



CHINA CLASSIFICATION SOCIETY

RULES FOR CLASSIFICATION OF OFFSHORE FLOATING INSTALLATION

PART IV WELL FLUID INPUT AND PROCESSING, CRUDE OIL STORAGE AND EXPORT SYSTEMS

CCS OFFSHORE ENGINEERING TECHNOLOGY CENTER

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CHAPTER 1 GENERAL

SECTION 1 GENERAL REQUIREMENTS

1.1.1 Mode of well fluid feed

1.1.1.1 The well fluid may be input from the wellhead above the water surface via the subsea pipeline and single point to the floating installation for processing.

1.1.1.2 The well fluid may be directly input from the wellhead which is located above the water surface and mounted on its own floating structure to the floating installation for processing.

1.1.1.3 The well fluid may be input from the wellhead below the water surface, i.e. from the subsea production system, to the floating installation for processing.

1.1.2 Principles for well fluid processing

1.1.2.1 The crude oil obtained after well fluid processing is to be stable crude oil meeting national or industrial standards, i.e. meeting the conditions for safe transport.

1.1.2.2 Natural gas is to be recovered as economically and reasonably as possible and the unrecoverable natural gas is to be discharged by flaring.

1.1.2.3 The production water may be discharged into the sea only after it has been processed to comply with the provisions of MARPOL and discharge standards specified by the coastal state government.

1.1.3 Mode of crude oil export

See the provisions in 5.1.1 through 5.1.5, Chapter 5 of this PART for the mode of crude oil export.

1.1.4 Integrated design

In the design of floating production unit, the well fluid input system, well fluid processing system, and the processed oil/gas product storage and export system are to be planned and designed in an integrated way and the interfaces are to be clearly defined.

1.1.5 Subsea pipeline

Subsea pipeline is to be in compliance with the provisions in the Rules for Submarine Pipeline System of CCS.

1.1.6 Single point mooring arrangement

Single point mooring arrangement is to be in compliance with the provisions in the Rules for the Construction and Classification of Single Point Mooring Systems of CCS.

1.1.7 Drawing and documents

The following drawings shall be made in triplicate or made into electronic drawings for CCS to review. For plans to be submitted for the subsea production system, refer to the applicable provisions in the Rules for Offshore Oil and Gas Process System of CCS.

- (1) Riser structure plan;
- (2) Riser release control diagram;
- (3) Riser release procedure;
- (4) Flow diagram of crude oil washing and stripping system;
- (5) Piping and instrument diagram of crude oil washing and stripping system;
- (6) Crude oil washing operation procedure;
- (7) Flow diagram of crude oil feeding, transport and export system;
- (8) Piping and instrument diagram of crude oil feeding, transport and export system;
- (9) Arrangement plan of crude oil tank venting system;
- (10) Operation procedure of crude oil export;
- (11) Crude export hose release procedure.

CHAPTER 2 WELL FLUID INPUT SYSTEM

SECTION 1 SUBSEA PRODUCTION SYSTEM

2.1.1 Overview

2.1.1.1 Subsea production system shall not be as a classified part of the Rules, but relevant inspections such as design review, manufacturing inspection and test inspection can be carried out according to the requirements of the owner to improve the safety of the whole well flow input. For detailed requirements, please refer to the relevant provisions of Guidelines for Certification Issuing of Subsea Production Systems of the Press.

2.1.1.1 Subsea production system shall not be as a classified part of the Rules, but relevant inspections such as design review, manufacturing inspection and test inspection can be carried out according to the requirements of the owner to improve the safety of the whole well flow input. For detailed requirements, please refer to the relevant provisions of Guidelines for Certification Issuing of Subsea Production Systems of the Press.

2.1.2 Riser system

The inspection requirements for classification of production, export and injection riser systems shall meet the applicable requirements of CCS Guidelines for Inspection of Marine Riser Systems.

2.1.3 Turret, single point, production distribution unit machinery and piping

2.1.3.1 The safety performance requirements of process equipment and piping in turrets, single points and production distribution units shall not be lower than the relevant requirements in CCS Rules for Offshore Oil and Gas Process Systems, and the parts not included shall be designed, constructed and tested according to recognized standards.

2.1.3.2 The safety requirements of general machinery in turrets and single points shall not be lower than the requirements of the Rules.

CHAPTER 3 WELL FLUID PROCESSING SYSTEM

SECTION 1 GENERAL REQUIREMENTS

3.1.1 General

The main function of well fluid processing system is to separate desired stable crude oil from the well fluid and to deliver the oil to the storage tank; the natural gas separated during the course of crude oil production may be used as fuel gas after further processing, or may be re-injected into the formation layer, and where it is economic, the liquefied petroleum gas contained in the natural gas may be recovered; and the water separated during the course of crude oil production may be re-injected into the formation layer or discharged into the sea provided that the water meets the discharge standards.

3.1.2 Requirements on arrangement and function of production process tanks

The requirements on arrangement and function of process tanks related to the well fluid processing system are as follows:

(1) Slop tank

Like oil tanker, a floating installation is to be provided with two slop tanks to receive the tank washing water and also the slop from closed drain tank, flare scrubber or open drain tank. The oil separated from the slop tank should be pumped into the crude oil production system for further processing and the separated water should be pumped into the production water process tank for processing.

The slop tank and production water tank may be arranged between the pump room and crude oil storage tank as buffer tanks.

(2) Crude oil process tank

When high-viscosity heavy crude is processed, it is very difficult to achieve the required water cut of not more than 0.5% through conventional three-stage processing, therefore, a crude oil process tank placed inside the float hull that processes the feedstock by sedimentation is normally required after the electric dehydration processor provided. The internal temperature of said crude oil process tank can be higher than 90°C, and on account of such high temperature, the vents of the tank should be fitted with coolers. Crude oil is processed normally in two stages in the process tank. The separated crude oil should be pumped into the crude oil stabilization tank; whereas the separated production water should be pumped into the production water stabilization tank.

The crude oil process tank should be situated between crude oil storage tanks to reduce heat loss. The temperature of heavy crude oil tanks is generally to be maintained within a range from 60°C to 65°C.

(3) Production water process tank

Production water process tank is to be provided to process the separated water from the slop tank, crude oil stabilization tank and production water stabilization tank as well as the waste water from the water injection system and chemical injection system. The production water is processed normally in two stages in its process tank. The separated crude oil should be pumped into the crude oil stabilization tank and the processed production water may be used as tank washing water or water for injection, or may be discharged into the sea provided that it meets the discharge standards.

(4) Crude oil stabilization tank

Crude oil stabilization tank may be provided as needed. The settled water in the bottom of the tank should be pumped into the production water process tank and the separated oil should be pumped into the crude oil storage tank.

(5) Production water stabilization tank

Production water stabilization tank may be provided as needed. The settled water separated from the tank should be pumped into the production water process tank and the separated oil should be pumped into the slop tank.

3.1.3 Production process tank and crude oil storage tank

The requirements specified in Chapter 4 of this PART regarding the arrangement, tank-to-tank transfer, tank washing and transfer, inerting and venting of crude oil tanks also apply to production process tanks. The inerting and venting piping systems of the production process tanks may be independent of those of the crude oil storage tanks.

3.1.4 Relevant rules

Well fluid processing system and its auxiliary service systems are to be in accordance with the detailed provisions in the Rules for Offshore Oil and Gas Process System of CCS.

CHAPTER 4 CRUDE OIL STORAGE SYSTEM

SECTION 1 GENERAL REQUIREMENTS

4.1.1 Purpose of crude oil storage

The main purpose of crude oil storage is to solve the contradiction between the continuity of crude oil production in the oilfield and the intermittency of crude oil export; in addition, crude storage may further facilitate water separation by sedimentation and help stabilize to some extent the crude oil parameters.

4.1.2 Crude oil storage capacity

4.1.2.1 The crude oil storage capacity of a floating installation is to be designed taking into account the peak oil production, shuttle tanker oil extraction cycle and the effects of inclement weather on oil extraction cycle.

4.1.2.2 Where the peak production can be maintained for two to three years, the storage capacity should be designed with consideration of the peak production; and where the peak production can be maintained for less than one year, the oil storage capacity should be designed based on 85% to 90% of the peak production.

4.1.2.3 In general, the proper cycle of oil offloading should be five to seven days; the offloading cycle is to be not more than 10 days at maximum and not less than 3 days at minimum.

4.1.2.4 The volume of crude oil storage tank is divided into effective volume and ineffective volume. The ineffective volume mainly consists of the volume reserved for protective inert gas at the top, the volume of the residual crude oil in the bottom that cannot be discharged and the volume occupied by the sounding pipe. 90% to 95% of the total tank volume is normally taken as the effective volume of the oil to be exported.

4.1.3 Design and arrangement of crude oil storage tank

Crude oil storage tanks are to be designed in terms of number, position and arrangement taking into account the production process tanks described in Chapter 3 of this PART.

The arrangement of crude oil tanks is to meet the requirements stated in PART II of the Rules.

4.1.4 Filling of crude oil tanks

4.1.4.1 The filling systems of crude oil tank include produced crude oil direct filling system and tank-to-tank transfer system.

4.1.4.2 The filling pipe of crude oil tanks is to meet the following requirements:

(1) The filling pipe is to be extended to the bottom portion of tank to prevent electrostatic discharge due to splashing. The distance of the filling pipe mouth from the tank bottom is normally not more than the diameter of the pipe;

(2) The filling pipe mouth is to be as far as possible from the discharge pipe mouth;

(3) No isolating valve is to be fitted in the filling pipe.

4.1.5 Tank-to-tank transfer of crude oil

4.1.5.1 Means for tank-to-tank transfer of crude oil are to be provided to maintain the balance and stability of the float hull during the export operation and satisfy the needs of tank cleaning.

4.1.5.2 Means are to be provided as needed to transfer oil and water between crude oil tank and production process tank and between various process tanks.

4.1.5.3 The tank-to-tank transfer is normally achieved through crude export pumps, tank washing pumps and stripping pumps.

4.1.5.4 Transfer between production process tanks is normally achieved through the specially fitted oil transfer pump and water transfer pump.

4.1.6 Heating of crude oil tanks

4.1.6.1 The temperature of crude oil heating medium is not to exceed 220°C.

4.1.6.2 The piping for heating of crude oil can be led in and out only from the top of the crude oil tank and isolating valves are to be fitted at the piping inlet and outlet.

4.1.6.3 Where steam is used for heating, the condensate header is to be connected to the condensate inspection tank for oil leak detection. In addition, a valve to allow inspection of each heating coil for oil leak is to be provided at the outlet of the condensate branch of each crude oil tank, and the opening of this valve is to be located on an open deck.

4.1.6.4 Where thermal oil is used for heating, the provisions in Section 13, Chapter 3, PART V of the Rules are to be complied with.

4.1.7 Monitoring system for crude oil tank

4.1.7.1 Level measurement and monitoring

(1) Each crude oil tank is to be provided with at least two mutually distant sounding pipes on the deck and each sounding pipe is to be fitted with a deck valve.

(2) Each crude oil tank is to be provided with a closed level telemetry system which is of an approved type and can be monitored from the main control room (e.g. radar level telemetry system). Escape of gas from the crude oil tank is to be avoided while the said system is in service.

(3) Crude oil tanks are to be provided with high level alarms and crude oil filling operation is to be stopped once the high level alarm is raised.

4.1.7.2 Temperature measurement and monitoring

Crude oil tanks are to be provided with temperature detecting means which are used to measure the temperature of the crude oil in the upper, middle and lower portions and can be monitored from the main control room.

4.1.7.3 Pressure measurement and monitoring

Crude oil tanks are to be provided with inert gas pressure detecting means which can be monitored from the main control room.

4.1.7.4 Monitoring of gas components in crude oil tank

Ballast tanks including crude oil areas of crude oil tanks shall be equipped with monitoring systems for protection gas components.

4.1.8 Operations of crude oil tanks

Operations such as crude oil filling, tank-to-tank transfer, export, ballasting and tank cleaning are to be carried out such that the effects of float hull deformation on piping and deck module/structure are minimized.

4.1.9 Corrosion protection zinc for crude oil tanks

Each crude oil tank is to be provided with anti-corrosion zincs at its bottom.

4.1.10 Isolation of crude oil tanks

Means to isolate each crude oil tank is to be provided to facilitate repair, maintenance and inspection.

SECTION 2 CRUDE OIL TANK VENTING SYSTEM

4.2.1 General requirements

4.2.1.1 Crude oil tanks referred to in this Section also include slop tanks and production processing tanks.

4.2.1.2 Each crude oil tank is to be fitted with venting arrangements which will limit the pressure or vacuum in the tanks. Vent pipes of crude oil tanks are not to be in connection with the air pipes led from other tanks. The venting arrangements are to be designed to provide:

(1) Venting of gas in large volume into and out of the crude oil tank during the course of crude oil filling, transfer and export as well as gas purging and gas-freeing. Taking account of that the crude oil is filled continuously and that the flow rate of crude oil filling is not likely to be consistent with that of oil transfer, it is recommended to provide an additional set of pressure vent valves that specially serves the crude oil filling operation.

(2) Discharge of gas in small volume from the crude oil tank or entry of air in small volume into the tank to suit the temperature changes when crude oil filling, transfer and export operations are being stopped.

4.2.1.3 A secondary means is to be provided for use in case of failure of the large-volume venting arrangement described in 4.2.1.2 (1) of this Section. Alternatively, pressure sensors may be fitted in each protected crude oil tank. The monitoring system of said sensors is to be arranged in the crude oil control room or the position from which crude oil operations are normally carried out. Such monitoring equipment is also to provide an alarm facility which is activated by detection of over-pressure or vacuum conditions within a tank.

4.2.1.4 The pressure/vacuum protection arrangement fitted on inert gas header required in Chapter 10, PART VIII of the Rules may be considered as a secondary venting arrangement.

4.2.1.5 It is to be ensured that the primary venting arrangement operates before the secondary venting arrangement when the primary and secondary venting arrangements are being adjusted.

4.2.2 Venting system

4.2.2.1 The venting system of each crude oil tank may be separate or combined with that of other tanks and may be connected to an inert gas system.

4.2.2.2 Where combined systems are adopted, isolating valves or other acceptable means of isolation are to be provided to isolate each crude oil tank. Where an isolating valve is adopted, a locking device is to be fitted and controlled by a responsible person. Signs capable of clearly indicating the working conditions of the valve or other acceptable means are to be provided. Where crude oil tanks have been isolated, it is to be ensured that the corresponding isolating valves have been opened before the filling or transfer or offloading of those tanks is commenced. Any isolating means must allow the gas arising from temperature change inside the tank to circulate continuously.

If filling, transfer or offloading of crude oil tanks or crude oil tank groups is intended, which are isolated from a common venting system, these crude oil tanks or crude oil tank groups are to be fitted with two sets of means for over-pressure or under-pressure protection.

4.2.2.3 In no case are shut-off valves to be fitted either above or in the pipe leading to pressure/vacuum valves. However, by-pass valves may be fitted or provision may be made to enable the tank pressure/vacuum valves to be held in an open position. The arrangements are to be such that clear indication is given when the by-pass valve is open or the pressure/vacuum valve is secured in the open position.

4.2.2.4 The pressure/vacuum valve is to be located on open deck and means are to be provided to enable the functioning of the valve to be easily checked.

4.2.2.5 Pressure/vacuum valves are to be capable of regulating the tank internal pressure to prevent the crude oil tanks from sustaining a positive pressure (generally not more than 0.021 MPa) which is greater than the tank pressure, and a negative pressure of less than 0.007 MPa.

4.2.2.6 In consideration of the factor that the gas generated in the tank may increase during crude oil filling or transfer, the cross-sectional area of the vent pipe of each crude oil tank is to be determined based on the maximum design loading rate multiplied by a factor of at least 1.25 in order to prevent the pressure of any crude oil tank from exceeding its design pressure.

4.2.2.7 The venting arrangement is to be connected to the top of each crude oil tank and to be capable of automatically draining the liquid to the crude oil tank when the floating installation is under all normal trimming and listing conditions. Where it is impractical to fit the automatic drain pipe, a permanent drainage arrangement is to be provided to drain the condensate liquid in vent piping to the crude oil tank.

4.2.3 Arrangement of vapor outlets

4.2.3.1 Outlets from vent pipes and, where necessary, outlets/inlets from pressure/vacuum valves are to be provided with readily renewable wire gauze or safety cap of an approved type. Material of wire gauze is to be resistant to corrosion.

4.2.3.2 Vent outlets and pressure/vacuum valve are to be arranged to discharge the vapor in an upward vertical direction. Vent outlets and pressure/vacuum valve inlets and outlets are to be arranged to prevent the entrance of water into the crude oil tanks.

4.2.4 Venting rate at vent outlet

4.2.4.1 The throttled venting rate at the outlet of large-volume gas vent described in 4.2.1.2 (1) of this Section is to be no less than 30m/s.

4.2.4.2 At the outlet of small-volume gas vent described in 4.2.1.2 (2) of this Section, the gas may be discharged in free flow.

4.2.5 Height and location of vent outlets

4.2.5.1 The vent outlet is to be located no less than 6m above the crude oil tank deck; where the vent pipe is located within the range of the oil, gas and water processing platform or the utility module platform, or 4m near any of the said platforms, it is to be arranged no less than 6m above the platform. The height requirements specified in this paragraph do not have to be met and the wire gauze may be waived provided that the pressure/vacuum protections fitted on the inert gas header is in accordance with 4.2.1.5 of this Section.

4.2.5.2 The vent outlets are to be not less than 10m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard.

4.2.6 Preventive measures against liquid rising in the venting system

Provisions are to be made to guard against liquid rising in the venting system to a height which would exceed the design head of crude oil tanks. This may be accomplished by high-level alarms or overflow control systems or other equivalent means, together with independent gauging devices and crude oil tank filling procedures.

SECTION 3 INERT GAS PROTECTION SYSTEM OF CRUDE OIL TANKS

4.3.1 General requirements

4.3.1.1 The waste gas from thermal medium furnace and other burning installation should be used as the source of inert gas on the floating installation. Where the waste gas and flue gas are not enough, special burning furnaces may be provided to replenish the flue gas supply.

4.3.1.2 The temperature of the flue gas to be used as inert gas is to be lower than 60°C; and the dust removal coefficient, desulfurization degree and dehumidification rate of the inert gas are not to be higher than 90%, 95% and 99% respectively.

4.3.1.3 The inert gas inlet into the tank is to be located far away from the vent outlet to avoid short circuit.

4.3.1.4 The detailed requirements for inert gas are also to be in accordance with the provisions in Chapter 10, PART VIII of the Rules.

SECTION 4 TANK WASHING, STRIPPING AND CLEANING SYSTEM

4.4.1 Tank washing

4.4.1.1 The purpose of tank washing is to:

- (1) remove the deposits accumulating on the structures of crude oil tanks and production process tanks to improve the effective utilization of tank volume;
- (2) meet the requirement that the tanks must be cleaned when loading of different oil products is intended;
- (3) meet the requirement that the tanks must be cleaned when entry of personnel into the tank for repair is required.

4.4.1.2 Tank washing includes oil washing and water washing. Crude oil produced on the unit is usually used for oil washing and the working oil temperature is controlled within the range from 60°C to 80°C. Production water or seawater is normally used for water washing and the working water temperature should be controlled within the range from 80°C to 90°C.

4.4.1.3 Tank washing operation is completed mainly by tank washing machines which can be categorized into deck fixed type, in-tank submerged type and deck portable type. The arrangement and number of tank washing machines and the performance of the nozzles are to be capable of basically ensuring full coverage of the surfaces to be washed.

4.4.1.4 The floating installation should be provided with special purpose tank washing pumps and the oil-submersible crude export pumps may also be used as tank washing pumps.

4.4.2 Tank stripping

4.4.2.1 The purpose of tank stripping is to:

- (1) Suction the residual fluid of crude oil tanks and production process tanks;
- (2) Suction the residual fluid in the equipment such as crude oil pump, etc.;
- (3) Suction the residual fluid after tank washing.

4.4.2.2 The floating installation should be provided with special purpose tank stripping pumps, and the oil-submersible crude export pumps may also be used as tank stripping pumps. A stripping pump is to be slightly larger than the tank washing pump and may also serve as a backup pump for the tank washing pump. In addition, the special purpose stripping pump may be combined with the vacuum self-suction device to constitute an independent stripping system.

4.4.3 Tank cleaning

4.4.3.1 The purpose of tank cleaning is to create a suitable working environment for the personnel entering the tank for inspection and repair.

4.4.3.2 Tank cleaning operation is to be carried out in strict accordance with the procedure approved by CCS.

4.4.4 Crude oil washing

4.4.4.1 General

Oil tank washing includes crude oil washing and fresh water washing. Compared with fresh water washing, crude oil washing has the following advantages:

- (1) It has better effects in prevention of marine oil pollution;
- (2) The attached materials dissolved by the tank washing liquid can be offloaded together with the crude oil, thus increasing the offloaded oil volume and cargo carrying capacity;
- (3) It is capable of protecting the crude oil tank from corrosion.

4.4.4.2 Requirement on arrangement/system to be provided

Each floating installation is to be provided with a crude oil washing system to meet the needs of tank washing and reduce the potential pollution from tank washing.

4.4.4.3 Specifications to be complied with

The crude oil washing system on a floating installation is to comply with the International Maritime Organization (IMO) Resolution A.446 (XI)-Revised Specifications for the Design, Operation and Control of Crude Oil Washing Systems, as amended by the subsequent Resolution A.497 (XII) and Resolution A.897 (21).

4.4.4.4 Key safety requirements for tank washing

The three IMO resolutions regarding crude oil washing involve safety requirements, the key points of which are as follows:

(1) Crude oil washing piping system

Crude oil supply piping, crude oil washing piping and all associated valves are to be made of steel or other equivalent materials which have sufficient strength to withstand the possible pressure; the crude oil supply piping is to be fitted with means of overpressure protection; and the piping is to be tested to 1.5 times of its working pressure after it has been installed on board.

(2) Crude oil tank washing machine

Crude oil washing machine is to be permanently installed and its design is to be approved by the Administration. Each cargo oil tank is to be fitted with a tank washing machine.

(3) Crude oil tank washing pump

The pump used for crude oil tank washing may be a cargo oil pump or a special purpose pump for crude oil tank washing. The flow rate of the pump is to meet the demand of the flow rate required for the maximum number of tank washing machines as specified in the Operation and Equipment Manual to work simultaneously at the required pressure (generally 1.2MPa), and in the meanwhile, to supply the drive liquid required by the stripping ejector.

Recycling of “dirty oil” (i.e. cargo oil which has been used to wash the tank) is to be avoided during cargo tank washing.

(4) Tank stripping system

Effective tank stripping system must be provided to ensure the effects of tank washing. Effective positive displacement pump, self-suction centrifugal pump, ejector or other equipment approved by the Administration is to be used as the tank stripping pump. In general, the rated flow rate of the stripping plant is to be 1.25 times of the total flow rate required for simultaneous operation of all tank washing machines.

(5) Inert gas system

It must be ensured that the oxygen content within the tank is less than 8% and the inert gas system must operate properly during cargo tank washing. The inert gas supplied during crude oil washing must be continuously

monitored.

(6) Oil level measuring device

Oil level measuring devices must be provided to improve tank washing efficiency and accurately monitor the amount of residual crude oil in the tank during crude oil washing.

(7) Communication equipment

During crude oil washing operation, safe and reliable means of communication are to be provided between the cargo oil control room and the involved locations such that oil offloading and crude oil washing operations can be regulated in a timely way. This means of communication is to be explosion-proof two way radio approved by the Administration.

(8) Operation and Equipment Manual

The Operation and Equipment Manual must be approved by the Administration and its content is to include: full text of the Revised Specifications for the Design, Operation and Control of Crude Oil Washing Systems; diagram of crude oil washing system; indication of the positions of each pump, piping and tank washing machine of the crude oil washing system; instructions to the crude oil washing system and the operational procedure checklist used to check if the crude oil washing equipment is in normal operation; hazard of oil leak in crude oil washing system, necessary means for prevention of oil leak and the measures to be taken in the event of an oil leak; operation checklist to be used by the crew before commencement of crude oil washing at each oil offloading, etc.

CHAPTER 5 CRUDE OIL EXPORT SYSTEM

SECTION 1 GENERAL REQUIREMENTS

5.1.1 Types of crude oil export systems

Crude oil export systems will generally fit into one or a combination of the following categories:

- (1) Riser and subsea pipeline system;
- (2) Tanker transfer;
- (3) Shoreside transfer

Shoreside transfer system is a system which is disconnected from the disconnecting single point mooring system and transfers oil on its own after the floating installation is fully loaded. Periodical suspension of production is required on oilfields where this system is employed.

The type of export system to be selected is mainly determined by economic considerations and currently shuttle tanker transfer is the most common way of crude export.

5.1.2 Types of shuttle tanker transfer

Shuttle tanker transfer can be accomplished using any one or combination of the following transfer schemes. The safer and more economic transfer scheme is to be selected by the designer based on the advantages/disadvantages of each scheme and the oilfield environment.

- (1) Tandem transfer;
- (2) Alongside transfer;
- (3) Separate offloading mooring system transfer.

5.1.3 Tandem transfer system

5.1.3.1 General

- (1) Tandem transfer system is also called stern transfer system and may be used in harsher environments compared with alongside transfer. Tandem transfer is a commonly used crude oil export system.
- (2) A dynamically positioned tanker may increase the operational limits and reduce the impact to the mooring system of a floating installation.

5.1.3.2 Offloading hose and hawser

Offloading hose and hawser are to be in compliance with the relevant provisions in Section 3 of this Chapter.

5.1.4 Alongside transfer system

5.1.4.1 General

Alongside transfer system, also called side-by-side transfer system, is often used on a ship shaped floating installation operating in areas with benign weathers.

5.1.4.2 Hose transfer

(1) Where marine type hoses are used to transfer crude oil from the floating installation to the tanker by the side of the unit, such hoses are to be in accordance with the provisions in the Hose Standards of the Oil Companies International Marine Forum (OCIMF).

(2) Cargo hoses are to be tended by the cargo hose derrick or a gantry arrangement.

(3) Means are to be provided to prevent harmful wear of the hoses due to friction with the edge of the floating installation.

(4) An automatic release connector is to be provided at the end of the export tanker to prevent rupture of the hose due to excessive pulling force or collision and such connector is to be designed to minimize the oil spillage in case of disconnection.

5.1.4.3 Loading arm transfer

(1) The design move envelope of the loading arm is to be in line with the mooring and fendering limitations and is to accommodate the expected draft ranges and heave, roll and pitch motion between the tanker and the floating installation.

(2) The loading arm is to be designed, manufactured and tested in accordance with the standards recognized by CCS, such as the Design and Construction Specification for Marine Loading Arms of Oil Companies International Marine Forum (OCIMF).

(3) An alarm sequence using the positioning information and preset motion limitations is to be programmed and linked to an emergency release system at the end of the loading arm.

5.1.4.4 Fender system

(1) The fender is to be designed to absorb the impact of the largest planned tanker berthing alongside the floating installation.

(2) Fenders should preferably be of a rubber, floating type filled with air or foam.

(3) Fenders are to be arranged to spread the impact force as evenly as possible along the sides of the floating installation.

(4) Smaller secondary fenders may be provided on the bow and stern for additional protection against impact from the export tanker while approaching or leaving the floating installation.

(5) Fender lifting equipment is to be designed to accommodate the largest size and heaviest type fender to be used.

(6) Local buckling in the fender area is to be checked and appropriately considered during design.

5.1.5 Separate offloading mooring system

5.1.5.1 The separate offloading mooring system is a system in which an export tanker will be moored separately at a distant location from the floating installation and connected to the unit through one or a number of risers and subsea pipelines delivering fluids.

5.1.5.2 A separate offloading mooring system is to be used where separation between the floating installation and the export tanker is important for the sake of safety or in areas where space is too limited to allow safe tandem transfer. This type of special export terminal is more suitable for operations under severe sea conditions.

5.1.5.3 The subsea pipelines and single point mooring systems are to respectively comply with the provisions in the Rules for Submarine Pipeline System and the Rules for the Construction and Classification of Single Point Mooring Systems of CCS.

5.1.6 Crude oil export safety and environmental protection

5.1.6.1 In order to ensure crude export safety and prevent marine environmental pollution, the potential risks that may be encountered during the export operation are to be analyzed in a systematic and comprehensive way, and the counter measures and a written crude oil export procedure are to be developed. This procedure is to include at least the following:

- (1) Meteorological and sea condition restrictions on export operations;
- (2) Volume of crude oil stored in storage tanks, coordination between the time of tanker arrival and the cycle of sea conditions;
- (3) Required technical conditions of the systems related the export operation (e.g. inert gas, ballast, nitrogen purging, firefighting systems, etc.);
- (4) Assignment of duty and scope of responsibility of various personnel involved in the export operation;
- (5) Automatic and emergency release procedures.

5.1.6.2 The operations of shuttle tankers are to be in accordance with the Ship to Ship Transfer Guide (Petroleum) published by the Oil Companies International Marine Forum (OCIMF).

5.1.6.3 Bunds are to be provided for collection of possible leakage from loading hose end-connections and offloading manifold. The height of bunds must take operational movements of the unit into account.

5.1.6.4 Crude oil export operation is to be performed during daytime as far as possible.

5.1.7 Failure protection

The offloading system is to be designed such that a single failure and mal-operation are not to result in personnel injury, significant release of hydrocarbons and significant mechanical damage.

SECTION 2 CRUDE EXPORT PUMP AND PIPING SYSTEM

5.2.1 Arrangement form of crude oil export pump

The crude export pumps used on floating installation are normally arranged in either of the following two types, which is to be selected by the designer based on the advantages/disadvantages of each type:

- (1) Concentrated arrangement in pump room

The concentrated arrangement in pump room, where the crude export pumps are arranged in the pump room in a concentrated way, is mainly featured by convenient centralized control, proven technology and low cost.

- (2) **Decentralized pump compartment arrangement**

For distributed arrangement in crude oil tanks, the oil-submersible, hydraulic drive crude export pumps are arranged in each crude oil tank in a distributed way. The distributed arrangement of export pumps in crude oil tanks has many advantages and is mainly used on large tankers and floating installation.

5.2.2 Crude export pump

5.2.2.1 For concentrated arrangement in pump room, at least one backup pump with the same capacity as that of the primary pump is to be provided, in addition to the primary pump.

5.2.2.2 Crude export pumps (also called crude oil pump) for the purpose of filling or emptying the crude oil tanks are to be used exclusively for this purpose, except that they may be used for crude oil washing, cargo pump room drainage and filling or emptying water ballast in the crude oil tanks.

5.2.2.3 All pumps which are capable of developing a pressure exceeding the design pressure of the system are to be provided with relief valves. Each relief valve is to be so arranged as to discharge back to the suction side of the pump, and to effectively limit the pump discharge pressure to the design pressure of the system. Other means to prevent overpressure at the pump discharge side will be specially considered by CCS.

5.2.2.4 The protection system, set point and response time of the pump are to be designed to protect the downstream equipment and piping from damage.

5.2.2.5 The pump discharge side is to be fitted with a check valve to prevent back flow.

5.2.2.6 Each crude oil pump outlet is to be fitted with a crude oil pressure gauge.

5.2.2.7 For concentrated arrangement, crude oil pumps are to be located inside a separate pump room. The pumps and their prime movers are to comply with the explosion-proof requirements described in Chapter 7, PART VIII of the Rules.

5.2.2.8 Where crude oil pumps are driven by steam engines or turbines having a steam temperature not exceeding 220°C, the prime movers may be installed in the pump room. Where crude oil pumps are driven by the hydraulic motors installed in the pump room, applicable measures are to be taken to protect the hydraulic oil of the motors from being contaminated by the crude oil under normal conditions.

5.2.2.9 Where crude oil pumps are driven by shafting which passes through a pump room bulkhead or deck, gastight glands are to be fitted to the shaft at the pump room plating. The glands are to be efficiently lubricated from outside pump room and are to be so designed as to prevent overheating. The seal parts of the glands are to be of materials that will not initiate sparks. Where a bellows piece is incorporated in the design, it is to be hydraulically tested to 0.34 MPa before fitting.

5.2.2.10 Crude oil pumps installed in cargo pump rooms and driven by shafts passing through pump room bulkheads are to be fitted with temperature sensing devices for bulkhead shaft glands and shaft bearings of cargo pumps from outside of pump room. Alarm is to be initiated for excessive temperature of the above-mentioned glands and bearings. Temperature monitoring is to be in accordance with the relevant provisions in PART VIII of the Rules.

5.2.2.11 Crude export pumps are to be capable of being stopped from a suitable position outside the pump room, as well as inside the space of prime movers of the pumps.

5.2.2.12 The crude export pumps are to be stopped when the inert gas filling pressure or crude oil tank pressure reaches the lower limit during crude export operation.

5.2.3 Additional requirements for deep well pump (submersible pump)

5.2.3.1 Where the crude oil in the crude storage tanks is transferred by a separate deep well pump located in each tank, means capable of draining the crude oil in the tanks in the event of failure of the deep well pump are to be provided.

5.2.3.2 The hydraulically driven submersible pump fitted inside the crude oil tank is to be designed such that contamination of the operating medium with crude oil cannot take place under normal operating conditions.

5.2.3.3 It is to be noted that sufficient overhead clearance is reserved for removal of the pump during the design of the modules above the main deck.

5.2.4 Crude oil piping

5.2.4.1 The filling pipe extending into the crude oil tanks (including production processing tanks) is to be as close as possible to tank bottom to avoid electrostatic discharge due to splashing.

5.2.4.2 The crude oil pipeline can only be laid within the crude oil area. If it is unavoidable, the crude oil export pipeline can be led to the open non-dangerous area at the bow and stern. When the crude oil export pipeline passes through the residential area, it shall pass through the residential area at an open part, and the pipeline passing through this area shall be welded.

5.2.4.3 Terminal pipes, valves and other fittings in the crude oil loading and discharging lines to which shore installation hoses are directly connected, are to be of steel or ductile material. They are to be of robust construction and strongly supported.

5.2.4.4 Expansion rings are to be provided, where necessary, for crude oil loading and discharging pipelines. Expansion joint that is flexible type or slide-type should not be used in order to minimize the possible leakage.

5.2.4.5 For crude oil loading and discharging lines, means are to be provided to enable the contents of the crude oil lines and pumps to be drained to a crude oil tank or slop tank or other appropriate tanks. The oil drain tank, where it is located within the pump room, is to be of a closed structure fitted with air and sounding pipes led to an

open deck.

5.2.4.6 The operating rods for cargo valves in crude oil tanks are to be extended to positions above the open deck. In the case of crude oil tanks which are located adjacent to below-deck pump rooms or pipe tunnels, the operating rods may be located in these spaces at the bulkhead. Stuffing boxes are to be fitted where the operating rod passes through the deck or bulkhead and to be so constructed that packing may be renewed from outside the crude oil tanks. Indicators are to be provided at the operating hand wheels to show whether the valves are open or closed.

5.2.4.7 Materials used for the friction parts of the valves and operating rods of the cargo oil piping and of flexible couplings in shafts between the cargo pumps and the prime movers are such as to preclude the possibility of sparking while in operation.

5.2.4.8 Crude oil pipe lines are not to pass through ballast tanks. Where this cannot be avoided, the pipes passing through ballast tanks are to have a wall thickness and are to be provided with welded joints.

5.2.4.9 All pipe lines are to be effectively earthed.

5.2.4.10 The crude oil piping is to be arranged taking into account the proper space to be reserved between the piping and the main deck and upper platform.

5.2.4.11 The piping is to be a self-drained, welded with the minimum number of flanged joints and to be provided with connections for inerting and cleaning of the offloading system.

5.2.4.12 Means to drain the offloading system (including hoses) are to be provided and the hoses are to be purged after each offloading operation.

5.2.5 Remote control valves

5.2.5.1 Valves on deck and in pump rooms which are provided with remote control are, in general, to be arranged for local manual operation independent of the remote operating mechanism.

5.2.5.2 Where the valves and their actuators are located inside the cargo tanks, two separate suction lines are to be provided in each tank or alternative means of emptying the tank, in the event of a defective actuator, are to be provided.

5.2.5.3 All actuators are to be of a type which will prevent the valves from opening advertently in the event of the loss of pressure in the operating medium. Indication is to be provided at the remote station showing whether the valve is open or shut.

5.2.5.4 Materials of construction of the actuators and piping inside the cargo tanks are to be suitable for use with the intended cargo.

5.2.5.5 Compressed air is not to be used for operating actuators inside cargo tanks.

5.2.5.6 The actuator operating medium in hydraulic systems is to have a flash point of 60°C or above (closed cut test) and is to be compatible with the intended cargoes.

5.2.5.7 The design of the actuators is to be such that contamination of the operating medium with cargo liquid cannot take place under normal operating conditions.

5.2.5.8 Where the operating medium is oil, or other fluid, the supply tank is to be located as high as practicable above the level of the top of the cargo tanks, and all actuator supply lines are to enter the cargo tanks through the highest part of the tanks. Furthermore, the supply tank is to be of the closed with an air pipe led to a safe place on the open deck and fitted with a flameproof wire gauge diaphragm at its open end. The tank is also to be fitted with a high and low level audible and visual alarm. The requirements of this paragraph need not be complied with if the actuators and piping are located external to the cargo tanks.

5.2.5.9 It is recommended that for remote control valves not arranged for manual operation, emergency means must be provided for operating the valve actuators in the event of damage to the main hydraulic circuit on deck. In the case of valves located inside cargo tanks, this could be achieved by ensuring that the supply lines to the actuators are led vertically inside the tanks from deck, and that connections, with necessary isolating valves, are provided on deck for coupling to a portable pump carried on board.

5.2.6 Output metering

5.2.6.1 The exported crude oil is to flow through the metering station and the precision of metering instruments is to be in compliance with national metrological standards.

5.2.6.2 The device should be equipped with an on-site calibrator meeting the explosion-proof requirements.

5.2.6.3 A flow computer should be used to timely calculate the volume of transferred fluid.

SECTION 3 OFFLOADING HOSE, HOSE REEL AND HAWSER

5.3.1 Offloading hose

5.3.1.1 Offloading hoses are to be designed and manufactured in accordance with the recognized standards. The Guide to Manufacturing and Purchasing of Hoses for Offshore Moorings of the Oil Companies International Marine Forum (OCIMF) is one of the CCS recognized standards.

5.3.1.2 It is recommended that an over-the-rail type hose be used for a horizontal hose/manifold connection where the hose end has to bend over the side of the vessel, and a reinforced-type hose be used where the hose end hangs from the manifold connection.

5.3.1.3 Tail type hoses (e.g. dumbbell type) should be used in locations where the hose string is susceptible to kinking or continuous bending.

5.3.1.4 The end of the hose string on the side of the tanker is to be fitted with hanging chain, blind flange of the quick closing/opening arrangements, pick-up line and float.

5.3.1.5 Means are to be provided to prevent solidification and wax deposition of crude oil in the hose where the ambient temperature is lower than the pour point of crude oil or the crude oil has high wax content.

5.3.1.6 Means for flushing the hoses are to be provided.

5.3.1.7 Electrically conductive connection between the floating installation and the hose and between hoses is to be maintained continuously, and non-electrically conductive connection is to be used between the hose and the shuttle tanker.

5.3.1.8 The loading hose is to be fitted with fail safe isolation valve(s) that will close off flow automatically if the loading hose is disconnected or broken.

5.3.1.9 The design parameters (e.g. flow rate, pressure, minimum allowable bending radius) and operation environmental limits of the offloading hose are to be clearly indicated.

5.3.1.10 The hose is to be fitted with a weak connector, the design of which has been proven, to minimize the spillage of crude oil into the sea in case of a controlled or uncontrolled accidental disconnection between the floating installation and the tanker.

5.3.2 Hawser

5.3.2.1 Hawsers should be of a nylon, polypropylene or polyester material for the purpose of corrosion prevention.

5.3.2.2 The hawser is to, as a minimum, have a safety factor of 3 against failure.

5.3.2.3 The design load for the mooring line emergency disconnect system and its foundation is to be the minimum breaking strength of the mooring line. The maximum stress in the disconnect system is to not exceed the yield stress or 80% of the minimum breaking stress, whichever is lower.

5.3.2.4 Quick release connection for the hawser assembly is to be provided.

5.3.2.5 Hawsers are to be inspected and tested periodically.

5.3.3 Hawser and hose

5.3.3.1 The offloading hose and hawser are to be arranged such that they cannot affect the normal operation of the propellers.

5.3.3.2 Spark arising from metal to metal contact during pull in or out of offloading hose and hawser is to be avoided.

5.3.3.3 Breakage points, weak links and release points are to be located and arranged such that personnel are not put in danger if the system breaks or is released.

5.3.4. Hose payoff and windup reel

5.3.4.1 The payoff and windup of transfer hoses are normally achieved by such two means as by reel and by horizontal placement.

5.3.3.2 The hose reel is to be designed to ensure smooth payoff and windup of the hose and prevent the hose sections and connections from being subjected to puncture, twining and overstress.

5.3.4.2 The design of swivel joint/gooseneck is to be proven.

5.3.4.4 A deliberate reel maintenance and hose replacement plan is to be prepared.

SECTION 4 OFFLOADING CONTROL, MONITORING AND RELEASE SYSTEM

5.4.1 General requirements

5.4.1.1 The system is to have instrumentation enabling continuous measurement of the following parameters:

- (1) Offloading pressure;
- (2) Status of hose and hawser connection;
- (3) Tension in connection equipment (e.g. hose winch);
- (4) Tension in hawser.

5.4.1.2 The control system is to have all necessary interlock functions as necessary to avoid spillage or other maloperations of the offloading system, (e.g. trip of system if hose connection is broken or start of crude export pump prior to connection of loading hose will not be possible).

5.4.1.3 The control station is to, as a minimum, have two independent systems for communication with other affected control stations and shuttle tanker.

5.4.2 Offloading control station

5.4.2.1 There is to be a control station for remote operation and monitoring of the offloading operation. This is to have direct view or indirect monitoring, e.g. by closed circuit TV, of relevant marine systems.

5.4.2.2 CCTV cameras are to be of adequate quality with necessary manipulation functions available. Wiper and cleaning functions are also to be implemented.

5.4.2.3 The control station is to have the following functions:

- (1) Control and monitoring of operations;
- (2) Shutdown of offloading operations;
- (3) Remote/ local emergency release of hawser connections located on the floating installation;
- (4) Remote/local emergency release of the hose connection located on the floating installation.

5.4.3 Local control room

5.4.3.1 In addition to abovementioned offloading control stations, a local control station with direct view of the operation is to be provided in the vicinity of the offloading hose. This control station is to be used when connecting the hose to the shuttle tanker. After connection, the remote monitoring station is to be used.

5.4.3.2 The local control station is to be located and protected with regard to relevant accidental events, e.g. hose rupture, fire, ingress of gas etc. Where the station is located in a hazardous area, internal overpressure ventilation and escape routes are to be provided.

5.4.4 Requirements for shuttle tankers

Offloading of oil from the floating installation is to be in close conjunction with the loading of shuttle tankers. Shuttle tankers are to have the following functions:

- (1) Shutdown of offloading operations;
- (2) Remote emergency release of connections located on the shuttle tankers;
- (3) Manual emergency release of connections located on the shuttle tankers.

5.4.5 Release

5.4.5.1 Release includes automatic (normal) release and emergency (manual) release.

5.4.5.2 The automatic release system is to be failsafe. The emergency release system is to be independent of the automatic system.

5.4.5.3 Normal and emergency release are not to result in oil leakage, create ignition sources, or any other form of overloading or damage to the floating installation.

5.4.5.4 The system details of the offloading system are to be declared in a protection philosophy document declaring the mooring line and hose release systems in respect of normal operation and emergency release. The philosophy is to include a system diagram, showing all instruments, safety devices, interlocks and the telemetry system installed. The design limitations of the system are to be clearly stated and at least include flow rates, design pressure, temperatures, minimum hose bending radius, breaking loads as well as operational weather limitations.