# PART 6 CHAPTER 2

## POSITION MOORING (POSMOOR)

**JULY 1989**

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CHANGES IN THE RULES

General.

The present edition of the Rules includes additions and amendments decided by the Board as of June 1989, and supersedes the January 1984 edition of the same chapter.

The Rule changes come into force on 1st of January 1990.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections 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

Main changes.

The whole chapter has been extensively amended and revised. The requirements applying to catenary mooring have been extended to cover a wide range of units included for different service. Thruster assisted mooring systems have been treated in a separate section and the requirements extended.

Corrections and Clarifications.

In addition to the above stated rule amendments, some detected errors have been corrected, and some clarifications have been made in the existing rule wording.
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SECTION 1
GENERAL REQUIREMENTS

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A 200 Class notations.
A 300 Basic assumption.

B. Documentation.
B 100 Plans, particulars and certificates.
B 200 Additional documentation for TA and ATA notations.
B 300 Anchor line record.

C. Structural arrangement for mooring equipment.
C 100 General.

A. Classification.

101 The requirements in this chapter apply to single point or spread point mooring systems which may be installed on units. The term «unit» in this chapter is defined as ship-shaped vessels, column stabilized units, offshore loading buoys, or other floating bodies relying on a catenary mooring system for station keeping.

102 These Rules are made to cover reliability of the mooring system and equipment on units for the purpose of safe positioning mooring.

A 200 Class notations.

201 For Mobile Offshore Units (MOU) the requirements are to be regarded as supplementary to those given for the assignment of Main Class, see MOU Rules Pt.3 Ch.2 Sec.5.

202 For units classified as ships the requirements are regarded as supplementary to the assignment of Main Class, see Ship Rules Pt.3 Ch.3 Sec.3.

203 Units with equipment complying with the requirements of this chapter will be assigned the Class Notation POSMOOR or POSMOOR V.

204 The additional letter V refers to a mooring system which is designed for positioning of the unit in the vicinity of other structures.

Note: For conventional mooring systems, the Class Notation POSMOOR V normally applies when the distance between the unit and other fixed or floating structures is limited to the maximum characteristic dimension of the unit. For unconventional anchoring systems the limiting distance between the unit and other vicinity structures to avoid collision hazard will be subject to special consideration by the Society.

205 If the unit's mooring system is designed for thruster assisted mooring, the system notation letters TA or ATA may be added to POSMOOR.

A 300 Basic assumption.

301 The classification is based on the condition that an up to date anchor line record (see B 300) is kept available for presentation to the Society's surveyors.

B. Documentation.

B 100 Plans, particulars and certificates.

101 Plans, particulars and certificates of the mooring equipment to be submitted as basis for approval/ documentation are specified in MOU Rules Pt.3 Ch.2 Sec.5 A300.

102 In addition to 101 the following is to be submitted for approval, as applicable:

- Windlass/winch and stopper design.
- Anchor design including anchor weight and anchor size. Material specification.
- Anchor line type including total line length and dimension. Material specification.

103 In addition to 102 the following is to be submitted for information, as applicable:

- 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 anchor unless type approval has been given. Holding power calculations for anchors designed to take vertical forces.
- Environmental induced loads and motions of the unit in all design conditions.
- Restoring forces and maximum line tension in all design conditions.
- Horizontal in-plane transient motions of the unit after single failure of the mooring system, as defined in Sec. 3 A 400. New equilibrium positions to be given.
- Anchor pattern used in the mooring system analysis.
- Waterdepth range at which the unit is intended to be operated.

104 For the following items NV-certification will be required:

- Steel wire rope
- Synthetic fibre rope
- Wire and fiber rope end attachments

B 200 Additional documentation for TA and ATA notations.

201 Documentation for thruster systems and power system is to be submitted according to Main Class requirements.

202 In addition to documents required by 201 the following is to be submitted for approval:

- System schematics for Remote Thrust Control system.
- Systems schematics for Automatic Thrust Control system.
- Power distribution schematics for thrust control systems.
- Test program for sea trials for thruster assistance.

203 In addition to documents required by 201 the following is to be submitted for information:

- Net available thrust output of each thruster showing which effects have been considered to derive the net thrust relative to nominal thrust output.
- Layout of Remote Thrust Control operator panels.
- Operating manual for thruster assistance.

204 Veritas certificate for automatic thruster control system is to be submitted.

205 If the thruster assistance is subject to redundancy requirements, see Sec. 3 B 300, the redundancy is to be documented by either

- a Failure Mode and Effect Analysis, covering all relevant sub-systems, or

In addition, the following is to be submitted:

- Test program for sea trials for thruster assistance.
a test program covering failure situations and thereby demonstrating redundancy, which is to be carried out during thruster assistance sea trials.

B 300 Anchor line record.

301 An anchor line record is to be submitted for information, giving the following particulars (and spaces for updating, see A 300) for every mooring line:

- Position on the unit.
- Type of chain/wire rope.
- Maker and time of production.
- Position of joining shackles.
- Record and position of breakages.

C 100 General.

101 The structural arrangements is to comply with requirements given in MOU Rules Pt. 3 Ch. 2 Sec. 5 B, as applicable.

102 During normal operation of the mooring system, any hull protection systems, e.g. anchor bolsters, should not obstruct the anchor lines.
 SECTION 2
ENVIRONMENTAL CONDITIONS AND LOADS

Contents.

A. Environmental Conditions.
 A 100 General.

B. Environmental Loads.
 B 100 General
 B 200 High frequency wave induced motions.
 B 300 Slowly varying wave induced motions.

A. Environmental Conditions.

A 100 General.

101 The Class Notations POSMOOR and POSMOOR V will be related to the limiting environmental condition(s) for the capability of the mooring system and for its intended purpose.

102 The environmental conditions are to include the following:

\[ V_{10\text{min}} = 10 \text{ minutes average windspeed at } 10 \text{ m above sea level} \]

\[ V_{\text{wind}} = \text{Wind driven current velocity} \]

\[ V_{\text{tide}} = \text{Tidal driven current velocity} \]

\[ H_s = \text{Significant wave height} \]

\[ T_z = \text{Average zero up crossing wave period} \]

\[ h = \text{Water depth} \]

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 extreme conditions, all seasons, see table A 1.

<table>
<thead>
<tr>
<th>Location</th>
<th>Field Position</th>
<th>h (m)</th>
<th>( H_s ) (m)</th>
<th>( T_z ) range (s)</th>
<th>( V_{10\text{min}} ) (m/s)</th>
<th>( V_{\text{wind}} ) (m/s)</th>
<th>( V_{\text{tide}} ) (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beryl</td>
<td>59°36'N 1°30'E</td>
<td>120</td>
<td>16</td>
<td>11,0—14,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brent</td>
<td>61°4'N 1°21'E</td>
<td>145</td>
<td>16</td>
<td>11,0—14,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ekofisk</td>
<td>56°37'N 3°15'E</td>
<td>70</td>
<td>14</td>
<td>10,0—13,5</td>
<td>41</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Frigg</td>
<td>59°54'N 2°5'E</td>
<td>105</td>
<td>16</td>
<td>11,0—14,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maureen</td>
<td>58°5'N 1°45'E</td>
<td>95</td>
<td>15</td>
<td>10,5—14,0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Statfjord</td>
<td>61°17'N 1°55'E</td>
<td>145</td>
<td>16</td>
<td>11,0—14,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valhall</td>
<td>59°16'N 3°13'E</td>
<td>70</td>
<td>14</td>
<td>10,0—13,5</td>
<td></td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Viking</td>
<td>53°30'N 2°20'E</td>
<td>30</td>
<td>10</td>
<td>8.5—12.5</td>
<td>41</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>Haltestaken</td>
<td>65°7'N 8°E</td>
<td>250</td>
<td>17</td>
<td>11,0—15,0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tromsøfjellet</td>
<td>71°19'N 20°E</td>
<td>240</td>
<td>17</td>
<td>11,0—15,0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table A 1 Extreme weather condition.

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

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A. Method.
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A 200 Quasistatic analysis.
A 300 Dynamic Analysis.
A 400 Transient motion.

B. Operation conditions.
B 100 Operation Condition I.
B 200 Operation Condition II.
B 300 Redundancy for operation condition II.

C. Safety factors and premises.
C 100 General.
C 200 Safety factors.
C 300 Permissible horizontal offset.
C 400 Permissible line length.
C 500 Anchor pattern.

A. Method.

101 The mooring system is to be analysed for the operation condition(s) given in B, as applicable for the function(s) of the unit.

102 The most unfavourable of the following loadcases is normally to be considered for the extreme condition and used for the mooring system analysis:
1) 10 minutes average windspeed and sea state corresponding to a 100 year-return-period combined a 10 year-return-period current.
2) Current velocity and seastate with 100-year-return-period combined with a 10 minutes average windspeed with a 10 year-return period.

Note:
Unless more detailed information or environmental data is available, the following correlation may be applied:
- The 10-year-windspeed to be taken as 90 percent of 100-year-windspeed.
- The 10-year-current velocity corresponds to the 100-year-current with the wind generated current reduced by 10 percent.

103 When anchoring takes place in shallow water, i.e. below 70 metres, the stiffness effect of the mooring system has to be included in the calculation of the high frequency motion of the unit.

104 When detailed field measurements are not available the wind velocity as function of height above the mean water level may be taken as:

\[ v_{zt} = v_{10min10} (0.1 z)^{0.13} \]

\[ z = \text{distance in m from still water level to the loadpoint.} \]

105 When detailed field measurement are not available, the variation in current velocity may be taken as:

\[ v_{ic} = v_{tc} + 0.02 \cdot v_{1hr10} \left( \frac{50-z}{50} \right) \]

\[ v_{tc} = \text{tidal current in m/s} \]
\[ v_{1hr10} = 1 \text{ hour average wind speed in m/s at 10 m above sea level} \]

106 Unless otherwise documented, the effective elastic modulus applied in the mooring analysis may be taken as:

\[ E = 5.6 \times 10^{11} \text{ N/m}^2 \text{ corresponding to } 2 \text{ times the nominal area of the chain.} \]
\[ E = 9.8 \times 10^{10} \text{ N/m}^2 \text{ for wire.} \]

107 Unless otherwise documented a friction coefficient of 1,0 in the line direction between the anchor line and seabed.

108 The stiffness characteristics of the mooring system are to be determined from recognized theory (e.g. based on the catenary equation).

109 The analysis of the system behaviour may be based on a quasistatic or dynamic approach. For deeper waters, i.e. beyond 450 metres, a dynamic approach according to A 300 is to be carried out.

Note:
Upon special consideration the Society may require a dynamic approach for smaller waterdepths.

110 The maximum allowable deviation for each anchor line in the anchor pattern, as basis for assignment of POSMOOR is \( \pm 10^9 \).
— Time varying effects of the exciting forces and moments.
— Inertia and damping effects of the moored unit and its mooring system.

The probability of simultaneous occurrence of the extreme values of wind, current and waves and their direction dependency may be included when satisfactory documented.

302 The analysis is normally to be carried out in the time domain.

303 The maximum path of excursion and the corresponding tension in the most heavily loaded line within a time period of at least 3 hours to be documented. The documentation is to include the instant at which the maximum anchor line response occurs.

Note: The dynamic analysis should include the low frequency effects of the slowly varying wave drift forces and, if relevant, the time dependent nature of the windloading. Current may normally be taken as constant. In case a simplified frequency-domain analysis is chosen, the non-linear damping and restoring forces may be approximated by a stochastic linearization method as follows:

— calculate the natural frequency of the mooring system.
— calculate spectral density of low-frequency excitation due to wind and waves at the natural frequency.
— estimate the damping ratio for the unit including the contribution from the mooring system.
— calculate standard deviation of the low-frequency response using a constant excitation spectrum given by the spectral density at the natural frequency.

The Society will accept an analysis method whereby the low frequency dynamic behaviour of the moored unit is analysed separately from the high frequency behaviour of local anchor lines by superimposing the values from the global response analysis to arrive to the total tension. Estimation of short-term extreme values for dynamic anchor line forces may be determined by using one of the following methods:

1) Statistical estimation of extreme motion of the upper-end mooring points as basis for harmonic excitation associated with representative period and phase angle relation between vertical and horizontal motion.

2) Time series generation of wave surface elevation for a certain duration, e.g. 3 hours, for location of highest wave. Dynamic tension in the upper-end mooring points to be simulated for a period of 2 - 3 minutes containing the highest wave.

A 400 Transient motion.

401 The transient motion behaviour of the unit following loss of holding power in one anchor line to be documented.

402 The documentation shall include information on the unit's excursion path, unit orientation and line tension during the transient mode in addition to the coordinates of the new equilibrium position referenced to the original position.

403 For the calculation of maximum tension, the transient motion as described in 401 and 402 is to be combined with the significant high frequency induced motion amplitude in the weather direction for the present sea state.

B. Operation conditions.

B 100 Operation Condition I.

101 Operation Condition I is defined as follows: Positioning mooring where a single failure of the positioning system will not lead to a critical situation for the overall safety of the unit and those onboard.

102 Single failure for this condition is the greater of loss in holding power of any one anchor line or failure of any one thruster, if latter is installed.

Note: The following typical service modes are identified as Operation Condition I:

B 200 Operation Condition II.

201 Operation Condition II is defined as follows: Positioning mooring where exceedance of position limitations will lead to a critical situation for the overall safety of the unit and those onboard.

202 Single failure in this condition is defined as any-one of the following failure modes:

a) Loss of holding power of any-one single mooring line.
b) Loss of thrust of any single thruster.
c) Single failure in thruster control or power system leading to stop of one or several thrusters.

Note: The following typical service modes are identified as Operation Condition II:

D 100 General

101 The permissible safety factor is defined as:

\[ SF = \frac{P_b}{T_{\text{max}}} \]

where

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

102 The permissible safety factor is dependent on:

- Operation condition
- Class Notation, i.e. intended service.
--- Type of analysis
--- Type of anchor line

C 200 Safety factors.

201 The permissible safety factors for chain cable and steel wire rope depending on the intended operation condition(s) are given in Table C1. Safety factors for other anchor line types will be considered by the Society upon received documentation.

C 300 Permissible horizontal offset.

301 The horizontal offset from a given reference point is to be within the operational service limitations.

302 When the unit is connected to a rigid riser connection, the maximum horizontal offset during transient motion (including significant first order motion) is given by the maximum allowable riser angle at the BOP ball joint and a safety margin of 2.5 percent of the waterdepth to be deducted.

303 When the unit is connected to riser(s), the maximum horizontal offset and rotation of the unit is not to exceed the given design specifications of the risers.

304 When the unit is connected by a gangway to another structure, the positioning system design and gangway structure is to meet the following:

The distance between the structures (except for the gangway) is not to be less than 10 metres at any point during transient motion (significant high frequency induced wave motion included).

--- During normal operation an excursion reserve of 1.5 metres on the specified maximum excursion of the gangway to be included.
--- The gangway is to be equipped with an alarm in the control room which is to be activated when the maximum excursion is exceeded.
--- The gangway is to be positioned so that it will not collide with any other structure after a single failure.

C 400 Permissible line length.

401 For anchors not specially designed to take uplift forces, the following applies:

--- The mooring lines are to have enough length to avoid uplift at anchors for intact equilibrium position or during maximum transient motion after a single failure. For intact equilibrium position, the greater of significant first order wave induced motion or significant slowly varying wave induced motion to be included. This is not required to be added to maximum transient motion.
--- Maximum deployed line length allowed to be taken into account in the calculation is limited to suspended length at line tension equal to breaking strength of the line plus 500 metres.

402 When the unit is connected by a gangway to another structure, the positioning system design and gangway structure is to meet the following:

C 500 Anchor pattern.

501 The anchor pattern is not to interfere the safety of bottom pipelines, flowlines or other petroleum systems.

502 Crossing of anchor lines is normally not accepted.

<table>
<thead>
<tr>
<th>Operation condition</th>
<th>Quasistatic analysis</th>
<th>Dynamic analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POSMOOR</td>
<td>POSMOOR V</td>
</tr>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact system</td>
<td>1,80</td>
<td>2,90</td>
</tr>
<tr>
<td>Transient motion</td>
<td>1,10</td>
<td>1,10</td>
</tr>
<tr>
<td>Temporary mooring after single line failure</td>
<td>1,25</td>
<td>1,40</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intact system</td>
<td>2,70</td>
<td>3,00</td>
</tr>
<tr>
<td>Transient motion</td>
<td>1,40</td>
<td>1,40</td>
</tr>
<tr>
<td>Temporary mooring after single line failure</td>
<td>1,80</td>
<td>2,00</td>
</tr>
</tbody>
</table>

1) Applies for anchor lines which are located within a critical sector, normally in a 180 degrees sector facing away from the installation, see figures 1 and 2.

--- For d≤L, the anchor lines outside the critical sector may be designed according to operation condition I, POSMOOR V.
--- For d>L, the anchor lines outside the critical sector may be designed according to operation condition II, POSMOOR.

Upon special consideration a narrower sector may be accepted.

Table C1 Permissible safety factors.
Fig. 1  Quasistatic usage factor for operation condition II for POSMOOR V upon single failure.

Fig. 2  Quasistatic usage factor for operation condition I for POSMOOR V upon single failure.
SECTION 4
THRUSTER ASSISTED MOORING SYSTEM

A. Classification.
A 100 General.
A 200 Definitions.

B. System requirements.
B 100 Thruster systems.
B 200 Power systems.
B 300 Control systems.
B 400 Manual thruster control.
B 500 Remote thrust control, joystick system
B 600 Automatic thruster control.
B 700 Automatic control.
B 800 Monitoring.
B 900 Consequence analysis.
B 1000 Simulation.
B 1100 Logging.
B 1200 Self-monitoring.

A. Classification.

A 100 General.

101 For units equipped with thrusters, a part or full net thrust effect may be taken into account in all design conditions. This effect is depending on the layout of the thrust control system and the design conditions. The permissible use of thrusters and the effects are given in Table A1 and is subjected to the system notation letters as follows:

<table>
<thead>
<tr>
<th>Letters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA</td>
<td>The vessel is provided with a thruster assisted mooring system which is dependent on a manual remote thrust control system.</td>
</tr>
<tr>
<td>ATA</td>
<td>The vessel is provided with a thruster assisted mooring system which is dependent on an automatic remote thrust control system.</td>
</tr>
</tbody>
</table>

102 The net thrust referred to in Table A1 is to be based on the following conditions:

- Fixed thrusters may be considered only if the thrust produced contributes to the force or moment balance.

Azimuthing thrusters will be considered to provide thrust in all directions, unless specific restrictions are defined.

- Thruster induced moment is to be taken into account when thruster assistance is analyzed.

103 When thrusters are used, failures leading to stop of thrusters are to be considered equivalent to line failure as defined in Sec. 3 B100-200, and the corresponding safety factors will apply. See Sec. 3 Table C1.

Note: The maximum effect of single failure should not cause lower safety factors than those in Sec. 3 Table C1. Black-out will be one typical maximum effect single failure. If black-out leads to lower safety factors than those permitted for damage condition, the power system has to be arranged with redundancy. Alternatively, the proportion of thrust to be used has to be reduced to a level where black-out still may be acceptable in view of safety factors.

104 Manual thruster control is intended only for limited time periods, and the arrangement assumes the continuous attention of an operator.

A 200 Definitions.

201 TA, thruster assistance, signifies a system comprising:

- thruster systems
- power systems
- control systems

where the thrusters are controlled manually to produce a thrust which will assist the mooring system of the unit.

202 ATA, automatic thruster assistance, signifies a system similar to TA with the addition of an automatic control mode.

203 Thruster system. The thruster system comprises the thruster units, included gear drives and control hardware for control of thrust speed/pitch and azimuth.

Note: Classification according to TA or ATA does not imply specific requirements regarding number of thrusters or capacity of these. The effect of thrusters will be determined and incorporated in the mooring analysis.

<table>
<thead>
<tr>
<th>Operation condition</th>
<th>Manual remote control Letter: TA</th>
<th>Automatic remote control Letter: ATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>70% of the net thrust effect from all except 1 thruster 1) 2) 3)</td>
<td>The net thrust effect from all except 1 thruster 1)</td>
</tr>
<tr>
<td>II</td>
<td>Is not to be accounted for.</td>
<td>Remaining thrust after thruster, power or thruster control failure.</td>
</tr>
<tr>
<td>Temporary (line failure)</td>
<td>70% of the net thrust effect from all thrusters 3)</td>
<td>The net thrust from all thrusters</td>
</tr>
<tr>
<td>II</td>
<td>Is not to be accounted for.</td>
<td></td>
</tr>
</tbody>
</table>

1) If the effects of the thrusters are different, the greatest thrust effect is to be deducted.
2) 0% for POSMOOR-V.
3) Provided continuous watch at joystick.

Table A1: Permissible use of thrust effect in a thruster assisted mooring system.
B System requirements.

B 100 Thruster systems.

101 Thrusters are to comply, as applicable, with MOU Rules Pt. 4 Ch. 2 Sec. 6 or Rules for Steel Ships Pt. 4 Ch. 2 Sec. 8, in accordance with the Main Class of the unit.

102 The thruster configuration may consist of both fixed and rotatable thrusters. Thrust output may be controlled by variable pitch, or variable speed, or other means which may be approved upon special consideration. The thruster configuration will be evaluated on basis of the mooring analysis.

B 200 Power systems.

201 Electrical installations are to comply with MOU Rules Pt. 4 Ch. 4 or Rules for Steel Ships Pt. 4 Ch. 4, in accordance with Main Class of the unit.

202 An automatic power management system is to be provided which will ensure adequate running generator capacity relative to power demand, i.e. available power reserve, and will execute immediate limitations in power consumption to prevent blackout due to overload caused by sudden shortage of available power.

203 The capacity of the power system is to be evaluated on the principle that single failure in the power system is to be considered equivalent to anchor line failure. The limiting requirements for tensions and motions as specified for the type of operation are to be applied.

204 If the permissible safety factors depend on certain thrusters to remain intact after failure as in 203, the power system is to be designed with redundancy to ensure operation of those thrusters. Rules for Dynamic Positioning Systems for Ships and Mobile Offshore Units (DYNPOS) may be used as guidance.

B 300 Control systems.

301 Control modes.

Notation TA is to include:
- Manual control of each thruster
- Remote thrust control, joystick system.

Notation ATA is to include:
- Manual control of each thruster
- Automatic control of all thrusters.

302 A mode selector is to be arranged in the thruster assistance control area to enable switching between remote thrust control, or automatic control, and manual control.

B 400 Manual thrust control.

401 Manual operation of each thruster, start, stop, azimuth, and pitch/speed control is to be arranged. Displays are to be provided for all information necessary for safe and practical operation.

402 Individual stop (emergency stop) of each thruster is to be possible from the thruster assistance control area.

403 The location of the thruster assistance control stand is to be chosen with consideration of the operation. Units operating at safe distance from other stationary structures may have the control stand in a control room with no direct view of the vessel surroundings. Units operating in the vicinity of other structures, i.e., with notation POSMOOR V, shall have a control stand wherefrom there is good view of the unit surroundings.

404 The thruster assistance control stand is to be equipped with displays for line tension and line length measurements.

B 500 Remote thrust control, joystick system.

501 The remote thrust control system is to be located in the control area together with the manual thruster controls and with the same access to thruster and mooring displays.

502 The remote thrust control system is to be a joystick system with integrated control of all thrusters. Automatic heading control is to be included.

503 At least one gyro compass is to be interfaced to the joystick system.

B 600 Automatic thrust control.

601 The automatic control mode is to include the following main functions:

- Automatic control for optimal use of available thrust in cooperation with the mooring system forces, and automatic compensation of the effects of mooring line failure, thruster failure and thruster power failure. Detailed requirements in B 700.

- Monitoring of position and mooring line tensions and alarm for excursions of limits. Detailed requirements in B 800.

- Consequence analysis consisting of prediction of line tensions and vessel position, both transient and final, in the event of single line failure, or thruster failure, under the prevailing environmental conditions. Detailed requirements in B 900.

- Simulation of motion and tensions during manoeuvres, changes of anchor patterns, effects of changing weather conditions, and effects of failures in thrusters or mooring. Detailed requirements in B 1000.

- Logging of relevant parameters for display or hard copy on operator request. Detailed requirements in B 1100.

- Self diagnostics with alarms for faults within the automatic control system or in data received from interfaced equipment. Detail requirements in B 1200.

602 The automatic control system is to be powered from an uninterruptible power source, UPS. The battery power reserve in the UPS should be sufficient for 15 minutes operation.

603 Redundant automatic thruster control is required when the mooring analysis is based on thruster assistance to meet limiting requirements.

B 700 Automatic control.

701 Damping of oscillatory motion. Oscillatory motion is to be effectively damped by use of thrusters. Typically, the excursion amplitude is to be about halved within 5 cycles after introduction of thruster assist.

702 Counteraction of environmental forces. The thrusters are to be controlled to produce thrust to counteract the environmental forces. The thrust is to be proportionate to the magnitude of line tension and position offset. Thrusters may be deactivated when line tensions and position offset are within acceptable limits.

703 Compensation of line failure. The thrusters are to be controlled to produce thrust to compensate for the effects of mooring line failure.

704 Compensation of thrust failure. The thruster control system is to be able to reallocate thrust...
when failure of a thruster is detected, or the operator de-
seselects a thruster.

700 Optimal use of available power.
When the power demand for use of thrusters exceeds
available power, the control system is to use the available
power in an optimal manner and introduce thrust limita-
tions to avoid overloads and black-out situations.
The method of thrust limitation is to be quick enough to
avoid black-out due to the sudden overload caused by stop
of one or more generators.

B 800 Monitoring.
801 Continuous monitoring is to be provided of all im-
portant parameters, which at least will include position,
heading, line tensions, available electrical power.
802 Deviations from desired position and heading are to
be compared with 2 adjustable limits. An alarm is to be
released when passing either limit. When passing the first
limit, the alarm may be considered as a warning and is to
be distinguishable from the alarm released at the second,
more severe limit.
803 Line tensions are to be monitored and compared to
both high and low limits.
804 Low line tension alarm may be interpreted as line
failure if the line tension measurement system has self-
check facilities, and these have not detected a measurement
failure. Otherwise, the low tension alarm is not to be interpreted
as line failure and used for thruster control unless one more
parameter e.g. position or heading indicates line failure.
805 Monitoring of position is to be based on position
measurements from at least one position reference system.
The position being calculated from mooring system data
may be used to check the direct position measurement, and
may be used in the event of failure of the position reference
system.
806 The position measurement should have an accuracy
of 2% of water depth, obtained either directly by one
source of reference or by pooling the results of several.
807 The position reference system is to be installed in a
location and manner most suitable for its type.
808 The position measurements are to be transformed to
represent the position of any critical point on the vessel as
determined by its application.
809 The ATA control panel is to be equipped with alarm
display for thrusters, which may be relayed from the
thruster alarm panel or general alarm system.
810 There is to be alarm display for failure of external
devices interfaced to the ATA system, e.g. gyro compass,
wind sensor, UPS.
811 All alarms are to be acknowledged by the operator
at the ATA control panel. For alarms relayed from general
alarm system or other common source, the acknowledge-
ment is to have only local effect.

B 900 Consequence analysis.
901 Concurrent with control and monitoring, there is to
be performed an analysis of the consequences of certain
defined failures under prevailing operating conditions.
The consequences are defined as line tensions and position
deviations in excess of accepted limits.
902 The failures to be considered are to include failure
of any mooring line, failure of any single thruster, or stop
of thrusters as will occur in the event of the most serious
failure in the power system.
903 The consequence analysis is to check the conse-
quence criteria against all defined faults in sequence, and
the repetition rate is not to be less than once per 5 minutes.
904 All computed consequences are to release an alarm,
or a warning. The consequence and reason are to be suit-
ably identified. The warning/alarm is to be acknowledged.

B 1000 Simulation.
1001 The simulation functions may be executed in an off-
line computer system with access to process data. If the
control system is used for simulation, the priority is to be
next to control, monitoring and consequence analysis.
1002 The simulation facility may use the display system
of the control system, but is not to obstruct the presenta-
tion of alarms.
1003 The simulation facility should at least provide for:
   — Simulation of mooring conditions on input of proposed
     anchor pattern and line tensions.
   — Simulation of effects of changing weather conditions.
   — Simulation of line tensions and transit motion and final
     position caused by line failure. The effects are to be
displayed in true time scale.
   — Simulate relevant functions both with and without
     thruster assistance.

B 1100 Logging.
1101 Automatic logging is to be done of important pa-
rameters. This at least include all line tensions, position
and heading deviations, power consumption, thrust result-
tant in magnitude and direction, wind speed and direction.
1102 The frequency of data recording shall be high enough
to give reasonable presentations of transient behaviour.
1103 The data is to be presented in graphical form, cov-
ering at least one hour back in time.

B 1200 Self-monitoring.
1201 There is to be automatic self-monitoring of the au-
tomatic control system, which is to detect computer stop,
software hang-ups, power failures, and false operation of
interfaced equipment as far as this can be determined from
the central system.
SECTION 5
MOORING EQUIPMENT

Contents.

A. Anchors.
A 100 General.
A 200 Proof testing of anchor strength of embedment type
A 300 Type approval of embedment anchors.

B. Anchor Lines of Chain Cable/Steel Wire Rope.
B 100 General.

C. Fairleads.
C 100 General.

D. Windlasses, Winches and Stoppers.
D 100 General.
D 200 Materials and certification.
D 300 Capacity.
D 400 Stoppers.
D 500 Strength and design load.

E. Tension Measuring Equipment.
E 100 General.

A. Anchors.

A 100 General.
A 101 Normally, the anchors are to be of the embedment or pile anchor type. Other anchor types may be accepted upon special consideration.
A 102 Anchor of embedment type shall be designed in such way that additional anchors can be attached.
A 103 Relevant rule requirements for embedment type anchors given in MOU Rules Pt. 3 Ch. 2 Sec. 5 are applicable.
A 104 Design of pile anchors is to be based on recognized Codes and Standards.

Note:
Design criteria for anchor piles may be taken according to Rules for Fixed Offshore Installations Pt.3 Ch.1 Sec.9.

A 200 Proof testing of anchor strength of embedment type
A 201 The strength of anchor and shackle is not to be inferior to that of the anchor line. For dimension of anchor shackle, see MOU Rules Pt. 3 Ch. 2 Sec. 5.
A 202 Proof testing of the anchor shall be carried out according to MOU Rules 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 embedment anchors.
A 301 Design of embedment type anchors may be given Type Approval.
A 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 MOU Rules Pt. 3 Ch. 2 Sec. 5.
A 303 Testing of the anchor shall be carried out according to MOU Rules 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.
B 101 The stud chain cable anchor lines, if used in the position mooring system, are to be of the steel grade NV K3 RIG or NV K4 RIG. The stud chain cable may be substituted, partly or completely, by steel wire rope, see 104-106, or by alternative mooring lines, see Sec. 3 C 201.

Note:
Upon special consideration other chain grades may be accepted. Notice is to be paid to possible regulations concerning anchor lines for mobile offshore units given by the authorities for the territory in question.

B 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.
B 103 Requirements concerning materials, manufacture, testing tolerances and other relevant requirements for anchor chain cables and accessories specified in MOU Rules Pt. 3 Ch. 2 Sec. 5 apply.
B 104 Relevant requirement concerning steel wire rope according to MOU Rules Pt. 3 Ch. 2 Sec. 5 F 200 apply.
B 105 The wire ropes are to be drawn galvanized or finally galvanized according to ISO standard 2232.
B 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.

C. Fairleads.

C 100 General.
C 101 Fairleads are to be designed in accordance with MOU Rules 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.
D 101 The windlass is normally to have:
   - One cable lifter for each anchor.
   - Coupling for release of each cable lifter from the driving shaft.
   - Static brakes for each lifter.
   - A dynamic braking device.
D 102 The windlass with prime mover is to be able to exert the pull specified by table D1 directly on the cable lifter. For double windlasses the requirements apply to one side at a time.
### Lifting force

<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>$4 w_w h_{\text{max}} + W_A$</td>
<td>15 min.</td>
</tr>
<tr>
<td>Chain</td>
<td>1,7 m/s</td>
<td>$w_c h_{\text{max}} + W_A$</td>
<td>15 min.</td>
</tr>
</tbody>
</table>

$d_c$ = diameter of chain in mm

Table D1 Prime mover lifting force.

<table>
<thead>
<tr>
<th>Item</th>
<th>Type of documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving shaft:</td>
<td>NV-certification</td>
</tr>
<tr>
<td>Gear wheels:</td>
<td>Design documentation</td>
</tr>
<tr>
<td>Dynamic brakes:</td>
<td>x</td>
</tr>
</tbody>
</table>

Note:
- $w_w$ = wire weight in air
- $w_c$ = chain weight in air
- $h_{\text{max}}$ = maximum design water depth
- $W_A$ = weight of anchor

### Certification of winch/windlass

Table D2 Certification of 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>Max. load on brake before slipping. Minimum 0,6 $P_B$</td>
<td>$0,67 \sigma_e$ or $0,80 \sigma_f$ in brake and winch/windlass components</td>
</tr>
<tr>
<td>Stopper disengaged, Brakes engaged</td>
<td>$P_B$</td>
<td>$0,73 \sigma_e$ or $0,98 \sigma_f$ in stopper</td>
</tr>
<tr>
<td>Stopper engaged</td>
<td>$P_B$</td>
<td>$0,73 \sigma_e$ or $0,9 \sigma_f$ in brake and winch/windlass components</td>
</tr>
<tr>
<td>Brake engaged</td>
<td>$0,4 P_B$</td>
<td>$0,5 \sigma_e$ or $0,60 \sigma_f$ in winch/windlass components</td>
</tr>
<tr>
<td>Pulling</td>
<td>$0,4 P_B$</td>
<td>$0,5 \sigma_e$ or $0,60 \sigma_f$ in winch/windlass components</td>
</tr>
</tbody>
</table>

$\sigma_e$ = defined in MOU Rules Pt. 3 Ch. 1 Sec. 3 C 300

$x$ = specified minimum upper yield stress of the material

$\sigma_t$ = specified minimum tensile strength of the material

$P_B$ = minimum breaking strength of anchor line

### Design load and strength requirements for winch/windlass

103 The number of pockets in the cable lifter is normally not to be less than 5.

104 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 and certification.

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

202 In addition to the requirements in Pt. 3, Ch. 2, Sec. 5, A 308, table A1, the following winch/windlass components are subject to NV-certification, see table D2.

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 until the brakes are activated.

302 For windlasses/winches not fitted with stoppers, the braking system is to be separated into two independent systems, each able to hold a minimum static load corresponding to 50% of the minimum breaking strength of the anchor line.

303 For windlasses/winches fitted with a stopper device the static braking capacity is not to be less than the minimum breaking strength of the anchor line in addition to an independent secondary brake with static braking capacity of 50% of the breaking strength of the 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.

Note:
In lieu of braking capacity information, the dynamic braking capacity may be taken according to Table D3.
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 MOU Rules Pt. 3 Ch. 2 Sec. 5 G 200.

D 500 Strength and design load.

501 For the structural parts of the windlass/winches the strength requirements are given in Table D4.

E. Tension Measuring Equipment.

E 100 General.

101 If tensioning measurement is installed, instrumentation is to comply with MOU Rules Pt. 4 Ch. 5 Instrumentation and Automation, Sec. 3 Component Design and Installation.
SECTION 6
TESTS

Contents.

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

B. Test of TA and ATA Systems.
   B 100 General.

A. Test of Windlass/Winch.
   A 100 Tests before assembly.
      101 Before assembly the parts mentioned in MOU Rules 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/winches of a delivery to one unit 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/winches 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.

B. Test of TA and ATA Systems.

B 100 General.
Tests of thruster assisted mooring are to be carried out in a realistic mooring situation according to an approved test procedure in the presence of a Surveyor.

101 All control, monitoring, alarm and simulation functions of the thruster control systems are to be tested.

102 In addition to 101, tests of simulated failures are to be carried out to verify redundant systems in thruster and power installations where these have been required.