test is exempted, each anchor shall be preloaded to reach the load necessary for the ultimate bearing capacity of the anchor, but not less than the average design tensile force;

(5) For the disconnectable mooring system, the tensile test load shall be the larger of the maximum design load under the disconnectable environment and the maximum design load of the mooring cable under the design environment.

11.2.2.4 Post-installation inspection

(1) It shall be carried out as soon as possible after the initial connection between the floating device and the mooring system;

(2) It shall be confirmed whether there is any external damage to the mooring line;

(3) Coordinate positioning inspection shall be carried out for anchor points and buoys of mooring system after installation.

11.2.3 Buoy positioning and anchor tieback inspection

11.2.3.1 Single point buoy transport

The towing transportation of single point buoys shall meet the applicable requirements of *Technical Rules for Legal Inspection of Towing at Sea* issued by Maritime Safety Administration of the People's Republic of China and CCS *Maritime Towing Guide* (2011).

11.2.3.2 The installation offset of the center position of the buoy shall meet the requirements of installation procedures.

11.2.4 Installation inspection of risers, hoses and submarine cables

11.2.4.1 Installation offsets of risers, hoses and submarine cables shall comply with the requirements of installation procedures.

11.2.4.2 After installation of risers and hoses, hydrostatic tests and completion investigations shall be carried out.

11.2.5 Inspection of tieback connection between floating production and oil storage unit and single point moorings

11.2.5.1 In-place connection of floating production and oil storage Unit

(1) During in-place connection, the offshore weather conditions shall meet the requirements of design documents;

(2) According to the requirements of design documents, after the floating production and oil storage unit is in place, the buoy shall be connected under the condition of keeping the design positioning accuracy, and the position offset between the floating production and oil storage unit and the buoy shall be observed and adjusted during the connection process. When the buoy is lifted into the buoy cavity, maintain the tension of the lifting cable and activate the locking button to gradually increase the locking force of the buoy. After the buoy is locked, a buoy limiting block shall be installed between the upper matching ring and the buoy locking groove to limit the movement of the buoy in various horizontal directions. (Where applicable)

11.2.5.2 Slip ring stack slip and connection

(1) When the movable slip ring is connected in a sliding way, the offshore weather conditions shall meet the requirements of the design documents;

(2) Start the lifting device and the sliding device, and move the sliding stack device to the designated position to complete the connection.

11.2.5.3 In-compartment connection and rotation test (where applicable)

(1) Install an emergency shut-off valve in the compartment of the single point moorings and connect cables and riser accessories;

(2) Move the floating production and oil storage unit around the turret for full turning test, and test the function of single point moorings and slip ring.

11.2.6 Inspection of inlet and outlet systems

11.2.6.1 Verify that the buoys and arched brackets are installed correctly.

11.2.6.2 Installation of riser clips and terminal flanges

(1) Installation of riser clips on buoys and arched brackets shall be monitored to verify that the riser is adequately secured and will not be damaged by excessive tightening of clamps;

(2) Verify whether the installation of the riser terminal flanges complies with the approved procedures.

11.2.6.3 Upon completion of installation, the entire subsea assembly shall generally be inspected and verified for compliance with the reviewed design specifications and layout. Where on-site visibility is limited, alternative methods of verification of installation shall be submitted for review and shall be carried out as required by the on-site surveyors.

11.2.6.4 Hydrostatic test

(1) The hydrostatic test of the inlet and outlet system shall be carried out in accordance with the approved procedures;

(2) The test pressure and duration of hydrostatic test shall follow the applicable specifications.

11.2.6.5 Floating hose

(1) It shall be verified that the installation of the outlet floating hose conforms to the approved procedures;

(2) During the laying of floating hoses, verify that the bending radius of the hose string is not less than the limit recommended by the manufacturer;

(3) After installation, the entire floating hose shall be subjected to hydrostatic pressure tests in accordance with approved procedures and specifications.

11.2.6.6 If a subsea control device is installed, a functional test shall be performed.

11.2.6.7 All navigational aids shall be functionally tested to prove that they are in good working condition.

11.2.7 Release system test

11.2.7.1 For releasable mooring systems, after the release operation test is completed, the time for the release of the floating device and the mooring system shall be recorded in the operation manual.

11.2.8 Test during commissioning

11.2.8.1 Debug safety and operational readiness. Verify personnel safety precautions during commissioning, including checking the readiness of all life-saving equipment, fire and gas detection systems, firefighting equipment, emergency shutdown systems, etc.

11.2.8.2 Testing of communication equipment. The communication system test shall be verified before the trial operation.

11.2.8.3 Startup and testing of production support system. Before commissioning, verify the startup and test of all auxiliary public systems of the process system.

11.2.8.4 Tie-back and testing. Verify proper connection and testing of the entire process system, including leak testing of the entire system, process control function and emergency shutdown system.

11.2.8.5 Injection into the production system. Before injecting hydrocarbons into the production system, verify whether the oxygen of the whole production system has been purged to an acceptable level.

11.2.8.6 Hydrocarbon injection and flow control. Verify the injection of hydrocarbons in the process system and whether the system can control the well water flow in the system in a stable manner without inappropriate control

problems.

11.2.8.7 Verify the start-up of the flare system (if applicable), including necessary precautions to eliminate the risk of explosion or fire.

11.2.8.8 The commissioned process system shall be validated to ensure proper operation for at least 12 hours.