PART 6 CHAPTER 2

POSITION MOORING (POSMOOR)
JANUARY 1984

SECTION:

1 General Requirements ................................................................. 1
2 Environmental Conditions and Loads ........................................... 2
3 Mooring System Analysis ............................................................ 3
4 Mooring Equipment .................................................................... 5
5 Tests ........................................................................................ 7
INTRODUCTION

• General.

This is a new chapter of the Rules, decided by the Board to come into force on 1st of January 1984, for the optional additional class notation POSMOOR or POSMOOR V.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of errata presented in the introduction booklet. The introduction booklet is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the Rules. Buyers of reprints are advised to check the updated list of Rule chapters printed on the front page of the introduction booklet to ensure that the chapter is current.
SECTION 1
GENERAL REQUIREMENTS

A. Classification.
A 100 Scope.
A 200 Application.
A 300 Class notations.

B. Documentation.
B 100 Plans, particulars and certificates.

C. Structural Arrangement for Mooring Equipment.
C 100 General.

Contents.

A. Classification.

100 Scope.
101 The class notation is intended to ensure reliability of mooring system and equipment on column stabilized units for the purpose of safe position mooring.

200 Application.
201 The Rules in this Chapter apply to column stabilized units which are equipped with, and rely primarily on, a mooring system for position keeping. The requirements are to be regarded as supplementary to those given for the assignment of main class, see Pt. 3 Ch. 2 Sec. 5.

300 Class notations.
301 Vessels with additional equipment complying with the requirements of this Chapter will be assigned the class notation POSMOOR or POSMOOR V.
302 The additional letter V refers to a mooring system which is designed for positioning of the vessel in the vicinity of other structures. The class notation POSMOOR V applies when the distance between the vessel and other fixed or floating structures is less than the maximum characteristic dimension of the vessel.
303 If the vessel’s mooring system is designed as a thruster assisted mooring system, the system notation letters TA or ATA may be added to POSMOOR.

Note:
It may also be necessary to comply with governmental regulations of the country in which the vessel is registered and/or operated.

B. Documentation.

100 Plans, particulars and certificates.
101 Plans, particulars and certificates of the mooring equipment as specified in Pt. 3 Ch. 2 Sec. 5 A 300 are to be submitted for approval or documentation.

102 In addition to 101 the following is to be submitted for approval:
- Windlass/winch and stopper design.
- Anchor design including anchor weight, anchor size and documentation on anchor stability, penetration ability, dragging performance and holding capacity in soft mud or silt, sand or gravel, and hard clay or similar compact material. Material specification.
- Anchor line type including total line length and dimension. Material specification.

103 In addition to 101 the following is to be submitted for documentation:
- Windlass/winch lifting capacity and static and dynamic braking capacity.
- Strength calculation of main components of windlass/winch, i.e. cable lifter drum, couplings, shafts, brakes, gear and frame base.
- Strength calculation of full scale anchor unless type approval of the anchor has been given.
- Environmental loads and wave induced motions of the vessel in all design conditions.
- Horizontal restoring forces and maximum line tension as function of displacements in all design conditions.
- Motion of the vessel (including transient motion) and new equilibrium position for design condition DC, see Sec. 3 B.
- Anchor pattern used in mooring system analysis.
- Maximum and minimum design water depth.
- The characteristics of the thrust control system, see Sec. 3 D 103.

104 For the following items Det norske Veritas’ material certificate will be required:
- Steel wire rope.
- Wire end attachment.

C. Structural Arrangement for Mooring Equipment.

100 General.
101 The structural arrangement is to comply with the requirements given in Pt. 3 Ch. 2 Sec. 5 B, as may be applicable.
SECTION 2
ENVIRONMENTAL CONDITIONS AND LOADS

Contents.

A. Environmental Conditions.
A 100 General.

B. Environmental Loads.
B 100 General.
B 200 Wave induced motions.

A. Environmental Conditions.

B 100 General.

101 The class notations POSMOOR and POSMOOR V will be related to operating area(s), time period(s) and environmental conditions as specified to the Society.

102 The environmental conditions shall include the following:

- $V_{1hr10}$: 1 hour average wind speed at 10 m above sea level
- $V_{\text{wind}}$: Wind driven current velocity
- $V_{\text{tc}}$: Tidal driven current velocity
- $H$ : Significant wave height
- $T_z$ : Average zero upcrossing wave period
- $h$ : Water depth.

The environmental conditions as specified to the Society will be included in the Appendix to Classification Certificate.

Guidance:

For the North Sea, the following values may be used for survival conditions, all seasons:

<table>
<thead>
<tr>
<th>Location</th>
<th>Field</th>
<th>Position</th>
<th>Waves</th>
<th>Current</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$h$ (m)</td>
<td>$H$ (m)</td>
<td>$T_z$-range</td>
</tr>
<tr>
<td></td>
<td>Beryl</td>
<td>59° 36' N</td>
<td>1° 30' E</td>
<td>120</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Brent</td>
<td>61° 4' N</td>
<td>1° 21' E</td>
<td>145</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Ekofisk</td>
<td>56° 32' N</td>
<td>3° 15' E</td>
<td>70</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Frigg</td>
<td>59° 54' N</td>
<td>2° 8' E</td>
<td>105</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Maureen</td>
<td>58° 5' N</td>
<td>1° 45' E</td>
<td>95</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Statfjord</td>
<td>61° 13' N</td>
<td>1° 55' E</td>
<td>145</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Valhall</td>
<td>59° 16' N</td>
<td>3° 13' E</td>
<td>70</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Viking</td>
<td>53° 30' N</td>
<td>2° 20' E</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Haltenbanken</td>
<td>65° 5' N</td>
<td>8° E</td>
<td>250</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Tromsoflaket</td>
<td>71° 19' N</td>
<td>20° E</td>
<td>240</td>
<td>17</td>
</tr>
</tbody>
</table>

1) Normally the upper $T_z$-value will be the governing value in the mooring system analysis.

Note:
It is the intention of these Rules that by specifying environmental conditions for upper and lower water depth limits and intermediate water depths may normally be covered.
SECTION 3
MOORING SYSTEM ANALYSIS

Contents
A. Method.
   A 100 General.
      A 200 Quasistatic analysis.
      A 300 Dynamic analysis.
      A 400 Transient motion.

B. Design conditions.
   B 100 Condition O.
   B 200 Condition S.
   B 300 Condition DO.
   B 400 Condition DS.

C. Permissible Usage Factors.
   C 100 General.

D. Use of Thrusters.
   D 100 General.

A. Method.
   A 100 General.
      101 The mooring system is to be analysed for all design
          conditions as specified in B.
      102 The most unfavourable heading of the vessel rela-
          tive to the mean direction of the waves, wind and current
          shall normally be considered and used in the mooring
          system analysis.
      103 The analysis of the system behaviour may be based
          on a quasistatic or dynamic approach.

A 200 Quasistatic analysis.
   201 In a quasistatic analysis the wind, current and
      main wave directions are to be assumed to be coincident
      and the maximum environmental forces are considered
      to occur at the same time.
   202 The wind, current and mean wave drift forces are
      to be considered as static forces which result in a mean
      quasistatic displacement of the moored vessel. The oscil-
      latory, wave induced motions are normally to be taken
      as excursions of the moored vessel around the mean
      quasistatic displacement.
   203 The stiffness characteristics of the mooring system
      are to be determined from recognized theory (e.g. based
      on the catenary equation).
   204 The mean and total quasistatic displacements and
      the associated tension in the most heavily loaded anchor
      line are to be determined based on the stiffness charac-
      teristics of the mooring system.
      The displacements are defined as follows:

      Mean quasistatic displacement:
      The moored vessel will take an equilibrium position at
      which the restoring force from the mooring system
      equals the sum of the environmental static forces.
      The distance from this position to a position correspon-
      ding to zero environmental force is the mean quasistatic
      displacement.

      Total quasistatic displacement:
      The moored vessel is considered to oscillate about the
      equilibrium position with an amplitude equal to the wave
      induced motion amplitude. The total sum of the mean
      quasistatic displacement and the motion amplitude is the
      total quasistatic displacement.

   205 Normally only the surge, sway and yaw motions at
      the centre of gravity need to be considered for determi-
      nation of the anchor line tension. The motions refer to
      the most probable largest wave induced motion amplitu-
      de during a seastate duration of 2 hours.

   Guidance:
   The tension distributions in condition O and S may be opti-
   mized in the calculation procedures, e.g. by 'slackling off' on the
   leeward side.
   For condition DO and DS the tension distribution prior to line
   failure shall not be adjusted to optimize for the usage factor re-
   quirements in these conditions. The tension distribution shall be
   based on that used for conditions O and S.

A 300 Dynamic analysis.
   301 In a dynamic analysis the following is normally to be
      taken into account:
      — Time varying effects of the exciting forces.
      — Inertia and damping effects of the moored vessel and
        its mooring system.

   The probability of simultaneous occurrence of the ex-
   treme values of wind, current and waves and their direc-
   tion dependence may be included when satisfactorily
   documented.

   302 The analysis is normally to be carried out in the
      time domain.
   303 The maximum path of excursion and the corre-
      sponding tension in the most heavily loaded line within a
      time period of not less than 1 hour is normally to be doc-
      umented. The time period is to include the instant at
      which the maximum high frequency wave induced res-
      ponse occurs.

   Guidance:
   The dynamic analysis should include the low frequency effects
   of the slowly varying wave drift forces and the time dependent
   nature of the wind loading. Current may normally be taken as
   constant.
   The society will accept also the analysis method whereby the
   low frequency dynamic behaviour of the moored vessel is ana-
   lyzed separately from the high frequency behaviour of local
   anchor lines. It is then required that the line tensions found from
   the local dynamics analysis are superimposed on the values
   found from the global analysis to arrive at the total tension level.

A 400 Transient motion.
   401 The transient motion behaviour of the vessel fol-
      lowing loss of holding power in condition DO is to be
      documented.
   402 The documentation shall include information on
      vessel excursion path, vessel orientation and line tension
      during the transient motion in addition to coordinates of
      the new equilibrium position referenced to the original
      position.

B. Design Conditions.
   B 100 Condition O.
      101 Condition O — Operating is defined as follows:
          The condition during which the weather condition(s) are
          such that the vessel may perform its duties without ex-
          ceeding a pre-determined tension level in the anchor li-
          nes. See Table C1.

   B 200 Condition S.
      201 Condition S — Survival is defined as follows:
          The condition during which the vessel is subjected to the
          most severe weather condition(s), and in which it is able
          to stay on location without exceeding a predetermined
          tension level in the anchor lines. See Table C1. The
          weather conditions shall refer to the 100 year return per-
iod based on weather data for the specified season. See also Sec. 2 A 101.

B 300 Condition DO.

301 Condition DO — Damaged operating is defined as follows:
The condition when the vessel has lost holding power from any one of its anchor lines in operating condition.

B 400 Condition DS.

401 Condition DS — Damaged survival is defined as follows:
The condition when the vessel has lost holding power from any one of its anchor lines in survival condition.

C. Permissible Usage Factors.

C 100 General.

101 The permissible usage factor, \( \eta_p \), to be used is dependent on the type of analysis employed and the vessel's intended class notation.
The usage factor is given by the following:
\[
\eta = \frac{T_{\text{max}}}{P_B}
\]

\( T_{\text{max}} \) = maximum line tension in the most heavily loaded anchor line.
\( P_B \) = minimum breaking strength of the anchor line.

Table C1 Permissible usage factor, \( \eta_p \)

<table>
<thead>
<tr>
<th>Design condition</th>
<th>Quasistatic analysis</th>
<th>POSMOOR</th>
<th>POSMOOR V</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>0,37</td>
<td>0,33</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>0,55</td>
<td>0,50</td>
<td></td>
</tr>
<tr>
<td>DO</td>
<td>0,55</td>
<td>0,50</td>
<td></td>
</tr>
<tr>
<td>DS</td>
<td>0,80</td>
<td>0,70(^{1})</td>
<td></td>
</tr>
</tbody>
</table>

\(^{1}\) Normally in an 180° sector facing away from the installation \( \eta_p \) is not to exceed 0,50. The magnitude of the sector is dependent on the collision hazard with other structures. A narrower sector may be considered if documented. See Fig. 1.

102 For a quasistatic analysis, the permissible usage factors depending on the intended class notation are given in Table C1.

103 For a dynamic analysis, other permissible usage factors may be accepted upon consideration of the received documentation.

Note:
The usage factors given for conditions DO and DS in Table C1 refer to the line tensions in the new equilibrium position.

Table D1 Permissible use of thrust effect in a thruster assisted mooring system.

<table>
<thead>
<tr>
<th>Design condition</th>
<th>Vessel's layout of thrust control system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manual remote control</td>
</tr>
<tr>
<td></td>
<td>Letter: TA</td>
</tr>
<tr>
<td>O</td>
<td>Is not to be accounted for</td>
</tr>
<tr>
<td>S</td>
<td>70% of the net thrust effect from all except 1 thruster(^{1})</td>
</tr>
<tr>
<td>DO</td>
<td>Is not to be accounted for</td>
</tr>
<tr>
<td>DS</td>
<td>70% of the net thrust effect from all thrusters</td>
</tr>
</tbody>
</table>

\(^{1}\) If the effects of the thrusters are different, the greatest thrust effect is to be deducted.
MOORING EQUIPMENT

Contents.
A. Anchors.
   A 100 General.
   A 200 Proof testing of anchor strength.
   A 300 Type Approval of anchor.
B. Anchor Lines of Chain Cables/Steel Wire Ropes.
   B 100 General.
C. Fairleads.
   C 100 General.
D. Idler Wildcats.
   D 100 General.
E. Windlasses, Winches and Stoppers.
   E 100 General design.
   E 200 Materials.
   E 300 Capacity.
   E 400 Stoppers.
   E 500 Strength and design load.

A. Anchors.
A 100 General.
101 Normally, the anchors are to be of the embedment type. Other anchor types may be accepted upon special consideration.
102 The anchors shall be designed in such a way that additional anchors can be attached.
103 Relevant regulations given in Pt. 3 Ch. 2 Sec. 5 apply.

Note:
The Society considers that sufficient anchor holding power is to be ensured through operational procedures and requirements and it is therefore not included as part of the Rule requirements.

A 200 Proof testing of anchor strength.
201 The strength of anchor and shackle is not to be inferior to that of the anchor line. For dimension of anchor shackle see Pt. 3 Ch. 2 Sec. 5.
202 Proof testing of the anchor shall be carried out according to Pt. 3 Ch. 2 Sec. 5 with the exception of the proof load which is to be 50% of the minimum breaking strength of the anchor line.

A 300 Type Approval of anchor.
301 Design of anchors may be given Type Approval.
302 The anchor and shackle shall be designed to withstand a load equivalent to the minimum breaking strength of the strongest anchor line assumed applied in connection with the anchor in question, without exceeding the breaking strength. For anchor shackles, see also Pt. 3 Ch. 2 Sec. 5.
303 Testing of the anchor shall be carried out according to Pt. 3 Ch. 2 Sec. 5 with the exception of proof load which is to be 50% of the minimum breaking strength of the strongest anchor line assumed applied in connection with the anchor in question.

B. Anchor Lines of Chain Cable/Steel Wire Rope.
B 100 General.
101 The stud chain cable anchor lines to be used in the position mooring system are to be of the steel grades NV K2, K3, K4 or ORQ (Oil Rig Quality). The stud chain cable may be substituted, partly or completely, by steel wire rope, see 104-106.
102 The diameters of the stud chain cables and/or steel wire ropes to be used in the position mooring system are related to the required minimum breaking strength of the anchor lines, as analysed and calculated according to Sec. 3.
103 Requirements concerning materials, manufacture, testing tolerances and other relevant requirements for anchor chain cables and accessories specified in Pt. 3 Ch. 2 Sec. 5 apply.
104 Relevant requirement concerning steel wire rope according to Pt. 3 Ch. 2 Sec. 5 F 200 apply.
105 The wire ropes are to be drawn galvanized or finally galvanized according to ISO standard 2232.
106 The steel wire rope is normally to be of all-steel construction 6x37 Classification with minimum 31 and maximum 52 wires in each strand. The use of a synthetic fibre core may be accepted only upon special consideration.

Other steel rope constructions (e.g. spiral strand and locked coil ropes) may be accepted by the Society upon special consideration.

Note:
Notice is to be paid to possible regulations concerning anchor lines for mobile offshore units given by the authorities for the territory in questions.

C. Fairleads.
C 100 General.
101 Fairleads are to be designed in accordance with Pt. 3 Ch. 2 Sec. 5 H.

Note:
Increasing the number of pockets in fairleads above the rule requirement will generally lead to lower stresses and reduced wear. For fairleads which are close to, e.g. less than 5 chain-links from a windlass, it is advised to use more than 5 pockets due to high stiffness of the system.

D. Windlasses, Winches and Stoppers.
D 100 General.
101 The windlass is to have:
   — One cable lifter for each anchor.
   — Coupling for release of each lifter from the driving shaft.
   — Static brakes for each lifter.
   — A dynamic braking device.
102 The number of pockets in the wildcat is normally not to be less than 5.
103 The ratio between winch drum diameter and wire diameter is normally to be in accordance with the recommendations of the wire manufacturer. However, the ratio should as a minimum satisfy the following requirement:

\[
\frac{D_d}{d_w} > 16
\]

\(D_d\) = winch drum diameter.
\(d_w\) = nominal wire diameter.
D 200 Materials.

201 Material requirements for the main components in windlasses/winches are to comply with relevant specifications given in Pt. 2 and Pt. 3 Ch. 2 Sec. 5 G 200.

D 300 Capacity.

301 The lifting force of the windlass/winch in stalling is not to be less than 40% of the minimum breaking strength of the relevant anchor line.

The windlass/winch is to be able to maintain the stalling condition for 30 seconds.

302 For windlasses/winches not fitted with stoppers the static braking capacity is not to be less than the minimum breaking strength of the relevant anchor line. In addition a second brake system is to be arranged which is to be able to hold a minimum static load corresponding to 50% of the minimum breaking strength of the relevant anchor line.

303 For windlasses/winches fitted with a stopper device the static braking capacity is not to be less than 80% of the minimum breaking strength of the relevant anchor line, while the second brake system is to be able to hold a minimum static load corresponding to 50% of the minimum breaking strength of the relevant anchor line.

304 The dynamic braking capacity shall satisfy relevant requirements without overheating. The criteria as specified to the Society will be included in the Appendix to Classification Certificate.

Guidance:
The dynamic braking capacity should normally satisfy the requirements given in Table D1:

<table>
<thead>
<tr>
<th>Type of anchor line</th>
<th>Payout speed</th>
<th>Brake load</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire</td>
<td>2,2 m/s</td>
<td>4(W_w \cdot h_{\max} + W_a)</td>
<td>15 min.</td>
</tr>
<tr>
<td>Chain</td>
<td>1,7 m/s</td>
<td>(W_c \cdot h_{\max} + W_a)</td>
<td>15 min.</td>
</tr>
</tbody>
</table>

\(W_w\) = wire weight in air.
\(W_c\) = chain weight in air.
\(h_{\max}\) = maximum design water depth.
\(W_a\) = weight of anchor.

D 400 Stoppers.

401 The chain stoppers may be of 2 different types:

- A stopper device fitted on the cable lifter/drum shaft preventing the cable lifter/drum to rotate (pawl stopper).
- A stopper preventing the anchor line to run out by direct contact between the stopper and the anchor line.

The latter type is to be of such design that the anchor line is not damaged at a load equivalent to the minimum breaking strength of the anchor line.

402 The material requirements are given in Pt. 3 Ch. 2 Sec. 5 G 200.

D 500 Strength and design load.

501 For the structural parts of the windlass/winch the strength requirements are given in Table E2.

Table D2 Design load and strength requirements for winch/windlass.

<table>
<thead>
<tr>
<th>Case</th>
<th>Load on line</th>
<th>Max. equivalent stress, (\sigma_e) to be the smaller of the following values:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitted with chain or pawl stopper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stopper disengaged</td>
<td>Max. load on brake before slipping. Minimum 0,8 (P_B)</td>
<td>0,67 (\sigma_y) or 0,80 (\sigma_F) in brake and winch windlass components</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,73 (\sigma_y) or 0,9 (\sigma_F) in stopper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,73 (\sigma_y) or 0,9 (\sigma_F) in brake and winch/windlass components</td>
</tr>
<tr>
<td>Without stopper</td>
<td></td>
<td>0,5 (\sigma_y) or 0,60 (\sigma_F) in winch/windlass components</td>
</tr>
</tbody>
</table>

\(\sigma_e\) is defined in Pt. 3 Ch. 1 Sec. 3 C 300.
\(\sigma_y\) = specified minimum upper yield stress of the material.
\(\sigma_F\) = specified minimum tensile strength of the material.
\(P_B\) = minimum breaking strength of anchor line.
SECTION 5
TESTS

Contents.

A. Test of Windlass/Winch.
  A 100  Tests before assembly.
  A 200  Functional test.

A. Test of Windlass/Winch.
  A 100  Tests before assembly.
  101  Before assembly the parts mentioned in Pt. 3 Ch. 2 Sec. 5 G 300 are to be pressure tested in the presence of the Surveyor.
  A 200  Functional test.
  201  After completion at least one windlass/winch of a delivery to one rig is to be shop tested in the presence of a surveyor to verify that the required lifting capacity, static/dynamic braking capacity can be attained. Alternatively, it may be accepted that only the prime mover of one windlass/winch is tested. In such cases calculations are to be submitted for verification of resulting lifting forces as well as the braking force.
  202  After installation onboard functional tests are to be carried out in the presence of a Surveyor. These tests are to verify that all windlasses/winches with brakes, stoppers etc. function satisfactorily. A test program is to be prepared for the Surveyor’s approval.
  203  At least one of the windlasses/winches is to be tested for its maximum continuous lifting capacity.
  204  The dynamic brake is to be tested on at least one of the windlasses/winches.