TÜRK LOYDU

CHAPTER 70 - MULTI-POINT MOORING SYSTEMS

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This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction as defined in TL- PR 29.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

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Multi-Point Mooring Systems

AMENDMENTS

Revised Sections	RCS No.	EIF Date*
Section 04	05/2021	01.01.2022
Section 07	02/2016	01.07.2016

* Entry into Force (EIF) Date is provided for general guidance only, EIF dates given in Rule Change Summary (RCS) are considered valid. In addition to the above stated changes, editorial corrections may have been made.

SECTION 1

GENERAL, DEFINITIONS

A. Validity, Equivalence

1. The Rules apply to the strength, stability and corrosion of Multi-Point Mooring Systems (MPMS), as well as the materials used for the structural components and the procedures for positioning and installation of such systems.

2. The Rules are applicable to MPMS operating in the Eastern Mediterranean, Aegean, Marmara and the Black Sea waters.

3. MPMS commissioned and rendered operational prior to the publication of The Rules may be classed by **TL** provided that they are shown to satisfy the requirements of The Rules.

B. Accessibility

1. All components and equipment of MPMS are required to be accessible for inspection and maintenance.

2. Inaccessible MPMS components are required to be documented by certified divers and communicated to **TL**.

C. Documents for Approval

1. Forged and cast steel, the structural steel for plates and beams as well as any forged iron structural components are required to be documented according to **TL** Rules, Chapter 2 - Material and submitted to **TL** in triplicate.

2. In addition to the requirements of the previous paragraph, anchors and chains are required to comply with **TL** Rules, Chapter 2 - Material, Section 11 and to be documented accordingly.

3. Production, testing and quality control documentation is required whenever concrete is used for structural components.

4. The environmental conditions of the geographical region where the MPMS is positioned must be determined and documented for submission to TL.

5. The largest and the smallest ships to be moored must be specified with their principal dimensions, displacements, wind projection areas and general profile drawings.

6. A technical drawing or a schematic presentation is required which indicates the respective positioning of the mooring buoys and the ship.

7. The wind, current and wave conditions used as a basis for the design calculations are to be presented in a table.

8. The details of the methods and models used to determine the wind, current and wave loads, together with the results of the analyses are required .

9. The variation with changing wind, current and wave conditions of the loads acting on the ship must be presented in tables and figures.

10. The distribution to the buoys of the total loading on the ship for various wind, current and wave conditions must be presented in tables and figures.

11. The assumptions and other details providing the basis for the Reliability and Risk Analysis must be documented.

To ensure conformity with The Rules, the following drawings and documents indicating, without any ambiguity, the arrangement and the scantlings of the structural members are to be submitted in triplicate:

12. Signal buoy and pipe connection details.

13. Details of equipment used for the MPMS.

14. The manufacturing and rigging details of the sinker blocks.

15. General arrangement plan of the MPMS.

16. Mooring plan for each buoy system.

17. Plans and cross-section drawings of the mooring buoys, manufacturing details.

18. Mooring buoys shell expansion drawings.

19. The general arrangement plan of the MPMS superimposed on the bathymetric map of the location.

Documentation required for the anchors, chains, sinkers and other special components comprising the infrastructure of the MPMS:

20. Drawings and certificates pertaining to the mooring chains and their arrangements.

21. Drawings and certificates pertaining to the anchors of the mooring system.

22. Drawings and certificates pertaining to the sinker blocks of the mooring system.

23. Drawings and certificates pertaining to the catenary mooring system.

24. Sustainable force calculations for anchors and sinker blocks.

25. The "Scenario Report" entailing the details of the procedures for positioning and installation of the MPMS and the drawings and documents pertaining to the scenario report required by The Rules.

The documentation required in relation to the buoyancy, stability and watertight intactness of the MPMS:

26. The tank plan indicating the watertight subdivisions of the buoy.

27. Drawings and calculations indicating the buoy weight and centre of gravity, as well as the detailed weight information for the equipment connected to the buoy, such as the chain, anchor, etc..

28. Documents and certificates for the watertight port covers.

29. Buoyancy and hydrostatics calculations for the buoys.

30. Static stability calculations for the buoys.

31. Stability calculations in the presence of wind and waves, if deemed necessary.

32. Damaged stability calculations based on varying damage scenarios.

33. Drawings and documents related to the draught marks.

34. Documentation pertaining to prevention and control of corrosion and biological fouling as indicated in Section 9.

D. Definitions

1. General

In the following sections, the SI unit system is used unless stated otherwise.

2. Main Dimensions

2.1 Breadth

For those buoys having circular waterline, the breadth is the moulded buoy diameter in any direction. For those buoys with rectangular or similar waterline geometry, breadth is the maximum moulded value of the shorter dimension.

2.2 Length overall

For those buoys having circular waterline, length overall is equal to the breadth. For those buoys with rectangular or similar waterline geometry, length overall is the maximum moulded value of the longer dimension.

2.3 Light draught

Light draught is the draught of the buoy when it floats freely without any connections, carrying no loads.

2.4 Deep draught

Deep draught is the draught of the buoy with all the equipment of the MPMS such as the anchors, chains etc. are connected, but without a moored ship.

2.5 Operating draught

Operating draught is the draught of the buoy when the system functions in a secure and reliable manner. It is assumed that under the operating condition, the chains, anchors and all other equipment are connected and a ship is moored to the system.

2.6 Damaged draught

Damaged draught is the draught at which the buoy attains damaged equilibrium.

2.7 Freeboard

Freeboard is the vertical distance between the top edge of the deck and the waterline at which the buoy floats.

2.8 Depth

Depth is the is the vertical distance between the top edge of the deck and the base line of the buoy.

2.9 Vertical centre of gravity

Vertical centre of gravity is the vertical distance between the base line and the centre of gravity of the buoy.

2.10 Light displacement

Light displacement is the weight of water volume displaced by the buoy when the buoy is free of any external load, including those of chains and anchors.

2.11 Full displacement

Full displacement is the weight of water volume displaced by the buoy when all the equipment of the MPMS such as the anchors, chains etc. are connected, but without a moored ship.

2.12 Lightweight

Lightweight is the weight of the buoy when the buoy is free of any external load, including those of chains and anchors.

2.13 Load condition

Load condition is the condition valid for any given operational state of the buoy, attained in the presence of all loads applied, including the lightweight and the chain and anchor loads.

2.14 Watertight condition

Watertight condition is the condition of the buoy under a given sea state and load condition, when complete prevention of ingress of water is achieved.

2.15 Critical angle

In the case of the buoy heeling due to any reason, critical angle is the heel angle reached when the deck edge is immersed.

2.16 Yield stress R_{eH} [N/mm^2]

In general, yield stress is to be determined as the nominal upper yield point by tension test. It is defined as the stress value corresponding to the first decrease in tension as strain is increased. In order to measure the yield stress under room temperature, the rate of stress change must not exceed 30 N/mm^{2}s for steels and 10 N/mm^2 for other materials. The results of the tension test should have a minimum precision of 1 N/mm^2.

2.17 Tensile stress R_m [N/mm^2]

When determining the tensile strength for ductile materials, the strain rate should not exceed %40/min after the yield point is reached. Rate of stress change may not exceed 2,5 N/mm^2 for brittle materials such as cast iron. The results of the tension test should have a minimum precision of 1 N/mm^2.

E. Rounding-off Tolerances

In order to remain in agreement with the standards, the plate thickness values should be rounded off to full or half millimeter by reducing to full or half millimeter when the decimal is equal to or less than 0.2 or 0.7 respectively and by increasing to full or half millimeter when the decimal is greater than 0.2 and 0.7 respectively.

F. Direct Calculations, Computer Programs

1. The structural design of the MPMS buoys are to be carried out by direct calculations using a finite element analysis program package approved by **TL**. The calculations are expected to provide colour coded contours of the Von-Mises stress, normal stress and shear stress distributions.

2. In the case of model tests being employed for determining the structural design loads, the scaled model must represent the full scale ship correctly in terms of scale and geometrical detail. **TL** is to be provided with documentation containing information, certificates, etc. describing the circumstances in which the model tests are performed. If computational fluid mechanics is used to calculate the structural design loads, the software is to be previously verified by the results of full or model scale measurements. Documentation including the details of such verification is to be submitted to **TL** for approval.

3. In case of an analysis based on the Radiation and Diffraction Theory is to be performed for determining the structural design loads, the method of calculation and the computer software is to be approved by **TL.**

4. The results of the finite elements analysis is to be submitted in a detailed report to **TL** for approval.

5. In case of model experiments, comprehensive information about the model tests is to be submitted in a detailed report to **TL** for approval.

SECTION 2

MATERIALS

Page

A. General

1. These Rules pertain to the properties of the structural materials used for the multi-point mooring systems (MPMS).

2. The properties of all materials mentioned in the rules shall be in accordance with the **TL** Rules, Chapter 2 - Material and Chapter 3 - Welding.

3. Materials whose properties are different from those required by these Rules may only be used with the special approval of **TL**.

B. Structural Steel for Plates and Beams

1. Hot-rolled, weldable hull structural steel of ordinary strength is to be used as plates and beams in the construction of multi-point mooring systems. The ordinary hull structural steel is defined as the steel which has the minimum yield strength of 235 N/mm^2 and the tensile strength of 400-520 N/mm^2 .

2. Ordinary strength hull structural steel is classified into grades TL-A, TL-B, TL-D and TL-E, which denote steels with varying strength properties.

For plates and wide flat-bars:

- grades TL-A, TL-B, TL-D, TL-E
  TL-A 32, TL-D 32, TL-E 32
  TL-A 36, TL-D 36 and TL-E 36

  up to 100 mm. thickness,

- grades TL-A 40, TL-D 40, TL-E 40
  TL-F 32, TL-F 36 and TL-F 40

  up to 50 mm. thickness,

for beams, girders, stiffeners, bars etc.:

- all grades up to 50 mm. thickness

may be used in the construction of multi-point mooring systems.

3. For the structural members with thickness values higher than mentioned above, under special conditions, some deviation from the **TL** Rules, chapter 2 - Material and Chapter 3 - Welding may be permitted after an investigation into the exceptional circumstances or additional conditions may be rendered applicable.

4. The material factor k has the value 1 for the ordinary hull structural steel. If for special structures, the use of steels with yield strength less than R_{eH} = 235 N/mm^2 has been accepted, the material factor k is to be determined by

$$k = 235 / R_{eH}$$

5. Rolled materials which are stressed in the direction of their thickness are to be examined by ultrasonic testing against stratification and inclusion of non-metallic deposits.

6. In case of high local stresses in the thickness direction, e.g. due to shrinkage after welding in single bevel or double bevel T-joints with a large volume of weld metal, steels with known material properties in the thickness direction are to be used in order to avoid lamellar failure.

7. The material classification given in Table 2.1 is to be used for the selection of structural materials to be used in the construction of mooring buoys. The materials used for various structural members are not allowed to be of lower grades than those obtained from Table 2.1 according to actual thickness and material class (I, II, III).

Table 2.1 Material classes

Class / Thickness* t[mm]	I	II	III
≤ 15	A	A	A
>15 ≤ 20	A	A	B
>20 ≤ 25	A	B	D
>25 ≤30	A	D	D
>30 ≤35	B	D	E
>35 ≤40	B	D	E
>40 ≤50	D	E	E
>50 ≤100	D**	E	E

* *Actual thickness of the structural material*

** E when *t>60 mm.*

C. Forged Steel, Cast Steel

The forged and cast steel used in the construction of multi-point mooring systems is to comply with the **TL** Rules, Chapter 2 - Materials. The tensile strength of forged or cast steel is not to be less than 400 N/mm^2.

D. Cast Iron

If cast steel is to be used in the construction of multi-point mooring systems, the requirements of **TL** Rules for Materials, Section 7 are applicable.

E. Concrete

Any concrete material to be used in the construction of multi-point mooring systems shall at least comply with the class standard CE 35. Table 2.2 shows the stress values associated with various classes of concrete.

If concrete is incorporated in the multi-point mooring system, any reinforcements in the concrete which are likely to be adversely effected by corrosion are to be protected against corrosion by all necessary preventive measures.

Table 2.2 Stress values for concrete classes

Class	Normal stress [N/mm^2]
CE 25	25
CE 35	35
CE 45	45
CE 55	55

- The water to cement ratio of the concrete structures shall not exceed 0.45.

- Sea water shall not be used in the production of the concrete.

Depending on the function and purpose of the structure, **TL** may require additional measures against erosion, freezing and dissolution or additional properties such as durability under sudden temperature changes, ability to set underwater, etc.

F. Material Selection for the Mooring System

1. Buoys

Hull structural steel of ordinary strength is to be used to construct the buoys of the multi-point mooring system. The ordinary strength hull structural steel shall comply with the requirements of **TL** Rules, Chapter 2 - Materials, Section 6, in addition to the Rules laid down here.

2. Chains

2.1 These Rules apply to the production and testing of the studded anchor chains and related accessories used in the multi-point mooring systems (MPMS). Under special circumstances, short linked chains without studs may be used upon the approval of **TL**. All chains and associated members are to be produced using materials conforming with the requirements of **TL** Rules, Chapter 2 - Materials, Section 9, B. The chains are classified according to Table 2.3.

Table 2.3 Quality classification of chains

Quality level	Definition	R_m [N/mm^2]
K1	Ordinary quality	370-490
K2	Special quality	490-690
K3	High quality	min. 690

2.2 If quality level K1 material is used together with high capacity anchors, the chains are to be manufactured using materials with tensile strength R_m not less than 400 N/mm^2.

2.3 The chains of quality level K2 and K3 may only be procured from companies approved by **TL**, after tempering procedures are finalized by the producers.

2.4 The steel materials used in manufacturing studded anchor chains are classified as TL-K1, TL-K2 and TL-K3 according to their nominal strength. The short linked chains without studs may only be manufactured using TL-K1 and TL-K2 quality materials.

3. Anchors

- Anchors may be manufactured using forged steel or cast iron.

- The anchors are to be produced using materials conforming with the requirements of **TL** Rules, Chapter 2 - Materials, Section 9, A.

4. Sinkers

The sinker blocks may be produced using concrete or cast iron.

- The concrete used to produce sinkers is to comply with the requirements of Section 2, E. The reinforcement material used for concrete sinkers may be of ordinary strength steel. The reinforcement which is outside the concrete and in contact with sea water must be of grades TL-A 36, TL-D 36, TL-E 36 or TL-F 36.

- The cast iron used to produce sinkers is to comply with the requirements of Section 2, D.

Table 2.4 Mechanical properties of off-shore chain cable materials

Grade	Yield strength (1) [N/mm^2] min.	Tensile strength R_m [N/mm^2]	Elogation A_5 [%] min.	Reduction in area (3) [%] min.	Charpy V-notch impact test		
					Test temperature °C (2)	Average energy [J] min	Arc welding average energy [J] min
TL-R3	410	690	17	50	0 -20	60 40	50 50
TL-R3S	490	770	15	50	0 -20	65 45	53 53
TL-R4	580	860	12	50	-20	50	36

(1) *The aimed value of the ratio of yield to tensile is maximum 0,92.*
(2) *According to TL's decision, the notched bar impact test for grades TL-R3 and TL-R3S may be performed at 0 °C or -20 °C.*
(3) *Reduction in area for cast steel:*
for grades R3 and R3S : min. 40%
for grades R4 : min. 35% - Forgings shall be properly heat-treated.

SECTION 3

ENVIRONMENTAL CONDITIONS

Page

A. General

1. The multi-point mooring systems (MPMS) are to be designed taking into consideration the environmental loads defined in this Section.

2. The environmental loads applied to the system for calculating the reaction forces on the mooring lines are to be based on the wave, wind and current conditions having 50 years recurrence period.

3. For the mooring systems to be placed in the Turkish territorial waters, either the collection and analysis of long term local wave, wind and current measurements or the use of relevant published data is required. In the case of neither approach being available, the values given in Sections B, C and E may be used in the calculations.

4. The local environmental loads and the occurrence of combinations of load components may differ from region to region. In order to calculate the loading on the mooring lines, those combinations yielding the highest loads must be selected. For those regions outside the geographical areas covered by these Rules, the environmental data collected in those regions shall be obtained and used in the calculations.

B. Determination of Location Dependent Conditions

1. In general, the environmental design loads are also dependent on the tension forces prescribed to the mooring lines. The motions of the floating structure in response to the environmental loads and the reaction of the multi-point mooring lines to these motions are to be taken into account in the calculation of the mooring line tension forces. The characteristic effects of the loads are to be based on the steady environmental conditions. The loading parameters are as follows:

- Significant wave height (Hs)
- Peak wave period (Tp) or zero crossing period (Tz)
- Wave spectrum (Jonswap or the wave spectrum measured in the specified region)
- Directional wave energy dispersion function (long crested waves or 4th order cosine function)
- Dominant wave direction
- Average wind speed measured at 10 m above sea level for 1 hour average period ($U_{1\text{ hour, }10\text{ m}}$)
- Wind spectrum function
- Wind direction
- Surface current speed (Vc)
- The variation of current with depth
- Current direction
- Water depth

- Tidal range
- Ground conditions
- Formation of marine life

2. The parameters listed above shall be defined separately in the calculations of the extreme loads and the fatigue loads.

C. Waves

1. The sea states are to be determined taking into account the maximum probable conditions to be encountered in a 50 years period. The wave conditions are to be determined using the measured significant wave height – peak wave period distribution data and/or they are to be calculated.

2. The multi-point mooring system calculations must be based on the joint probability distributions of significant wave height and peak wave period attributed to the specified region.

3. In order to ensure an appropriate design for the multi-point mooring system, the calculations are to be performed along the equal height contour for 50 years period (Figure 3.1). The ships moored by multi-point mooring systems perform low frequency motions and therefore the critical conditions may arise in sea states with long peak wave periods.

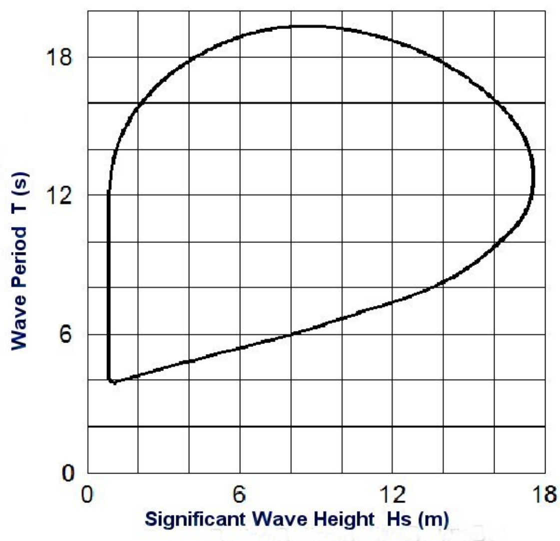


Figure 3.1 An example of equal height contour graph for wave height and wave period

4. For the Western Mediterranean and for various regions surrounding Turkey, the typical sea states with the 50 years recurrence period are given in Table 3.1. Each sea state is characterised with its significant wave height and wave period (Tp or Tz). Table 3.1 may be used for initial design when the detailed measured data is not available for the specified region. The relationship between Tz and Tp is given as

$$T_Z = T_P \left(\frac{5 + \gamma_P}{11 + \gamma_P} \right)^{1/2}$$

where γ_P is the peak enhancement parameter.

Table 3.1 Typical sea states for Turkey and the Western Mediterranean

Location	Parameter	Maximum value or range
East Black Sea (East of Sinop)	H_s T_p	7.1 m 8.5 - 11 s
West Black Sea (West of Sinop)	H_s T_p	7.8 m 7 - 11 s
Marmara Sea	Hs Tp	3.5 m 5.5 - 7.2 s
Aegean Sea	Hs Tp	6.1 m 7 – 10 s
West Mediterranean (West of Anamur)	Hs Tp	6.5 m 8 - 12 s
East Mediterranean (East of Anamur)	Hs Tp	6 m 8 - 13 s
Mediterranean (Egypt)	Hs Tp	12.1 m 14.4 s
Mediterranean (Libya)	Hs Tp	8.5 m 14 s

When the peak enhancement parameter for the specified region is not available, the values given in Table 3.2 may be used in the calculations.

D. Winds

1. The average wind speed must be based on the extreme probability distributions with 50 years recurrence period, obtained from measurements made 10 m above the still water level in the specified region.

Table 3.2 Peak enhancement parameters for the wave spectrum

Location	γ_p
East Black Sea (East of Sinop)	2.7
West Black Sea (West of Sinop)	3.3
Marmara Sea	3.7
Aegean Sea	2.9
West Mediterranean (West of Anamur)	1.4
East Mediterranean (East of Anamur)	1.0
Mediterranean (Egypt)	2.6
Mediterranean (Libya)	1.3

2. The wind loads may be calculated as a combination of the steady and unsteady components, the latter representing the transient gusts. The low frequency ship motions induced by wind gusts represented by the relevant wind spectrum is to be taken into account.

3. Depending on the location of the specified region, the API wind spectrum may be used (API RP 2A).

4. The steady component of the wind speed is to be represented by the average value measured for 1 hour duration at 10 m above sea water level.

The 1 hour average wind speeds for various regions are given in Table 3.3.

Table 3.3 1 hour average wind speeds

Location	$U_{1\,hour,\,10\,m}$
East Black Sea (East of Sinop)	33 m/s
West Black Sea (West of Sinop)	27 m/s
Marmara Sea	25 m/s
Aegean Sea	32 m/s
West Mediterranean (West of Anamur)	35 m/s
East Mediterranean (East of Anamur)	32 m/s
Mediterranean (Egypt)	25 m/s
Mediterranean (Libya)	25 m/s

E. Currents

1. The current speeds for a specified region must be based on the probability distributions of extreme cases of the surface current speed parameters.

2. The components of the currents are as follows:

- Tidal currents related to the astronomical tides
- Circulation currents particular to a given sea
- Currents induced by wind
- Seasonal turbulent currents
- Soliton currents

The total current is to be obtained by the vectorial summation of the components mentioned above. The current speed and direction is to be represented by a current profile indicating the variation with water depth. Depending on the geographical location, the contribution to the design loads by the currents may be significant.

3. When statistical data is not available for the specified region, the current speed induced by the wind at still water level may be calculated by

$$V_{C,\,wind} = 0.015\ U_{1hour,10m} \qquad \text{[m/s]}$$

4. When statistical data is not available for the specified region, the circulation current speeds at still water level may be obtained from Table 3.4.

Table 3.4 Current speeds

Location	Current speed
East Black Sea (East of Sinop)	0.8 m/s
West Black Sea (West of Sinop)	1.1 m/s
Marmara Sea	2.0 m/s
Aegean Sea	1.5 m/s
West Mediterranean (West of Anamur)	1.0 m/s
East Mediterranean (East of Anamur)	1.2 m/s
Mediterranean (Egypt)	0.8 m/s
Mediterranean (Libya)	1.0 m/s

5. The effect of the currents on the wave drift forces acting on the moored ship shall be taken into account.

F. The Effects of Wave, Wind and Current Direction on the Mooring System

1. The multi-point mooring system is to be configured in such a way that, with respect to the particular conditions prevailing in the indicated location, the system should be capable of carrying the environmental loads favourably.

2. For ships moored and fixed in a given direction, the wind, wave and current loads are to be assumed to act on the ship in the same direction. However, the extreme cases of loading must be taken into account by considering the unusual and varying configurations of moored ships.

3. The calculations shall be performed for symmetrical multi-point mooring systems between 0 and 180 degrees and for asymmetrical systems between 0 and 360 degrees and they shall include steps of maximum 45 degree incremental angles with all loads acting in the same direction. Additionally, the waves, wind and current acting in the direction of mooring lines are to be included in the calculations. If available for the indicated location, the directional dispersion data for waves, wind and currents may be used in the calculations.

4. If the directional dispersion data for waves, wind and currents are not available for the indicated location, the following simultaneous combinations of wave, wind and current loads may be used in the calculations:

- Waves, wind and current acting in the same direction, with the direction of the symmetry axis of the ship at 0, 45, 90, 135 and 180 degrees (5 different directions).

- Wind and current acting in the same direction and waves with a 30 degrees angle to wind and current, with the direction of the symmetry axis of the ship at 0, 45, 90, 135 and 180 degrees (5 different directions).

- The wind direction having a 30 degrees angle with respect to waves and the current direction having a 90 degrees angle with respect to waves, with the direction of the symmetry axis of the ship being at 0, 45, 90, 135 and 180 degrees (5 different directions).

Figure 3.2 illustrates an applicable combination of load and ship's symmetry axis directions.

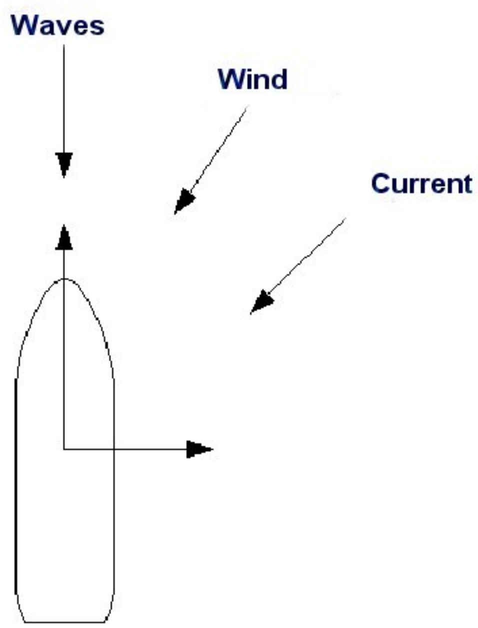


Figure 3.2 The illustration of wave, wind and current directions

SECTION 4

DESIGN LOADS AND ANALYSIS

Page

A. General

1. In this Section, the design loads and the analysis procedures applicable in the structural design and assessment of multi-point mooring systems are defined.

2. The multi-point mooring system to be structurally analyzed is assumed to consist of buoys and the chains, steel cables or synthetic lines and other intermediate members connecting the buoys to anchors positioned at the sea bed.

3. The buoys shall be positioned to provide for the largest ship the space to maneuver freely amongst the buoys and moor securely. Meanwhile, it is to be considered that ships of smaller size may experience difficulty in holding their position under extreme external loads due to excessively long mooring lines.

4. The design loads are to be based on the environmental loads defined in Section 3.

5. The analysis is to be based on those combinations of the external loads which result in the highest structural demand on the system.

6. The design criteria used in the analysis shall be based on two limit states: the Ultimate Limit State (ULS) at failure and the Serviceability Limit State (SLS) under working loads. These limit states are defined as follows:

a) The extreme limit state in which the buoys and the anchors together with the members connecting the ground tackle structure to the buoys carry the maximum probable external loads immediately before failure (ULS).

b) The operational limit state in which the ship reaches the limits of its capability to continue loading and unloading under high external loads (SLS).

7. External loading due to wind and waves shall be calculated by taking into account the maximum values with the highest probability to be encountered during a period of 50 years.

8. The calculation of the external loading, the motions of the moored ship and the loads acting on the buoys shall be carried out separately for the ship in fully loaded condition and for the ship in ballast condition.

9. A comprehensive report incorporating a detailed account of the procedure used in calculating the design loads and the results obtained from these calculations shall be submitted to the approval of **TL**.

B. External Loads Acting on the Ship

1. Wind Loading

1.1 The wind loads may be determined by one of the following procedures:

a) Wind tunnel testing employing scaled models.

b) The empirical method described in the document "*OCIMF Mooring Equipment Guidelines (MEG4)*".

c) Computational fluid dynamics (CFD).

The ship model used in the wind tunnel tests must be correctly scaled and it must represent the full scale ship in detail. The conditions under which the model tests are performed are subject to **TL** approval.

In case of computational fluid dynamics analysis, the computer software must be previously validated by comparisons with full scale or model scale test results. The validation must be documented, submitted to and approved by **TL** prior to the CFD analysis.

1.2 The calculation of the wind loading shall include the periodic wind gusts as well as the average wind load.

2. Current Loads

2.1 The current loads may be determined by one of the following procedures:

a) Testing scaled models in ship model testing facilities.

b) The empirical method described in the document *"OCIMF Mooring Equipment Guidelines (MEG4)"*.

c) Computational fluid dynamics (CFD).

The ship model used in the ship model testing tank must be correctly scaled and it must represent the full scale ship in detail. The conditions under which the model tests are performed are subject to **TL** approval.

In case of computational fluid dynamics analysis, the computer software must be previously validated by comparisons with full scale or model scale test results. The validation must be documented, submitted to and approved by **TL** prior to the CFD analysis.

2.2 The current loads are to be determined taking into account the shallow water effect.

2.3 The current loading on the mooring chains and lines may be neglected.

3. Wave Loading

3.1 The average wave drift forces acting on the ship moored in a multi-point mooring system may be determined by one of the following procedures:

a) Testing scaled models in ship model testing facilities.

b) Computational analysis based on Radiation or Diffraction Theory.

c) The following empirical formulae may be used if the procedures given above are found to be unavailable:

The average wave drift force in the direction of ship's length

$$F_X = \left[0.0388\,\rho.03 \quad {}_B H_s^2 \sin^2\left(\frac{T}{2H_s}\right) + 0.311\,\rho.3 \quad {}^2 \frac{H_s^{2.5}}{L^{1.5}} \right] \cos\beta$$

The average wave drift force in the direction of ship's beam

$$F_Y = \left[0.0388\,\rho.03 \quad {}_s^2 \sin^2\left(\frac{T}{2H_s}\right) \right] \sin\beta$$

Rotation moment

$$N = \left[-0.125\,\rho.125 \quad {}_s^2 \sin^2\left(\frac{T}{2H_s}\right) \right] \cos\beta os\beta s - 0.03 F_Y L$$

Here,

F_X = The average wave drift force in the direction of ship's length [kN],

F_Y = The average wave drift force in the direction ofship's beam [kN],

N = The average wave drift moment acting to rotate the ship [kNm],

L = Ship's waterline length [m],

B = Ship's waterline beam [m],

T = Ship's average draught [m],

Hs = Significant wave height [m],

β = Wave direction,

0^0 : Bow waves

90^0 : Beam waves

180^0 : Stern waves

g = Gravitational acceleration [m/s^2],

ρ = Sea water density [t/m^3].

3.2 The first order wave loads, which cause the moored ship to execute oscillatory motions in six degrees of freedom may be determined by model tests or by computational analysis based on an appropriate theory. When such results are not available, the wave drift forces acting on each buoy shall be increased by % 10.

C. Method of Analysis

1. Scope

The determination of the following loads and stresses constitutes the scope for the structural analysis of multi-point mooring systems:

- The response of the moored ship to external excitation and the loads acting on the system due to the ship motions.

- The stresses induced in the mooring lines.

- The loading on the buoy structures and on the anchoring components of the mooring system.

2. Behavior and Response of the Moored Ship

2.1 The behavior and response of a ship moored in the multi-point mooring system shall be determined by a quasi-static analysis. The results of the analysis shall provide the following information:

a) The forces and moments acting on the ship due to wind, current and wave drift loads, obtained for various wind, current and wave directions.

b) The deviation of the ship from its original position under the influence of wind, current and wave drift forces, obtained for various wind, current and wave directions.

2.2 The analysis shall be repeated at maximum 45 degree intervals to cover all probable combinations of wind, current and wave directions.

2.3 The analyses shall take into account the mooring pre-stresses present on the buoys. The magnitude of the mooring pre-stresses is not to exceed %10 of the stress induced by the maximum force acting on each buoy determined in the worst environmental case scenario.

2.4 The restoring force exerted by a mooring chain is to be calculated by solving non-linear chain equations.

2.5 The equilibrium condition between the loads acting on the ship and the restoring forces exerted by the mooring system shall be studied in order to determine the behavior of the moored ship under varying external loads. The analysis is to take into account the facts that the chain equations describing the buoy's ground tackle are non-linear and the ship executes coupled transitions and rotations.

2.6 The maximum stresses induced in the mooring lines are to be determined by the analysis outlined in the previous paragraph.

2.7 The assumptions and other details incorporated in the computational analysis for determining the behavior and response of the moored ship are to be documented and submitted to TL for approval.

3. Loads Acting on the Buoy's Ground Tackle

3.1 A computational analysis shall be performed for determining the loads exerted on the buoys and their ground tackle by the moored ship under external loads. The results of such analysis are to reveal the variations in the positions of the buoys and the forces acting on the buoys and their ground tackle due to the positional variations caused by the motion of the moored ship under the influence of the wind, current and wave drift forces.

3.2 The positions of anchors shall be assumed to be fixed at all times.

3.3 The pre-stresses present in the multi-point mooring system which arise during the mooring of the ship shall be assumed to be constant and the effects of wind, current and waves on the pre-stresses shall be neglected.

4. Limit State Stresses

4.1 Characteristic stresses in ULS

4.1.1 In the ULS analysis, all members of the ground tackle shall be assumed to be undamaged.

4.1.2 The maximum force acting on the buoy due to wind, current and wave loading shall be calculated by,

$$T_{MAX} = T_P + T_{ORT}$$

where,

T_{MAX} = is the maximum force acting on the buoy [kN],

T_{ORT} = is the total average force acting on the buoy due to external loading on the moored ship [kN],

T_P = is the force which induce the pre-stressing on the buoy [kN],

4.1.3 If the multi-point mooring system consists of identical buoys, the analysis shall be performed only for the buoy which is effected by the highest loading. For systems with buoys having varying structural design characteristics, each buoy and associated members shall be investigated separately.

SECTION 5

STRUCTURAL STRENGTH OF MOORING BUOYS

Page

A. General

1. Scope

1.1 The rules for the structural design of the mooring buoys are outlined in this section.

1.2 This section also includes the general principles to be followed in the selection of materials for the structural members.

2. Principles of the Analysis

2.1 The structural design requirements and recommendations are based on the principle of allowable stress.

2.2 The thickness and section modulus values determine the preliminary scantlings of the structural members of the mooring buoys.

2.3 The scantlings of the structural members shall be verified by direct calculations in terms of the allowable stress.

2.4 The validity and accuracy of the structural Finite Element Model used in the direct calculations shall be demonstrated to the satisfaction of **TL**.

3. Principles of the Structural Design

The mooring buoy shall be divided into four compartments by two vertical watertight bulkheads perpendicular to each other. Each compartment shall be supported by at least two frames whose members shall be joined by brackets at the connections to the floors and deck beams. Each symmetric half of the bulkhead with respect to the drawbar is to be supported by at least one stiffener.

Access to the compartments are to be provided by one manhole for each compartment. These manholes shall not interrupt the continuity of the support members.

B. Materials

1. General

The selection of materials for the structural members of the mooring buoys is to be carried out according to the **TL** Rules, Chapter 2 - Materials and Chapter 3 - Welding. Special provisions for mooring gear such as the quick release hooks are possible provided that the relevant test results are available.

2. Hull Structural Steel for Plates and Beams

2.1 Ordinary structural steel with a nominal yield stress R_{eH} of at least 235 N/mm^2 and a tensile strength of 400-520 N/mm^2 is to be used for the construction of the mooring buoys in accordance with the Rules outlined in Section 2, B.

2.2 Steels with yield and tensile strength characteristics higher than those of the ordinary hull structural steels are designated as high tensile strength steels. According to the Rules, Chapter 2 - Materials, three groups of high tensile strength steels having the nominal upper yield stress R_{eH} of 315, 355 and 390 N/mm^2 are identified.

Table 5.1 indicates the value of the material factor k mentioned in various sections of the Rules for those cases where the high tensile strength steels are used. For high tensile strength steel with other nominal yield stress properties, the material factor k may be calculated by the formula

$$k = \frac{295}{R_{eH} + 60}$$

Table 5.1 Material factor, k

R_{eH} [N/mm²]	k
315	0,78
355	0,72
390	0,66

C. Design Loads

1. General

This Section provides data regarding the design loads for determining the scantlings of the mooring buoy structural members by means of the design formulae given in the following sections or by means of direct calculations. The dynamic components of the design loads are also regarded as the design values applicable within the design concept of this Section.

2. Definitions

2.1 Load center

The load center for the stiffeners is the midpoint of the unsupported span. For plates, a general formula is given later in this Section.

2.2 Unsupported span

The unsupported span ℓ of a stiffener is its length including the end connecting structures (brackets).

2.3 Symbols

H = The height of a mooring buoy (distance between keel and deck) [m]

R = For buoys with circular waterline, the buoy diameter, for non-circular buoys, half of the longest diagonal [m],

T_{MAX} = The mooring force acting on the drawbar [KN],

z = The distance from the load center to the deck [m],

z_1 = The height to the intermediate deck from the bottom plating [m],

ℓ = The unsupported span of a stiffener [m],

h = Design pressure head [m],

ρ = Density of fluids [t/m³]
ρ = 1,0 t/m³, both for fresh water and sea water.

3. Design Pressure

The structural design of the mooring buoy is to be carried out for the pressure value calculated by

$$p = 10 \cdot h + p_o \qquad [kN/m^2]$$

where, **h** shall be separately defined for each structural member.

The values of **h** are given in 3.1, 3.2 and 3.3 for the deck, side and bottom plating of the exterior structure and in 3.4 and 3.5 for the bulkheads and intermediate decks of the interior structure. Additionally,

p_0 = The external dynamic pressure loading

$$p_0 = 2 \cdot c_0 \qquad [kN/m^2]$$

$$c_0 = 0{,}08\,R + 4$$

3.1 Deck pressure

The pressure load on the deck is to be calculated using the greater value of **h** obtained from

$$h = 1 \qquad [m]$$
$$h = R \qquad [m]$$

3.2 Side pressure

The pressure load on the sides of the mooring buoy is to be calculated using the greater value of **h** obtained from

$h = 2H/3 + 1$ [m]

$h = R$ [m]

3.3 Bottom pressure

The pressure load on the bottom plating is to be calculated using the greater value of **h** obtained from

$h = H + 1$ [m]

$h = R$ [m]

3.4 Bulkhead pressure

The pressure loads on the compartment bulkheads are to be calculated as

$h = H$ [m]

3.5 Intermediate deck pressure

The pressure loads on the intermediate decks are to be calculated as

$h = H - z_1$ [m]

D. Scantlings

1. General

In this Section, the Rules for determining the plate thicknesses and the section moduli of stiffeners are given. The brackets may be designed according to the **TL** Rules, Chapter 1 – Hull.

2. Plate thicknesses

The plate thicknesses for the deck, sides and the bottom plating and the interior bulkheads and intermediate decks shall be calculated individually according to the formula given below, which also includes the allowance for corrosion.

$$t = 2 \cdot a \cdot \sqrt{p \cdot k} + 3 \qquad [mm]$$

a = The maximum distance between the support frames [m]

(For those buoys with circular waterlines, the maximum distance between the support frames is defined as the length of the arc of the side plating between the frames).

p = The design pressure calculated according to the value of **h** obtained from Section C, 3.1, 3.2, 3.3, 3.4 and 3.5 for the deck, sides and the bottom plating, the interior bulkheads and intermediate decks.

3. Stiffeners

3.1 Definitions

- The support members used in the buoy structure are to be designated as stiffeners and their scantlings are to be determined by the general expression provided in 3.2 below, taking into account the location of the member in the structure.

- When circular stiffeners are configured to support the deck, the distance between the frames is defined as the largest of the radius of the circular stiffener, the distance between the circular stiffeners or the distance between the side and the circular stiffener.

3.2 Stiffener section modulus

The section modulus of the stiffeners shall not be less than,

$$W = c_1 \cdot a \cdot \ell^2 \cdot p \cdot k \qquad [cm^3]$$

where, c_1 is given for various configurations at the ends of stiffeners as,

$c_1 = 0{,}33$ both ends supported by brackets

$c_1 = 0{,}45$ one end supported by a bracket

$c_1 = 0{,}66$ both ends not supported by brackets

p = the design pressure calculated as in Section C, 3.

When calculating the design pressure **p**, the design pressure head **h** shall be calculated by adding 1m to the distance from the load center to the deck as follows:

Main deck	: h = 1	[m]
Tween deck	: h = z + 1	[m]
Sides	: h = z + 1	[m]
Bottom	: h = z + 1	[m]
Watertight bulkhead	: h = z + 1	[m]

4. Drawbar

The drawbar is the continuous member at the centre of the buoy which connects the mooring line hook on the deck to the chain at the bottom. (Figure 5.1). Taking the mooring line load into consideration, the scantlings of the drawbar is to be determined as follows.

T_{MAX} : Mooring line load as defined in Section 4, "Design Loads and Analysis".

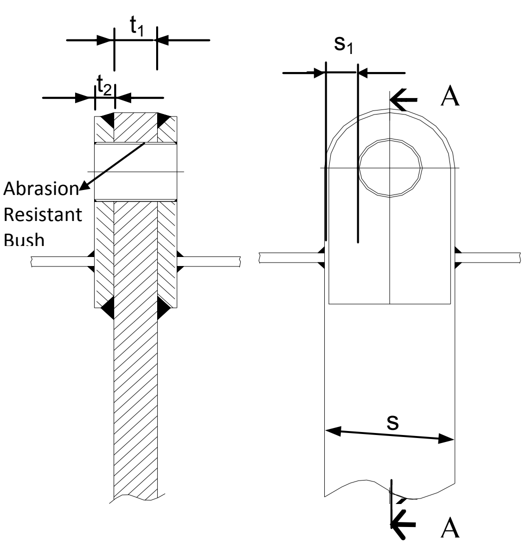


Figure 5.1 Details of drawbar construction

The cross-section area of the drawbar shall not be less than,

$A_{min} = 25.\ T_{MAX.}\ .\ k$ $[mm^2]$

$A_1 = s.\ t_1$ $[mm^2]$

$A_2 = 2.s_1.\ (2\ t_2 + t_1)$ $[mm^2]$

- where both A_1 and A_2 shall be equal to or greater than A_{min} .

Here, the conditions

$s_1 \geq s/4$ and $t_2 \geq t_1/2$

is to be satisfied.

- In case of the doubling plates are not incorporated in the design, the requirements concerning A_2 and t_2 is to be ignored.

5. Manholes

5.1 Openings shall be incorporated in the design of the buoys in order to facilitate access to the interior for inspection and maintenance. If the buoy diameter is greater than 1200 mm, the access arrangement shall allow full entrance.

5.2 The minimum dimensions of the access openings shall be as follows:

- Manholes: not less than 300x400 mm, preferably 400x600 mm.
- The bolts and nuts shall not be less than size M20.
- Stainless steel bolts and nuts are to be preferred and the connections are to be secured by locking nuts.
- For a manhole of dimensions 400x600 mm, a minimum of 16 bolts are to be configured as shown in Figure 5.2. For manhole sizes other than 400x600 mm, the number of bolts shall be determined proportionally.

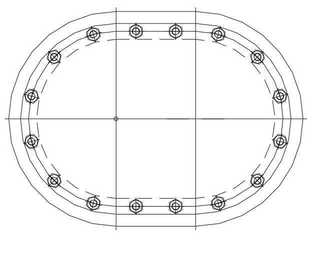


Figure 5.2 Configuration of manhole bolts

5.3 The edges of the manholes are to be supported effectively to prevent loss of plate strength. The installation of the manhole cover may cause deformations along the edges of the opening. Such deformations shall be avoided by welding flange plates or other means of reinforcement along the edges of the openings. (Figure 5.3).

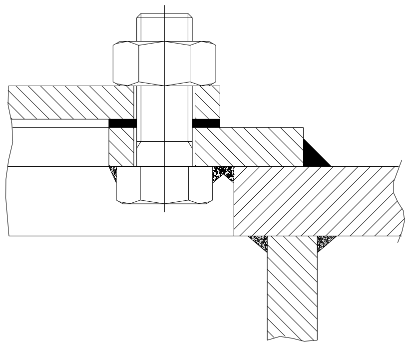


Figure 5.3 Detail of manhole cover bolt arrangement

5.4 The reinforcing members of the manhole and its cover shall be made of ductile material. Gray cast iron or muleable cast iron shall not be used for this purpose. In case metal sealing components are not used, the expulsion of the sealing compound or the sealing cord by pressure shall be prevented by an appropriate fitting along the cover edge. The distance between the fitting and the edge of the manhole shall be uniform all around the opening and it shall not exceed 2 mm. The height of the edge fitting shall at least be 5 mm more than the thickness of the sealing compound or the sealing cord.

5.5 The sealing compound or the sealing cord shall constitute a closed loop. The material used for sealing is to be suitable under the given operating conditions.

E. Direct Calculations

1. General

- The direct calculations shall be performed by the finite element method (FEM).
- The calculations shall be carried out using a FEM software package approved by **TL.**
- The structure of the buoy shall be incorporated in the FEM model as a whole and a three dimensional structural analysis shall be performed.

2. Boundary Conditions

At the point of connection of the chain to the buoy, all displacements in x, y and z directions shall be set to zero, while the buoy shall be free to rotate (Figure 5.4).

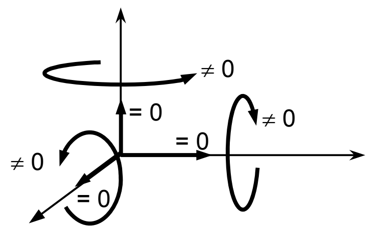


Figure 5.4 Boundary conditions

The boundary conditions shall be applied to the node on the symmetry axis, in the interior edge of the hole at the lower end of the drawbar (Figure 5.5).

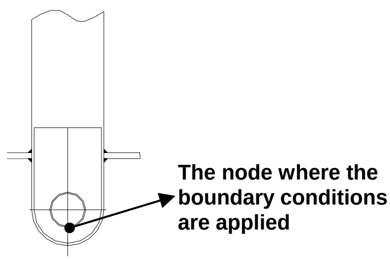


Figure 5.5 The application of the boundary condition

3. Design Loads for Direct Calculations

3.1 External pressure

The external pressure shall be calculated according to C. 3 and it will be applied to the deck, sides and the bottom. The design pressure shall be determined by the average pressure head, neglecting the change in the head due to height. The pressure distribution shall be calculated individually for the deck, sides and the bottom for the maximum "**h**" and shall be applied to the surfaces perpendicularly.

3.2 Mooring line load

The mooring line load "T_{MAX}" is to be applied in the direction of the drawbar axis.

The mooring line load shall be modeled either as a single force acting on a node (Figure 5.6a) or as a number of forces acting on several neighboring nodes (Figure 5.6b) so as not to impair the loading symmetry. If the mooring line load is distributed to more than one node, each nodal force shall be obtained by dividing the load by the number of nodes.

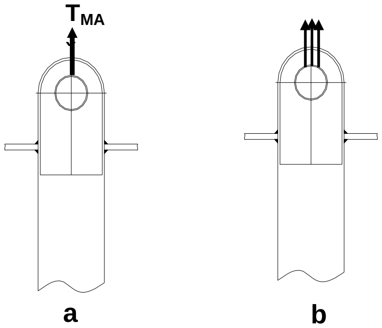


Figure 5.6 The application of the mooring line load

4. Finite Element Structural Model

The structure is to modeled by shell elements. The beams may be modeled by equivalent flat bars. However, the meshing must provide for at least two rows of elements along the length (the height of the flat bar must be made up of at least two elements). The type of element used to model the structure shall have the bending capability and the nodes shall carry three degrees of freedom in displacement and three degrees of freedom in rotation, i.e. six degrees of freedom in total.

5. Stress Analysis and the Permissible Stress

The permissible stress is determined by the following equation:

$$\sigma_{PULS} = \frac{235}{1,3xk}$$

- The "Element Von Mises Stress" obtained as the result of the finite element analysis must not exceed the permissible stress anywhere, except at the node where the boundary condition is applied and the nodes in the immediate neighborhood of this node.

- If the "Element Von Mises Stress" exceeds the permissible stress at the node where the boundary condition is applied and the nodes in the immediate neighborhood of this node, it may be disregarded by the approval of **TL**.

SECTION 6

MOORING BUOY SYSTEM AND EQUIPMENT

Page

A. General, definitions

1. General

1.1 This Section is comprised of the rules pertaining to the components of the buoy anchorage system of the Multi-Point Mooring Systems (MPMS). The components of the anchorage system are classified as the chains, sinkers, anchors and other specialized equipment.

1.2 The anchorage lines of mooring buoy systems are made up of chains, chain assemblies, chain accessories and other related components. The anchorage systems with lines or combinations of lines made of steel wires or synthetic fibers may be designed according to ISO 19901-7:2004(E) rules. **TL** requirements shall also be satisfied independently.

1.3 Unless stated otherwise, the definitions, abbreviations and formulae mentioned here comply with the information, explanations and assumptions provided in Section 6, A.2.

1.4 Unless stated otherwise, the ground structure of the sea floor is as defined in Section 7, B.

1.5 The product list providing the properties of chains and accessories are given in Appendix A. The product list for the drag anchors are given in Appendix B.

2. Definitions

Anchor : The device dropped on to the sea floor to prevent a floating structure to move away from the desired location by wind, current, etc., providing anchorage by deadweight, drag - embedment, grappling, direct-embedment or piling.

Anchoring : Restricting the motion of a ship to a small area by dropping anchor onto the sea floor.

Anchor Ring : Moving link where a line or chain is connected to the anchor.

Bill : The tips of flukes.

Crown : The end of anchor shank, where the flukes and stabilizers are connected.

Eyebolt : Fixed ring for connecting a line or chain to a member of the anchoring system.

Fluke : The flat hinged extensions connected to the shank for digging into the soil as the anchor is dragged.

Link : Connection member of a chain.

Loading : Ultimate Limit State force carried by the anchorage sub-system, (ULS, Section 4, A.4).

Mooring : Restraining at sea by lines of floating structures such as ships, floating docks, buoys and platforms.

Shank : The main body of the anchor which connects the flukes, stabilizers or stocks and the anchor ring.

Stabilizer : Elements (usually bars) at the fluke end, perpendicular to the shank.

Stock : Elongated member connected to the shank at the top end below the ring, positioned perpendicular to the flukes for helping the flukes to dig in the sea floor as the anchor drags.

Stud : The reinforcing centre cross-bar of a chain link. Such a link is called a stud link.

Throat : Part of shank where the stock is connected to the anchor.

3. Symbols

W_b : Weight of sinker block or anchor submerged in water [kN],

W_h : Weight of anchor in air [kN],

H_z : The holding capacity of chain [kN],

H_t : The holding capacity of the sinker block or anchor [kN],

$\mathbf{r_d}$: Sea water density,

$\mathbf{r_ç}$: Anchor density,

DWA : Deadweight anchor,

MPMS : Multi-Point Mooring System,

DEA : Direct-embedment anchor,

ISO : International Standards Organization,

DA : Drag-Embedment anchor,

PA : Pile anchors,

GA : Grappling Anchor,

TL : Turkish Lloyd,

SPMS : Single Point Mooring System.

B. Materials

1. The materials used to in the various components of a MPMS shall comply with the standards outlined in Section 2 unless stated otherwise.

2. **T**he corrosion performance of the components shall be assessed in conformity with the requirements of Section 9 unless stated otherwise.

C. Infrastructure

1. General

1.1 The infrastructure of a mooring system is comprised of the mooring lines, sinkers and the anchors.

1.2 A mooring line entails the chains and the chain accessories. The use of other types of mooring lines is subject to **TL** approval.

1.3 The rules and requirements pertaining to the mooring lines (chains and accessories) are outlined in D.2. The rules and requirements pertaining to the sinkers and the anchors are given in D.3 and D.4 respectively.

1.4 The mooring lines shall be in the catenary form. The mooring lines in any other form and shape are subject to approval by **TL**.

2. Types of infrastructure

Figure 6.1 illustrates a reliable example of a catenary type MPMS. The number 2 buoy may be dispensed with if the physical conditions are not suitable. Each mooring line shall at least incorporate 3 lengths of chain as shown in Figure 6.1. In exceptional cases, a mooring line may be constructed using 2 lengths of chain. In such a case TL must be satisfied by calculations indicating the safe operation of the system. The ground leg (the anchor line) shall be at least a single length of chain. Under full load applied to the buoy, it must be verified that the ground leg links do not execute vertical motion. This is to be achieved by adequately heavy sinkers. The sinker blocks shall be shall be arranged symmetrically in the system.

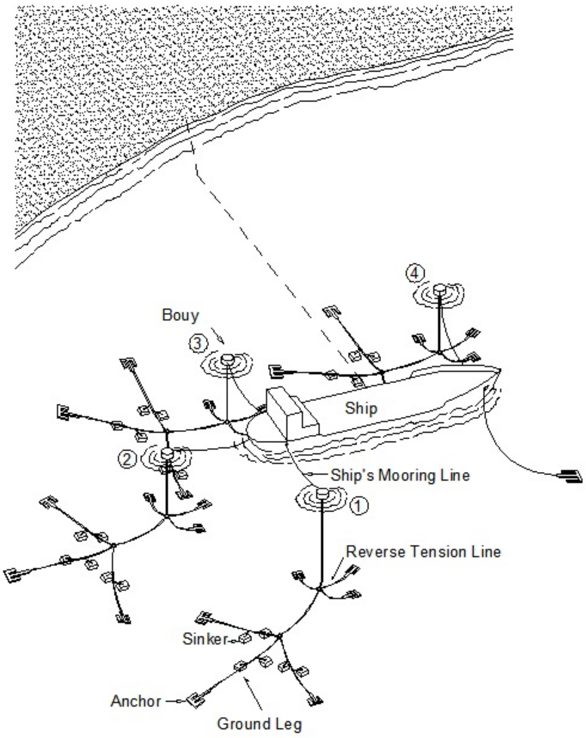


Figure 6.1 A catenary mooring system

The angles between the ground legs and the rest of the mooring lines of systems with 3 lengths of chain shall not exceed $\phi_1 = 45^0$. For systems with 2 lengths of chain, the angle between the ground leg and the rest of the mooring line shall not exceed $\phi_1 = 30^0$. The riser chain shall be supported by a reverse tension line. The reverse tension line is indispensable. In case sufficient tension is achieved during the installation of the system, the lateral tension lines may be dispensed with. Such an arrangement is subject to **TL** approval. The catenary mooring systems 1, 2, 3 and 4 shown in Figures 6.2 – 6.5 are acceptable arrangements for systems designed for loads below 30 tonnes applied to the buoy. If the load at the buoy is over 30 tonnes, the catenary mooring systems 2 and 3 shown in Figures 6.3 and 6.4 are applicable. For the acceptance of the systems installed before the present **TL** rules, the buoy load shall be ignored and the system shall be approved if it is shown to be capable carrying the design load.

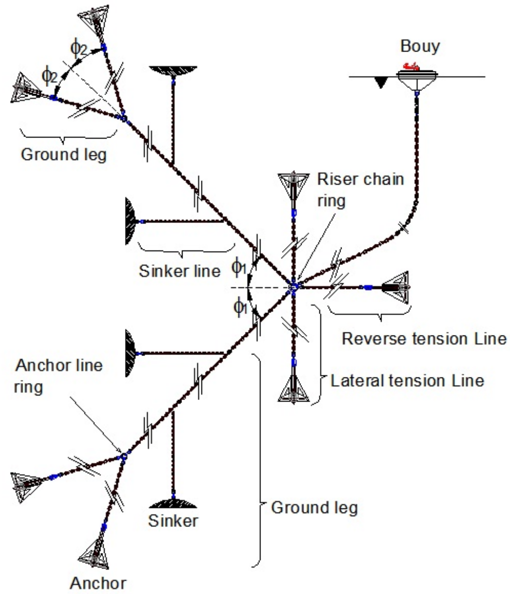


Figure 6.2 Catenary mooring system 1

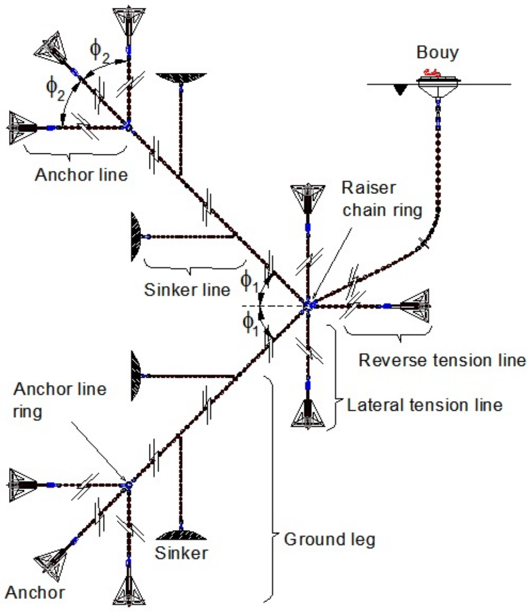


Figure 6.3 Catenary mooring system 2

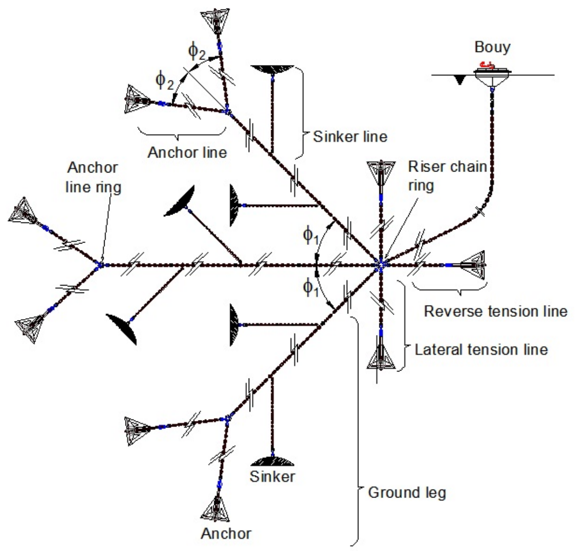


Figure 6.4 Catenary mooring system 3

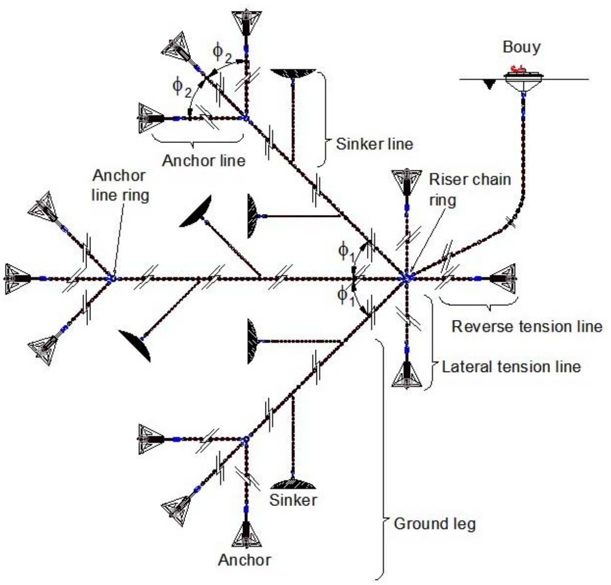


Figure 6.5 Catenary mooring system 4

All system components are to be shown to be structurally safe by calculating the load carried by each line, taking into account the angles. The lower end of the riser chain (the riser chain ring) must be in contact with the sea floor when the buoy floats freely. In this case, the riser chain shall not carry any additional tension.

For Serviceability Limit State (SLS), the safe operational load of the system is to correspond to 1/3 the failure load of the components. For the Ultimate Limit State (ULS), the safe load is to correspond to 2/3 the failure load of the components (see Section 4, A.4).

D. System components

The requirements pertaining to the sinkers, anchors, chains and other components which constitute the infrastructure of the mooring system are outlined in the following section.

1. Buoys

The buoy of the MPMS shall comply with the requirements of Section 5.

2. Chains

The following requirements apply to the chains and related accessories and auxiliary components.

2.1 General

2.1.1 The chain assemblies consist of connection components, swivels and shackles. When the mooring line is constructed using materials other than chain assemblies, the requirements given in A1.2 are applicable.

2.1.2 Chains and chain assemblies of the MPMS shall be of types approved and certified by **TL**. The Chains and chain assemblies are certified and classed according to the requirements outlined in Section 10.

2.1.3 The materials used to manufacture the chain and chain assembly components shall comply with the requirements of Section 2, F.2 and Section 5, B.

2.1.4 Additionally, the requirements of the **TL** Rules, Chapter 1 - Hull, Section 17 apply to the MPMS used for anchoring and mooring ships.

2.1.5 The installation of the chains and chain assemblies on the sea floor shall comply with the requirements of Section 7, C.

2.1.6 The geometrical and physical properties of the type of chains, chain assemblies and accessories are presented in the Appendix A, Product List – Chains and Accessories.

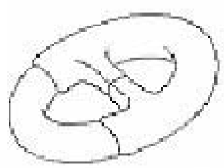
2.2 Definitions

Cast chain: This type of chain link with its stud is cast as a whole and it is fabricated in compliance with the standard commercial chain link sizes.

Dilok Chain: Dilok chain is a forged chain which does not require welding during fabrication. Each part consists of a male and a female part. Firstly, the female part is punched out and heated. The male part is then threaded through the next ring and inserted cold into the female part. Dilok chains are fabricated in the standard commercial chain link sizes.

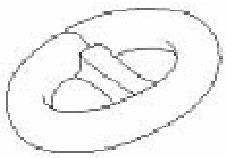
Cast Chain

Butt Welded Chain: This type of chain is fabricated by forging a steel rod into a link shape and butt welding the joint at the closed end. The stud is inserted before the metal cools and the link is pressed together on the stud. In some cases, the stud is welded to the link at both ends after the pressing applied to the link.



Dilok Chain

Various types of common chain links and chain fittings are defined in the following section. Their geometry and standard dimensions are given in Appendix A.



Butt Welded Chain

A – Type Link: This is the common type of link used to produce chains for anchoring and mooring.

B – Type Link: The B-Link is similar to the A-Link but it is larger in chain diameter.

E – Type Link: The E-Link is an open link without a stud, allowing a D- or F-Shackle to be threaded through.

C – Type Link: The stud of a C-Link is placed close to one end allowing a D- or F-Shackle pin to pass through its larger opening at the other end.

Pear Link: One end of a pear link is wider than the other and it is used as the final link at the end of a chain.

Chain Joining Link: It is a detachable joining link which may be of the Bald type, Kenter shackle type, pear type or the lugless shackle type.

Anchor Joining Link: It is a detachable joining link and it may be of the Bald or Kenter shackle type as illustrated in Appendix A.

D – Type Link: Otherwise called the D-Shackle, D-Link is a joining link similar to an anchor joining link but it is smaller has a circular

F – Type Link: Otherwise called the F-Shackle, F-Link is a joining link similar to D-Shackle but it is larger.

Buoy Shackle: The buoy shackle is used to connect an end link or anchor joining shackle to the tension bar of the buoy.

Sinker Shackle: The link of a sinker shackle is elongated to accommodate the sinker connection to a chain by passing the chain through the shackle

Swivel: The swivels prevent twisting in the lengths of chain which constitute various legs of the mooring system.

Swivel Shackle: The connections of common A-Links to a swivel are facilitated by shackles at both of its ends.

Modified Swivel Shackle: It is a swivel shackle with different dimensions at the ends, suitable for use in the riser chain.

Ring: A ring is a large steel circular link, also called the ground ring, usually used to join the riser chain to the ground legs.

2.3 Chain links

2.3.1 A – Type Link: The lengths of chain constituting the mooring and anchoring system are to consist of butt welded A–Type Links.

2.3.2 B – Type Link: A B–Type Link is to be used to join the last common studed link and the final link of a length of chain.

2.3.3 E – Type Link: An E–Type Link is to be used as the final link of a length of chain in order to facilitate the connection of shackles and detachable links.

2.3.4 C – Type Link: An C–Type Link is to be used for the same purpose as an E-Type Link where a link larger than an E-Type Link is appropriate.

2.3.5 Pear Link: A Pear Link is to be used as the final link of a length of chain allowing connections such as to a ground ring or to an anchor joining link.

2.4 Chain joining links

The chain joining links are to be used to connect two lengths of common link chain, two A-Type Links, a swivel and a A-Type Link or similar components of the system.

2.5 Anchor joining link

The anchor joining links are to be used to connect a length of common chain to ground rings or anchor rings, buoy shackles or for similar connections.

2.6 Shackles

2.6.1 D – Type Shackle: The D-Type Shackles are to be used to connect relatively longer lengths of chain together.

2.6.2 F – Type Shackle: The F-Type Shackles are to be used to join the final links of relatively larger sized chains or to connect such lengths of chain to anchors.

2.6.3 Buoy Shackle: A buoy shackles is to be used to connect the buoy to a length of chain.

2.6.4 Sinker Shackle: A sinker shackle is to be used to connect a sinker to a length of chain.

2.7 Swivels

An adequate number of swivels are to be used to prevent twisting in the riser chain and the ground legs during installation.

2.8 Swivel shackles

2.8.1 Swivel Shackle: The swivel shackles are to be used to connect standard swivels to the system.

2.8.2 Modified Swivel Shackle: The modified swivel shackles are used instead of the standard swivel shackles to prevent twisting in the riser chain.

2.9 Rings

A ground ring is to be used to connect the riser chain to three or more ground legs of the mooring system.

2.10 Holding capacity of chain legs

The holding capacity provided by the chain is directly proportional to the length of chain laid on the sea floor and it is to be calculated by the formula

$$H_z = 7 * l_z * w \quad [kN]$$

Here,

l_z = is the length of chain laid on the sea floor [m],

w = is the weight per unit length of the chain in sea water [t/m].

The ground legs of the MPMS is to be weighed down in order to maintain their load carrying capacity parallel to the sea floor even in the presence of sudden variations in the topology of the sea floor.

3. Sinkers

3.1 General

- The sinkers are heavy blocks installed on the sea floor to function as a type of deadweight anchor.

- The sinkers are connected to the ground legs by chains. The connecting lengths of chain shall comply with the requirements outlined in D.2. In the case of components other than chains and chain accessories to be used for connecting sinkers to the system, the requirements laid down in A1.2 shall be satisfied.

- The sinker blocks may be incorporated into a mooring system by two different configurations:

1) The buoy may be connected to the sinker blocks by means of a chain line as shown in Figure 6.6a. In this case, the sinker blocks are to satisfy the requirements laid down in D.4.4 for the deadweight anchors. Such a system is not of the catenary type.

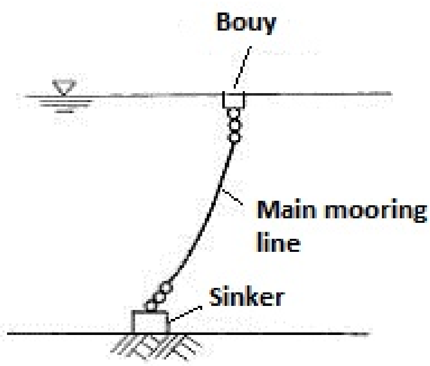


Figure 6.6a Sinker mooring

2) The buoy is connected to the sea floor by a chain line and an anchor. The sinker blocks weigh the chain line down and provide dynamic damping for reducing the vertical motion in the system, as shown in Figure 6.6b.

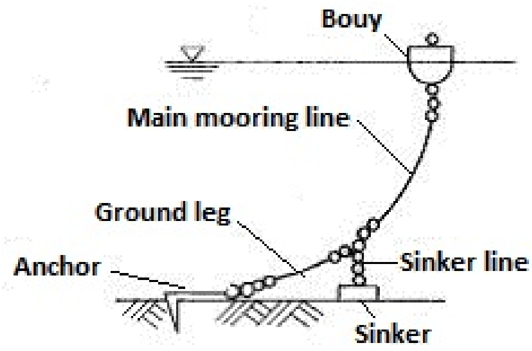


Figure 6.6b Anchor-Sinker mooring

- The sinker blocks are to be installed symmetrically on both sides of the chain line.

- The sinkers shall be connected to the ground legs by chains. The sinker chain lines shall satisfy the requirements laid down in D.2.

- The length of the sinker chain line shall not exceed 4m.

- The installation of the sinker blocks on the sea floor shall be carried out in accordance with the requirements of Section 7, C.

- The sinker blocks are to be installed on the sea floor in a stable and safe position.

- The dimensions of the sinker chain and the sinker hairpin, padeye or eyebolt shall be calculated considering the weight of the sinker in air.

- The sinker blocks are approved, certified and classed by **TL** in accordance with Section 7, F and Section 10.

3.2 Materials

- The sinker blocks may be fabricated using concrete and/or cast iron.

- The concrete used to fabricate sinkers shall satisfy the requirements of Section 2, E and Section 2, F.4.

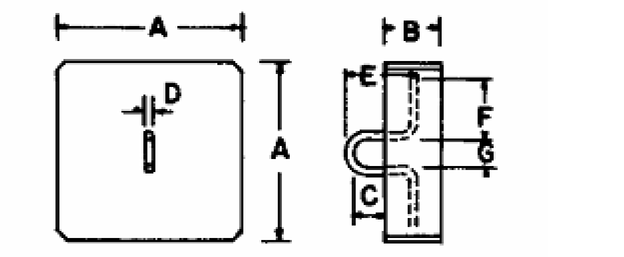
- The sinker blocks made up of cast iron shall satisfy the requirements of Section 2, D and Section 2, F.4.

3.3 Types of sinker blocks

3.3.1 Concrete sinkers

1) Table 6.1 shows the dimensions of the square based, steel reinforced concrete sinker blocks. The intermediate values may be obtained by interpolation from Table 6.1. Any extrapolations to obtain values beyond the low and high limit values are not allowed. The hairpin, padeye or eyebolt of the sinker block may be designed outside the standards provided in Table 6.1.

Table 6.1 Concrete sinkers



WEIGHT		DIMENSIONS [mm]					
[kg]	A	B	C	D	E	F	G
453.6	889	254	101.6	19	254	304.8	88.9
907.2	1143	304.8	101.6	25.4	280	355.6	88.9
2265.9	1447.8	457.2	1275	41.27	406.4	457.2	101.6

In such a case, a detailed stress analysis by direct calculations of the Von-Mises stress field shall be carried out and the results shall be approved by **TL**.

2) The square based, chain reinforced sinker blocks may be used in the MPMS. The reinforcements shall be arranged perpendicular to each other as illustrated in Figure 6.7.

The use of sinker blocks reinforced in a way different than described above is subject to special approval by **TL**.

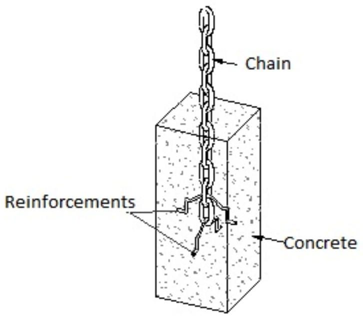


Figure 6.7 Chain reinforced concrete sinker block

3) The dome shaped, chain reinforced concrete sinkers as illustrated in Figure 6.8, may be used in the MPMS if approved by **TL**.

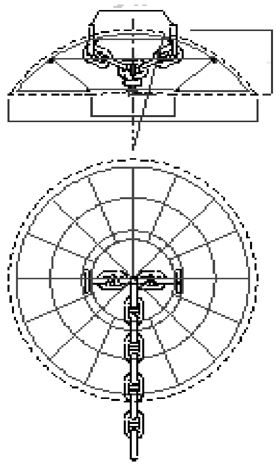


Figure 6.8 Dome type concrete sinker

- The sinker chain properties and dimensions must satisfy the requirements of Section 2, E and must facilitate connection to the main ground leg of the system.

- The concrete sinker blocks must be protected and configured accordingly in order to prevent the connection components to cause damage under full load operation conditions.

3.3.2 Other sinker blocks

The requirements of D 4.4 pertaining to the deadweight anchors are also applicable to cast iron sinker blocks. The material used in the fabrication of cast sinker blocks must previously be certified by **TL**.

3.4 Holding capacity

The holding capacity of a sinker block is defined as the maximum forces applied to the sinker installed on the sea floor before it moves horizontally or vertically. The vertical force is the sum of the weight of the sinker in water and the ground effect. The horizontal force is the maximum friction between the block and the sea floor before the block drags. The holding capacity of the sinker blocks are to be calculated by considering the sinker weight in water only.

Table 6.2 Holding force factor

Holding force factor (e)	Sea floor vacuum effect	
Sinker Type	**Effective** (Sand, Mud)	**Not effective** (Hard, Rocky)
Square Based	1.5	1
Dome Type	4	1

The vertical holding force of a concrete sinker block is to be calculated by

$$H_t = W_b * e$$

where

e is the holding force factor (see Table 6.2).

The holding force factor is directly related to the sea floor properties. In the case of sufficient information about the nature of the sea floor not being available, it shall be assumed that sea floor vacuum effect does not exist.

4. Anchors

4.1 General

4.1.1 Certified anchors are to be used in the MPMS infrastructure. The certification shall include the information listed in Table 6.3. In addition, the anchors to be deployed in a MPMS shall satisfy the requirements of Section 10 for certification and classification.

Table 6.3 Anchor document

Anchor type	=
Weight (excluding stock) [kg]	=
Anchor weight [kg]	=
Length of shank [mm]	=
Length of stock [mm]	=
Inclination radius [mm]	=
Test load [tonnes]	=
Description	=
Test certificate number	=
Test machine count	=
Certification year	=
Weight of anchor head [kg]	=
Test failure information	=

4.1.2 The types of anchors to be used in a MPMS are the Drag-Embedment Anchor DA (Figure 6.9), Deadweight Anchor DWA (Figure 6.10), Grappling Anchor GA (Figure 6.11), Direct-Embedment Anchor DEA (Figure 6.12) and Pile Anchor PA (Figure 6.13). The type of anchor to be used is to be selected according to Table 6.4.

4.1.3 The rules of the present section apply to Drag–Embedment Anchors with flukes and to Deadweight Anchors. The use of Direct-Embedment Anchors, Pile Anchors and Grappling Anchors in a MPMS is subject to special approval by **TL**.

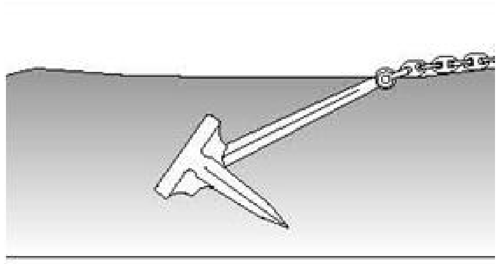


Figure 6.9 Drag-Embedment Anchor

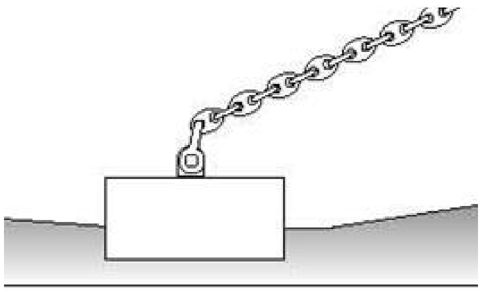


Figure 6.10 Deadweight anchor

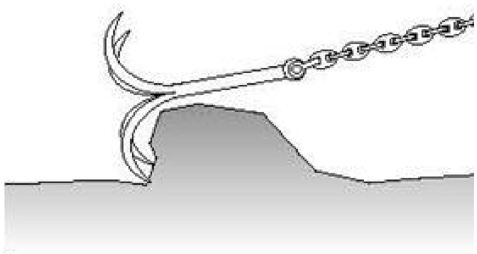


Figure 6.11 Grappling anchor

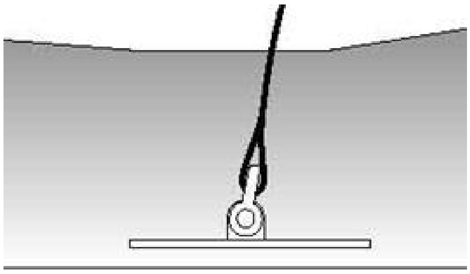


Figure 6.12 Embedded anchor

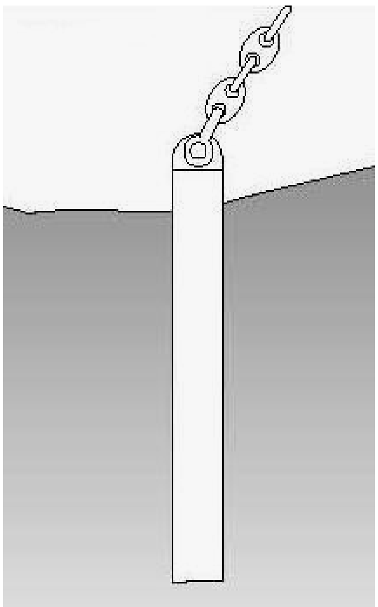


Figure 6.13 Pile anchor

4.1.4 In addition to the present requirements, MPMS used to provide anchorage and mooring for ships shall comply with the **TL** Rules, Chapter 1 - Hull, Section 17.

4.1.5 The anchors are to be connected to the system using chains and chain assemblies. When the anchor connections are provided with materials other than chains and chain assemblies, the requirements of A1.2 become applicable.

4.1.6 The procedures used to install anchors on the sea floor shall satisfy the requirements of Section 7, C.

4.2 Materials

The properties of the materials used to fabricate anchors shall comply with the requirements of Section 2,C.

Table 6.4 Comparison of anchor types

Anchor Types	DWA	PA	DEA	DA	GA
Sea Floor Properties					
Soft clay, mud	+	X	+	+	-
Soft clay to a depth of 6 m, below hard layers	+	+	-	X	-
Hard clay	+	+	+	+	-
Sand	+	+	+	+	-
Icy floor	+	+	+	X	
Large stones, rocks	+	-	-	-	X
Soft rocks, corals	+	+	+	X	+
Hard, large rocks	+	X	X	-	+
Sea Floor Geometry					
Inclination < 10^o	+	+	+	+	
Inclination >10^o	-	+	+	-	
Load Direction					
Multiple directions	+	+	+	-	-
Single direction	+	+	+	+	+
Uplift	+	+	+	-	+
Lateral Load Magnitude					
Up to 45.4 tonnes	+	X	+	+	+
Between 45.4 - 454 tonnes	X	+	X	+	-
Above 454 tonnes	-	+	-	-	-

\+ : Functional
X : Functional, but not a reliable selection
- : Not functional

4.3 Drag-Embedment Anchors (DA)

4.3.1 Table 6.5 illustrates the types of Drag-Embedment Anchors. The geometrical properties of the types of Drag-Embedment Anchors to be used in MPMS infrastructures are given in APPENDIX B, Product List – Anchors.

The drag-embedment anchors are expected to hold against both uplifting and lateral loading. It is to be assumed that the anchor resists the uplifting loads by its weight in water. The resistance exerted by the anchor against the lateral loading is designated as the holding capacity of the anchor.

4.3.2 Holding capacity

4.3.2.1 The holding capacity of a drag-embedment anchor is to be calculated by

$H_t = H_r (W_h/4536)^a$

where,

H_t : is the static holding capacity [kN],

H_r : is the holding capacity of the reference anchor in air [kN],

W_h : is the weight of the anchor in air [kg],

a : is an constant.

The values associated with various holding capacity parameters are given in Table 6.6 for the drag-embedment anchors.

4.3.2.2 In the absence of adequate information on the ground characteristics of the sea floor, the holding capacity of anchors is to be calculated by

$H_t = e{*}W_h$

where e is a non-dimensional effectiveness coefficient given in Table 6.5 for various anchor types, each assumed to weigh 10 tonnes. If relevant information is not available, the minimum value of effectiveness coefficient is to be used.

4.3.2.3 When information about the anchor selected for use in the MPMS infrastructure is not available, the holding capacity is given by

$H_t = 17W_b^{2/3}$ for soft mud,

$H_t = 10W_b^{2/3}$ for hard mud,

$H_t = 3W_b$ for sand,

and

$H_t = 0.4W_b$ for flat rock.

4.3.2.4 If both the ground characteristics of the sea floor and the anchor properties are unknown, the minimum holding capacity calculated by the formulae given in 4.3.2.3 shall be selected. An anchor safety factor of 1.5 shall be applied in the calculations.

The weight of the anchor in water (W_b) is calculated by

$W_b = (1-\mathbf{r}_d/\mathbf{r}_ç) W_h$

If the material density for the anchor and the sea water density are unknown, the weight of the anchor in water is assumed to be equal to the %85 of its weight in air.

4.4 Deadweight anchors (DWA)

The heavy objects installed as anchors on the sea floor are designated as deadweight anchors. The types of deadweight anchors are illustrated in Table 6.7. The deadweight anchors are fabricated using steel, concrete or ferro-cement. The use of such anchors in the infrastructure of a MPMS is subject to special approval by **TL**. The use of deadweight anchors in a catenary mooring system is not allowed.

5. Special equipment

The special equipment used on the buoy shall be approved and certified by **TL**.

5.1 Mechanical equipment

The main equipment allowed on the buoy deck is as follows:

- Safety rails,
- Quick release hooks,
- Non-slip surfacing,
- Fenders.

Table 6.5 Drag-Embedment Anchor (DA) types

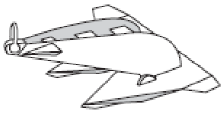
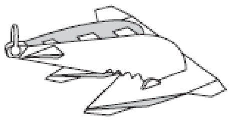
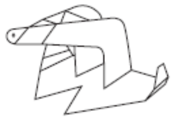
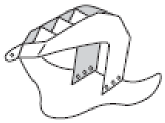
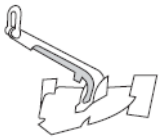
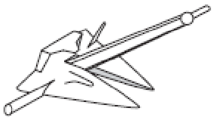
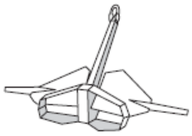
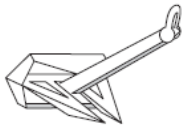
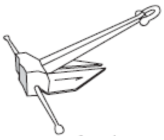
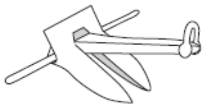
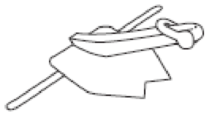
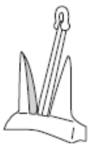
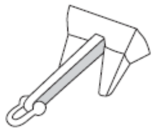
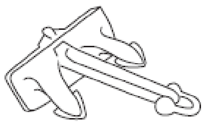
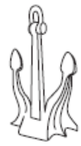
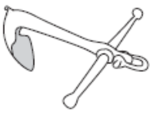
Type	Effectiveness Coefficient				
Type 1	33-55	 TLC – 1	 TLC – 3	 FFTS	
Type 2	17-25	 TLC – 23	 TLC – 24	 TLC – 22	
Type 3	14-26	 TLC – 5	 TLC – 18	 TLC – 20	 TLC – 6
Type 4	8-15	 TLC – 7	 TLC – 8	 TLC -9 TLC -10 TLC -14	 TLC – 16
Type 5	8-11	 TLC – 11	 Stokes	 TLC – 17	 Weldhold
Type 6	4-6	 TLC – 12	 TLC – 13	 Union	 Spek
Type 7	<6	 Single fluke stock	 Stock	 Drag stock	 Double drag stock

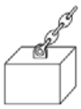
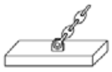
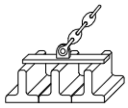
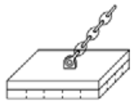
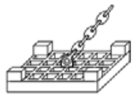
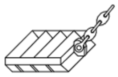
Table 6.6 Holding capacity parameters

Anchor type (1)	Soft Ground (Soft clay and mud)		Hard Ground (Sand and clay mud)	
	H_r [kN]	a	H_r [kN]	a
TLC – 16	934	0.94	1201	0.94
TLC – 23 Cast	142	0.92	1112	0.8
TLC – 25 Flat flukes twin shank	1112	0.92	**(2)**	**(2)**
TLC – 24 Twin shank	841	0.92	934	0.94
TLC – 7	387	0.92	560	0.8
TLC – 6	618	0.92	**(2)**	**(2)**
TLC – 11	387	0.92	560	0.8
TLC – 22	841	0.92	445	0.8
TLC – 8	387	0.92	560	0.8
TLC – 9	520	0.92**(8)**	267 445 **(3)**	0.8 0.8
TLC – 12	934	0.94	1201	0.94
TLC – 14	520	0.92**(8)**	267 445 **(3)**	0.8 0.8
TLC – 10	934	0.94	1112 **(4)** 845 **(5)**	0.94 0.94
TLC – 21	618	0.92	1290	0.8
TLC - 18	841	0.92	1290	0.8
TLC – 5	618	0.92	734	0.8
TLC – 20	1112	0.92	**(6)**	**(6)**
TLC – 1 Straight shank	841	0.92	934	0.94
TLC – 13 Fixed fluke	205	0.92	311 196 **(7)**	0.8 0.8
TLC - 13 Hinged fluke	107	0.92	311 196 **(7)**	0.8 0.8

(1) *For hard ground as specified by the manufacturer, ,for soft ground at 50^o fluke angle*
(2) *Data not available*
(3) *Fluke angle 28^o*
(4) *Fluke angle 30^o*
(5) *For dense sand*
(6) *The anchor not suitable for the particular ground characteristics*
(7) *Fluke angle 48^o*
(8) *Fluke angle 20^o*

a: exponential constant

Table 6.7 Deadweight anchors

				
a) Sinker	b) Squat clump	c) Rails or scrap iron	d) Concrete slab	e) Open frame with weighted corners
. Effective . Easy to use	. Lateral stability . Large area of contact with sea floor	. High weight, small volume . Low cost	. High lateral load carrying capacity . Less likely to drag	. High lateral load carrying capacity . Low stresses in the line . Shallow embedment
				
f) Mushroom	g) Wedge	h) Slanted skirt	i) Circular slab with shear keys, free fall	j) Free fall (DELCO)
. Shallow embedment	. Shallow embedment . Lateral stability . Multi-directional motion	. Deep embedment . Multi-directional motion	. Free fall installation . High lateral load carrying capacity	. Free fall installation . Effective

5.1.1 Safety rails

A safety rail 20 cm high and made of 2 inch galvanized pipe shall be installed along the perimeter of the buoy deck.

5.1.2 Quick release hook

A quick release hook with load carrying capacity %50 above the maximum design load shall be installed on the buoy. Its material properties shall agree with the requirements of Section 2.

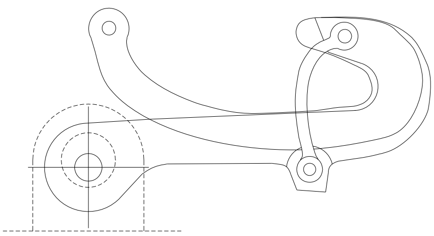


Figure 6.14 Quick release hook

5.1.3 Non-slip rubber surfacing

The buoy deck shall be covered by a non-slip surface, either made up of non-slip metal plates or rubber sheeting, to provide for safe movement of persons on the deck. The rubber sheeting must resist the adverse effects of sea water, heat and ultraviolet light until at least the following buoy survey. The rubber surfacing is to be bordered by a steel guide.

5.1.4 Fenders

Wooden or rubber fenders shall be installed around the buoy. The wooden or rubber fenders must resist the adverse effects of sea water, heat and ultraviolet light until at least the following buoy survey.

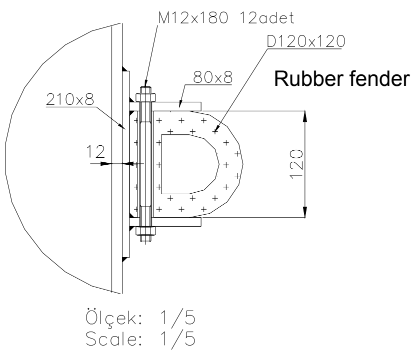


Figure 6.15 Fender

Figure 6.15 shows the minimum dimensions of the fender assembly. The fender dimensions may be increased depending on the size of the buoy.

5.2 Electric and electronic equipment

The electric and electronic equipment installed on the buoy must resist the adverse effects of sea water, heat and ultraviolet light until at least the following buoy survey. Such equipment shall be waterproofed and shall carry IP68 rating.

E. Special Buoys

The mooring system may have auxiliary buoys other than those used for mooring in the catenary configuration. Such buoys may be of two types:

- The start of hoseline marker buoy (Figure 6.16)

- End of pipeline marker buoy (Figure 6.17)

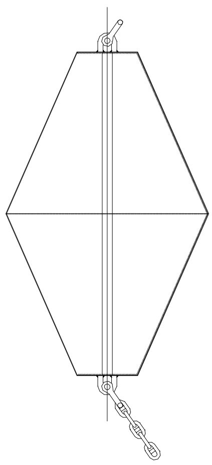


Figure 6.16 Start of hoseline marker buoy

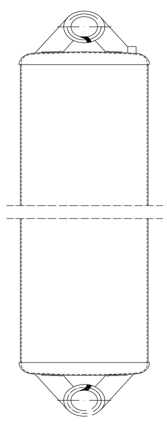


Figure 6.17 End of pipeline marker buoy

The construction of the marker buoys does not require internal support members. Their minimum plate thickness shall not be less than 4 mm.

F. Environmental Safety Factors

1. The motion of the ship due to wind, current and wave loads and the consequent changes in its position are to be limited as not to cause damage to the loading and unloading equipment. Such motions must also be limited to prevent the ship to overrun one of the mooring buoys of the system when there is no ongoing loading and unloading operation.

2. The length of the ground legs of the mooring system must be sufficiently long to prevent uplifting forces to apply to the anchors under ULS, SECTION 4, A.4 conditions. Under ALS conditions, some vertical force may apply to the anchors provided that their holding capacity is not reduced.

3. In the preparation stage, the configuration of the mooring system must be planned taking into consideration the pipelines and cables which may be present on the sea floor.

4. During the design stage, the mooring lines shall be configured so as not to cross or touch each other.

G. Reliability and Risk Analysis

1. It is suggested that appropriate reliability and risk analyses should be carried out to demonstrate that sufficient reliability exists in face of accidents or extreme natural events which are likely to induce adverse effects on the personnel, the environment or the system itself.

2. In addition to the extreme natural phenomena, the reliability and risk analysis shall also take into account the human errors and the failure or deficient functioning of the mechanical components used in the operation of the mooring system.

3. The elements of risk likely to diminish the safety of the system shall be classified with respect to the loss of life, environmental damage or material damage they may induce. The probability of such risks to be realized individually or simultaneously must be determined and for each case, the amount of damage likely to incur is to be established.

SECTION 7

POSITIONING AND INSTALLATION

Page

A. General, Definitions

1. General

1.1 This Section outlines the Rules applicable to the mooring system infrastructure described in Section 6,C. For layouts which are different than those described in Section 6,C, the procedures used for the positioning and installation of the systems are subject to the approval of **TL**.

1.2 The anchors, chains and accessories, the sinker blocks is to comply with the requirements of Section 6,D.

2. Definitions

2.1 Working angle

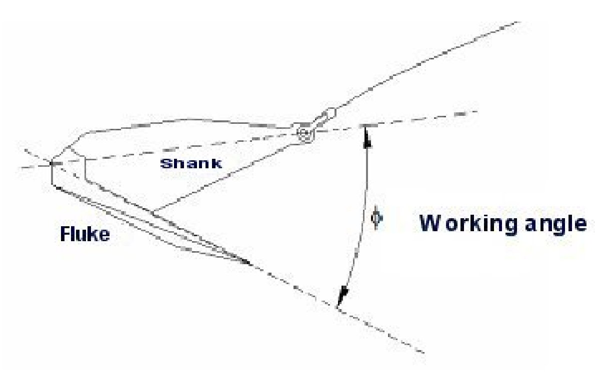


Figure 7.1 Working angle

The embedment of the anchor securely in the seafloor depends on the correct selection of the working angle. The working angle may also be designated as the fluke angle, fluke-shank angle or anchor angle. For the hinged anchors, the working angle is defined as the angle between the shank or the hinge and the fluke. For anchors without the hinge, such as the elbowed shank or older stocked anchors, the working angle is defined as the angle between the shank or the back of the fluke and the tip of the fluke.

2.2 DGPS

DGPS is the "Differential Global Positioning System" with a nominal precision of 1 m or less.

2.3 Traction force

The traction force, which may also be called the anchorage force, is the load that defines the maximum holding capacity of the anchorage sub-system.

2.4 Traction line loading

The traction line loading is a type of tensioning procedure, which may also be called the tandem loading (see, Section 7,C.5).

2.5 Step

During the traction line loading, the tension is applied until a specified traction force is achieved, followed by a waiting period of at least 3 minutes and the "step" is repeated by increasing the tension as many times as required.

B. Definition of Ground Type

- The ground strength is expressed in terms of the shear strength of the soil.

- The ground type is classified according to the grain size.

- The grain size grading for ground types are given in Table 7.1.

- In the absence of sufficient information regarding the ground type, the rules of Section 6, D.4.3.2.

Table 7.1 Ground types with respect to the grain size

Grain size	Ground type
< 2 µm	Clay
2 – 6 µm	Fair mud
6 – 20 µm	Medium mud
20- 60 µm	Large grain mud
60 – 200 µm	Fine grain sand
200 – 600 µm	Medium grain sand
0.6 – 2 mm	Large grain sand
2 – 6 mm	Fine grain gravel
6 – 20 mm	Medium grain gravel
20 – 60 mm	Large grain gravel
60 – 200 mm	Stones
> 200 mm	Rocks

C. Selection of the Installation Method

1. General

1.1 The Rules outlined in this Section apply to the positioning and installation of the multipoint mooring system and the related equipment, the pre-tensioning of the traction lines and anchors, the prediction of drag distances for the anchors and the equipment and personnel. They are applicable to the sub-systems described in Section 6, C.2.

1.2 Figure 7.2 shows the Control and Authorization Pyramid which defines the hierarchy of rules, control and authorization to be complied with during the execution of the positioning and installation procedures.

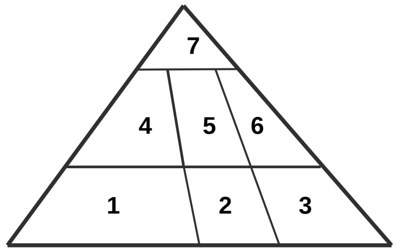


Figure 7.2 Control and Authorization Pyramid

Here,

1) **TL**, practical guidance

2) **TL**, manuals and notes

3) International rules and obligations

4) **TL**, Rules for off-shore structures

5) Other **TL** Rules

6) International standards and codes

7) **TL,** MPMS Rules

1.3 Only drag-embedment anchors shall be used to provide the anchorage for the MPMS. If for any reason the use of other types of anchors are proposed, the procedure for the positioning and installation of the anchorage system is to be submitted to **TL** for approval.

1.4 The rules regarding the control and approval of the operations prior to, during and subsequently to the positioning and installation of the systems which employ drag-embedment anchors are outlined in E and F respectively.

1.5 The operations is to be undertaken only when the weather and sea conditions are favourable. The operations are to be postponed when the sea state exceeds Beaufort Scale 3.

1.6 If the anchorage system has two traction lines, each line shall be capable of carrying the traction load individually. If the anchorage system has three traction lines, each line shall be capable of carrying half of the traction load individually.

2. Equipment and Personnel

2.1 The positioning and installation of the MPMS anchorage systems shall be carried out utilizing one or more service vessels. Tugs may be used as service vessels.

2.2 The service vessel shall be sufficiently equipped with the hardware likely to be used during the positioning and installation operations such as welding appliances, diving equipment with surface support, windlass, dynamometer, etc.. Additionally, the service vessel shall have the required physical properties such as a large deck area, and fast manoeuvrability.

2.3 The number of service vessels, the equipment and hardware to be used for positioning and installation is to be determined and approved by **TL** before the operations start. The bollard pull capacity of the service vessel shall exceed the required traction force by at least %10. If a vessel with such capability is not available, the operation may be carried out with two vessels in tandem.

2.4 The anchorage sub-system of the MPMS shall be installed on the seafloor by personnel including the diving team, of sufficient knowledge and experience, subject to approval by **TL**. The appropriate information about the personnel shall be submitted to TL and the approval shall be obtained before the operation.

2.5 A minimum of two divers shall be on duty during the operation. **TL** is to determine whether the dives are only for observation. The dive permits shall be obtained from the local harbour authority.

2.6 An Emergency Response Plan shall be prepared based on an assessment of the probable risks during the diving activity. The Emergency Response Plan is to indicate the location and distance of the nearest decompression chamber. **TL** may require the Emergency Response Plan to be submitted for approval.

3. Preparations Before Installation

3.1 The working angle for each anchor in the system is to be determined according to the ground type and fixed on each anchor before the anchors are positioned on the seafloor. If data on the working angle according to the ground type is not supplied by the anchor manufacturer, the values given in Table 7.2 is to be used.

Table 7.2 Working angles

Ground type	Anchor working angle (averaged)
Very soft mud	50º
Medium mud	32º
Hard mud and sand	32º

3.2 The chains are to be laid on the service vessel deck taking the order of installation into account and secured by appropriate use of shackles, eyebolts, lines and stoppers.

3.3 All connections such as swivels, anchors and chain shackles must be completed while the system is on the deck prior to the laying on the seafloor.

3.4 The connections of the traction and mooring lines shall not be performed underwater. Such connections may only be built underwater by the approval of **TL**.

4. Installation Procedure

4.1 The contractor shall prepare a "Scenario Report" outlining the procedure to be followed during the installation of the anchorage system. An example is provided in Appendix C. The Scenario Report is to include the details satisfying the requirements of C.4,5,6,7 and 8.

4.2 The requirements of C.3 shall be fulfilled before the anchors and chains are lowered to the seafloor.

4.3 The operations shall be performed by a well equipped, **TL** approved service vessel of sufficiently large deck area, satisfying the requirements of C.2.1,2.2 and 2.3.

4.4 The chains shall not be lowered freely from the deck. The slack shall be taken up by a windlass, applying tension along the axis determined in accordance with the project configuration.

4.5 The installation of the chains shall be executed under DGPS supervision, providing digital monitoring for the position of system components during the operation. The DGPS system used in the operations shall be approved by **TL**.

4.6 The anchors shall be initially placed at a location sufficiently far afield from the final location, taking into account the predicted drag distance. The expected positioning inaccuracy is to be declared in the Scenario Report mentioned in 4.1.

4.7 The subassembly of all components of the anchorage system shall be completed before the operations for setting the anchors commence.

4.8 As the traction lines incorporate more than one anchor, the procedure for setting the anchors by traction line loading must be carried out according to the rules outlined in C.5.

5. Setting Anchors, Traction Line Loading

5.1 The anchors on a single chain leg are to be set simultaneously by traction line loading (tandem loading). If a different method of anchor setting is proposed, approval of TL is to be obtained prior to the operations.

5.2 The traction force applied to set the anchor is to be measured by a calibrated wireless dynamometer approved by **TL**. In the case of a dynamometer not being continuously in use during the operation, the procedure is to be approved by **TL**.

5.3 Each traction line is set taut together with the temporary reverse tension line connected to two rings positioned on the axis along which the traction line is laid on the seafloor.

5.4 The traction lines shall be set taut by means of the windlass on the service vessel. The service vessel must provide the bollard pull for the required traction force either on its own power or by deploying a high capacity anchor to gain purchase in the opposite direction.

5.5 As achieving the specified traction load in a single step cannot be expected, the specified traction load on each traction line shall be reached by at least 4 steps of equal force increments. For the anchor to set satisfactorily and the system to stabilise, there shall be a waiting period of at least 3 minutes between each step.

5.6 The procedure for setting the anchor by traction line loading shall be declared complete at the end of the 20 minutes waiting time which shall follow the last step where the specified traction load is achieved.

5.7 The procedure for setting anchors by traction line loading shall be applied to each traction line separately.

5.8 The distance of anchor drag during traction line loading operation shall comply with the requirements of Section7, C.6.

5.9 If the specified traction force is not achieved, the anchors are repositioned and the procedure is repeated.

5.10 If the traction line loading operation is unsuccessful after the second execution, **TL** may require;

- A comprehensive examination of the ground properties of the seafloor

or

- A readjustment to the anchor working angle following an investigation of ground conditions by divers

before the operations are repeated.

5.11 When the required traction force is not achieved despite following the procedures of 5.10, the anchor shall be embedded at a minimum depth of 2 m employing a method approved by **TL**. For ground type clay soil, this operation shall take place 36 hours after the procedures of 5.10 fail. For ground type sand, the waiting period shall be 6 hours. **TL** may increase the waiting period and the anchor embedment depth, if deemed necessary.

5.12 In the case of ground conditions deteriorating due to mechanical actions and soil liquefaction, further traction line loading operations on the same traction line shall be discontinued. For the work to resume, new procedural scenarios shall be developed keeping the coordinates of the buoys unaltered.

6. Anchor Drag Distance

6.1 The distance the anchor travels as a result of the traction line loading is to be designated as the drag distance. The final position of the anchor shall correspond to the specified location. Any deviation from the specified location shall remain within the boundaries of a square area of sides at most 10 m long, designated as the area of tolerance (Figure 7.3). The dimensions of the tolerance area shall be declared in the Scenario Report, subject to approval by **TL**.

6.2 The correction to the final position inside the tolerance area of the anchor approved by **TL** is to be executed by adding chain length for insufficient drag distance and by shortening the chain length for excess drag distance. **TL** may require the traction line loading operation to be repeated if deemed necessary.

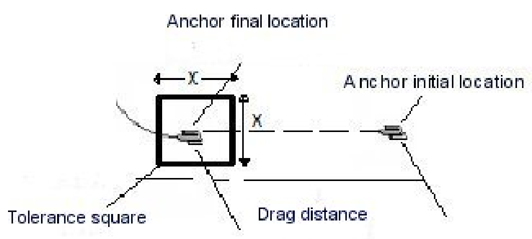


Figure 7.3 Drag distance

6.3 The anchor drag distance may be calculated using the tables provided in Appendix D. The drag distances calculated according to an alternative method shall be submitted to **TL** for approval.

7. Installation of Transverse and Reverse Traction Lines

7.1 Following the traction line loading operation, the stability of the main traction line is to be maintained by the reverse traction line.

7.2 Following the traction line loading operation, the ground ring is placed on the deck and the riser chain and the transverse traction lines are connected to the ground ring.

7.3 The loading operation need not be applied to the sinker line as it is not a load bearing member of the anchorage system.

8. Installation of Sinker Blocks

Following the completion of the mooring buoy installation, the sinker blocks are added to the subassembly of the anchorage system.

9. Finalising the Installation

The survey of the final configuration of the anchorage system shall be carried out by underwater camera operations after the installation of the subassembly is completed. The final coordinates of the system components are determined, marked and submitted to **TL** for approval. The visible components of the system above water must be documented by video following the completion of installation operations.

10. Design Criteria

If not indicated elsewhere in these Rules, the structural and mechanical components (mooring hardware, e.g., connecting links, shackles, etc.) which transmit the mooring loads are to be designed to the greater of the following two loads:

- 2.50 times the maximum design anchor leg (or mooring line) load in design storm condition.
- 3.00 times the maximum design anchor leg (or mooring line) load in operating condition.

D. Assumptions, Calculations and Direct Measurement Systems

The types of electronic and mechanical systems used to support the installation operations are not subject to any restrictions. However, the accreditation and acceptance of relevant instrumentation and devices shall be performed by **TL** for each project undertaken separately. The precision limits shall be determined by TL for each project individually. The basic calculations (such as compatibility calculations for dissimilar mapping standards) shall be submitted to **TL** for approval.

E. Control Phases

A plan shall be prepared indicating the stages of the installation operation at which the positions of the system components shall be surveyed (preferably by DGPS) and it shall be submitted to **TL** for approval.

F. Conditions for Approval

The acceptance of a MPMS installation is subject to fulfilment of the requirements laid down in Section 7, Appendix C and Appendix D. Following the completion of installation, **TL** shall carry out the approval surveys and produce the approval documentation.

SECTION 8

BUOYANCY, STABILITY AND WATERTIGHT INTEGRITY

Page

A. General

1. Scope

This Section consists of the Rules and recommendations related to the buoyancy and stability of the Multi-Point Mooring Systems (MPMS).

- The buoyancy and stability requirements for safe operation are laid down in this Section.
- The information provided in this Section serves as the guidelines for determining the minimum conditions regarding the safe flotation and stability of the system with respect to the design loads and parameters.
- In this Section, the operational limits when damaged are provided in terms of the safe operation criteria.

2. Symbols

L = Length [m],

B = Breadth [m],

D = Diameter [m],

H = Depth [m],

GZ = Righting arm [m],

HA = Wind heeling arm [m],

GM = Metacentric height [m],

VCG = Vertical centre of gravity [m],

GZ_{max} = Maximum righting arm [m],

φ = Heel angle [degrees],

φ_k = Critical angle [degrees],

φ_{max} = Angle of maximum GZ [degrees],

W = Lightweight [ton],

Δ_b = Light displacement [ton],

Δ_{ty} = Fully loaded displacement [ton],

T_o = Service draught [m],

T_b = Light draught [m],

T_{ty} = Fully loaded draught [m],

T_d = Damaged draught [m],

f = Freeboard [m],

F_r = Wind force [N],

V_r = Wind velocity [m/s],

A = Projection area [m^2].

B. Buoyancy

1. Floatability Conditions

Under the specified operational conditions and sea states, the buoy with its attached assembly of anchorage system shall float safely and provide the required service without any additional external support.

The buoy must satisfy the floatability conditions in the 3 different states described below:

a) In the free state without any chains and lines attached.

b) When the assembly of the anchorage system is connected with a chain.

c) When the MPMS is operational with a ship moored.

2. Sufficient Freeboard

2.1 The buoy shall have sufficient freeboard under each of the above floatability conditions. It is recommended that, when the buoy is connected to the anchorage system by a chain, i.e. in the fully loaded condition, the buoy should have a freeboard of at least 1 m. Under special conditions, provided that the buoy satisfies other stability and floatability conditions, **TL** may approve a fully loaded freeboard less than 1 m.

2.2 Here, the safety of the personnel who may have to operate on the buoy for purposes of repair, maintenance or emergency intervention is taken into account. In doing so, the adverse wave and wind conditions are also considered.

2.3 Depending on its weight, the buoy shall have a higher freeboard when floating freely without being connected to the chain.

2.4 When a ship is moored in the MPMS, the freeboard of the buoy may vary along its circumference due to its heel angle induced by the external mooring line loads.

3. Draught Marks

3.1 The draught values shall be marked on the sides of the buoy with port and starboard symmetry, indicating the fully loaded draught when chain and anchor loads are present and the light draught when it floats freely without the chain and anchors attached and without any other loads. The draught marks shall be visible at a reasonable distance away from the buoy.

3.2 The marks shall be welded on the side plating and painted in a colour contrasting with the colour of the buoy in accordance with the **TL** draught marks standards.

3.3 If required by **TL**, other marks indicating different loading and operational conditions may have to be added to the standard draught marks.

C. Stability

1. General

The stability of the buoys and therefore the stability of the complete mooring system is, in principle, similar to that of a displacement hull. However, the distinct characteristics of the mooring systems due to differences in the functionality and physical properties shall be taken into account. The stability of the system shall be examined in both the undamaged (intact) and the damaged conditions.

1.1 The analysis shall include various cases of operating and loading conditions applicable to the system under consideration when the two general conditions of stability mentioned in the previous paragraph are examined.

1.2 The intact and damaged stability of the buoy shall be evaluated under 3 different operating conditions:

- When floating freely,
- When connected to the chain and anchors,
- When a ship is moored in the MPMS.

The first of these conditions does not point to an operational scenario. However, the stability of the free floating buoy is important during the initial installation operation and in the case of an accident in which a broken chain connection may leave the buoy free floating deviating from its operational configuration. Under the conditions defined above, the criterion to be satisfied shall be the floatation of the buoy with a safe amount of freeboard and sufficient stability.

1.3 Lightweight

The lightweight of the buoy shall be determined by either basic weighing or by calculation. The lightweight includes all the attachments and equipment on the buoy, except the chain and anchors of the anchorage assembly.

1.4 Vertical centre of gravity

The VCG of the buoy is to be determined correctly by calculation or by any other valid method, as it is a critical parameter used in the stability assessment. Initially the VCG of the buoy structure and the attachments and equipment are to be determined separately and later combined to obtain the VCG of the final buoy configuration.

2. Intact Stability

Due to symmetry, the buoy is to float with zero trim and zero heel angle in the light condition, i.e. without any loading, and in the fully loaded condition, i.e. with the chain attached. The following conditions shall be satisfied for intact stability:

2.1 In the absence of any external force acting on it, the buoy is to float upright in calm water with positive GM.

2.2 The buoy shall be shown to have sufficient reserve stability to resist the heeling moments which are to be encountered during towing, installation and service operation conditions.

2.3 Under all possible equilibrium positions, all openings likely to cause water ingress, if any exists, shall be shown to be situated above the waterline.

2.4 The equilibrium positions mentioned above apply to the buoy being under the influence of all types of static heeling moments, wind and wave moments, heeling moments due to loss of watertight integrity and moments exerted by towing vessels. The stability analysis shall cover these moments acting singly, in combinations of pairs, multiples or all at once.

2.5 Righting arm, GZ

Due to the symmetry of a cylindrical buoy, the heel angle shall be defined as rotation about any diameter designated as the buoy length and the righting arms associated with various heeling angles shall be calculated in a similar fashion to those performed for a ship. The righting arm values are to be plotted against the heel angle values to obtain the GZ-φ curve, an example of which is illustrated in Figure 8.1.

2.6 Righting moment, M_R

Following the calculation of righting arms, the righting moments may be obtained as the product of righting arms and associated displacements. If the deck is not permitted to enter the water, the maximum equipment or personnel weight on the buoy and hence the critical cases of deck loading are to be determined in this manner.

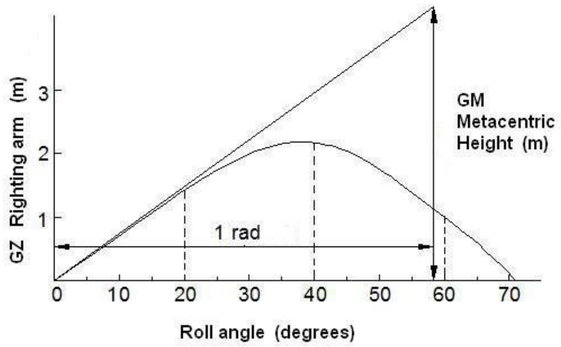


Figure 8.1 GZ-φ Stability curve

2.7 Wind force

When the freeboard of the buoy is relatively high compared to its depth and the projection area subjected to the wind effect is sufficiently large, the stability analysis shall take the wind pressure into account. Depending on the wind pressure, heeling arms are to be calculated with respect to the same coordinate system used in the calculation of above mentioned righting arms . The wind force is to be determined using the equation,

$$\mathbf{F_r} = 0.306 \cdot \mathbf{V_r^2} \cdot \mathbf{A}$$

where,

F_r = Wind force [N],

V_r = Wind velocity [m/s],

A = Projection area [m^2].

2.7.1 The wind velocity shall not be less than 40 knots for sheltered waters such as bays, estuaries, inland waters, lakes and rivers.

2.7.2 For open sea, 60 knots of the wind velocity shall be assumed in the stability calculations. The wind speed shall be increased by %50 to take the effects of wind gusts into account.

2.8 Wind heeling arm, HA

In the calculation of the wind heeling arms and moments, the moment arm is defined as the vertical distance between the centres of under water and above water projection areas. Additionally, the system is assumed to be floating freely.

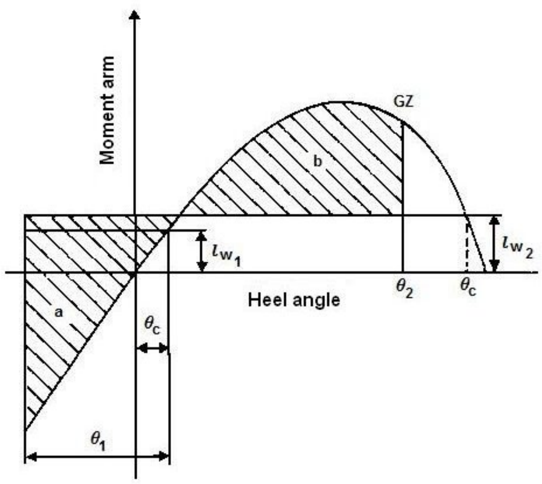


Figure 8.2 Wind heeling arms

2.8.1 The wind heeling arms are to be calculated for a sufficient number of heel angles in a similar manner to the calculation of righting arms.

2.8.2 The wind heeling arm values shall be assumed to vary linearly with the heeling angle.

2.8.3 The weather criterion including the wind heeling moments shall be calculated in accordance with **TL** Rules, Chapter 1 - Hull, Section 1. Figure 8.2 is a sample diagram illustrating the weather criterion.

2.9 Conditions of sufficient stability

For sufficient stability, the system shall satisfy the following conditions based on the analysis of GZ and HA diagrams calculated including wind effects:

2.9.1 In the fully loaded condition and in the absence of a moored ship, the edge of the deck may enter water only if the safe operation of the system is not impaired.

2.9.2 All deck openings likely to cause water ingress shall remain above the waterline under all operating conditions.

2.9.3 The heeling angle φ_{max}, at which the GZ righting arms curve has the maximum value, shall be greater than 25^0.

2.9.4 The metacentric height GM shall be greater than 0.30 m.

2.9.5 The heel angle at which the edge of the deck enters water is to be calculated using the equation

$$\tan \varphi_k = 2f/B$$

In all cases where the deck edge is not allowed to enter the water, the heeling angle shall be less than the value calculated by the equation above.

D. Watertight Integrity And Subdivision

1. Watertight Integrity

1.1 The buoy is to remain watertight and intact for safe service operation. In case the system is damaged for any reason, the operation is to continue for a limited period and/or in a limited form. The attachments and equipment are not to suffer damages.

1.2 All openings including the inspection hatches of the buoy shall be documented to be watertight. The openings between the watertight compartments of the buoy shall be equipped with watertight hatches to be shown in the plan for watertight compartmentation.

2. Compartmentation

2.1 The buoy shall be divided into a sufficient number of watertight compartments to prevent capsizing in case of any damage scenario.

2.2 The cylindrical mooring buoys shall be divided into at least four watertight compartments by two vertical bulkheads perpendicular to each other. When any one of these compartments is flooded, the system is to have sufficient stability to continue functioning.

2.3 For buoys of geometrical shape other than cylindrical, the compartmentation shall ensure sufficient stability for the system to continue functioning when a number of neighbouring compartments up to %25 of the total volume are flooded. The stability calculations shall document the conditions mentioned above.

E. Damaged Stability

1. Flooding

1.1 Partial flooding of the buoy is allowed provided that the deck equipment is not prevented from functioning and the deck openings do not cause ingress of water. As long as these conditions are satisfied, the number and location of flooded compartments are to be considered irrelevant.

1.2 The designer must demonstrate that, when any one of the compartments is flooded, the buoy has sufficient stability to safely float and limited service operation to continue.

1.3 When any one of the compartments is flooded, all openings likely to cause water ingress, if any exists, shall be left above the waterline achieved at that damaged equilibrium condition.

1.4 Provided that the approval of **TL** is obtained, the number of flooded compartments allowed may be determined differently depending on the buoy operating conditions.

2. Permeabilities

2.1 The permeability of the internal compartments of the buoy is to be determined by calculations. In the absence of calculations, the permeability value shall be %95 for void compartments.

2.2 In case any equipment is located in a compartment, the permeability of that compartment shall be %85.

SECTION 9

CORROSION AND FOULING CONTROL

Page

A. General, Definitions

1. General

In this Section, corrosion and fouling control of buoys, which are the most important component of Multi-Point Mooring Systems (MPMS), and other related equipment are outlined. The correct selection and application of a corrosion control method or methods will extend the service life of the system. It shall be kept in mind that corrosion rate depends on the environmental conditions. Therefore, the determination of data on important corrosion parameters such as the local current densities under the operational conditions and other similarly important parameters assume significance.

The rules laid down in this Section are applicable to new building MPMS, whereas the existing systems are to be exempted. In these systems, the survey period for buoys is assumed to be 4 years and the design life of chains and other equipment will be taken as 20 years.

1.1 In general, especially in marine environment, it is not possible to avoid corrosion entirely. However, it is possible to slow it down by taking necessary precautions.

1.2 Two of the most widely used methods to control corrosion in buoys and related systems are paints, coatings and cathodic protection.

1.3 It is possible to take various preventive measures to reduce corrosion in the preliminary design stage. Water entrapment and stress concentration are primary causes of corrosion. Therefore, corrosion prevention may be achieved by revising the design of critical components or structural parts at this stage.

1.4 To prevent galvanic corrosion, usage of different metals, wherever possible, shall be avoided, and every endeavor shall be made towards the insulation of these materials, in case of an inevitable use.

1.5 There are a number of parameters that affect corrosion. The correct and proper determination of these parameters is of paramount importance in corrosion control.

2. Definitions

2.1 Anode potential

Potential between the anode and electrolyte.

2.2 Closed-circuit anode potential

Anode potential when electrically connected to a local structure to be protected.

2.3 Coating breakdown factor

The ratio of initial current density required to polarize a coated steel surface as compared to a bare steel surface.

2.4 Electric field gradient

The change in electrical potential per unit distance through a conductive medium, arising from electric current.

2.5 Electrochemical capacity

The total amount of electricity produced when a unit mass (usually 1 kg) of anode material is consumed electrochemically.

2.6 Current density

The current entering or leaving a unit area of electrode surface.

2.7 IR drop

The voltage due to any current, developed between two points in the metallic path or in the lateral gradient in an electrolyte such as seawater or seabed, measured between a reference electrode and the metal, in accordance with the Ohm's Law.

2.8 Protection potential

The structure-to-electrolyte potential for which the metal corrosion rate is insignificant.

2.9 Utilization factor

The fraction of the anodic material which can be used in the cathodic protection process.

3. Symbols and Abbreviations

A_T = Total area to be protected [m^2],

A_{CPR} = Area of cathodically protected region [m^2],

UWR = Underwater region,

SP = Shop – primer,

I_T = Total protective current [A],

I_{CPR} = Protective current for a cathodically protected region [A],

i_{CPR} = Protective current density for a CPR [mA/m^2],

i_i = Initial current density [mA/m^2],

i_f = Final current density [mA/m^2],

i_m = Average current density [A],

I_{af} = Single anode current output for actual end-of-service- life,

CPC = Cathodic protection against corrosion,

CPR = Cathodic protection region,

TR = Tidal region,

SCE = Calomel reference electrode,

m_T = Total mass of sacrificial anodes [kg],

m_{CPR} = Sacrificial anode mass for a cathodic protection region [kg],

Q_g = Electrochemical efficiency of sacrificial anode alloy [%],

t_S = Protection period [yıl],

f_i = Initial coating breakdown factor,

f_f = Final coating breakdown factor,

f_m = Average coating breakdown factor,

Δf = Yearly increase in coating breakdown factor [%],

R_a = Anode resistance [ohm],

R_d = Resistivity of seawater [ohm · cm],

ΔV = Residual corrosion potential [V],

A_{cs} = Anode cross-sectional area [m^2],

N = Required number of anodes,

E_a = Anode design closed-circuit potential [V],

E_c = Design protective potential [V],

ρ_F = Density of fouling organisms [kg/m^3],

ρ_{SW} = Density of seawater [kg/m^3],

D_N = Nominal chain or rope diameter [mm],

ΔT_F = Fouling layer thickness [mm],

M_F = Mass of fouling [kg/m],

W_F = Weight of fouling [kN/m],

μ = Utilization factor,

A_{WS} = Wetted surface area of anode [m^2],

L_a = Anode length [cm],

r = Equivalent radius of anode [cm],

C = Circumference of a cross-section [cm].

4. Materials

4.1 In order to prevent corrosion, the materials which are used in constructing buoys and related components of the mooring system shall be corrosion resistant in seawater.

For other rules and specifications for materials and material selection, reference shall be made to; **TL** Rules, Chapter 1 – Hull, Section 22.

4.2 Corrosion tolerances

In case of only uniform surface corrosion or if pitting corrosion is expected on the surface in marine environment, the corrosion tolerances for different materials shall be taken as specified below.

Non-alloy and light alloy steel:

0.21 mm.	wetted surfaces
0.10 mm.	surfaces exposed to air in marine environment

For cast iron:

0.12 mm.	wetted surfaces
0.06 mm.	surfaces exposed to air in marine environment

B. Cathodic Protection

In order to minimize corrosion, the buoy system shall be protected cathodically proportional to its design life and the steel structure shall be sufficiently polarized. Although there are two widely recognized methods for cathodic protection, only the sacrificial anode system which suits these types of buoy systems best is considered in this Section.

1. General Terms and Requirements

1.1 Electrical continuity: All the parts in the system shall be electrically continuous and the ones that are not, shall be made continuous.

1.2 If electrical continuity cannot be sustained by a metallic connection, additional cathodic protection shall be used.

1.3 The effect on the efficiency of the cathodic protection system of other parts or systems connected to the structure to be protected, shall also be considered.

2. Current Density

2.1 The cathodic protection of a MPMS depends on certain required parameters such as current density, water temperature, oxygen level, resistivity of seawater, sediments, currents and biological activities.

2.2 The design current densities given in Table 9.1 are to be regarded as suggested values in the design stage. It shall be noted that the real current densities change with changing environmental conditions in a specific region.

Table 9.1 Current densities for design purposes

Region	Current density [mA/m^2]
Mediterrenean	90
Black Sea	70
Africa	90
North sea (above 62^{0}N) North sea (55^{0}N-62^{0}N) North sea (below 55^{0}N)	130 120 90
USA (West coast)	100
Australia (West coast)	80
Gulf of Mexico	80
India	90
Brasil	90
China	90
Gulf of Arabia	90
Mud (in general)	20

2.3 The cathodic protection system shall polarize the steel structure rapidly in order to prevent pitting corrosion. The initial current densities are suggested to be taken higher than those given in Table 9.1.

2.4 Although, lower current densities are capable of maintaining polarization, the cathodic protection system shall have the ability to polarize steel under adverse conditions and even after heavy consumption of the anode material.

2.5 If suitable high resistance coating systems are applied, lower current densities than those given in Table 9.1 may be used.

2.6 Paints and coatings deteriorate in time and physical damages occur on MPMS. To take into account these damages in the design stage, suitable coating deterioration factors are to be used based on the values supplied in Section 7.3.

3. Effect of Environmental Conditions

In the design of cathodic protection systems, extreme positive and negative environmental conditions are to be considered. The maintenance periods are longer in regions having positive environmental conditions such as low salinity, low tidal variations, low dissolved oxygen, low temperature, moderate currents and still water.

On the other hand, corrosion and erosion rates are increased and maintenance periods are shortened in regions having adverse environmental conditions such as high salinity, high tidal variations, turbulence, high dissolved oxygen, high temperature and strong currents. The cathodic protection is more effective even in adverse environmental conditions and shall be planned accordingly.

4. Cathodic Protection Criteria

4.1 A cathodic protection system is a system which is capable of polarizing the steel structure with respect to the Ag/AgCl/seawater reference electrode based on the values given below:

a) Between -0.80 and -1.10 volts (aerobic conditions).

b) Between -0.90 and -1.10 volts (anaerobic conditions).

Figure 9.1 shows the variation of potentials measured against Ag/AgCl reference electrode as compared to potentials in waters having different salinity and resistivity measured against SCE and $Cu/CuSO_4$ electrodes. The corresponding values may be determined for different conditions using the nomogram in Figure 9.1.

4.2 For potentials less than -1.10 volts, Ag/AgCl electrode shall not be used in order to avoid damages due to hydrogen absorbtion and not to reduce fatique life. The maximum negative potential shall not be less than -0.95 volts for steel having tensile strength over 700 N/mm^2. However, in case of the risk of steel cracking due to hydrogen embrittlement, the potential shall not be less than 0.83 volts (with respect to Ag/AgCl reference electrode).

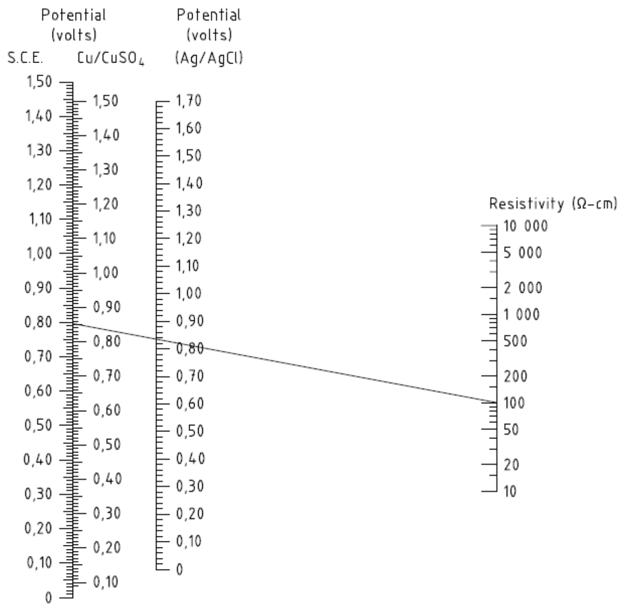


Figure 9.1 Nomogram for correction of potentials

4.3 In order to prevent adverse effects of hydrogen, application of high strength connection members shall be avoided. The hardness of such connection materials shall not exceed 300 Vickers.

4.4 The potential of steel which functions above 25°C shall be 1 mV negative for each degree of temperature above 25 ^{0}C. Tablo 9.2 shows current densities for various conditions.

5. Required Information and Documents

The following information and plans of a cathodic protection system shall be submitted to **TL**:

5.1 The condition and damage rates of surfaces on which cathodic protection is to be applied.

5.2 The seawater resistivity.

5.3 All current densities used as design parameters.

5.4 The types, locations and means of attachment of the reference electrodes.

5.5 The details of all paints and coatings and locations to be applied.

Table 9.2 Current densities for various conditions

Typical cathodic protection region		**Protective current density i_f [mA/m^2] (minimum values)**	
Underwater parts of offshore steel structures (depending on environmental conditions)	Uncoated	UWR	80-130
		TR	Current density of protected uncoated underwater part + 20%
	Coated	UWR	Current density of protected uncoated underwater part + 1-2% + 1-1.5%/year
		TR	Current density of protected uncoated underwater part + 2-5% + 1-1.5%/year

5.6 The electrically connected parts.

6. Sacrificial Anode System

The cathodic protection system to be used shall be designed in ample detail with due consideration of the information and parameters outlined below in addition to the requirements laid down in Section 4:

6.1 The design life of the system [years].

6.2 The anode material and the minimum design capacity of the anode material [Ah/kg].

6.3 The anode dimensions with inserts and their locations.

6.4 The net and gross weight of anodes [kg].

6.5 The installation details.

6.6 The locations and arrangement plans of the anodes.

6.7 The anodic resistance calculations; as installed and when consumed to their design and utilization factors [ohm].

6.8 The closed-circuit potentials of anode material [volt].

6.9 The anode design utilization factor.

6.10 General characteristics of sacrifial anodes

6.10.1 The anodes to be installed shall comply with the requirements outlined in this Section.

6.10.2 The plans showing details of nominal dimensions, tolerances and fabrication details shall be submitted for approval.

7. Anode Materials

7.1 Anode materials are to be approved alloys of aluminium and zinc having closed-circuit potential of at least -1.00 volt (with respect to Ag/AgCl reference electrode). The magnesium based anodes may be used for protection of materials which are not susceptible to hydrogen embrittlement for a short period of time. Table 9.3 and Table 9.4 show some characteristics of zinc and aluminium anodes respectively.

7.2 Steel inserts

7.2.1 The anode material shall be cast around a steel insert in a way that shall maintain itself homogeneously even if it is consumed up to the design utilization factor.

7.2.2 The anodes shall be rigid enough to avoid vibration in the steel anode support (insert).

7.2.3 The steel insert shall be cleaned off its grease and its surface shall be blast cleaned according to ISO 8501 Sa 2½ standard with a minimum surface roughness of 50 µm. This standard for cleanliness shall be maintained throughout the casting process.

7.3 Anode characteristic information

The anodes are to be clearly marked revealing the following information:

- Anode manufacturer's name.
- Lot (Serial) number and/or initials.
- Approved identification mark for the anode material.

Table 9.3 Zinc alloy anodes for seawater

Element	TL-Zn1	TL-Zn-2
Al	0.10-0.50	≤0.10
Cd	0.025-0.07	≤0.004
Cu	≤0.005	≤0.005
Fe	≤0.005	≤0.0014
Pb	≤0.006	≤0.006
Zn	≥99.22	≥99.88
Potential T=20°C	-1.03V Ag/AgCl/seawater	-1.03V Ag/AgCl/seawater
Q_g T=20°C	780 Ah/kg	780 Ah/kg
efficiency T=20°C	95%	95%

Table 9.4 Aluminium alloy anodes for seawater

Element	TL-AL1	TL-AL2	TL-AL3
Si	0.10-0.50	≤0.10	Si+Fe
Fe	0.025-0.07	≤0.004	≤0.10
Cu	≤0.005	≤0.005	≤0.02
Mn	≤0.005	≤0.0014	0.15-0.50
Zn	≤0.006	≤0.006	2.0-5.0
Ti	≥99.22	≥99.88	0.01-0.05
In	0.01-0.03	-	0.01-0.05
Sn	-	0.05-0.15	-
Others	≤0.10	≤0.10	≤0.15
Al	remaining	remaining	remaining
Potential T=20°C	-1.05V Ag/AgCl/ Seawater	-1.05V Ag/AgCl/ Seawater	-1.05V Ag/AgCl/ Seawater
Q_g T=20°C	2000 Ah/kg	2000 Ah/kg	2700 Ah/kg
Efficiency T=20°C	95%	95%	95%

7.4 Inspection of anodes

7.4.1 All anodes shall be cleaned and prepared for inspection. Their surfaces shall not be hammered or treated to obscure possible defects.

7.4.2 The anodes are to be inspected prior to possible painting of their bottoms.

7.4.3 The anode surface shall be free of any significant slag or other residue that may adversely affect its performance.

7.4.4 The shrinkage depressions shall not exceed 10% of the nominal depth of the anode or 50% depth of the anode insert, whichever is smaller.

7.4.5 The presence of longitudinal cracks is not permitted. Only small tranverse cracks may be acceptable provided that:

a) They are not wider than 5 mm,

b) They are within the entirely supported section of the steel insert,

c) They do not extend around more than two faces or 180^0 of anode circumference.

7.4.6 Any casting and/or moulding faults such as cold shuts or surface laps shall not exceed 10 mm depth or extend over a total length equivalent to more than three times the anode width.

7.5 Anode dimensions

7.5.1 The accuracy and verification of dimensions are under the responsibility of the manufacturer unless otherwise specified.

7.5.2 The diameter of cylindrical anodes shall be within ± 5% of the nominal diameter.

7.5.3 For long slender anodes, the following dimensions shall apply:

a) The average length shall be within 3% of nominal length or ± 25 mm, whichever is smaller.

b) The average width shall be ±5% of nominal width.

c) The average depth shall be ±10% of nominal depth.

7.5.4 The maximum deviation from longitudinal alignment shall not exceed 2% of the length.

7.5.5 The steel insert shall be within ±5% of the nominal position in the anode width and length and within ±10% of nominal position in depth.

7.5.6 Except where previously agreed, the anode insert fixing dimensions are to be within ±1% of nominal dimensions or ±15 mm, whichever is smaller.

7.6 Anode weight tolerances

7.6.1 The anodes are to be weighed and the weight of the individual anodes shall be within ±5% of the nominal weight for anodes less than 50 kg or ±3% of the nominal weight for anodes 50 kg or more.

7.6.2 No negative tolerance shall be permitted on the total contract weight and the positive tolerance shall be limited to 2% of the nominal contract weight.

7.7 Bonding and internal defects

7.7.1 The manufacturer has to demonstrate that satisfactory bonding exists between the anode material and the steel support and that there are no significant internal defects. This may be verified by sectioning of an anode selected randomly from the batch or by other approved means.

7.7.2 For verification, at least one anode or at least 0.5% of each production run is to be sectioned transversely at 25%, 33% and 50% of the nominal length of the anode or at other agreed locations for a particular anode design.

7.7.3 The cut surfaces are to be essentially free of slag or dross.

7.7.4 Small isolated gas holes and porosity may be accepted provided that their surface area is not greater than 2% of the surface area of that section.

7.7.5 No section is to exhibit more than 10% lack of bonding between the insert and the anode material.

7.8 Electrochemical tests

The electrochemical performance testing is to be carried out by the manufacturer in accordance with previously approved procedures designed to demonstrate batch consistency of the as cast electrochemical properties.

7.9 Certification

7.9.1 The manufacturer shall submit a copy of the material certificate for the accepted anodes.

7.9.2 The certificate is to include the following information:

a) The name of the manufacturer.

b) The description of the anode alloy information or trade mark.

c) The casting identification number.

d) The chemical composition.

e) The heat treatment details if applicable.

f) The electrochemical test results.

g) The weight information.

h) The customer's name, order number and name of the sturucture to be used on.

7.10 Anode installation

7.10.1 The location and installation details of the anodes are to be submitted for approval.

7.10.2 The metallic connection between the anode and the structure to be protected shall be established as perfectly as possible.

7.10.3 The anodes shall be attached to the structure so as to ensure that they remain secure in place throughout their design life.

7.10.4 In case where bracelet type anodes are used, the metallic connection between the anode and the structure shall not rely on the anode material being tight around the structure.

7.10.5 The location and attachment of the anodes are to be determined taking into account the stress field in the related structural members.

7.10.6 The anode supports may be directly attached to structure in low stress regions provided that they are not installed in way of butts, seams, nodes or stress risers. They shall not be attached to separate members which are in relative motion with respect to each other.

7.10.7 All welding work is to be carried out by qualified welders with approved welding procedures.

7.10.8 All welding shall be inspected by acceptable means (i.e. non-destructive testing).

7.10.9 The anodes are to be located at positions where they may not be affected by approaching ships or other craft.

7.10.10 Magnesium anodes are not to be used in way of higher tensile steel or coatings which may be damaged by the high negative potential unless suitable dielectric shields are fitted.

8. Calculation of the Anode System

The following indicates an acceptable method for determining the number and weight of anodes to achieve the required level of polarization on most structures. Other methods may be accepted provided that they demonstrate reasonable equivalence.

The selected anodes are to be of sufficient dimensions and weight to provide required current throughout the service life.

8.1 Coating breakdown factor

The current demand of a coated buoy increases with time as the coating deteriorates. Accordingly, the cathodic protection capacity required to maintain the same level of protection shall be provided. In order to achieve this, the coating breakdown factor shall be taken into account in the calculations.

The mean coating breakdown factor, f_m, is to be calculated as follows:

$$\mathbf{f_m = f_i + (0.5 \Delta f \cdot t_d)}$$

The final coating breakdown factor, f_f, is to be calculated as follows:

$$\mathbf{f_f = f_i + (\Delta f \cdot t_d)}$$

where,

f_i : Initial coating breakdown factor.

f_f : Final coating breakdown factor.

Δf : Yearly increase in coating breakdown factor.

t_d : Design life [year].

The required parameters to calculate the coating breakdown factors are given in Table 9.5.

The coating breakdown factors are based on coating quality being in accordance with commonly applied industry standards. The coating breakdown factors do not include any allowance for excessive damage to buoy coatings during fabrication or installation. If such conditions are anticipated, either the affected surface area shall be estimated and included in design calculations as bare metal surface (f_f = 1) or the coating breakdown factors in Table 9.5 shall be increased.

Table 9.5 Coating breakdown factors for various coating types

Coating type	Factor f_i	Δf
Asphalt/coal tar enamel + concrete	0.010	0.0005
Fusion bonded epoxy (FBE) + concrete	0.010	0.0005
Fusion bonded epoxy	0.020	0.0010
Elastomeric materials (polychloroprene or equivalent)	0.005	0.0002
Multilayer polyethylene (including FBE primer) (PE) and polypropylene, corrosion resistant polypropylene (PP)	0.005	0.0002
Multilayer (including FBE primer) corrosion resistant PE/PP+ concrete	0.002	0.0001
Thermal insulation systems (fully bonded)	0.002	0.0001

8.2 Surface area calculation

The surface area which is to be protected shall be calculated including the surfaces which are electrically connected to the system.

8.3 Calculation of current requirements

According to the calculated surface area and the coating system, the mean (I_m) and the final (I_f) current demand shall be calculated separately by the following formulas.

$$\mathbf{I_m = A_T \cdot f_m \cdot i_m} \qquad \mathbf{I_f = A_T \cdot f_f \cdot i_m}$$

where,

I_m = Average current demand [ampere].

I_f = Final current demand [ampere].

i_m = Average current density [ampere/m^2].

i_f = Final current density [ampere/m^2].

f_m = Average coating breakdown factor.

f_f = Final coating breakdown factor.

A_T = Total surface area to be protected [m^2].

8.4 Type and dimensions of anodes to be selected

The anode type is to be selected by considering fabrication, installation and operation details. The resistance calculation method of the anodes shall be determined by the anode type. The dimensions of an anode shall be sufficient to supply the required current density over the design life of the system.

8.5 Anode weight calculation

The total net weight of an anode which will provide cathodic protection throughout the design life is to be determined by the formula given below.

$$m_T = I_m \cdot t_d \cdot \frac{8760}{\mu Q_g}$$

where,

m_T = Total anode weight [kg],

I_m = Average current demand [ampere],

t_d = Design life [year],

Q_g = Electrochemical capacity of anode material [Ah/kg],

μ = Utilization factor.

The utilization factors for verious anode types are given below:

μ = 0.9 For fully supported tubular anodes.

μ = 0.80 For bracelet anodes (half shell).

μ = 0.75 For bracelet anodes (stand-alone type).

The electrochemical capacities for aluminium and zinc anode materials may be taken from Table 9.6.

Table 9.6 Electrochemical capacities

Anode material	Environment	Electrochemical capacity [Ah/kg]	Closed-circuit potential [V]
Al-based	seawater	2000	-1.05
	mud	1500	-0.95
Zinc-based	seawater	780	-1.00
	mud	780	-0.95

8.6 Determination of anode weight and quantity

The number of anodes for the selected anode type shall be determined to satisfy the estimated mean and final current demand. The final dimensions of the anodes and the weight of an individual anode shall be optimized based on the results of successive calculations using the formulae given below.

Total weight of the anodes is to be calculated by the following formula:

$$m_T = N \cdot m_{CPR}$$

where,

N = Total number of anodes installed,

m_T = Total weight of anodes [kg],

m_{CPR} = Single anode weight [kg].

8.6.1 Anode manufacturers supply standard precast anode types to the market. Although the above-mentioned formula is correct, in practice N and m_T are determined by the following expression:

$$m_T \leq N \cdot m_{CPR}$$

8.6.2 End-of-service-life current output I_f for an individual anode is to be calculated by the formula given below.

$$I_f = \frac{I_m}{N}$$

where,

I_f = Required end-of-service-life current output of anodes [ampere].

I_m = Mean current demand to protect a certain area at the end-of-service-life [ampere].

N = Number of anodes to be installed.

8.6.3 It shall be demonstrated by appropriate calculations that the cathodic protection system is capable of polarizing the structure initially and when consumed up to the design utilization factor.

8.6.4 At the end-of-service-life, it shall be assumed that the anode length is reduced 10% and the remaining anode material is distributed evenly on the steel insert.

8.6.5 For a given anode dimension and weight, the actual end-of-service-life anode current output is to be calculated by the following formula.

$$I_{af} = \frac{E_c - E_a}{R_a} = \frac{\Delta V}{R_a}$$

where,

I_{af} = Actual end-of-service-life, individual anode current output [ampere].

E_a = Design closed-circuit potential of the anode [volt].

E_c = Design protection potential [volt], minimum negative potential.

R_a = Total circuit resistance [ohm], assumed to be equal to the anode resistance.

8.6.6 Selected anodes shall be of sufficient dimensions and weight to provide required current demand throughout the service life.

8.6.7 The polarized steel potential shall be taken as -0.8 volts (with respect to Ag/AgCl/seawater reference electrode). This value may further be reduced (the absolute value may be increased) in regions where sulphate reducing bacteria (SRB) are present.

8.6.8 For the end-of-service-life seawater resistivity, it is assumed that the anodes are consumed according to their utilization factor. The anode dimensions corresponding to this consumption rate shall be used in the anode resistance R_a calculation laid down in Section 8.7.

8.6.9 The metallic resistance shall also be taken into account for anodes installed sparsely.

Note:
$\Delta V = E_c - E_a$ is usually named as driving design voltage [volt].

8.6.10 In order to provide the required current, the actual final anode current output shall be equal or greater than the final required anode current output:

$$I_{af} \geq I_f$$

The above expression and previously given formulae to calculate the anode weight shall be used to optimize the number, dimensions and weight of anodes to be used. For anodes which comply with the above-mentioned formulae, total anode weight may be determined by an economical optimization method which considers anode fabrication and installation costs.

8.7 Anode resistance calculation

The anode resistance R_a is to be calculated by the formula given below when the anode cross-section area is small considering its length and the clearance from the bottom of the anode to the structure surface is less than 300 mm.

$$R_a = \frac{R_d}{2\pi\pi_a}\left(\frac{\ln(4L_a)}{r} - 1\right)$$

where,

R_d = Seawater resistivity [ohm.cm].

L_a = Anode length [cm].

r = Equivalent anode radius [cm].

$$r = \sqrt{\frac{A_{cs}}{\pi}}$$

A_{cs} = Cross-sectional area of anode [cm^2].

For non-cylindrical anodes, the raidus r may be calculated by the formula:

$$r = \frac{C}{2\pi}$$

where,

r = Radius of the anode [m].

C = Circumference of the anode [m].

Other anode resistance formulae shall be verified theoretically and/or experimentally.

When bracelet type anodes are used locally, the resistance is to be calculated as follows:

$$R_a = \frac{0.315\,R_d}{\sqrt{A_{WS}}}$$

where,

A_{WS} = The exposed surface area of anode [cm^2].

For tubular structures, every structural member shall be considered separately in order to establish an even distribution of anodes.

If the actual values are not known, the values given in Figure 9.2 may be utilized for typical seawater resistivity which change with temperature and salinity.

The seawater resistivity values for some Turkish coastal waters are given in Table 9.7. These values which are valid at a distance of 100 m. from the coast and at 15^{0}C water temparatute, are for seawater only. These values are provided for design purposes only, for actual values, field measurements shall be carried out.

The measured seawater resistivity values shall be used for that specific location. If no values are available, 0.30 ohm.m at all depths and 1.50 ohm.m for the sea floor shall be used for seawater resistivity.

Table 9.7 Seawater resistivity for some Turkish coastal waters

Region	Resistivity [ohm.cm]
Eastern Black Sea	26-27
Western Black Sea	32-35
Istanbul Srait	35
Golden Horn	55-60
Izmit Bay	30
Gemlik	27-32
Prince island's region	30
Tekirdağ	29-32
Dardanelles Strait	27-30
Izmir Bay	27-29
Uzunada	27-29
Alsancak	32
Antalya	25-28
Iskenderun	24-26

The resistivity values are different for structures or members located on the sea floor. The values pertaining to different sea bottom types given in Table 9.8 are to be used for design purposes.

Table 9.8 Sea bottom resistivity

Sea bottom type	Resistivity [ohm.cm]
Mostly clay	60-75
Soft clay	75-110
Sand and hard clay	110-160

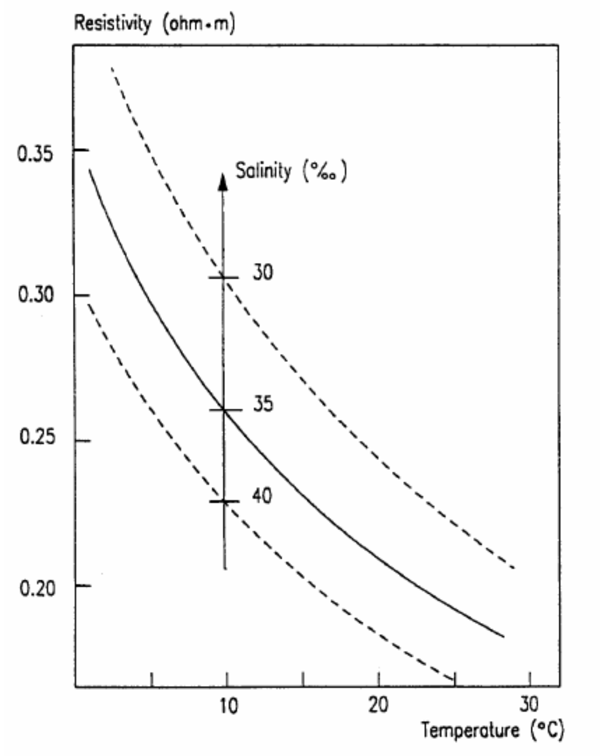


Figure 9.2 Seawater resistivity

8.8 Location of anodes

Having defined the quantity and dimensions of the anodes according to the suggested nominal current densities, the anodes are to be distributed on the steel surface depending on the required level of protection. During installation, extra care shall be given to regions with joints.

C. Corrosion Protection of Anchors and Chains

1. Cathodic Protection

The cathodic protection methods are more effective when used together with paints and coatings. In general, anchors do not require cathodic protection since they are mostly submerged in mud or sand and isolated from the corrosive environment.

1.1 The chains, a significant component of most offshore and marine structures, need to be protected against corrosion and wear. Increasing the thickness of chain links may be considered as a protection method against corrosion and wear. The diameter of chain links is to be increased by 0.2-0.4 mm/year over the design service life at the splash zone or hard sea floor where corrosion and wear are most detrimental. For other parts of the chain, the diameter of the links may be increased by 0.1-0.2 mm/year over the design service life.

1.2 The cathodic protection of chains are recommended since it improves their design life. Zinc anodes are usually used for this purpose. There are different types of anodes available, however the ones which will provide sufficient protection, will be easily installed and will not obstruct the operation are to be used. The electrical connection between the anodes are to be established by a galvanized steel wire cable with a diameter of 1.5-2.0 cm. However, both ends of the wire cable are subject to high risk of galvanic corrosion, therefore they shall be insulated appropriately or protected with additional anodes.

1.3 In practice, the anodes are to be replaced when their weight drop down to ¼ of the original weight. The replacement operation shall be carried out by qualified personnel and underwater depending on the anode type.

2. Painting of Anchors and Chains

2.1 The anchors and chains are to be painted with multi-layer paint depending on the protection level, after removal of oil and dirt from the surface and blast cleaning. If the chain and anchor will not be painted immediately after blast cleaning, an appropriate application of shop-primer is required to avoid flash rusting.

2.2 The chains and anchors which are placed in marine environment for a long period of time shall be painted with corrosion resistant and antifouling paints. The paint shall be applied under suitable temperature and weather conditions. The painting and/or coating method shall comply with the requirements of standard painting tests regarding thickness and workmanship quality.

2.3 A multi-layer paint application with contrasting colors is recommended.

D. Paints and Coating Systems

1. Paints are also utilized, along with cathodic protection, in the corrosion protection of MPMS. In most cases, cathodic protection and paints are used concurrently.

2. The paints are required to be corrosion resistant in the marine environment. The underwater parts are to be painted with antifouling paints.

3. A suitable surface preparation method shall be applied to surfaces before the application of paints and coatings.

4. The surface preparation method, the paints and coating system and the painting method have to be determined and approved in advance.

5. Before the painting operation, the following information and plans shall be summitted for approval.

5.1 The shop-primer used shall not have any adverse effects on welds and paints.

5.2 The selected paint type and its compliance with the environmental conditions shall be approved.

5.3 The surface preparation methods and standards applied prior to painting shall be approved. References will be made to national and international standards.

5.4 The painting method and procedures shall be approved.

5.5 The number of coating layers and total dry film thickness shall be approved.

6. For other details of painting and coatings, reference is to be made to **TL** Rules, Chapter 1 – Hull, Section 22.

7. The surface roughness for the top layer shall be 30-45 µm. The surface roughness for the hard-to-reach areas may be of 50 µm if cleaned satisfactorily.

8. The tests and approval of paint systems are to be carried out by **TL** based on the above mentioned rules and requirements.

9. For coatings, the rules and standards outlined in **TL** Rules, Chapter 1 – Hull, Section 22 are to be applied.

10. Certification of painting applications is to be based on the rules of **TL** Rules, Chapter 1 – Hull, Section 22.

E. Fouling Control

1. General

The deposition of living organisms on MPMS in marine environment creates an unwanted condition for the entire system in terms of stability and corrosion.

If left uncontrolled, it increases the weight of the buoy significantly and endangers safety and operation of the system.

2. Rate of Fouling

Fouling is an important parameter which needs to be considered in MPMS. The fouling thickness depends on the environmental conditions. Fouling results in weight and thickness increase in buoy, chain and anchor system and therefore results in increase in drag coefficient. The fouling induced corrosion is also a significant problem.

2.1 Fouling depends on the environment where the system is located. If no specific information is available on fouling for a specific site, the values for fouling thickness given in Table 9.10 for the North Sea may be used for design purposes.

Table 9.10 Fouling layer thickness

	56-59^{0}N	**59-72^{0}N**
Water depth [m]	**Thickness [mm]**	**Thickness [mm]**
Between +2 and -40	100	60
Below -40	50	30

2.2 If the actual density of fouling organisms is not available for the site where the MPMS is installed, 1.325 ton/m^3 may be used for average density in the air.

2.3 The mass and weight of fouling may be calculated by the aid of the following formulae.

Mass of fouling,

$$M_F = \frac{\pi}{4}\left[\left(D_N + 2\Delta\Delta_F\right)^2 - D_N^2\right]\rho_F \cdot k \qquad \left(\frac{kg}{m}\right)$$

Wet weight of fouling,

$$W_F = 0.00981 \cdot M_F\left[1 - \frac{\rho_{SW}}{\rho_F}\right] \qquad \left(\frac{kN}{m}\right)$$

ρ_F = Density of fouling organisms.

ρ_{SW} = Density of seawater.

D_N = Nominal diameter of chain or wire rope.

ΔT_F = Fouling thickness.

M_F = Mass of fouling.

W_F = Weigth of fouling.

k = Coefficient
For chain 2.0
For wire rope 1.0

3. Painting

Antifouling paints are required be used against fouling. After a 4 year period, fouling on the system shall be monitored, in case of a significant fouling growth, mechanical cleaning shall be applied. If a loss in the effectiveness of the paint system is detected, the buoy shall be re-painted after a proper surface preparation.

In addition, the corrosion triggering characteristic of fouling shall be taken into consideration.

F. Standards and Norms Used

Some of the standards and rules used in this Section are referred from the following international standards.

DIN 50900	Corrosion of metals – Terms.
DIN 50927	Planning and application of electrochemical corrosion protection of internal surfaces of apparatus, containers and tubes (internal protection).
DIN 50929	Corrosion of metals; probability of corrosion of metallic materials when subject to corrosion from the outside; buried and underwater pipelines and structural components.
DIN 50930	Corrosion behaviour of metalic materials in contact with water.
DIN 81249	Corrosion of metals in sea water and sea atmosphere.
EN 971	Paints and varnishes. Terms and definitions for coating materials. General terms.
EN 1395	Thermal spraying. Acceptance inspection of thermal spraying equipment.
EN 12473	General principles of cathodic protection in sea water.
EN 12474	Cathodic protection for submarine pipelines.
EN 12495	Cathodic protection for fixed steel offshore structures.
EN 13173	Cathodic protection for steel offshore floating structures.
EN 13174	Cathodic protection for harbour Installations.
EN 13507	Thermal spraying. Pre-treatment of surfaces of metallic parts and components for thermal spraying.
EN 13509	Cathodic protection measurement techniques.
EN 22063	Metallic and other inorganic coatings. Thermal spraying. Zinc, aluminium and their alloys.

ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.
ISO 8501	Preparation of steel substrates for application of paint and related products – visual assessment of surface cleanliness. Part 1: rust grades and preparation grades of uncoated steel substrates.
ISO 11124	Preparation of steel substrates before application of paints and related products - Specifications for metallic blast-cleaning abrasives.
ISO 11126	Preparation of steel substrates before application of paints and related products - Specifications for non-metallic blast-cleaning abrasives
ISO 12944	Paints and varnishes - Corrosion protection of steel structures by protective paint systems.
ISO 14918	Paints and varnishes -- Corrosion protection of steel structures by protective paint systems.
ISO 14919	Thermal spraying - Wires, rods and cords for flame and arc spraying - Classification - Technical supply conditions.
ISO 15589-2	Petroleum and natural gas industries - Cathodic protection of pipeline transportation systems - Part 2: Offshore pipelines.
NORSOK	M-501 Standard for surface preparation and protective coating.
NORSOK	M- 503 Standard for cathodic protection.
SEW 390	Non-magnatic steels.
SEW 395	Non-magnetic steel casts.
VG 81255	Cathodic protection, materials for sacrificial anodes.
VG 81256	Cathodic protection of ships, external protection by sacrificial anodes.
VG 81258	Cathodic protection of ships, internal protection by sacrificial anodes.
VG 81259	Cathodic protection of ships, protection by implicit current cathodic protection method.

SECTION 10

CERTIFICATION AND CLASSIFICATION

A. Certification

1. The Multi-Point Mooring Systems built and installed under **TL** survey are certified by **TL**. Information on construction surveys are given in C.2.

2. The application for certification of the MPMS is initiated by the builder or owner/operator.

3. The documentation related to the MPMS shall be submitted to **TL** in triplicate. The contents of such documentation is outlined in Section ....

4. The certification applies to the whole of the MPMS as a single unit.

B. Classification and Class Notation

1. Classification

1.1 Following the certification of the MPMS, the total system may be classed by **TL** upon demand. The regular class validity period is 5 years.

1.2 If the MPMS is classed by **TL,** it will be subject to periodic surveys. Information on the scope and application of periodic surveys is given in E.

2. Class Notation

2.1 MPMS built in accordance with **TL** Rules and under **TL** survey shall receive the class notation

+ 1 A 5 Multi-Point Mooring System

where the numeral 5 denotes the class validity period in years.

2.2 If a MPMS is built according to the Rules of and under the survey of a recognised classification society and later classed by **TL**, the class notation shall start with the sign (+).

3. Class Validity Period

3.1 The class validity shall last so long as the prescribed surveys of the MPMS are performed periodically and the required maintenance and refitting are carried out under **TL** survey.

3.2 If the MPMS is not surveyed on the required date at the end of the prescribed period, the class shall be suspended.

3.3 In the case of the MPMS getting damaged or the damage possibly effecting the validity of **TL** classification, the system shall be surveyed before it is operational again.

3.4 In the case of owner/operator not being able to fulfil the requirements constituting the basis for classification or refusing to carry out the required modifications or repairs within the time period previously agreed, the classification of the MPMS shall be withdrawn.

3.5 If the required modifications or repairs are carried out and the class surveys of the MPMS are executed, the original class may be reinstituted. The surveys are conducted in accordance with class renewal survey rules.

3.6 The class validity period remain unchanged when the MPMS is taken out of service. Upon request, a survey due to be performed may be postponed until after the MPMS is put into service. Under these circumstances, the total scope of surveys shall be determined by **TL** considering each case individually.

3.7 If for any reason, the class is suspended or withdrawn by **TL**, this fact shall be included in the registry. The class certificates shall be returned back to **TL**.

C. The Classification of Multi-Point Mooring Systems Built in Accordance With TL Rules and Under TL Survey

1. General

1.1 The application for the classification of the MPMS by the builder or owner/operator shall be prepared in written form and addressed to **TL**.

1.2 Any request for modifications on previously approved plans shall be examined and approval renewed before the work based on altered plans proceeds.

1.3 **TL** surveyors shall be provided with sufficiently early notification of tests which are to be performed under **TL** supervision.

2. Construction Surveys

2.1 Proof shall be provided that the construction materials are tested in accordance with **TL** Rules, Chapter 2 - Material.

2.2 The conformity of construction with the approved plans and documents are to be inspected by on-site construction surveys.

2.3 Various components of the MPMS are to be tested for mechanical strength and, if required, for functional efficiency at the test facilities of the manufacturer. **TL** may further require extensive testing of recently designed components or those whose efficiency is not tested for a sufficiently long time.

2.4 The installation of the MPMS shall be supervised by **TL** surveyors. The standards of workmanship shall be examined and the required tests of watertightness and functionality shall be performed.

2.5 In order to enable **TL** surveyors to fulfil their duties, they are to be granted freedom of entrance into workshops where the components subject to approval are manufactured, assembled or tested. The shipyard or the builder shall provide **TL** surveyors with the personnel and hardware required for carrying out the necessary tests.

D. The Classification of Multi-Point Mooring Systems Not Built Under TL Survey

1. General

1.1 The application for the classification of a MPMS not built under **TL** survey shall be prepared in written form and addressed to **TL**.

1.2 The application shall include the documentation covering the scope defined in the **TL** Rules for Classification of MPMS and it shall be submitted to **TL** for examination.

1.3 If applicable, all details related to the valid classification, the class validity period and any requirements related to preserving the valid class shall be submitted to **TL**.

1.4 For a MPMS classified by a recognised classification society, submitting a single copy of required documentation may be sufficient under special conditions.

2. Classification Procedures

2.1 A MPMS is to be surveyed in compliance with Class Renewal Survey procedures for the system to be classified by **TL**.

2.2 If the MPMS is classed by a recognised classification society, **TL** may refrain from surveying all of the system components and postpone the surveys until the next scheduled survey date. In this situation, **TL** may agree to restrict the survey scope to that of an annual survey.

2.3 A class certificate will be issued following the surveyor releasing a positive report towards classification. For a MPMS classed by **TL**, the rules and regulations applicable to a MPMS built under **TL** supervision shall apply.

E. Surveys for the Continuation of Class

1. Types of Surveys

TL shall carry out the following surveys of the MPMS for the class to be maintained:

1.1 Annual surveys (see E.3.1).

1.2 Intermediate surveys (see E.3.2).

Under normal circumstances, the intermediate surveys are carried into effect 2.5 years after the class is initially issued and at each class renewal. The intermediate surveys may be performed simultaneously with the second or third annual survey.

1.3 The Class Renewal Surveys are performed once in five years (see E.3.3).

1.4 In the case of MPMS getting damaged to the extent that the service operation is hampered, the Damage Survey is put into effect (see E.3.4).

1.5 Singular surveys are carried out if the MPMS is subjected to modifications (see E.3.5).

1.6 TL reserves the right to demand a survey to be performed in the time period between two regular surveys. A prescribed regular survey may be substituted by this type of survey.

2. Explanatory Notes on Surveys

2.1 **TL** will notify its authorised surveyor in time for the scheduled regular surveys. Similarly, the surveyors shall be notified in time about the maintenance and repair activities for supervision to be arranged.

2.2 The records of each survey and special requirements for continuity shall be quoted in the Class Certificate.

The signature of the surveyor on the Class Certificate and other documents indicate a declaration that the surveyor has observed, inspected and approved at the time the survey is performed.

2.3 The reports prepared by the surveyor shall be inspected by staff at the central **TL** office.

2.4 In cases where the defects are temporarily rectified or where immediate repairs or part replacements are not deemed indispensable by the surveyor, the class of the MPMS may be restricted by a clause added to the Class Certificate. When the restriction is lifted, the Class Certificate shall be altered accordingly.

2.5 When the system components are damaged or worn to the extent that they no more satisfy **TL** requirements, these components shall be either repaired or replaced.

3. Execution of Surveys

3.1 Annual surveys

The annual survey of a MPMS shall at least include the following tests and inspections:

3.1.1 The examination and inspection of MPMS documentation and service records.

3.1.2 The external inspection of all joints, openings, hatches, watertight components, etc. and visible damages, cracks, deformations, corrosion effects, fouling and staining on the buoy.

3.1.3 Inspection of all connection components (chains, anchors, shackles, rings etc.) for visible damages, cracks and deformations.

3.2 Intermediate surveys

With the exception of coinciding with a Class Renewal Survey described in D.3.3, an intermediate survey is an annual survey extended as follows.

3.2.1 The scope shall include the annual survey inspections.

3.2.2 The buoy shall be subjected to a leak detection test using air under approximately 0.2 bar test pressure.

3.3 Class renewal surveys

The Class Renewal Surveys are to be repeated every 5 years. In addition to those laid down in E.3.2, the following tests and inspections shall be performed:

3.3.1 Inspections of buoy scantlings and wall thickness measurements using non-destructive testing shall be carried out.

3.3.2 Buoys which cannot satisfactorily be examined internally or whose internal examination does not yield relevant information concerning the condition of the structure shall be examined using other non-destructive testing methods or the buoy shall be subjected to a hydraulic pressure test.

3.3.3 Thickness measurements shall be performed on all members of the mooring system, which shall also be inspected for crack and corrosion damage detection.

3.3.6 If MPMS and its components are surveyed within the class validity period with scope covering a Class Renewal Survey, the Class Renewal Surveys of the components surveyed previously may be postponed upon the application of the owner/operator.

3.4 Damage surveys

3.4.1 If the MPMS is damaged to an extent effecting its class or if such a damage is predicted, **TL** shall perform a damage survey.

3.4.2 Following the damage, the MPMS shall be prepared for sufficiently close inspection and examination required for a successful survey.

The scope of a damage survey shall be determined by **TL** on the merit of each individual case.

3.5 Special surveys

3.5.1 The MPMS shall be subjected to special surveys after significant repairs and modifications to the design, operating conditions or hardware components.

F. Surveys Other than Class Surveys

1. Surveys Required by Special Arrangements

Surveys required by law, international treaties or other legal reasons shall be performed by **TL** upon request, in accordance with the relevant provisions.

2. Surveys Relevant to Equipment Safety

Upon request, **TL** will perform all necessary surveys, acceptance and pressure tests of special safety equipment, inspect the plans and issue the relevant certificates.

APPENDIX A

Product List – Chains and Accessories

Terminology			
		Turkish	**English**
A – Type Link	**:**	A – Baklası Normal(Genel) Bakla Lokmalı Normal Bakla	A – Link Common Link Stud Link Common Stud Link
B – Type Link	**:**	B – Baklası Geniş Bakla	B – Link Enlarged Link
E – Type Link	**:**	E – Baklası Uç Bakla Açık Uç Baklası	E – Link End Link Open End Link
C – Type Link	**:**	C – Baklası	C – Link
Pear Link	**:**	Armut Şekilli Uç Bakla Armut Şekilli Bakla Armut Şekilli Halka	Pear Link Pear Shaped Link Pear Shaped End Link Pear Shaped Ring
Chain Joining Link	**:**	Sökülebilir Bakla Kızaksız Bağlantı Kilidi Sökülebilir Bağlantı Baklası Sökülebilir Zincir Bağlantı Baklası Kenter Zincir Kilidi Baldt Tipi Zinir Kilidi	Chain Joining Link Detachable Joining Link Detachable Link Chain Connecting Link Kenter Shackle
Anchor Joining Link	**:**	Sökülebilir Çapa Bağlantı Baklası Kenter Çapa Kilidi Baldt Tipi Çapa Kilidi	Anchor Joining Link Detachable Anchor Connecting Link
D – Link **D – Shackle**	**:**	D – Baklası D – Kilit Bağlantı Kilidi "D" Tipi	D – Link Joining Shackle D – Shackle Joining Shackle "D" Type
F – Link **F – Shackle**	**:**	F – Baklası F – Kilit Çapa Bağlantı Kilidi "F" Tipi Uç Kilit Bükme Kilidi Çapa Kilidi	F – Link F – Shackle Anchor Joining Shackle "F" Type End Shackle Bending Shackle Anchor Shackle
Buoy Shackle	**:**	-	Buoy Shackle
Sinker Shackle	**:**	-	Sinker Shackle
Swivel	**:**	-	Swivel
Swivel Shackle	**:**	-	Swivel Shackle
Modified Swivel Shackle	**:**	-	Modified Swivel Shackle
Ring	**:**	Zemin Halkası	Ring Ground Ring

A – Type Link

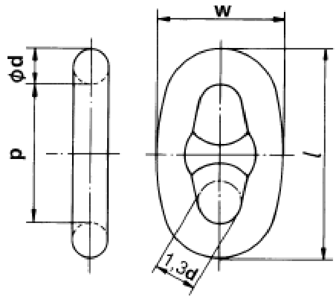
A – Type Link Main Dimensions			
d (mm)	**l (mm)**	**p (mm)**	**w (mm)**
12.5	75	50	45
14	84	56	50
16	96	64	58
17.5	105	70	63
19	114	76	68
20.5	123	82	74
22	132	88	79
24	144	96	86
26	156	104	94
28	168	112	101
30	180	120	108
32	192	128	115
34	204	136	122
36	216	144	130
38	228	152	137
40	240	160	144
42	252	168	151
44	264	176	158
46	276	184	166
48	288	192	173
50	300	200	180
52	312	208	187
54	324	216	194
56	336	224	202
58	348	232	209
60	360	240	216
62	372	248	223
64	384	256	230
66	396	264	238
68	408	272	245
70	420	280	252
73	438	292	263
76	456	304	274
78	468	312	281
81	486	324	292
84	504	336	302
87	522	348	313
90	540	360	324
92	552	368	331
95	570	380	342
97	582	388	349
100	600	400	360
102	612	408	367
105	630	420	378
107	642	428	385
111	666	444	400
114	684	456	410
117	702	468	421
120	720	480	432
122	732	488	439
124	744	496	446
127	762	508	457
130	780	520	468
132	792	528	475
137	822	548	493
142	852	568	511
147	882	588	529
152	912	608	547
157	942	628	565
162	972	648	583

d = Nominal diameter of A – Link

l = 6d

p = 4d

w = 3.6d



B – Type Link

B – Type Link Main Dimensions				
d (mm)	d_1 (mm)	l_1 (mm)	p_1 (mm)	w_1 (mm)
12.5	14	84	56	50
14	16	96	64	58
16	17.5	105	70	63
17.5	19	114	76	68
19	20.5	123	82	74
20.5	22	132	88	79
22	24	144	96	86
24	26	156	104	94
26	28	168	112	101
28	30	180	120	108
30	34	204	136	122
32	36	216	144	130
34	38	228	152	137
36	40	240	160	144
38	42	252	168	151
40	44	264	176	158
42	46	276	184	166
44	48	288	192	173
46	50	300	200	180
48	54	324	216	194
50	56	336	224	202
52	58	348	232	209
54	60	360	240	216
56	62	372	248	223
58	64	384	256	230
60	66	396	264	238
62	68	408	272	245
64	70	420	280	252
66	73	438	292	263
68	76	456	304	274
70	81	468	312	281
73	81	486	324	292
76	84	504	336	302
78	87	510	340	306
81	90	540	360	324
84	92	552	368	331
87	97	582	388	349
90	100	600	400	360
92	102	612	408	367
95	105	630	420	378
97	107	642	428	385
100	111	666	444	400
102	111	672	448	403
105	114	684	456	410
107	117	702	468	421
111	122	732	488	439
114	124	744	496	446
117	130	780	520	468
120	132	792	528	475
122	137	822	548	493
124	137	822	548	493
127	142	852	568	511
130	142	852	568	511
132	147	882	588	529
137	152	912	608	547
142	157	942	628	565
147	162	972	648	583
152	167	1002	668	601
157	173	1038	692	623
162	178	1068	712	641

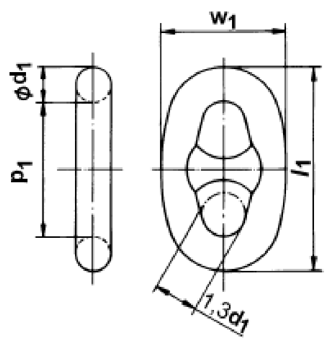
d = Nominal diameter of A – Link

d_1 = B – Type Link diameter ≈ 1.1d

l_1 = $6d_1$

p_1 = $4d_1$

w_1 = $3.6d_1$



E – Type Link

E – Type Link Main Dimensions				
d (mm)	d_2 (mm)	l_2 (mm)	p_2 (mm)	w_2 (mm)
12.5	16	86	54	50
14	17.5	96	61	56
16	19	108	70	64
17.5	20.5	114	76	70
19	22	127	83	76
20.5	24	137	89	82
22	26	148	96	88
24	28	160	104	96
26	32	177	113	104
28	34	190	122	112
30	36	203	131	120
32	38	215	139	128
34	40	228	148	136
36	44	245	157	144
38	46	257	165	152
40	48	270	174	160
42	50	283	183	168
44	52	295	191	176
46	56	312	200	184
48	58	325	209	192
50	60	338	218	200
52	62	350	226	208
54	64	363	235	216
56	68	380	244	224
58	70	392	252	232
60	73	407	261	240
62	73	416	270	248
64	76	430	278	256
66	81	449	287	264
68	81	458	296	272
70	84	473	305	280
73	87	492	318	292
76	92	515	331	304
78	95	529	339	312
81	97	546	352	324
84	100	565	365	336
87	105	588	378	348
90	107	606	392	360
92	111	622	400	368
95	114	643	413	380
97	117	656	422	388
100	120	675	435	400
102	122	688	444	408
105	127	711	457	420
107	130	725	465	428
111	132	747	483	444
114	137	770	496	456
117	142	793	509	468
120	147	816	522	480
122	147	825	531	488
124	152	843	539	496
127	152	856	552	508
130	157	878	566	520
132	162	894	574	528
137	165	926	596	548
142	170	958	618	568
147	180	999	639	588
152	185	1031	661	608
157	190	1063	683	628
162	195	1095	705	648

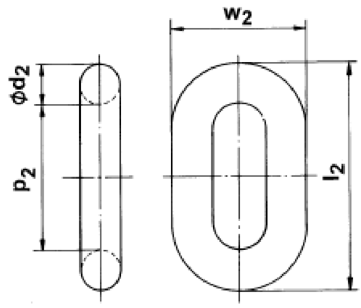
d = Nominal diameter of A – Link

d_2 = E – Type Link diameter ≈ 1.2d

l_2 ≈ p2+2d2 ≈ 6.75d

p_2 ≈ 4.35d

w_2 ≈ 3.6d



D – Shackle

D – Type Shackle Main Dimensions

d (mm)	d_3 (mm)	l_3 (mm)	p_3 (mm)	w_3 (mm)	a_1 (mm)	e_1 (mm)	f_1 (mm)	h1 (mm)	h2 (mm)	$2R_1$ (mm)	$2R_2$ (mm)
12.5	16	89	43	50	10	20	35	4	25	15	12.5
14	19	99	46	56	11	23	39	6	28	17	14
16	20.5	114	54.5	64	13	26	45	6	32	19	16
17.5	23	124	59	70	14	28	49	6	38	21	17.5
19	25	135	65	76	15	30	53	6	40	23	19
20.5	27	146	69.5	82	16.5	33	57	6	45	25	20.5
22	29	156	74.5	88	17.5	35	61	6	50	27	22
24	31	170	82	96	19	38	67	6	55	29	24
26	34	185	88	104	21	42	73	6	60	31	26
28	36	199	95.5	112	22.5	45	78	6	65	34	28
30	39	213	102	120	24	48	84	6	70	36	30
32	42	227	108.5	128	25.5	51	90	6	80	38	32
34	44	241	116	136	27	54	95	6	85	41	34
36	47	256	122	144	29	58	101	10	80	43	36
38	49	271	129	152	31	62	106	10	85	46	38
40	52	284	136	160	32	64	112	10	90	48	40
42	55	300	143	168	34	68	118	10	100	50	42
44	57	312	150	176	35	70	123	10	100	53	44
46	60	327	156	184	37	74	129	12	110	55	46
48	62	341	163.5	192	38.5	77	134	12	110	58	48
50	65	355	170	200	40	80	140	12	115	60	50
52	68	369	177	208	41	83	146	12	120	62	52
54	70	383	184	216	43	86	151	12	125	65	54
56	73	398	190	224	45	90	157	12	130	67	56
58	75	412	198	232	46	93	162	12	140	70	58
60	78	426	204	240	48	96	168	12	140	72	60
62	81	440	210	248	50	99	174	12	150	74	62
64	83	454	218	256	51	102	180	16	150	77	64
66	86	469	224	264	53	106	185	16	150	79	66
68	88	483	232	272	54	109	190	16	160	82	68
70	91	497	238	280	56	112	196	16	160	84	70
73	95	518	248	292	58	117	204	16	170	88	73
76	99	540	258	304	61	122	213	16	180	91	76
78	101	554	266	312	62	125	218	16	190	94	78
81	105	575	275	324	65	130	227	16	190	97	81
84	109	596	286	336	67	134	236	16	200	101	84
87	113	618	296	348	70	139	246	16	200	104	87
90	117	639	306	360	72	144	252	16	220	108	90
92	120	653	312	368	74	147	258	16	220	110	92
95	124	675	323	380	76	152	266	20	220	114	95
97	126	689	330	388	78	155	272	20	240	116	97
100	130	710	340	400	80	160	280	20	240	120	100
102	133	724	346	408	82	163	286	20	240	122	102
105	137	746	357	420	84	168	294	20	260	126	105
107	139	760	364	428	86	171	300	20	260	128	107
111	144	788	377	444	89	178	311	20	260	133	111
114	148	809	388	456	91	182	319	20	280	137	114
117	152	831	398	468	94	187	328	20	280	140	117
120	156	852	408	480	96	192	336	20	300	144	120
122	159	866	414	488	98	195	342	20	300	146	122
124	161	880	422	496	99	198	347	20	300	149	124
127	165	902	432	508	102	203	356	25	300	152	127
130	169	923	442	520	104	208	364	25	320	156	130
132	172	937	448	528	106	211	370	25	320	158	132
137	178	973	466	548	110	219	384	25	320	164	137
142	185	1008	482	568	114	227	398	25	350	170	142
147	191	1044	500	588	118	235	412	25	350	176	147
152	198	1079	516	608	122	243	426	25	350	182	152
157	204	1115	524	628	126	251	440	25	400	188	157
162	211	1150	550	648	130	259	454	25	400	194	162

d = Nominal diameter of A – Link

d_3 = D – Shackle diameter ≈ 1,3d

l_3 ≈ 7,1d

p_3 = l 3 – (d3 + a1 + e1) ≈ 3,4d

w_3 = 4d

a_1 ≈ 0,8d

e_1 ≈ 1,6d

f_1 ≈ 2,8d

g_1 ≈ 0,2d

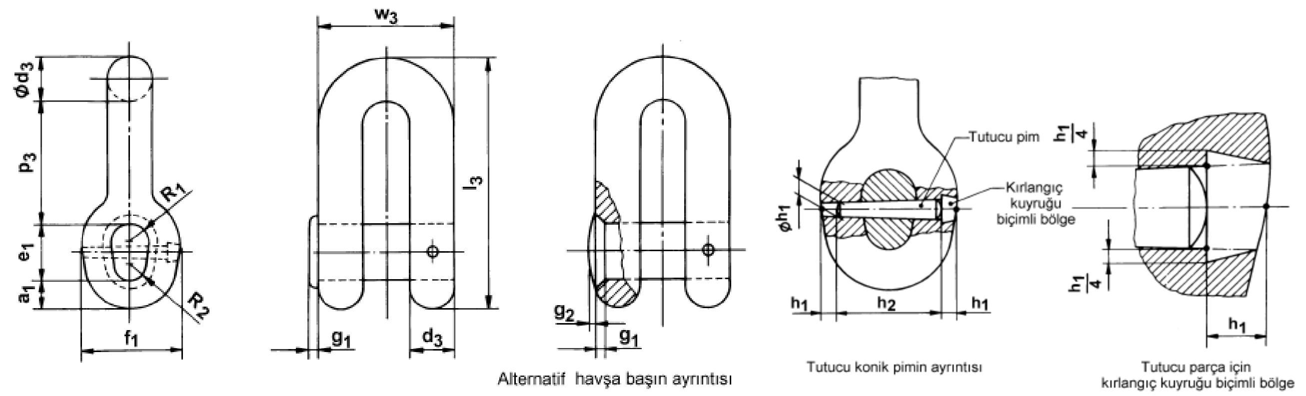
g_2 ≈ 0,1d

h_1 = Nominal diameter of conical pin

h_2 = Nominal length of conical pin

R_1 ≈ 0,6d

R_2 ≈ 0,5d



F – Type Shackle

F – Type Shackle Main Dimensions										
d (mm)	d_5 (mm)	l_5 (mm)	p_5 (mm)	w_5 (mm)	a_2 (mm)	e_2 (mm)	f_2 (mm)	h1 (mm)	h2 (mm)	m (mm)
12.5	17.5	109	57.5	65	11	23	39	4	28	17.5
14	19.5	122	64.5	73	12.5	25	43	6	30	19.5
16	22.5	139	73.5	83	14.5	29	50	6	35	22
17.5	24.5	152	81	91	15.5	31	54	6	40	24.5
19	26.5	165	87.5	99	17	34	59	6	45	26.5
20.5	28.5	178	94	107	18.5	37	64	6	45	28.5
22	31	191	101	114	20	39	68	6	50	31
24	34	209	110	125	22	43	74	6	55	34
26	37	226	120	135	23	46	81	6	60	37
28	39	244	129	146	25	51	87	6	70	39
30	42	261	138	156	27	54	93	6	75	42
32	45	278	147	166	29	57	99	6	80	45
34	48	296	156	176	30	62	105	6	85	48
36	50	313	166	187	32	65	112	10	85	50
38	53	331	175	198	34	69	118	10	90	53
40	56	348	184	208	36	72	124	10	95	56
42	59	365	193	218	38	75	130	10	100	59
44	62	383	202	229	40	79	136	10	110	62
46	64	400	212	239	41	83	143	10	115	64
48	67	418	221	250	43	87	149	12	115	67
50	70	435	230	260	45	90	155	12	120	70
52	73	452	239	270	47	93	161	12	125	73
54	76	470	248	285	49	97	167	12	130	76
56	78	487	258	291	50	101	174	12	140	78
58	81	505	261	202	52	105	180	12	140	81
60	84	522	276	312	54	108	186	12	150	84
62	87	539	285	322	56	111	192	12	160	87
64	90	557	294	333	58	115	198	16	150	90
66	92	574	304	343	59	119	205	16	160	92
68	95	592	313	354	61	123	211	16	160	95
70	98	609	322	364	63	126	217	16	170	98
73	102	635	336	380	66	131	226	16	180	102
76	106	661	350	395	68	137	236	16	190	106
78	109	678	359	406	70	140	242	16	190	109
81	113	705	373	421	73	146	251	16	200	113
84	118	731	386	437	76	151	260	16	200	118
87	122	757	400	452	78	157	270	16	220	122
90	126	783	414	468	81	162	279	16	220	126
92	129	800	422	478	83	166	285	16	240	129
95	133	827	437	494	86	171	295	16	240	133
97	136	844	446	504	87	175	301	20	240	136
100	140	870	460	520	90	180	310	20	240	140
102	143	887	468	530	92	184	316	20	260	143
105	147	914	483	546	95	189	326	20	260	147
107	150	931	492	556	96	193	332	20	260	150
111	155	966	511	577	100	200	344	20	280	155
114	160	992	524	593	103	205	353	20	280	160
117	164	1018	538	608	105	211	363	20	300	164
120	168	1044	552	624	108	216	372	20	300	168
122	171	1061	560	634	110	220	378	20	320	171
124	174	1079	570	645	112	223	384	20	320	174
127	178	1105	584	660	114	229	394	25	320	178
130	182	1131	598	676	117	234	403	25	320	182
132	185	1148	606	682	119	238	409	25	320	185
137	192	1192	630	712	123	247	425	25	350	192
142	199	1235	652	738	128	256	440	25	350	199
147	206	1279	676	764	132	265	456	25	350	206
152	213	1322	699	790	137	274	471	25	400	213
157	220	1366	722	816	141	283	487	25	400	220
162	227	1409	745	842	146	292	502	25	400	227

d = Nominal diameter of A – Link

d_5 = F – Type Shackle diameter ≈ 1,4d

l_5 ≈ 8,7d

p_5 = l 5 – (d5+ a2 + e2) ≈ 4,6d

w_5 = 5,2d

a_2 ≈ 0,9d

e_2 ≈ 1,8d

f_2 ≈ 3,1d

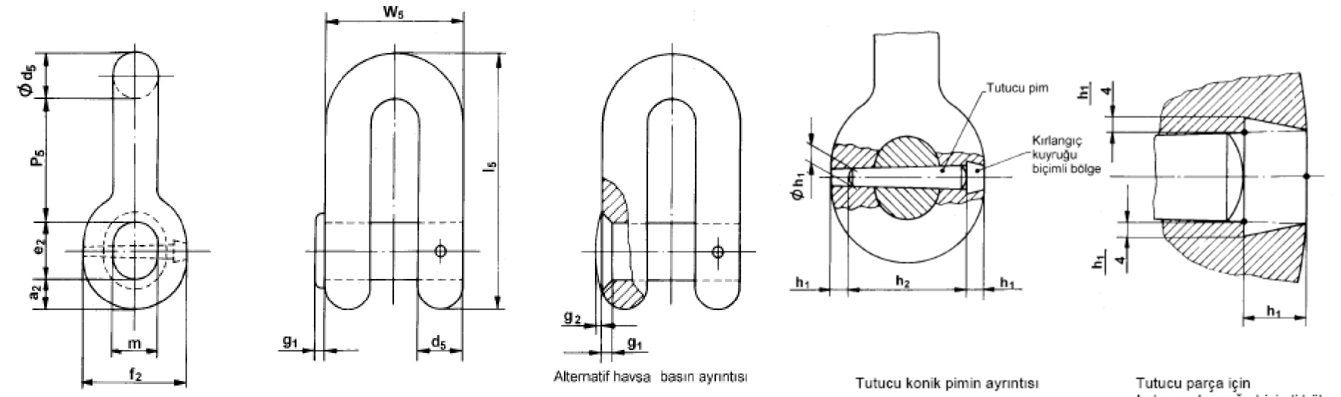
g_1 ≈ 0,2d

g_2 ≈ 0,1d

h_1 = Nominal diameter of conical pin

h_2 = Nominal length of conical pin

m ≈ 0,6d



Alternatif havşa basın ayrıntısı

Tutucu konik pimin ayrıntısı

Tutucu parça için kırlangıç kuyruğu biçimli bölge

D - Type Shackle (Anchor)

D Type Shackle (Anchor) Main Dimensions								
d (mm)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**F (mm)**	**G (mm)**	**M (mm)**	N (mm)
12.5	18	103	63	38	16	24	50	28
14	20	115	70	42	18	27	56	31
16	22	131	80	48	21	30	64	35
17.5	25	144	88	53	23	33	70	39
19	27	156	95	57	25	36	76	42
20.5	29	168	103	62	27	39	82	45
22	31	180	110	66	29	42	88	48
24	34	197	120	72	31	46	96	53
26	36	213	130	78	34	49	104	57
28	39	230	140	84	36	53	112	62
30	42	246	150	90	39	57	120	66
32	45	262	160	96	42	61	128	70
34	48	279	170	102	44	65	136	75
36	50	295	180	108	47	68	144	79
38	53	312	190	114	49	72	152	84
40	56	328	200	120	52	76	160	88
42	59	344	210	126	55	80	168	92
44	62	361	220	132	57	84	176	97
46	64	377	230	138	60	87	184	101
48	67	394	240	144	62	91	192	106
50	70	410	250	150	65	95	200	110
52	73	426	260	156	68	99	208	114
54	76	443	270	162	70	103	216	119
56	78	459	280	168	73	106	224	123
58	81	476	290	174	75	110	232	128
60	84	492	300	180	78	114	240	132
62	87	508	310	186	81	118	248	136
64	90	525	320	192	83	122	256	141
66	92	541	330	198	86	125	264	145
68	95	558	340	204	88	129	272	150
70	98	574	350	210	91	133	280	154
73	102	599	365	219	95	139	292	161
76	106	623	380	228	99	144	304	167
78	109	640	390	234	101	148	312	172
81	113	664	405	243	105	154	324	178
84	118	689	420	252	109	160	336	185
87	122	713	435	261	113	165	348	191
90	126	738	450	270	117	171	360	198
92	129	754	460	276	120	175	368	202
95	133	779	475	285	124	181	380	209
97	136	795	485	291	126	184	388	213
100	140	820	500	300	130	190	400	220
102	143	836	510	306	133	194	408	224
105	147	861	525	315	137	200	420	231
107	150	877	535	321	139	203	428	235
111	155	910	555	333	144	211	444	244
114	160	935	570	342	148	217	456	251
117	164	959	585	351	152	222	468	257
120	168	984	600	360	156	228	480	264
122	171	1000	610	366	159	232	488	268
124	174	1017	620	372	161	236	496	273
127	178	1041	635	381	165	241	508	279
130	182	1066	650	390	169	247	520	286
132	185	1082	660	396	172	251	528	290
137	192	1123	685	411	178	260	548	301
142	199	1164	710	426	185	270	568	312
147	206	1205	735	441	191	279	588	323
152	213	1246	760	456	198	289	608	334
157	220	1287	785	471	204	298	628	345
162	227	1328	810	486	211	308	648	356

d = Nominal diameter of A – Link

A = 1.2d

B = 8.2d

C = 5.0d

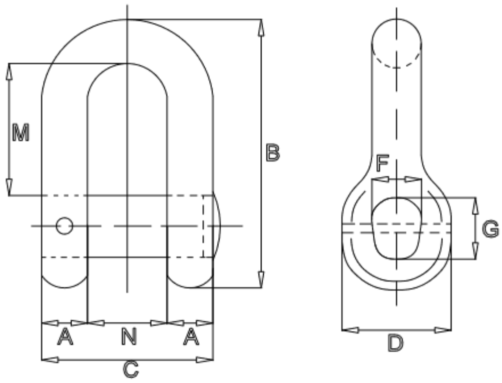
D = 3.0d

F = 1.3d

G = 1.9d

M = 4.0d

N = 2.2d



Kenter Chain Connection Shackle

Kenter Type Chain Connection Shackle Main Dimensions								
$d = d_4$ (mm)	l_4 (mm)	p_4 (mm)	w_4 (mm)	h1 (mm)	h2 (mm)	k (mm)	R_3 (mm)	R_4 (mm)
12.5	75	50	53	4	45	19	8.5	23
14	84	56	59	6	45	21	9.5	26
16	96	64	67	6	55	24	10.5	29
17.5	105	70	74	6	60	27	12	32
19	114	76	80	6	65	29	13	35
20.5	123	82	86	6	70	31	14	38
22	132	88	92	6	75	33	15	40
24	144	96	101	10	80	36	16	44
26	156	104	109	10	85	40	17.5	48
28	168	112	118	10	95	43	19	51
30	180	120	126	10	100	46	20	55
32	192	128	134	10	110	49	21.5	59
34	204	136	143	12	115	52	23	62
36	216	144	151	12	120	55	24	66
38	228	152	160	12	130	58	25	70
40	240	160	168	12	140	61	27	73
42	252	168	176	12	140	64	28	77
44	264	176	185	16	150	67	29	81
46	276	184	193	16	160	70	31	84
48	288	192	202	16	160	73	32	88
50	300	200	210	16	170	76	34	92
52	312	208	218	16	180	79	35	95
54	324	216	227	20	180	82	36	99
56	336	224	235	20	190	85	38	102
58	348	232	244	20	200	88	39	106
60	360	240	252	20	200	91	40	110
62	372	248	260	20	220	94	42	113
64	384	256	269	20	220	97	43	117
66	369	264	277	25	220	100	44	121
68	408	272	286	25	220	103	46	124
70	420	280	294	25	240	106	47	128
73	438	292	307	25	260	111	49	134
76	456	304	319	25	260	115	51	139
78	468	312	328	25	260	119	52	143
81	486	324	340	30	280	123	54	148
84	504	336	353	30	280	128	57	154
87	522	348	365	30	300	132	58	159
90	540	360	378	30	300	137	60	165
92	552	368	386	30	320	140	62	168
95	570	380	399	35	320	144	64	174
97	582	388	407	35	340	147	65	178
100	600	400	420	35	340	152	67	183
102	612	408	428	35	360	155	68	187
105	630	420	441	35	360	160	70	192
107	642	428	449	35	360	163	72	196
111	666	444	466	40	380	169	74	203
114	684	456	479	40	380	173	76	207
117	702	468	491	40	400	178	78	214
120	720	480	504	40	400	182	80	220
122	732	488	512	40	420	185	82	223
124	744	496	521	40	420	188	83	227
127	762	508	533	40	440	193	85	232
130	780	520	546	50	440	198	87	238
132	792	528	554	50	460	201	88	242
137	822	548	575	50	460	208	92	251
142	852	568	596	50	480	216	95	260
147	882	588	617	50	500	223	98	269
152	912	608	638	50	520	231	102	278
157	942	628	659	50	540	239	105	287
162	972	648	680	50	560	246	109	296

d= Nominal diameter of A – Link

d_4= Connection shackle diameter = d

l_4= 6d

w_4≈ 4,2d

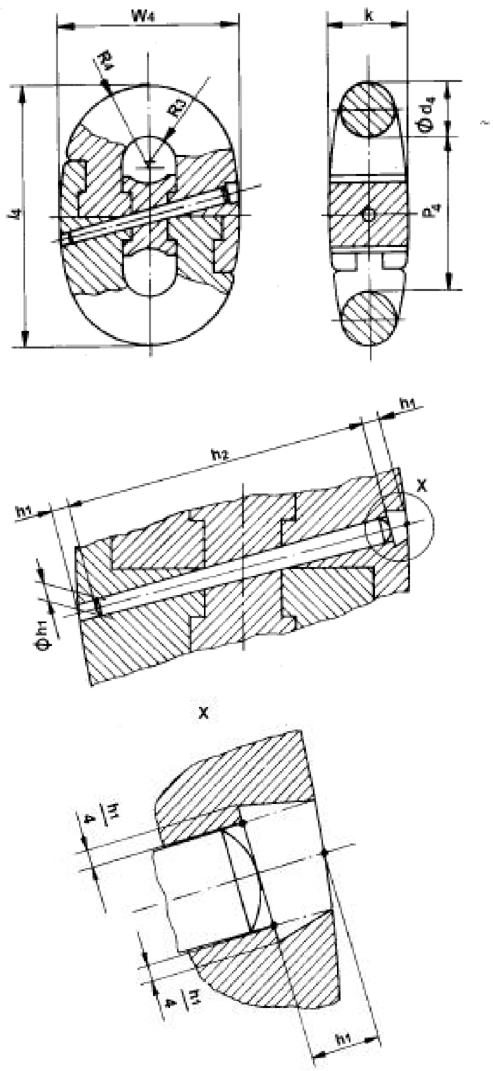
h= Nominal diameter of conical pin

h_2≈ 3,4d Length of conical pin

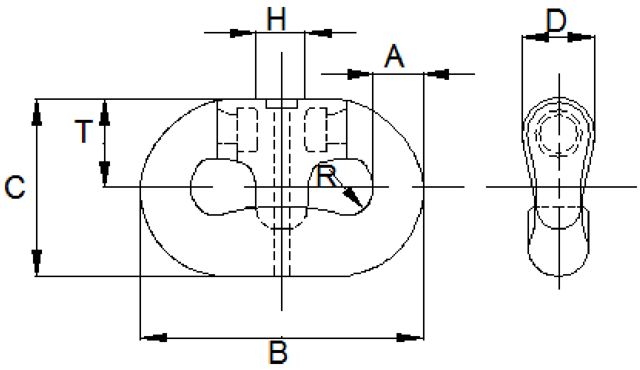
k≈ 1,52d

R_3≈ 0,67d

R_4≈ 1,83d



Baldt Type Chain Connection Shackle

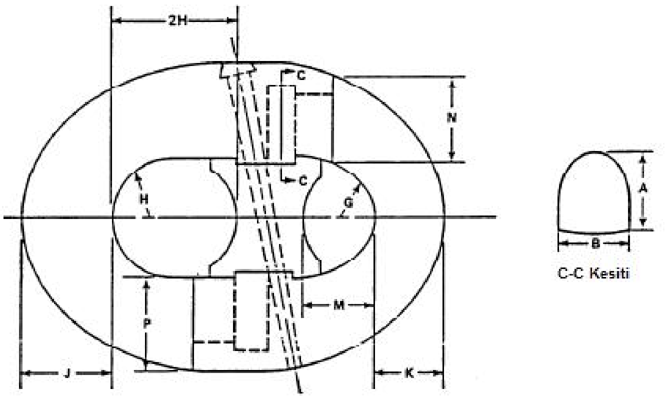


Baldt Type Chain Connection Shackle Main Dimensions										
d (mm)	A (mm)	B (mm)	C (mm)	D (mm)	H (mm)	R (mm)	T (mm)	Ağırlık (kg)	Dayanıklılık Testi (N)	Kopma Testi (N)
***19**	**19**	**114**	**74**	**24**	**22**	**13**	**24**	**0.9**	**214**	**334**
***21-22**	**22**	**133**	**86**	**28**	**29**	**15**	**28**	**1.6**	**285**	**436**
***24-25**	**25**	**152**	**98**	**32**	**29**	**17**	**32**	**2.0**	**374**	**574**
***27-29**	**29**	**171**	**111**	**36**	**32**	**19**	**36**	**2.7**	**472**	**716**
***30-32**	**32**	**191**	**123**	**40**	**37**	**21**	**40**	**3.9**	**578**	**881**
***33-35**	**35**	**210**	**135**	**44**	**35**	**23**	**44**	**5.0**	**698**	**1045**
***37-38**	**38**	**229**	**148**	**48**	**44**	**25**	**48**	**6.8**	**823**	**1246**
***40-41**	**41**	**248**	**160**	**51**	**50**	**27**	**51**	**9.1**	**961**	**1446**
***43-44**	**44**	**267**	**172**	**57**	**52**	**29**	**56**	**10.9**	**1108**	**1735**
46-48	**48**	**286**	**184**	**64**	**55**	**31**	**60**	**14.5**	**1268**	**1922**
49-51	**51**	**305**	**197**	**64**	**59**	**33**	**64**	**16.3**	**1432**	**2171**
52-54	**54**	**324**	**210**	**67**	**64**	**36**	**67**	**20.0**	**1610**	**2438**
56-57	**57**	**343**	**221**	**71**	**67**	**38**	**71**	**23.6**	**1793**	**2713**
59-60	**60**	**362**	**234**	**78**	**70**	**40**	**75**	**27.7**	**1988**	**3003**
62-64	**64**	**381**	**246**	**79**	**73**	**42**	**79**	**32.2**	**2189**	**3309**
65-60	**67**	**400**	**259**	**83**	**78**	**44**	**78**	**37.2**	**2402**	**3616**
# 68-70	**70**	**419**	**270**	**87**	**81**	**47**	**87**	**43.1**	**2624**	**3954**
71-73	**73**	**438**	**283**	**91**	**85**	**48**	**86**	**48.5**	**2847**	**4293**
# 75-76	**76**	**457**	**295**	**95**	**90**	**50**	**95**	**54.4**	**3083**	**4648**
78-79	**79**	**476**	**308**	**102**	**92**	**52**	**94**	**62.6**	**3327**	**5018**
81-83	**83**	**495**	**321**	**103**	**92**	**55**	**103**	**73.0**	**3577**	**5382**
84-86	**86**	**514**	**333**	**107**	**100**	**57**	**107**	**80.3**	**3835**	**5765**
# 87-89	**89**	**533**	**344**	**111**	**103**	**58**	**111**	**88.5**	**4101**	**6063**
90-92	**92**	**552**	**356**	**116**	**106**	**59**	**116**	**97.5**	**4542**	**6966**
94-95	**95**	**572**	**368**	**119**	**119**	**62**	**119**	**116.1**	**4982**	**7784**
97-98	**98**	**591**	**381**	**127**	**114**	**67**	**121**	**122.9**	**5360**	**8289**
100-102	**102**	**610**	**394**	**132**	**117**	**68**	**125**	**130.6**	**5774**	**8745**
105	**105**	**629**	**419**	**149**	**127**	**71**	**132**	**174.2**	**5994**	**9174**
108	**111**	**648**	**441**	**165**	**133**	**73**	**140**	**191.4**	**6199**	**9493**
111	**114**	**667**	**467**	**184**	**168**	**75**	**149**	**208.7**	**6982**	**10667**
114	**117**	**686**	**492**	**203**	**0**	**76**	**157**	**226.8**	**7437**	**11156**

* For high strength design.
# For heavy-duty design.

d= Nominal diameter of A – Link

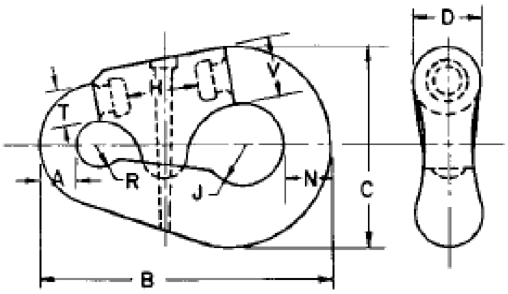
Kenter Type Anchor Connection Shackle



Kenter Type Anchor Connection Shackle Main Dimensions														
d (mm)	A(max) (mm)	B(max) (mm)	C(min) (mm)	C(max) (mm)	H(min) (mm)	H(max) (mm)	J(max) (mm)	J(min) (mm)	K(max) (mm)	M(min) (mm)	N(min) (mm)	N(max) (mm)	P(min) (mm)	P(max) (mm)
32	**48**	**40**	**19**	**25**	**37**	**38**	**52**	**32**	**40**	**38**	**38**	**44**	**54**	**70**
44	67	56	27	36	52	53	73	44	56	53	56	62	76	98
51	**76**	**64**	**30**	**41**	**60**	**61**	**84**	**51**	**64**	**61**	**64**	**71**	**86**	**112**
57	86	71	34	46	67	69	94	57	71	69	71	80	97	126
64	**95**	**80**	**38**	**51**	**75**	**76**	**105**	**64**	**80**	**76**	**80**	**89**	**108**	**140**
70	105	87	39	56	82	84	115	70	87	84	87	98	119	154
76	**105**	**95**	**46**	**61**	**90**	**91**	**126**	**76**	**95**	**91**	**95**	**107**	**130**	**168**
89	133	111	53	71	105	107	147	89	111	107	111	124	151	196
102	**152**	**127**	**61**	**81**	**120**	**127**	**165**	**102**	**127**	**122**	**127**	**142**	**173**	**224**

d= Nominal diameter of A – Link

Baldt Type Anchor Connection Shackle

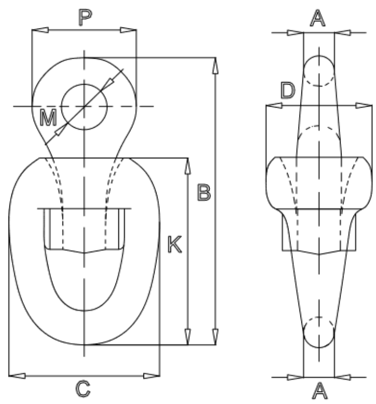


Baldt Type Anchor Connection Shackle Main Dimensions										
d(mm)	A(mm)	B(mm)	C(mm)	D(mm)	H(mm)	J(mm)	N(mm)	R(mm)	T(mm)	V(mm)
19	**24**	**194**	**132**	**38**	**57**	**30**	**32**	**17**	**24**	**35**
25-30	30	238	167	46	66	35	38	19	33	44
32-40	**40**	**298**	**206**	**59**	**83**	**43**	**48**	**26**	**40x44**	**56**
41-51	51	378	260	76	100	52	64	32	59x60	74
52-60	**60**	**454**	**313**	**92**	**121**	**64**	**76**	**37**	**62x73**	**88**
62-79	79	562	376	117	149	76	95	48	86x79	111
81-92	**92**	**651**	**419**	**133**	**149**	**79**	**124**	**54**	**111x102**	**130x133**
94-95	98	708	435	146	159	83	130	57	124x137	141
97-102	**121**	**908**	**572**	**191**	**191**	**108**	**165**	**73**	**130**	**181**
103-111	127	940	610	203	203	111	175	76	146x156	194
110-114	**133**	**991**	**648**	**216**	**216**	**114**	**184**	**105**	**165x175**	**203**

d= Nominal diameter of A – Link

Swivel

Swivel Main Dimensions							
d (mm)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**K (mm)**	**M (mm)**	**P (mm)**
12.5	**15**	**121**	**59**	**48**	**79**	**18**	**48**
14	17	136	66	53	88	20	53
16	**19**	**155**	**75**	**61**	**101**	**22**	**61**
17.5	21	170	82	67	110	25	67
19	**23**	**184**	**89**	**72**	**120**	**27**	**72**
20.5	25	199	96	78	129	29	78
22	**26**	**213**	**103**	**84**	**139**	**31**	**84**
24	29	233	113	91	151	34	91
26	**31**	**252**	**122**	**99**	**164**	**36**	**99**
28	34	272	132	106	176	39	106
30	**36**	**291**	**141**	**114**	**189**	**42**	**114**
32	38	310	150	122	202	45	122
34	**41**	**330**	**160**	**129**	**214**	**48**	**129**
36	43	349	169	137	227	50	137
38	**46**	**369**	**179**	**144**	**239**	**53**	**144**
40	48	388	188	152	252	56	152
42	**50**	**407**	**197**	**160**	**265**	**59**	**160**
44	53	427	207	167	277	62	167
46	**55**	**446**	**216**	**175**	**290**	**64**	**175**
48	58	466	226	182	302	67	182
50	**60**	**485**	**235**	**190**	**315**	**70**	**190**
52	62	504	244	198	328	73	198
54	**65**	**524**	**254**	**205**	**340**	**76**	**205**
56	67	543	263	213	353	78	213
58	**70**	**563**	**273**	**220**	**365**	**81**	**220**
60	72	582	282	228	378	84	228
62	**74**	**601**	**291**	**236**	**391**	**87**	**236**
64	77	621	301	243	403	90	243
66	**79**	**640**	**310**	**251**	**416**	**92**	**251**
68	82	660	320	258	428	95	258
70	**84**	**679**	**329**	**266**	**441**	**98**	**266**
73	88	708	343	277	460	102	277
76	**91**	**737**	**357**	**289**	**479**	**106**	**289**
78	94	757	367	296	491	109	296
81	**97**	**786**	**381**	**308**	**510**	**113**	**308**
84	101	815	395	319	529	118	319
87	**104**	**844**	**409**	**331**	**548**	**122**	**331**
90	108	873	423	342	567	126	342
92	**110**	**892**	**432**	**350**	**580**	**129**	**350**
95	114	922	447	361	599	133	361
97	**116**	**941**	**456**	**369**	**611**	**136**	**369**
100	120	970	470	380	630	140	380
102	**122**	**989**	**479**	**388**	**643**	**143**	**388**
105	126	1019	494	399	662	147	399
107	**128**	**1038**	**503**	**407**	**674**	**150**	**407**
111	133	1077	522	422	699	155	422
114	**137**	**1106**	**536**	**433**	**718**	**160**	**433**
117	140	1135	550	445	737	164	445
120	**144**	**1164**	**564**	**456**	**756**	**168**	**456**
122	146	1183	573	464	769	171	464
124	**149**	**1203**	**583**	**471**	**781**	**174**	**471**
127	152	1232	597	483	800	178	483
130	**156**	**1261**	**611**	**494**	**819**	**182**	**494**
132	158	1280	620	502	832	185	502
137	**164**	**1329**	**644**	**521**	**863**	**192**	**521**
142	170	1377	667	540	895	199	540
147	**176**	**1426**	**691**	**559**	**926**	**206**	**559**
152	182	1474	714	578	958	213	578
157	**188**	**1523**	**738**	**597**	**989**	**220**	**597**
162	194	1571	761	616	1021	227	616



d= Nominal diameter of A – Link

A= 1.2d

B= 9.7d

C= 4.7d

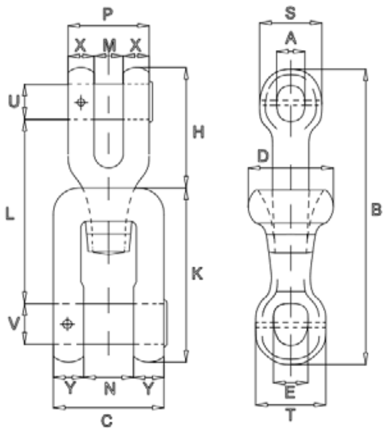
D= 3.8d

K= 6.3d

M= 1.4d

P= 3.8d

Swivel Shackle



A=1.2d	K=8.65d	T=3.4d
B=13.8d	L=8.55d	U=1.6d
C=5.0d	M=1.4d	V=1.9d
D=3.8d	N=2.2d	X=1.3d
E=1.3d	P=4.0d	Y=1.4d
H=5.15d	S=2.8d	

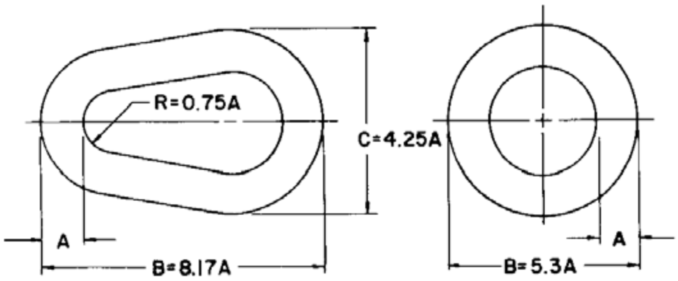
Swivel Shackle Main Dimensions

d (mm)	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	H (mm)	K (mm)	L (mm)	M (mm)	N (mm)	P (mm)	S (mm)	T (mm)	U (mm)	V (mm)	X (mm)	Y (mm)
12.5	15	173	63	48	16	64	108	107	18	28	50	35	43	20	24	16	18
14	17	193	70	53	18	72	121	120	20	31	56	39	48	22	27	18	20
16	19	221	80	61	21	82	138	137	22	35	64	45	54	26	30	21	22
17.5	21	242	88	67	23	90	151	150	25	39	70	49	60	28	33	23	25
19	23	262	95	72	25	98	164	162	27	42	76	53	65	30	36	25	27
20.5	25	283	103	78	27	106	177	175	29	45	82	57	70	33	39	27	29
22	26	304	110	84	29	113	190	188	31	48	88	62	75	35	42	29	31
24	29	331	120	91	31	124	208	205	34	53	96	67	82	38	46	31	34
26	31	359	130	99	34	134	225	222	36	57	104	73	88	42	49	34	36
28	34	386	140	106	36	144	242	239	39	62	112	78	95	45	53	36	39
30	36	414	150	114	39	155	260	257	42	66	120	84	102	48	57	39	42
32	38	442	160	122	42	165	277	274	45	70	128	90	109	51	61	42	45
34	41	469	170	129	44	175	294	291	48	75	136	95	116	54	65	44	48
36	43	497	180	137	47	185	311	308	50	79	144	101	122	58	68	47	50
38	46	524	190	144	49	196	329	325	53	84	152	106	129	61	72	49	53
40	48	552	200	152	52	206	346	342	56	88	160	112	136	64	76	52	56
42	50	580	210	160	55	216	363	359	59	92	168	118	143	67	80	55	59
44	53	607	220	167	57	227	381	376	62	97	176	123	150	70	84	57	62
46	55	635	230	175	60	237	398	393	64	101	184	129	156	74	87	60	64
48	58	662	240	182	62	247	415	410	67	106	192	134	163	77	91	62	67
50	60	690	250	190	65	258	433	428	70	110	200	140	170	80	95	65	70
52	62	718	260	198	68	268	450	445	73	114	208	146	177	83	99	68	73
54	65	745	270	205	70	278	467	462	76	119	216	151	184	86	103	70	76
56	67	773	280	213	73	288	484	479	78	123	224	157	190	90	106	73	78
58	70	800	290	220	75	299	502	496	81	128	232	162	197	93	110	75	81
60	72	828	300	228	78	309	519	513	84	132	240	168	204	96	114	78	84
62	74	856	310	236	81	319	536	530	87	136	248	174	211	99	118	81	87
64	77	883	320	243	83	330	554	547	90	141	256	179	218	102	122	83	90
66	79	911	330	251	86	340	571	564	92	145	264	185	224	106	125	86	92
68	82	938	340	258	88	350	588	581	95	150	272	190	231	109	129	88	95
70	84	966	350	266	91	361	606	599	98	154	280	196	238	112	133	91	98
73	88	1007	365	277	95	376	631	624	102	161	292	204	248	117	139	95	102
76	91	1049	380	289	99	391	657	650	106	167	304	213	258	122	144	99	106
78	94	1076	390	296	101	402	675	667	109	172	312	218	265	125	148	101	109
81	97	1118	405	308	105	417	701	693	113	178	324	227	275	130	154	105	113
84	101	1159	420	319	109	433	727	718	118	185	336	235	286	134	160	109	118
87	104	1201	435	331	113	448	753	744	122	191	348	244	296	139	165	113	122
90	108	1242	450	342	117	464	779	770	126	198	360	252	306	144	171	117	126
92	110	1270	460	350	120	474	796	787	129	202	368	258	313	147	175	120	129
95	114	1311	475	361	124	489	822	812	133	209	380	266	323	152	181	124	133
97	116	1339	485	369	126	500	839	829	136	213	388	272	330	155	184	126	136
100	120	1380	500	380	130	515	865	855	140	220	400	280	340	160	190	130	140
102	122	1408	510	388	133	525	882	872	143	224	408	286	347	163	194	133	143
105	126	1449	525	399	137	541	908	898	147	231	420	294	357	168	200	137	147
107	128	1477	535	407	139	551	926	915	150	235	428	300	364	171	203	139	150
111	133	1532	555	422	144	572	960	949	155	244	444	311	377	178	211	144	155
114	137	1573	570	433	148	587	986	975	160	251	456	319	388	182	217	148	160
117	140	1615	585	445	152	603	1012	1000	164	257	468	328	398	187	222	152	164
120	144	1656	600	456	156	618	1038	1026	168	264	480	336	408	192	228	156	168
122	146	1684	610	464	159	628	1055	1043	171	268	488	342	415	195	232	159	171
124	149	1711	620	471	161	639	1073	1060	174	273	496	347	422	198	236	161	174
127	152	1753	635	483	165	654	1099	1086	178	279	508	356	432	203	241	165	178
130	156	1794	650	494	169	670	1125	1112	182	286	520	364	442	208	247	169	182
132	158	1822	660	502	172	680	1142	1129	185	290	528	370	449	211	251	172	185
137	164	1891	685	521	178	706	1185	1171	192	301	548	384	466	219	260	178	192
142	170	1960	710	540	185	731	1228	1214	199	312	568	398	483	227	270	185	199
147	176	2029	735	559	191	757	1272	1257	206	323	588	412	500	235	279	191	206
152	182	2098	760	578	198	783	1315	1300	213	334	608	426	517	243	289	198	213
157	188	2167	785	597	204	809	1358	1342	220	345	628	440	534	251	298	204	220
162	194	2236	810	616	211	834	1401	1385	227	356	648	454	551	259	308	211	227

d= Nominal diameter of A – Link

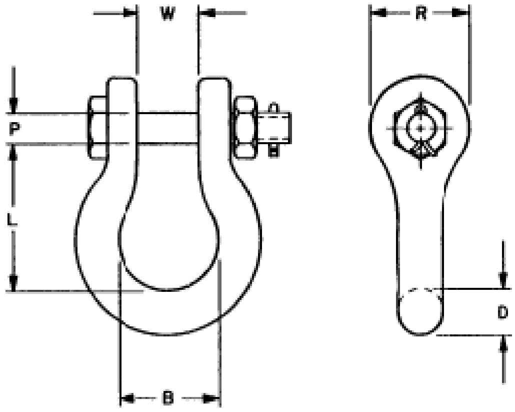
Ring Main Dimensions	
d (mm)	**A (mm)**
17-19	**21**
21-25	27
27-32	**33**
33-38	41
40-44	**48**
46-51	54
52-57	**60**
59-64	67
65-70	**73**
71-76	79
78-86	**89**
87-95	98
97-102	**108**

Ring



d= Nominal diameter of A – Link

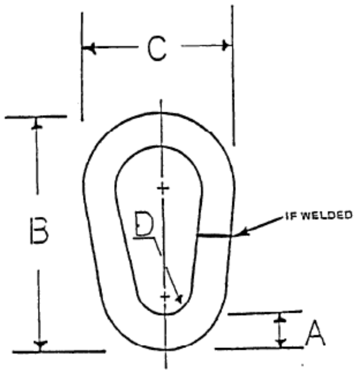
Buoy Shackle



Buoy Shackle Main Dimensions						
d (mm)	**W (mm)**	**P (mm)**	**R (mm)**	**L (mm)**	**D (mm)**	**B (mm)**
32	**53**	**36**	**78**	**122**	**33**	**85**
35	60	39	86	140	37	95
38	**64**	**42**	**94**	**152**	**40**	**102**
44	76	52	113	184	46	130
51	**86**	**59**	**130**	**203**	**52**	**150**
64	111	72	156	286	68	189
76	**133**	**85**	**169**	**349**	**78**	**205**
89	140	98	210	391	91	234
102	**146**	**111**	**235**	**387**	**104**	**260**

d= Nominal diameter of A – Link

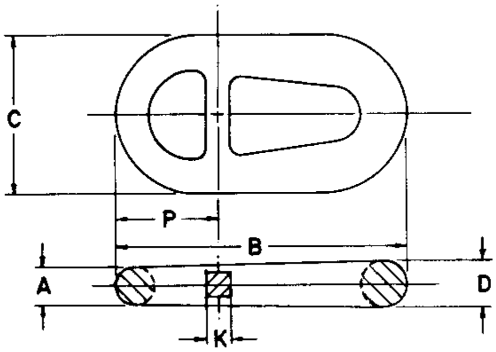
Pear Link



Pear Link Main Dimensions				
d (mm)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**
32	**34**	**273**	**142**	**26**
44	49	390	203	37
51	**58**	**468**	**244**	**44**
57	61	494	258	46
64	**68**	**546**	**285**	**51**
70	74	598	312	56
76	**81**	**645**	**339**	**61**
89	100	806	420	75
102	**109**	**883**	**460**	**83**

d= Nominal diameter of A – Link

C – Type Link



C - Type Link Main Dimensions						
d (mm)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**K (mm)**	**P (mm)**
19	**21**	**159**	**83**	**25**	**13**	**57**
22	24	184	92	29	16	65
25	**27**	**208**	**102**	**32**	**17**	**73**
30	30	229	114	35	19	86
32	**33**	**251**	**121**	**38**	**21**	**90**
35	38	292	152	44	25	108
38	**41**	**305**	**152**	**48**	**25**	**111**
41	44	335	162	51	29	117
44	**48**	**356**	**175**	**54**	**30**	**127**
48	51	397	187	57	32	130
51	**54**	**432**	**206**	**64**	**35**	**152**
54	54	432	206	64	35	152
57	**60**	**473**	**235**	**70**	**38**	**162**
60	60	473	235	70	38	162
64	**67**	**533**	**254**	**76**	**41**	**184**
67	67	533	254	76	41	184
70	**73**	**568**	**276**	**83**	**48**	**197**
73	73	568	276	83	48	197
76	**79**	**610**	**298**	**89**	**51**	**213**
83	89	724	343	102	60	241
86	**89**	**724**	**343**	**102**	**60**	**241**
89	102	791	381	114	67	275
95	**102**	**791**	**381**	**114**	**67**	**275**

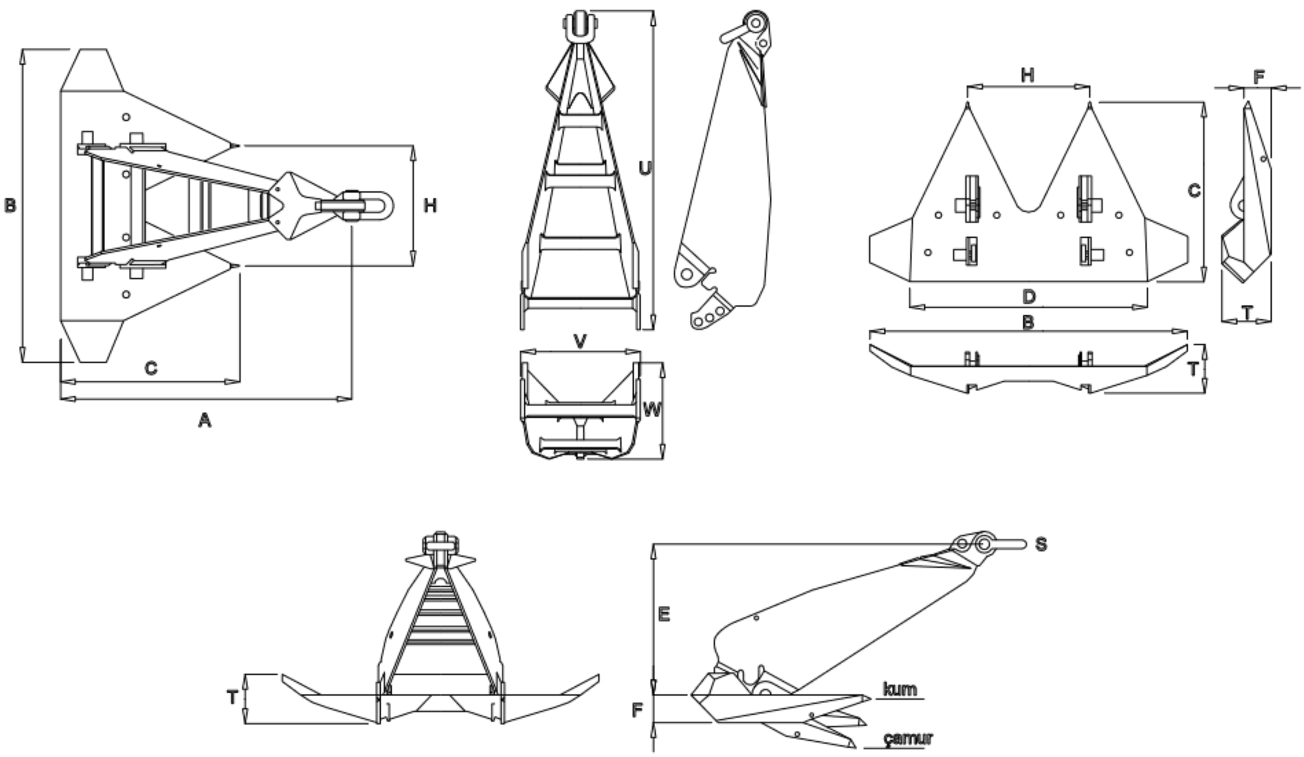
d= Nominal diameter of A – Link

APPENDIX B

Product List – Anchors

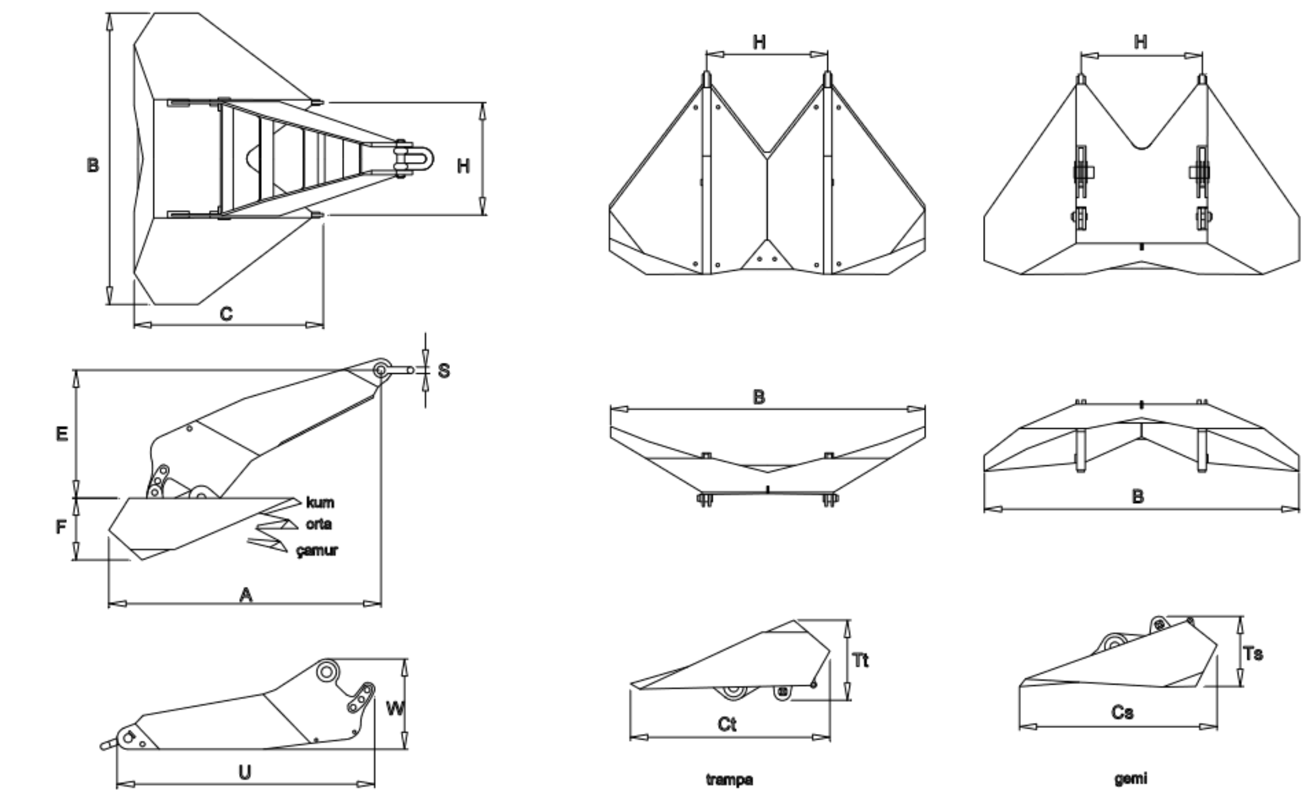
Terminology		
	Turkish	**English**
TLC – 1	Stevpris	Stevpris
TLC – 2	Yeni Jenerasyon Stevpris	New Generation Stevpris
TLC – 3	Stevshark	Stevshark
TLC – 4	Stevmanta	Stevmanta
TLC – 5	Stevin	Stevin
TLC – 6	Flipper Delta	Flipper Delta
TLC – 7	Danfort	Danfort
TLC – 8	LWT	LWT (US Navy Lightweight Type)
TLC – 9	Moorfast	Moorfast
TLC – 10	Stato	Stato
TLC – 11	AC 14	AC 14
TLC – 12	ABD Donanması Çiposuz	US Navy Stockless
TLC – 13	Baldt Çiposuz	Baldt Stockless
TLC – 14	Offdril 2	Offdril 2
TLC – 15	GS Tipi	GS Type
TLC – 16	Boss	Boss
TLC – 17	Snug Stowing	Snug Stowing
TLC – 18	Stevfix	Stevfix
TLC – 19	Stevfix + Çamur Adaptörü	Stevfix + Mud Adaptor
TLC – 20	Stevmud	Stevmud
TLC – 21	Stevdig	Stevdig
TLC – 22	Hook	Hook
TLC – 23	Mark 2	Mark 2 (Bruce SS)
TLC – 24	TS Tipi	TS Type (Bruce TS)

TLC – 1



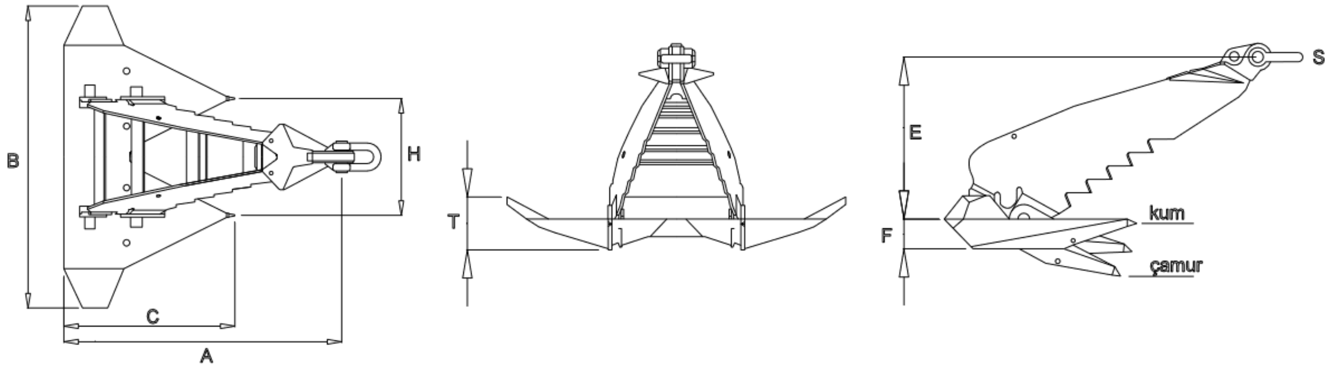
TLC – 1														
Anchor Weight (kg)	**Fluke Weight (kg)**	**Shank Weight (kg)**	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**E (mm)**	**F (mm)**	**H (mm)**	**T (mm)**	**S (mm)**	**U (mm)**	**V (mm)**	**W (mm)**
1500	**600**	**900**	**2954**	**3184**	**1812**	**2367**	**1505**	**271**	**1230**	**493**	**80**	**3294**	**1221**	**984**
3000	1300	1700	3721	4011	2283	2969	1896	342	1550	622	90	4141	1526	1240
5000	**2100**	**2900**	**4412**	**4756**	**2707**	**3529**	**2248**	**406**	**1837**	**738**	**110**	**4913**	**1817**	**1470**
8000	3400	4600	5161	5563	3166	4122	2629	474	2149	862	130	5747	2120	1719
10000	**4300**	**5700**	**5559**	**5992**	**3410**	**4442**	**2832**	**511**	**2315**	**929**	**140**	**6190**	**2285**	**1852**
12000	5200	6800	5908	6368	3624	4714	3010	543	2460	988	150	6578	2422	1968
15000	**6400**	**8600**	**6364**	**6860**	**3904**	**5087**	**3242**	**585**	**2650**	**1064**	**170**	**7090**	**2618**	**2120**
18000	7700	10300	6763	7290	4149	5407	3446	622	2816	1131	180	7533	2783	2253
20000	**8600**	**11400**	**7004**	**7550**	**4297**	**5609**	**3569**	**644**	**2917**	**1171**	**190**	**7806**	**2891**	**2334**
22000	9400	12600	7230	7794	4436	5799	3684	665	3011	1209	200	8060	2994	2409
25000	**10700**	**14300**	**7545**	**8133**	**4629**	**6035**	**3844**	**694**	**3142**	**1262**	**200**	**8406**	**3108**	**2514**
30000	12900	17100	8018	8643	4919	6431	4085	737	3339	1341	220	8936	3321	2671
65000	**27900**	**37100**	**10375**	**11184**	**6365**	**8322**	**5286**	**954**	**4321**	**1736**	**300**	**11563**	**4297**	**3456**

TLC – 2



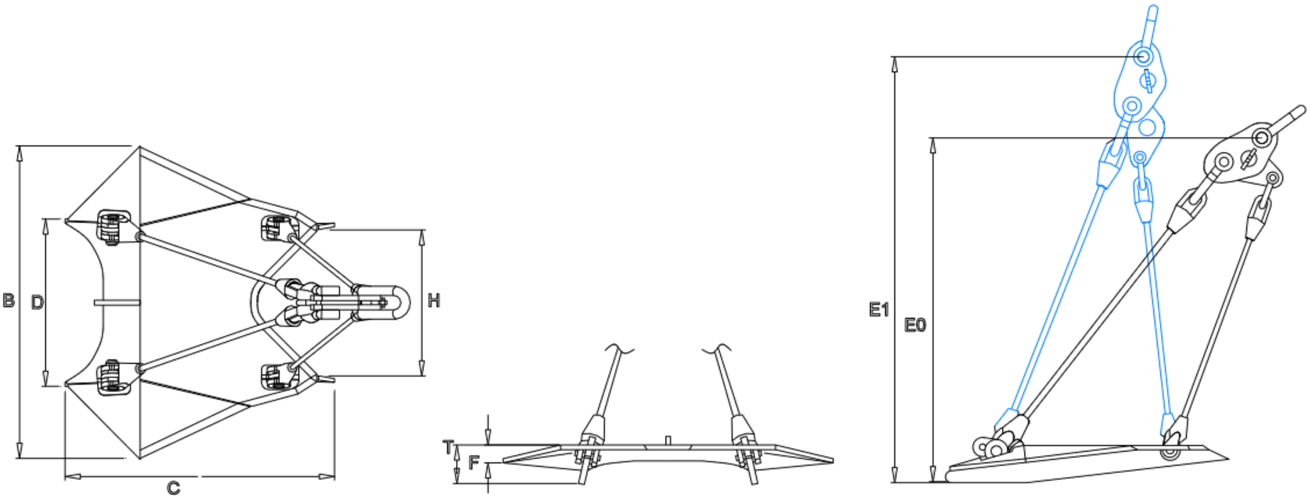
TLC – 2														
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**Ct (mm)**	**Cs (mm)**	**E (mm)**	**F (mm)**	**H (mm)**	**Tt (mm)**	**Ts (mm)**	**S (mm)**	**U (mm)**	**V (mm)**	**W (mm)**
1500	**2797**	**3059**	**1981**	**1980**	**1960**	**1321**	**641**	**1170**	**780**	**700**	**65**	**2790**	**1210**	**990**
3000	3523	3870	2495	2490	2470	1664	808	1490	980	880	80	3520	1540	1250
5000	**4178**	**4602**	**2958**	**2950**	**2930**	**1973**	**958**	**1781**	**1160**	**1040**	**100**	**4170**	**1830**	**1480**
8000	4886	5390	3460	3450	3430	2308	1120	2090	1360	1220	120	4880	2115	1730
10000	**5263**	**5807**	**3728**	**3720**	**3690**	**2486**	**1206**	**2253**	**1460**	**1310**	**130**	**5260**	**2320**	**1860**
12000	5593	6171	3961	3950	3920	2642	1282	2394	1550	1390	140	5590	2460	1980
15000	**6025**	**6679**	**4267**	**4260**	**4230**	**2846**	**1381**	**2610**	**1680**	**1500**	**160**	**6020**	**2690**	**2130**
18000	6402	7101	4534	4520	4490	3024	1468	2777	1780	1590	170	6400	2860	2270
20000	**6631**	**7368**	**4696**	**4690**	**4650**	**3132**	**1520**	**2890**	**1840**	**1650**	**180**	**6620**	**2970**	**2350**
22000	6845	7625	4848	4840	4800	3234	1569	3002	1900	1700	190	6840	3090	2420
25000	**7143**	**7962**	**5059**	**5050**	**5010**	**3374**	**1637**	**3138**	**1990**	**1780**	**200**	**7140**	**3230**	**2530**
30000	7591	8451	5376	5360	5320	3586	1740	3324	2110	1890	210	7580	3420	2690

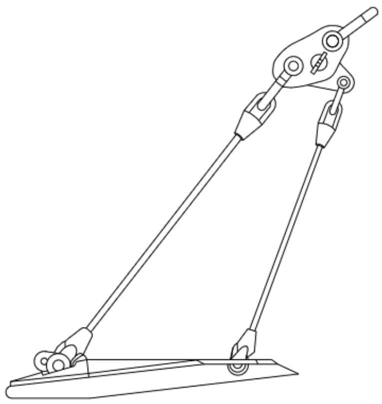
TLC – 3



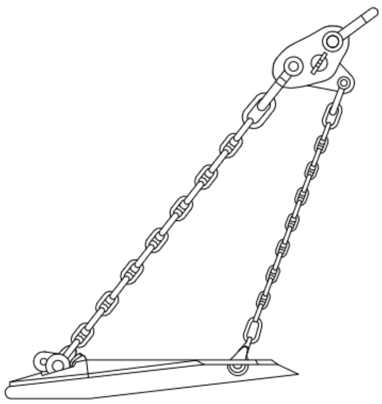
TLC – 3								
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**E (mm)**	**F (mm)**	**H (mm)**	**T (mm)**	**S (mm)**
1500	**2862**	**3085**	**1755**	**1458**	**263**	**1192**	**478**	**80**
3000	3605	3886	2212	1837	332	1502	603	90
5000	**4275**	**4608**	**2622**	**2178**	**393**	**1780**	**715**	**110**
8000	4999	5389	3067	2547	460	2082	836	130
10000	**5385**	**5805**	**3304**	**2743**	**495**	**2243**	**900**	**140**
12000	5723	6169	3511	2915	526	2383	957	150
15000	**6165**	**6645**	**3782**	**3140**	**567**	**2567**	**1031**	**160**
18000	6551	7062	4019	3337	602	2728	1095	170
20000	**6785**	**7314**	**4163**	**3457**	**624**	**2826**	**1135**	**180**
22000	7004	7550	4297	3568	644	2917	1171	190
25000	**7309**	**7879**	**4484**	**3723**	**672**	**3044**	**1222**	**200**
30000	7767	8373	4765	3957	714	3235	1299	210
65000	**10051**	**10834**	**6166**	**5120**	**924**	**4186**	**1681**	**300**

TLC – 4





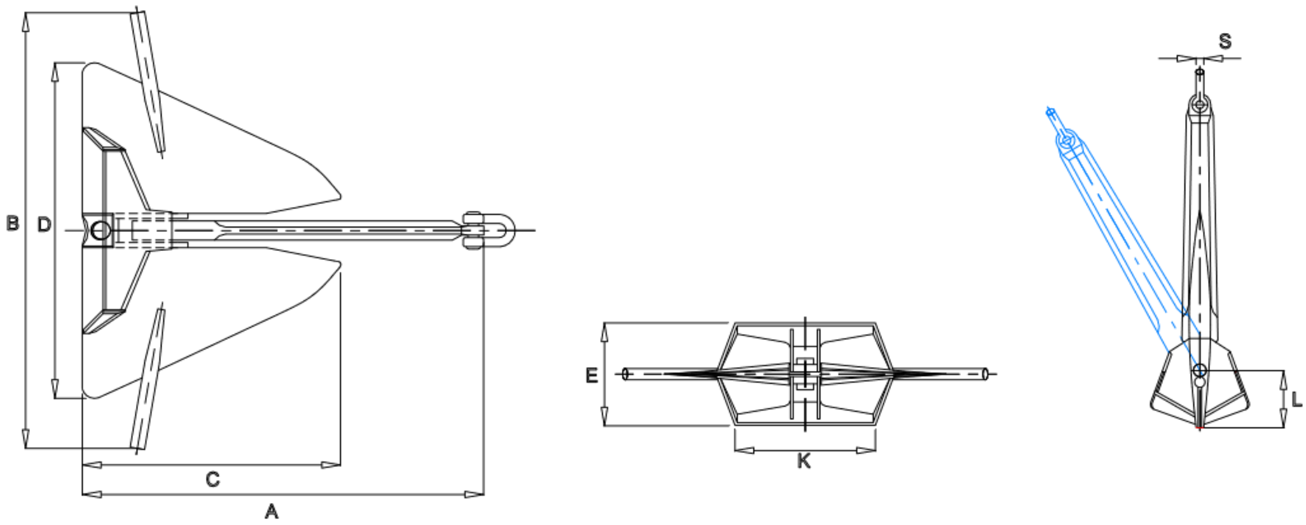
Stevmanta VLA -permanent



Stevmanta VLA -MODU

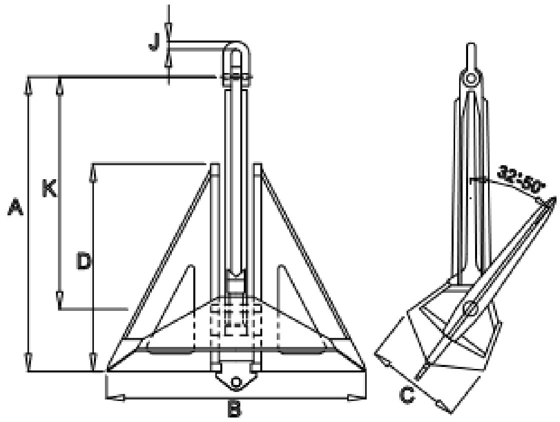
TLC – 4								
Area (m^2)	**B (mm)**	**C (mm)**	**D (mm)**	**E0 (mm)**	**E1 (mm)**	**F (mm)**	**H (mm)**	**T (mm)**
5	**3143**	**2976**	**1945**	**3075**	**3371**	**172**	**1459**	**639**
8	3975	3765	2460	3890	4264	217	1845	809
10	**4445**	**4209**	**2750**	**4349**	**4767**	**243**	**2063**	**904**
12	4869	4611	3013	4764	5222	266	2260	991
15	**5443**	**5155**	**3368**	**5326**	**5839**	**298**	**2527**	**1107**
17	5795	5488	3586	5670	6216	317	2690	1179
20	**6286**	**5953**	**3890**	**6150**	**6742**	**344**	**2918**	**1279**

TLC – 5



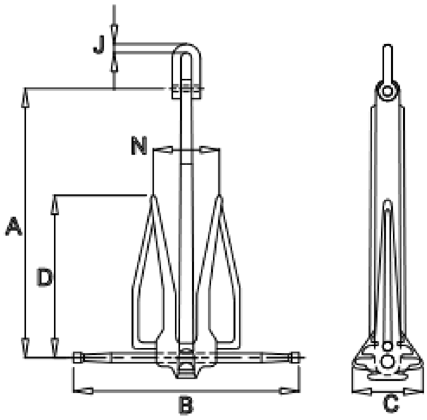
TLC – 5								
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**E (mm)**	**K (mm)**	**L (mm)**	**S (mm)**
1000	**2429**	**2654**	**1559**	**2023**	**737**	**1010**	**412**	**60**
1500	2774	3038	1785	2316	843	1156	471	65
3000	**3493**	**3828**	**2249**	**2918**	**1063**	**1456**	**594**	**80**
5000	4120	4538	2667	3460	1260	1727	704	80
7000	**4602**	**5077**	**2983**	**3871**	**1409**	**1932**	**788**	**90**
9000	5012	5521	3244	4209	1533	2100	857	100
12000	**5516**	**6076**	**3570**	**4632**	**1687**	**2312**	**943**	**110**
15000	5942	6545	3846	4990	1817	2490	1016	120
20000	**6372**	**6986**	**4100**	**5324**	**2048**	**2674**	**1083**	**160**
30000	7289	7997	4694	6094	2345	3061	1240	180

TLC – 6



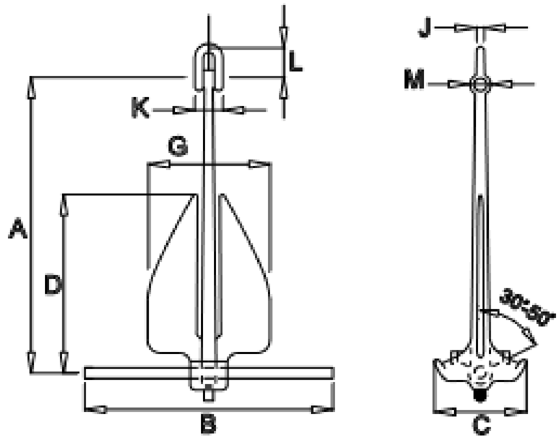
TLC – 6						
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**J (mm)**	**K (mm)**
299	**1380**	**1200**	**-**	**960**	**48**	**1080**
499	1726	1500	-	1200	52	1349
748	**1949**	**1700**	**-**	**1360**	**59**	**1530**
1000	2605	1960	740	1560	65	1680
1497	**2461**	**2140**	**-**	**1710**	**70**	**1926**
1996	2715	2361	-	1889	75	2126
2500	**3150**	**2660**	**1005**	**2130**	**79**	**2291**
2994	3105	2700	-	2161	90	2430
3992	**3424**	**2975**	**-**	**2380**	**100**	**2680**
5000	3945	3300	1260	2660	110	2926
6985	**4120**	**3580**	**-**	**2861**	**125**	**3219**
7500	4565	3850	1435	3080	-	-
10000	**5040**	**4270**	**1600**	**3400**	**140**	**3689**
12000	5335	4530	1705	3600	-	-
13494	**5120**	**4450**	**-**	**3561**	**149**	**4001**
15000	5735	4845	1830	3875	-	-
18008	**5636**	**4901**	**-**	**3920**	**160**	**4410**
20000	6405	5410	2010	4320	-	-
22498	**6090**	**5301**	**-**	**4240**	**170**	**4770**
27261	6499	5650	-	4520	179	5085
32500	**7320**	**6200**	**2310**	**4930**	**-**	**-**
40000	7850	6650	2480	5290	175	5720

TLC – 7



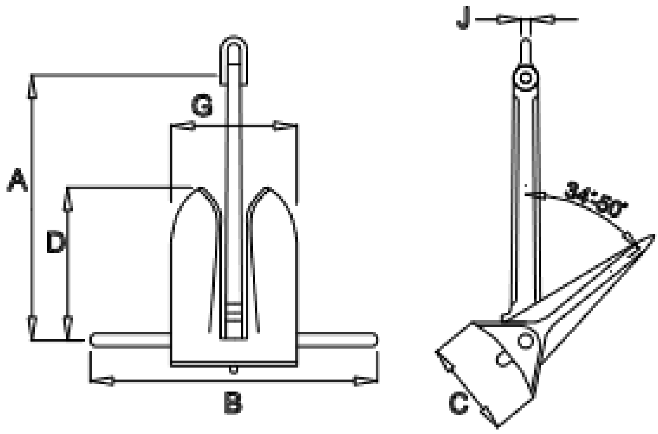
TLC – 7						
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**J (mm)**	**N (mm)**
91	**1334**	**1156**	**-**	**838**	**22**	**165**
227	1600	1384	-	1010	38	384
454	**1830**	**1580**	**410**	**1100**	**51**	**476**
907	2108	1822	-	1321	64	575
11340	**4710**	**4470**	**1195**	**2820**	**-**	**-**
1361	2388	2261	-	1499	76	365
1814	**2642**	**2508**	**-**	**1664**	**76**	**391**
2268	2780	2700	710	1650	86	457
2722	**2997**	**2845**	**-**	**1880**	**95**	**473**
3629	3277	3112	-	1965	105	514
4536	**3510**	**3330**	**890**	**2100**	**114**	**556**
5443	3730	3540	945	2240	121	584
6350	**3920**	**3720**	**995**	**2360**	**127**	**610**
7257	4100	4000	1040	2470	133	641
9072	**4370**	**4150**	**1110**	**2620**	**143**	**692**
11340	4710	4470	1195	2820	-	-
13608	**5000**	**4750**	**1270**	**3000**	**165**	**794**
15876	5258	4978	-	2997	165	838
18144	**5486**	**5207**	**-**	**3124**	**178**	**876**
22680	5893	5639	-	3378	191	953
27215	**6248**	**5969**	**-**	**3581**	**191**	**1016**
31751	6553	6274	-	3759	203	1067
36287	**6883**	**6579**	**-**	**3962**	**203**	**1118**
40823	7163	6833	-	4115	216	1168
45359	**7442**	**7112**	**-**	**4267**	**216**	**1219**

TLC – 8



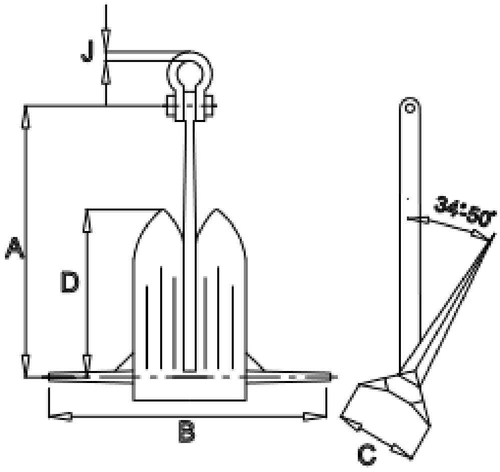
TLC – 8									
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**G (mm)**	**J(mm)**	**K(mm)**	**Lmm)**	**M(mm)**
45	**1054**	**1003**	**310**	**610**	**397**	**22**	**86**	**95**	**57**
68	1187	1130	348	686	441	25	102	140	60
91	**1207**	**1143**	**360**	**737**	**479**	**25**	**102**	**140**	**79**
113	1207	1143	370	737	479	25	102	140	79
136	**1346**	**1270**	**414**	**826**	**540**	**32**	**127**	**178**	**83**
159	1346	1270	424	826	533	32	127	178	83
181	**1461**	**1378**	**451**	**895**	**584**	**32**	**127**	**178**	**89**
204	1524	1435	467	933	610	32	127	178	95
227	**1562**	**1486**	**483**	**953**	**610**	**38**	**152**	**191**	**108**
340	1753	1638	540	1067	722	38	152	191	124
454	**1905**	**1803**	**622**	**1168**	**743**	**51**	**203**	**248**	**133**
907	2350	2159	762	1435	946	64	241	305	178
1361	**2756**	**2642**	**940**	**1676**	**1026**	**76**	**279**	**381**	**197**
1814	2946	2794	965	1803	1118	76	279	381	229
2268	**2997**	**2845**	**1003**	**1829**	**1137**	**89**	**318**	**432**	**241**
2722	3150	2997	1041	1930	1200	102	356	483	260
3175	**3150**	**2997**	**1041**	**1930**	**1200**	**102**	**356**	**483**	**260**
3629	3251	3073	1118	1981	1276	102	356	483	305
4082	**3378**	**3200**	**1149**	**2061**	**1327**	**102**	**356**	**483**	**318**
4536	3658	3480	1245	2235	1403	114	406	559	330
4989	**3658**	**3480**	**1245**	**2235**	**1403**	**114**	**406**	**559**	**330**
5443	3683	3518	1254	2264	1457	114	406	559	349
5897	**3912**	**3708**	**1324**	**2388**	**1530**	**127**	**445**	**610**	**368**
6350	3912	3708	1346	2388	1537	127	445	610	368
6804	**3988**	**3791**	**1473**	**2438**	**1572**	**127**	**445**	**610**	**378**
7257	4089	3874	1549	2496	1607	127	445	610	384
7711	**4166**	**3950**	**1422**	**2540**	**1651**	**127**	**445**	**610**	**394**
8165	4242	4026	1448	2591	1778	127	445	610	400
8618	**4321**	**4099**	**1473**	**2642**	**1753**	**140**	**508**	**635**	**406**
9072	4394	4166	1499	2692	1727	140	508	635	416
11340	**4851**	**4521**	**1708**	**2946**	**1905**	**140**	**508**	**673**	**406**
13608	5029	4801	1715	3073	1981	140	508	737	432
15876	**5283**	**5055**	**1803**	**3226**	**2083**	**152**	**533**	**775**	**457**
18144	5537	6096	1905	3327	2184	152	610	813	521
20412	**5766**	**6350**	**1981**	**3454**	**2261**	**159**	**660**	**838**	**559**
22680	5969	6604	2057	3581	2337	165	686	864	584
27215	**6350**	**7061**	**2184**	**3810**	**2464**	**165**	**737**	**914**	**610**
31751	6706	7366	2311	3988	2616	178	762	965	660
36287	**6985**	**7722**	**2413**	**4191**	**2718**	**191**	**787**	**1016**	**686**
40823	7290	8052	2515	4369	2845	203	838	1041	711

TLC – 9



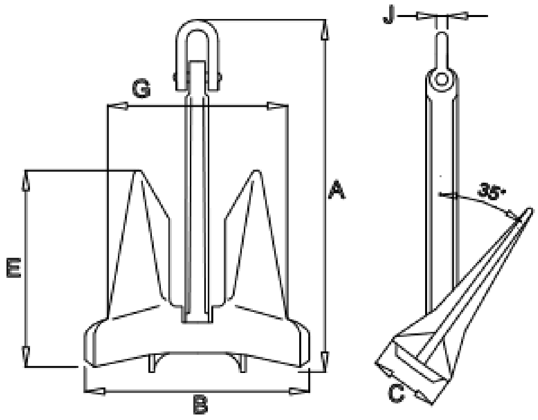
TLC – 9						
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**J (mm)**	**N (mm)**
454	**1549**	**1905**	**483**	**940**	**635**	**51**
1361	2235	2769	686	1372	940	76
2722	**2565**	**3632**	**787**	**1549**	**1067**	**102**
3629	3099	3886	965	1905	1295	102
4536	**3327**	**3988**	**1041**	**2032**	**1397**	**102**
5443	3531	4242	1092	2159	1473	102
6350	**3734**	**4496**	**1143**	**2286**	**1549**	**102**
7257	3886	4750	1219	2388	1626	127
9072	**4166**	**4978**	**1295**	**2591**	**1753**	**127**
13608	4801	5512	1499	2997	2007	127
18144	**5436**	**6299**	**1600**	**3226**	**2184**	**152**
22680	5639	6528	1676	3353	2261	152
27215	**5893**	**6883**	**1778**	**3556**	**2413**	**152**
31751	6198	6960	1854	3734	2540	152
36287	**6477**	**7569**	**1956**	**3912**	**2667**	**178**
40823	6756	7874	2032	4064	2769	178
45359	**6985**	**8128**	**2108**	**4216**	**2870**	**178**

TLC – 10



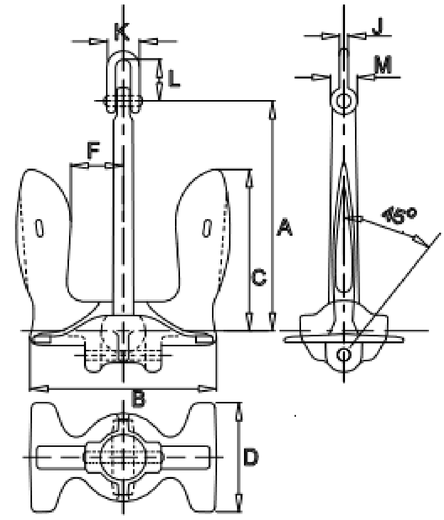
TLC – 10					
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**J (mm)**
91	**1067**	**1499**	**-**	**660**	**19**
1361	3277	2769	2769	1829	44
2722	**3658**	**3632**	**2632**	**2337**	**57**
4082	4064	4318	4318	2540	70
5443	**4724**	**5004**	**-**	**2870**	**76**
6804	5182	5690	1370	3200	89
9072	**5334**	**5842**	**1420**	**3277**	**95**
11340	5740	6248	1540	3480	102
13608	**5969**	**6528**	**1570**	**6223**	**127**
15876	6299	6883	1670	3886	133
18144	**6553**	**7188**	**1750**	**4064**	**140**
20412	6833	7493	-	4216	146
22680	**7036**	**7696**	**-**	**4343**	**152**
27215	7544	8128	2000	4572	152
31751	**7874**	**8534**	**-**	**4851**	**165**
36287	8179	8890	-	5080	165
40823	**8763**	**9296**	**-**	**5232**	**178**
45359	8890	9652	-	5486	191

TLC – 11



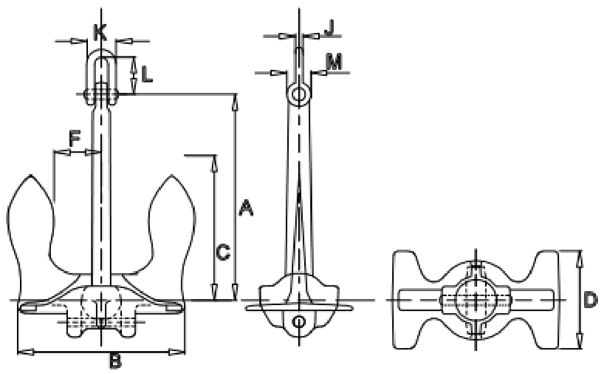
TLC – 11						
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**E (mm)**	**G (mm)**	**J (mm)**
1293	**2718**	**1549**	**483**	**1067**	**991**	**68**
1588	2921	1676	508	1143	1041	75
2109	**3200**	**1829**	**559**	**1245**	**1143**	**81**
2449	3378	1930	584	1321	1219	86
3062	**3632**	**2083**	**610**	**1422**	**1321**	**92**
4309	4089	2337	711	1600	1473	103
4899	**4267**	**2438**	**737**	**1651**	**1524**	**106**
5602	4470	2540	762	1753	1600	113
6441	**4674**	**2692**	**787**	**1829**	**1676**	**117**
8301	5080	2921	864	1981	1829	129
9299	**5283**	**3023**	**889**	**2057**	**1905**	**133**
10501	5512	3150	940	2134	1981	138
13494	**5969**	**3429**	**1016**	**2337**	**2159**	**151**
16896	6452	3683	1092	2515	2311	162
18801	**6680**	**3810**	**1143**	**2591**	**2388**	**168**
20003	6807	3912	1168	2667	2438	171
22997	**7137**	**4089**	**1219**	**2769**	**2565**	**179**

TLC – 12



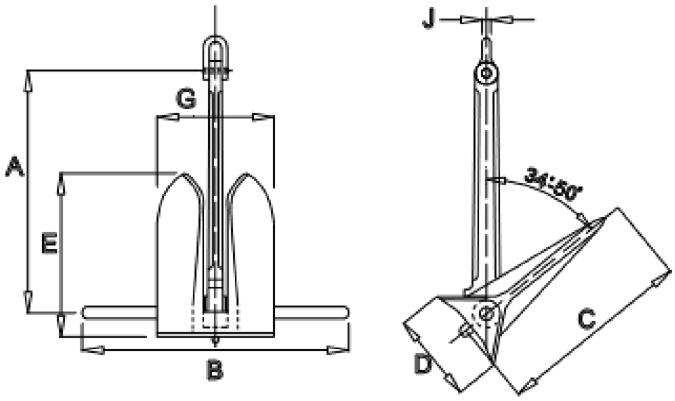
TLC – 12									
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**F (mm)**	**J(mm)**	**K(mm)**	**Lmm)**	**M(mm)**
136	**727**	**562**	**516**	**349**	**164**	**29**	**102**	**152**	**89**
181	800	619	568	384	176	32	111	173	98
227	**864**	**667**	**612**	**413**	**191**	**33**	**119**	**160**	**105**
272	914	709	651	439	202	37	127	168	111
363	**779**	**779**	**716**	**483**	**222**	**40**	**141**	**186**	**124**
454	1072	841	772	521	239	43	152	202	133
544	**1153**	**892**	**819**	**552**	**254**	**48**	**162**	**208**	**140**
590	1178	914	841	568	261	44	162	221	144
680	**1372**	**962**	**883**	**597**	**273**	**51**	**175**	**229**	**152**
816	1321	1022	938	633	291	52	186	243	162
907	**1372**	**1059**	**972**	**656**	**302**	**54**	**192**	**252**	**165**
998	1372	1092	1003	676	311	56	198	260	171
1134	**1600**	**1140**	**1048**	**706**	**324**	**57**	**208**	**273**	**183**
1361	1854	1270	1130	775	352	60	216	286	191
1588	**1629**	**1273**	**1171**	**789**	**363**	**64**	**227**	**305**	**200**
1814	1724	1334	1225	827	379	68	243	318	227
2268	**2032**	**1437**	**1319**	**889**	**408**	**73**	**260**	**343**	**232**
2722	1956	1529	1403	948	435	78	278	364	244
3175	**2159**	**1607**	**1475**	**997**	**458**	**81**	**292**	**384**	**252**
3629	2159	1680	1543	1041	479	86	305	400	264
4082	**2238**	**1746**	**1603**	**1083**	**498**	**89**	**318**	**416**	**275**
4536	2515	1810	1661	1121	516	92	329	432	335
4989	**2413**	**1868**	**1715**	**1159**	**531**	**95**	**340**	**445**	**298**
5443	2464	1924	1765	1194	548	98	349	457	302
5897	**2718**	**1965**	**1805**	**1184**	**559**	**100**	**359**	**467**	**313**
6350	2642	2048	1880	1270	573	105	371	487	327
6804	**2667**	**2089**	**1911**	**1295**	**587**	**108**	**381**	**498**	**330**
7257	2719	2117	1943	1311	602	108	384	505	337
8165	**3124**	**2200**	**2021**	**1365**	**625**	**111**	**400**	**524**	**351**
9072	2946	2280	2094	1413	648	114	413	545	364
10206	**3048**	**2370**	**2176**	**1468**	**674**	**121**	**432**	**565**	**378**
11340	3200	2456	2256	1522	699	127	446	583	392
13608	**3353**	**2608**	**2394**	**1616**	**742**	**133**	**475**	**621**	**416**
15876	3550	3505	2523	1703	781	140	500	654	438
18144	**3785**	**2872**	**2619**	**1778**	**819**	**143**	**511**	**689**	**451**
20412	3861	2988	2743	1851	849	152	543	711	476
27215	**4775**	**3194**	**3375**	**2218**	**967**	**191**	**622**	**737**	**521**

TLC – 13



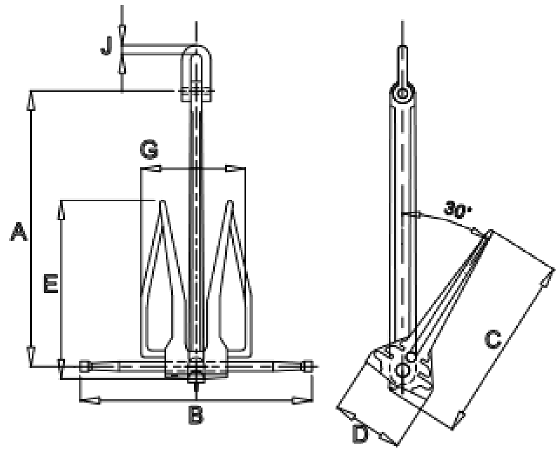
TLC – 13									
Anchor Weight (kg)	A (mm)	B (mm)	C (mm)	D (mm)	F (mm)	J(mm)	K(mm)	Lmm)	M(mm)
91	686	457	384	241	130	25	127	140	102
136	813	591	437	297	170	25	127	140	114
181	813	654	483	330	178	25	127	140	114
227	889	673	508	356	178	32	152	178	140
318	965	749	597	397	206	32	152	178	146
352	965	813	629	429	219	32	152	178	146
408	1067	813	610	432	229	38	165	191	165
454	1067	854	638	457	248	38	165	191	165
572	1168	924	721	476	251	44	191	216	171
649	1245	991	733	508	273	51	216	248	178
699	1245	1016	775	521	279	51	216	248	178
726	1245	1016	775	521	279	51	216	248	178
794	1321	1054	845	533	289	51	216	248	184
850	1321	1092	883	559	305	51	216	248	184
885	1321	1092	883	559	305	51	216	248	184
953	1473	1137	848	584	308	51	216	248	191
1134	1473	1137	848	591	308	51	216	248	191
1270	1473	1219	911	635	330	51	216	248	191
1361	1626	1194	914	648	324	64	254	305	222
1588	1626	1340	1003	699	362	64	254	305	222
1814	1794	1353	997	699	368	64	254	305	241
2041	1794	1441	1067	737	381	89	254	305	241
2268	1930	1461	1067	762	397	76	305	381	260
2722	1930	1613	1194	845	438	76	305	381	260
2858	1930	1613	1194	845	438	76	305	381	260
2948	2083	1613	1210	838	438	76	305	381	273
3062	2083	1651	1238	857	448	76	305	381	273
3175	2083	1692	1264	883	457	76	305	381	273
3447	2083	1715	1264	883	467	76	305	381	273
3674	2375	1683	1241	870	464	89	337	432	305
3901	2375	1740	1283	908	470	89	337	432	305
4082	2438	1784	1314	924	486	89	337	432	305
4536	2438	1918	1473	991	533	102	375	483	305
4989	2438	1918	1473	991	533	102	375	483	305
5443	2438	1949	1473	1016	527	102	375	483	305
5897	2489	1949	1473	1016	527	102	375	483	305
6350	2616	2045	1524	1118	565	102	375	483	330
6804	2616	2184	1651	1168	610	102	375	483	330
7257	2743	2184	1651	1168	610	102	375	483	330
8165	2845	2242	1667	1226	629	114	425	559	330
8573	2845	2242	1667	1226	629	114	425	559	330
9072	2845	2438	1829	1270	660	114	425	559	356
11340	3048	2616	1969	1365	711	114	425	559	381
13608	3200	2794	2096	1454	759	127	476	610	406
15876	3429	2946	2210	1524	800	127	483	635	432
18144	3556	3073	2311	1600	813	140	508	660	445
20412	3734	3200	2388	1651	864	140	533	686	457
22680	3861	3327	2515	1727	889	152	546	711	483

TLC – 14



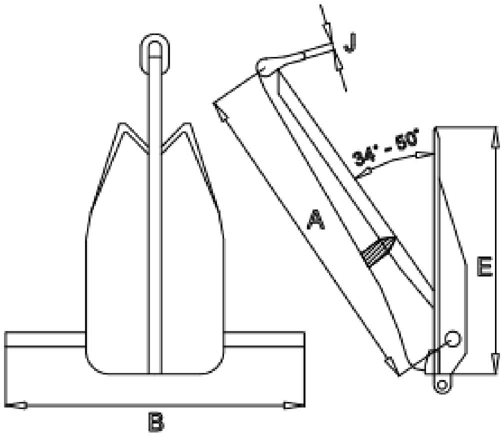
TLC – 14							
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**E (mm)**	**G(mm)**	**J(mm)**
227	**1205**	**1330**	**725**	**395**	**864**	**495**	**38**
454	1518	1673	914	498	1089	625	51
680	**1768**	**2119**	**1051**	**549**	**1248**	**740**	**51**
907	1949	2340	1148	606	1381	813	64
1134	**2099**	**2519**	**1251**	**651**	**1486**	**875**	**64**
1361	2229	2654	1330	679	1559	930	76
1588	**2350**	**2819**	**1400**	**730**	**1664**	**979**	**76**
1814	2499	2924	1461	800	1740	1019	76
2041	**2553**	**3064**	**1521**	**829**	**1803**	**1064**	**79**
2268	2645	3175	1575	860	1870	1100	86
2722	**2813**	**3375**	**1676**	**870**	**1991**	**1168**	**102**
3175	2950	3540	1753	914	2089	1230	102
3629	**3096**	**3889**	**1842**	**959**	**2191**	**1289**	**105**
4536	3335	4001	1984	1035	2359	1391	114
5443	**3540**	**4248**	**2108**	**1095**	**2499**	**1473**	**124**
6350	3731	4499	2219	1156	2638	1556	130
6804	**3900**	**4750**	**2219**	**1197**	**2638**	**1556**	**130**
7257	3900	4750	2318	1207	2759	1626	130
9072	**4201**	**4899**	**2496**	**1359**	**2975**	**1749**	**143**
11340	4524	5166	2680	1486	3127	1873	156
13608	**4810**	**5334**	**2858**	**1565**	**3404**	**2000**	**165**
15422	4899	5390	2953	1610	3515	2070	171
18144	**5120**	**5636**	**3089**	**1686**	**3673**	**2165**	**181**
20412	5331	5864	3213	1749	3824	2249	181
22680	**5601**	**6150**	**3359**	**1842**	**4001**	**2365**	**200**
27215	5936	6534	3569	1956	4250	2515	216
31751	**6236**	**6858**	**3753**	**2054**	**4470**	**2645**	**216**

TLC – 15



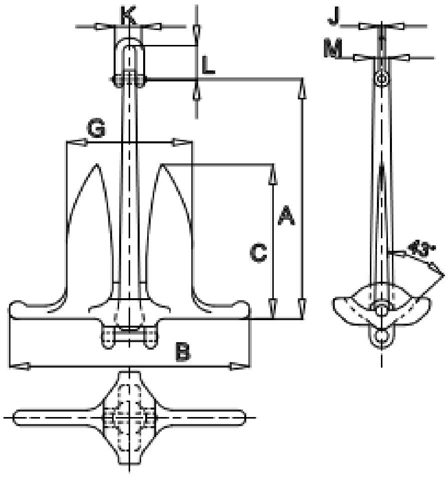
TLC – 15							
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**E (mm)**	**G(mm)**	**Jmm)**
34	**1159**	**1003**	**700**	**203**	**730**	**419**	**13**
45	1207	1041	721	221	749	440	16
68	**1245**	**1080**	**759**	**229**	**800**	**479**	**19**
91	1334	1156	819	248	870	521	25
136	**1422**	**1232**	**870**	**279**	**905**	**591**	**30**
181	1480	1321	921	300	956	625	35
227	**1600**	**1384**	**970**	**321**	**1030**	**660**	**38**
340	1715	1486	1040	370	1110	721	38
454	**1829**	**1581**	**1110**	**411**	**1181**	**760**	**51**
680	1956	1689	1168	479	1230	810	51
907	**2108**	**1822**	**1270**	**530**	**1351**	**910**	**64**
1134	2261	2146	1349	559	1440	930	64
1361	**2388**	**2267**	**1499**	**600**	**1610**	**991**	**75**
1588	2540	2416	1600	640	1715	1021	75
1814	**2642**	**2500**	**1661**	**660**	**1781**	**1049**	**76**
2041	2740	2600	1726	686	1884	1100	79
2268	**2845**	**2700**	**1791**	**711**	**1930**	**1149**	**86**
2722	2997	2861	1880	759	2029	1210	102
3175	**3124**	**2959**	**1970**	**791**	**2140**	**1260**	**102**
3629	3277	3119	2061	830	2229	1321	105
4536	**3505**	**3219**	**2464**	**889**	**2391**	**1421**	**114**
5443	3785	3721	2245	960	2470	1519	125
6350	**3861**	**3861**	**2289**	**979**	**2519**	**1561**	**130**
7257	4061	4059	2561	1010	2840	1649	133
9072	**4359**	**4140**	**2619**	**1110**	**2921**	**1770**	**143**
11340	4689	4399	2815	1194	3140	1905	149
13608	**5321**	**4759**	**3040**	**1280**	**3350**	**2040**	**165**
15876	5601	5004	3200	1349	3570	2149	170
18144	**5855**	**5182**	**3345**	**1410**	**3731**	**2245**	**181**
20412	6083	5440	3480	1465	3880	2335	181
22680	**6306**	**5634**	**3604**	**1519**	**4020**	**2419**	**200**
27215	6699	5990	3724	1614	4270	2575	216
31751	**7055**	**6304**	**3920**	**1699**	**4496**	**2710**	**206**

TLC – 16



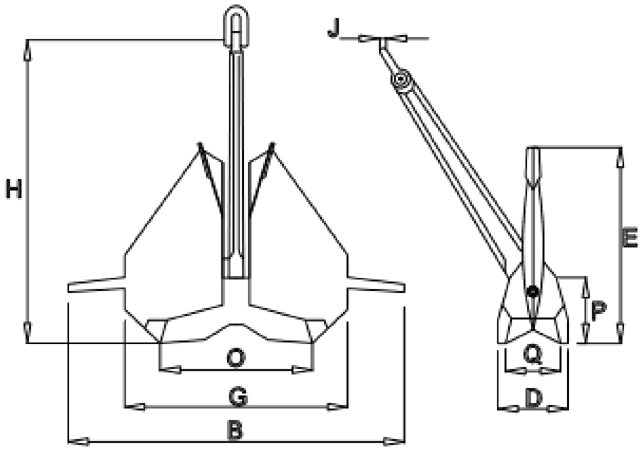
TLC – 16					
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**E (mm)**	**J (mm)**	**Tırnak Alanı (m^2)**
454	**1803**	**1753**	**1346**	**35**	**0.725**
2268	3150	3048	2337	51	2.193
4536	**3937**	**3810**	**2946**	**76**	**3.400**
6350	4547	4267	3302	89	4.311
9525	**5029**	**4877**	**3759**	**114**	**5.630**
13608	5664	5486	4242	127	7.126
18144	**6299**	**6096**	**4699**	**127**	**8.789**

TLC – 17



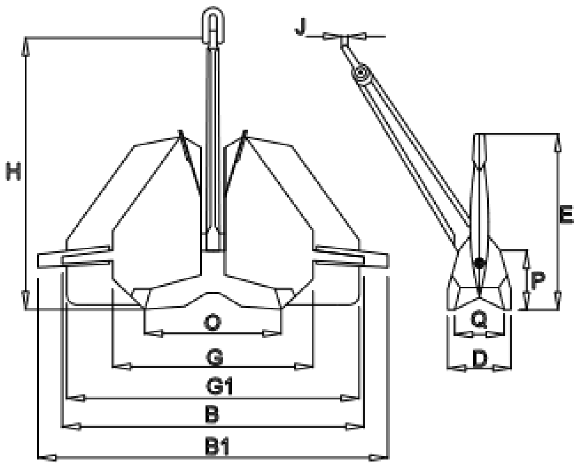
TLC – 17									
Anchor Weight (kg)	**A (mm)**	**B (mm)**	**C (mm)**	**D (mm)**	**G (mm)**	**J(mm)**	**K(mm)**	**Lmm)**	**M(mm)**
91	**784**	**754**	**511**	**306**	**411**	**25**	**102**	**140**	**70**
113	846	813	551	330	443	25	102	140	76
136	**897**	**864**	**584**	**349**	**470**	**25**	**102**	**140**	**86**
159	945	908	616	368	495	25	102	140	86
181	**987**	**949**	**645**	**387**	**518**	**25**	**102**	**140**	**89**
204	1026	987	670	400	537	25	102	140	86
227	**1060**	**1022**	**692**	**416**	**556**	**32**	**124**	**178**	**95**
340	1219	1168	794	476	638	32	124	191	111
454	**1340**	**1289**	**873**	**524**	**702**	**38**	**137**	**191**	**121**
907	1689	1626	1099	660	886	51	197	248	152
1361	**1930**	**1854**	**1257**	**752**	**1010**	**64**	**235**	**305**	**175**
1814	2127	2045	1384	832	1114	64	235	305	191
2268	**2296**	**2203**	**1492**	**895**	**1200**	**76**	**273**	**381**	**206**
2722	2438	2340	1588	953	1276	76	273	381	213
3175	**2565**	**2464**	**1670**	**1003**	**1343**	**76**	**273**	**381**	**232**
3629	2686	2578	1727	1048	1407	76	273	381	241
4082	**2794**	**2680**	**1816**	**1092**	**1461**	**89**	**305**	**432**	**254**
4536	2889	2775	1880	1130	1511	89	305	432	260
4989	**2985**	**2867**	**1943**	**1162**	**1562**	**102**	**340**	**483**	**267**
5443	3067	2946	1997	1197	1607	102	340	483	257
5897	**3150**	**3026**	**2051**	**1229**	**1648**	**102**	**340**	**483**	**283**
6350	3232	3105	2102	1260	1692	102	340	483	292
6804	**3302**	**3175**	**2149**	**1289**	**1727**	**102**	**340**	**483**	**298**
7257	3385	3251	2203	1321	1772	102	340	483	305
7711	**3454**	**3315**	**2248**	**1349**	**1807**	**102**	**340**	**483**	**311**
8165	3524	3381	2292	1375	1842	114	400	559	318
8618	**3581**	**3442**	**2334**	**1397**	**1876**	**114**	**400**	**559**	**324**
9072	3639	3496	2369	1422	1905	114	400	559	327
11340	**3912**	**3759**	**2553**	**1530**	**2051**	**114**	**400**	**559**	**352**
13608	4166	4001	2711	1629	2184	127	451	610	375
18144	**4572**	**4394**	**2972**	**1778**	**2388**	**140**	**483**	**660**	**406**
22680	4953	4750	3200	1930	2591	152	508	711	457
27215	**5232**	**5004**	**3404**	**2032**	**2743**	**152**	**559**	**762**	**483**
31751	5537	5283	3556	2159	2870	165	584	813	508
36287	**5766**	**5537**	**3708**	**2261**	**3048**	**165**	**610**	**838**	**533**
40823	5994	5740	3886	2337	3200	178	660	889	559
45359	**6198**	**5944**	**4013**	**2413**	**3302**	**178**	**686**	**914**	**584**

TLC – 18



TLC – 18									
Anchor Weight (kg)	**B (mm)**	**D(mm)**	**E (mm)**	**G (mm)**	**H (mm)**	**J(mm)**	**O(mm)**	**P(mm)**	**Q(mm)**
998	**2896**	**635**	**1676**	**1930**	**2515**	**65**	**1346**	**203**	**483**
1497	3327	711	1905	2210	2870	75	1549	229	533
2994	**4191**	**914**	**2388**	**2769**	**3607**	**90**	**1930**	**279**	**686**
4989	4953	1092	2845	3302	4293	100	2311	330	813
6985	**5537**	**1194**	**3175**	**3683**	**4801**	**121**	**2565**	**381**	**914**
9004	6020	1321	3454	4013	5207	130	2794	406	991
11997	**6629**	**1448**	**3810**	**4420**	**5740**	**140**	**3073**	**457**	**1092**
15014	7137	1549	4115	4750	6198	149	3327	483	1168
20003	**7849**	**1702**	**4521**	**5232**	**6807**	**170**	**3658**	**533**	**1295**
30005	9017	1956	5182	5994	7798	200	4191	635	1473

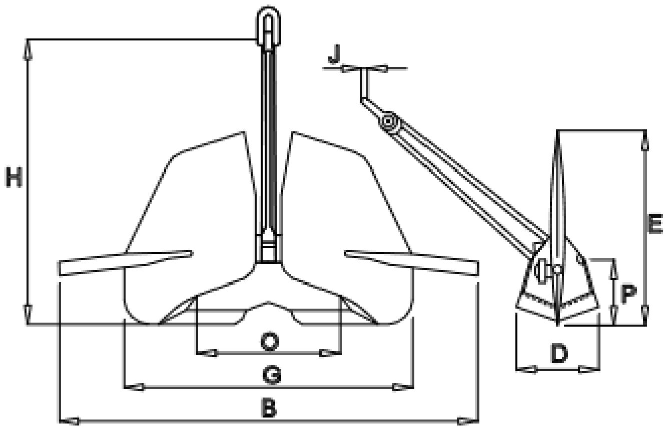
TLC – 19



TLC – 19											
Anchor Weight (kg)	**B (mm)**	**B1(mm)**	**D (mm)**	**E (mm)**	**G (mm)**	**G1(mm)**	**H (mm)**	**J(mm)**	**O(mm)**	**P(mm)**	**Q(mm)**
998	**3048**	**3861**	**737**	**1676**	**1930**	**2489**	**2489**	**65**	**1245**	**610**	**483**
1497	3505	4394	838	1905	2210	2845	2845	75	1422	686	533
2994	**4394**	**5537**	**1067**	**2388**	**2769**	**3581**	**3556**	**90**	**1778**	**864**	**686**
4989	5207	6579	1245	2845	3277	4267	4242	100	2108	1016	813
6985	**5842**	**7366**	**1397**	**3175**	**3683**	**4775**	**4750**	**121**	**2362**	**1143**	**914**
9004	6350	8001	1524	3454	3988	5182	5156	130	2565	1245	991
11997	**6985**	**8814**	**1676**	**3810**	**4394**	**5715**	**5664**	**140**	**2845**	**1372**	**1092**
15014	7518	9500	1803	4115	4724	6147	6121	149	3048	1473	1168
20003	**8280**	**10465**	**1981**	**4521**	**5207**	**6782**	**6706**	**170**	**3353**	**1626**	**1295**
30005	9449	11963	2261	5182	5969	7747	7696	200	3835	1854	1473

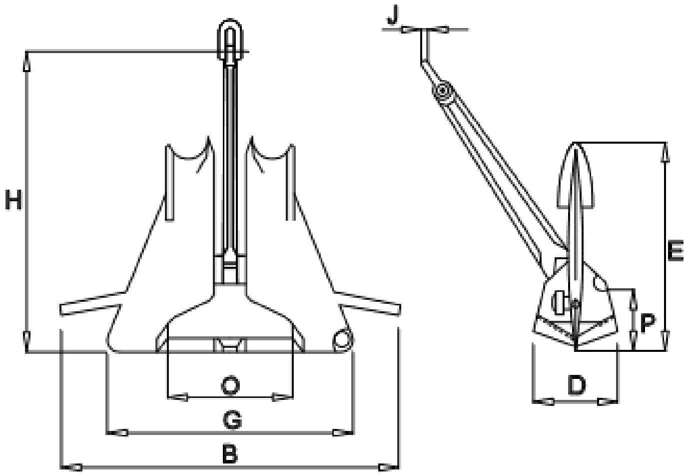
* The anchor weight does not include the adaptor weight. The total weight together with the adaptor is approximately %140 of the anchor weight given above.

TLC – 20



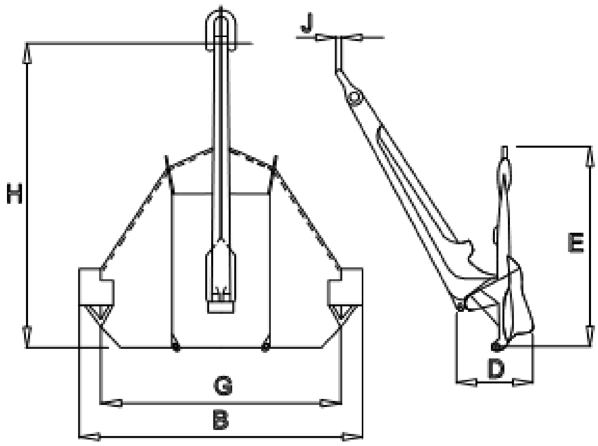
TLC – 20								
Anchor Weight (kg)	**B (mm)**	**D(mm)**	**E (mm)**	**G (mm)**	**H (mm)**	**J(mm)**	**O(mm)**	**P(mm)**
998	**3556**	**762**	**1651**	**2362**	**2388**	**65**	**1448**	**559**
2994	5131	1092	2388	3429	3429	90	2083	813
4989	**6071**	**1295**	**2819**	**4064**	**4064**	**100**	**2464**	**991**
6985	6782	1448	3150	4547	4547	121	2743	1092
9004	**7391**	**1575**	**3429**	**4928**	**4928**	**130**	**2997**	**1194**
11997	8128	1727	3785	5436	5436	140	3302	1321
15014	**8763**	**1854**	**4064**	**5842**	**5842**	**149**	**3556**	**1422**
20003	9627	2057	4470	6426	6426	170	3912	1549
30005	**11024**	**2362**	**5131**	**7366**	**7366**	**200**	**4470**	**1778**

TLC – 21



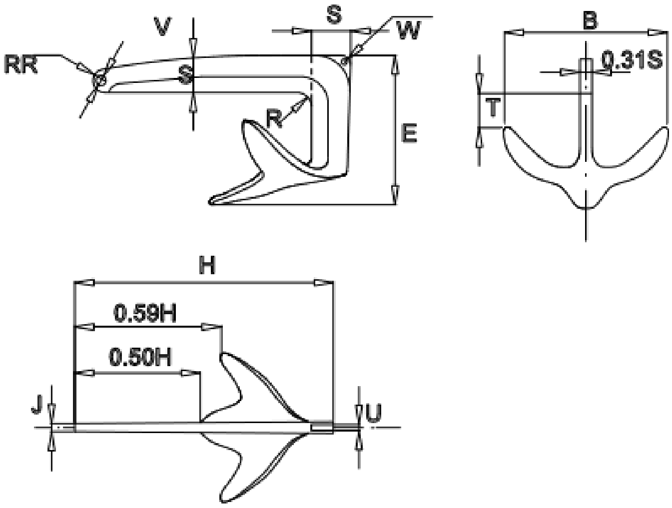
TLC – 21								
Anchor Weight (kg)	**B (mm)**	**D(mm)**	**E (mm)**	**G (mm)**	**H (mm)**	**J(mm)**	**O(mm)**	**P(mm)**
998	**2642**	**762**	**1549**	**1930**	**2311**	**65**	**965**	**406**
1497	3023	864	1778	2210	2642	75	1092	483
2994	**3810**	**1092**	**2235**	**2769**	**3327**	**90**	**1397**	**584**
4989	4521	1270	2642	3302	3937	100	1651	711
7076	**5055**	**1422**	**2946**	**3683**	**4420**	**121**	**1829**	**787**
9004	5512	1549	3226	3988	4801	130	2007	864
11997	**6045**	**1727**	**3531**	**4547**	**5283**	**140**	**2210**	**940**
15014	6528	1854	3810	4750	5690	149	2362	1016
20003	**7163**	**2032**	**4191**	**5232**	**6274**	**170**	**2616**	**1118**
30005	8204	2337	4801	5969	7163	200	2997	1295

TLC – 22



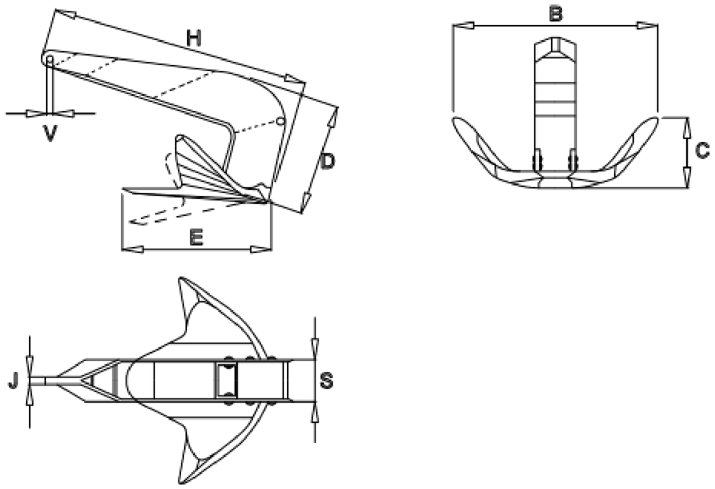
TLC – 22						
Anchor Weight (kg)	**B (mm)**	**D(mm)**	**E (mm)**	**G (mm)**	**H (mm)**	**J(mm)**
10002	**5461**	**1295**	**3937**	**4623**	**5944**	**140**
12496	5893	1372	4242	4978	6401	149
15014	**6248**	**1473**	**4521**	**5309**	**6807**	**160**
20003	6883	1626	4953	5842	7493	179
24993	**7417**	**1753**	**5334**	**6299**	**8077**	**191**
30005	7874	1854	5690	6680	8560	205
34994	**8306**	**1956**	**5969**	**7036**	**9017**	**214**
40007	8687	2032	6248	7366	9423	225
50008	**9347**	**2184**	**6731**	**7925**	**10160**	**244**
60010	9931	2337	7163	8433	10795	260

TLC – 23



TLC – 23											
Anchor Weight (kg)	**B (mm)**	**E(mm)**	**H (mm)**	**J (mm)**	**R (mm)**	**RR(mm)**	**S(mm)**	**T(mm)**	**U(mm)**	**V(mm)**	**W(mm)**
998	**1626**	**1346**	**2388**	**64**	**203**	**71**	**356**	**330**	**52**	**54**	**46**
1996	2057	1702	3023	84	254	90	432	432	60	67	54
2994	**2362**	**1930**	**3454**	**92**	**292**	**105**	**508**	**483**	**70**	**75**	**60**
6509	3073	2540	4521	125	381	137	660	635	92	100	75
9004	**3378**	**2794**	**5004**	**140**	**419**	**151**	**737**	**686**	**92**	**114**	**75**

TLC – 24



TLC – 24								
Anchor Weight (kg)	**B (mm)**	**C (mm)**	**D (mm)**	**E (mm)**	**H (mm)**	**J(mm)**	**S(mm)**	**Vmm)**
249	**1321**	**457**	**686**	**965**	**1651**	**52**	**267**	**37**
499	1651	559	864	1219	2057	62	330	46
75	**1854**	**635**	**940**	**1372**	**2311**	**62**	**368**	**46**
998	2032	686	1067	1499	2540	75	406	52
1497	**2337**	**787**	**1270**	**1702**	**2921**	**87**	**470**	**59**
1996	2565	864	1346	1880	3200	100	521	65
2495	**2769**	**940**	**1448**	**2032**	**3454**	**110**	**559**	**75**
2994	2946	991	1549	2159	3683	110	591	75
3992	**3226**	**1092**	**1702**	**2362**	**4039**	**122**	**648**	**81**
4989	3480	1168	1829	2565	4369	125	699	87
7008	**3886**	**1321**	**2057**	**2870**	**4877**	**149**	**787**	**100**
9004	4242	1422	2235	3099	5309	160	851	113
11997	**4674**	**1575**	**2464**	**3429**	**5842**	**160**	**940**	**113**
14991	5029	1702	2642	3683	6299	160	1010	113
20003	**5537**	**1880**	**2921**	**4064**	**6934**	**173**	**1111**	**125**
24993	5944	2007	3124	4369	7468	173	1200	125

SAMPLE SCENARIO REPORT
(Scenario title here)

PRESENTATION TABLE						
On behalf of the group who prepared the scenario					On behalf of the approval authority	
Presentation 1						
Presentation 2						
Presentation 3						
....						
....						
Presentations	Date	Prepared by	Control	Approval	Approved by	Definition and date

Report Number	On behalf of the contractor	On behalf of the employer
	Revised by:	Approved by:

Report title:			
Report No:			
Date:		**Prepared by:**	
Correction No:		**Controlled by:**	

CORRECTIONS TABLE				
Corrections in presentations	**Presentation No:**	**Definition**	**Date**	**Approval**
Depending on the presentations, this table must be completed considering the details such as each correction and/or after approval corrected page number, corrected subject and correction date. ***If necessary, the number of rows in the table may be increased and/or new pages may be added.***				

Report title:			
Report No:			
Date:		**Date:**	
Correction No:		**Correction No:**	

CONTENTS		<u>**Page No:**</u>
1.	General	
2.	Specifications and References	
3.	Equipment and Personnel	
4.	Preparations prior to Installation	
5.	Installation Procedure	
6.	Gerdirme İşleri, Taşıyıcı Hat Yüklemesi	
7.	Sürüklenme Mesafesi	
8.	Ters Gergi ve Yan Gergi Hatlarının Yerleştirilmesi	
9.	Installation of Sinker Blocks	
10.	Finalization of the Installation	
11.	Installation Procedures	
12.	Appendices	
	Appendix 1. Support Ship Characteristics, Personnel Information	
	Appendix 2. Scenario Drawings	
	The "Contents" of the Scenario Report may arranged as required. However, the contents of the report must at least include the 12 items outlined above. ***TL** may additionally require the inclusion in the Appendix section of further information and drawings related to the anchor and relevant documentation related to the dragging distance and tolerance rectangle.*	

Report title:			
Report No:			
Date:		**Prepared by:**	
Correction No:		**Controlled by:**	

1. General

In this section, the work is defined and general information about the contents of the scenario is provided.

2. Specifications and References

In this section, the technical specifications and the references to be used in the scenario report are presented.

3. Equipment and Personnel

In this section, relevant information on the support ship/ships and the responsibilities and accountabilities of the personnel is given. The information presented here must comply with the requirements of TL-MPMS, Section 7, 2. If necessary, the contents may be enhanced by providing additional drawings placed in the appendix.

4. Preparations prior to Installation

In this section, the physical properties of the anchor in the MPMS are described. The working angle of the anchor, the configuration of the anchor, the chain and the related equipment on the deck are explained. The information presented in this section must comply with the requirements of TL-MPMS, Section 7, 3.

5. Installation Procedure

In this section, the procedures to be employed for the installation of the anchor and chain components on the seabed are explained comprehensively. Each stage of work involved is described in detail.

6. Gerdirme İşleri, Taşıyıcı Hat Yüklemesi

In this section, TL-ÇNBS, Bölüm 7,5'de istenen kurallar çerçevesinde uygulanacak gerdirme işlemlerine ait bilgiler açık bir şekilde yazılır. Scenario resimleri EK kısmında verilir.

7. Sürüklenme Mesafesi

In this section, Sürüklenme miktarının tespitinde izlenen yol ile tolerans dörtgeninin boyutları bu bölümde verilir. Ayrıca , başarılı gerdirme işlemine karşılık eksik sürüklenme veya fazla sürüklenme durumlarında yapılacaklar açıklanır.

8. Ters Gergi ve Yan Gergi Hatlarının Yerleştirilmesi

In this section, Bu bölümde ters gergi ve yan gergi hatlarının yerleştirilmesi açık bir şekilde anlatılır.

9. Installation of Sinker Blocks

In this section, the procedure to be used for the installation of the sinker blocks is described in detail.

10. Finalization of the Installation

In this section, the procedures satisfying the requirements of TL-MPMS, Section7,9 are described.

11. Installation Procedures

In this section, depending on the average depth and favorable sea and weather conditions, the day by day scheduling of a single tensioning operation must be outlined. The schedules must include the following stages of the operation:

-Preparation
-Laying of the chains
-Tensioning work
-Ters gergi ve yan gergi hatlarının yerleştirilme süreci
-Installation of the sinker blocks
-Surveys

Report title:			
Report No:			
Date:		**Date:**	
Correction No:		**Correction No:**	

Appendix 1

TECHNICAL INFORMATION ON SUPPORT SHIP, DRAWINGS

Report title:			
Report No:			
Date:		**Prepared by:**	
Correction No:		**Controlled by:**	

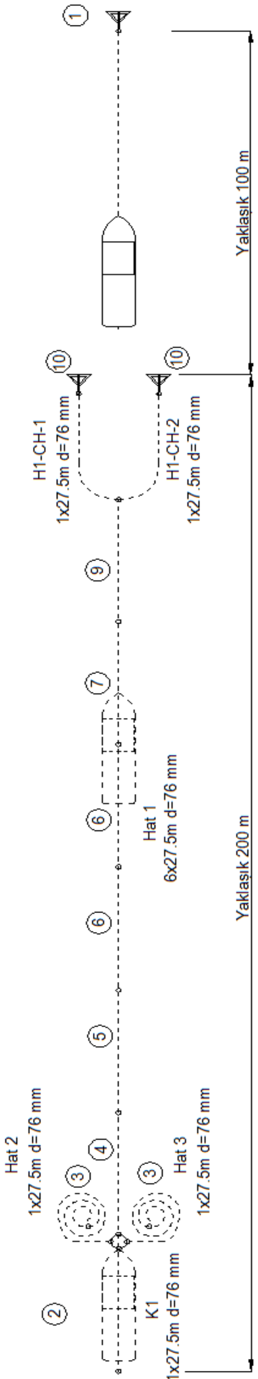
Appendix 2.

INSTALLATION ON THE SEABED, DRAWINGS

(Sample)

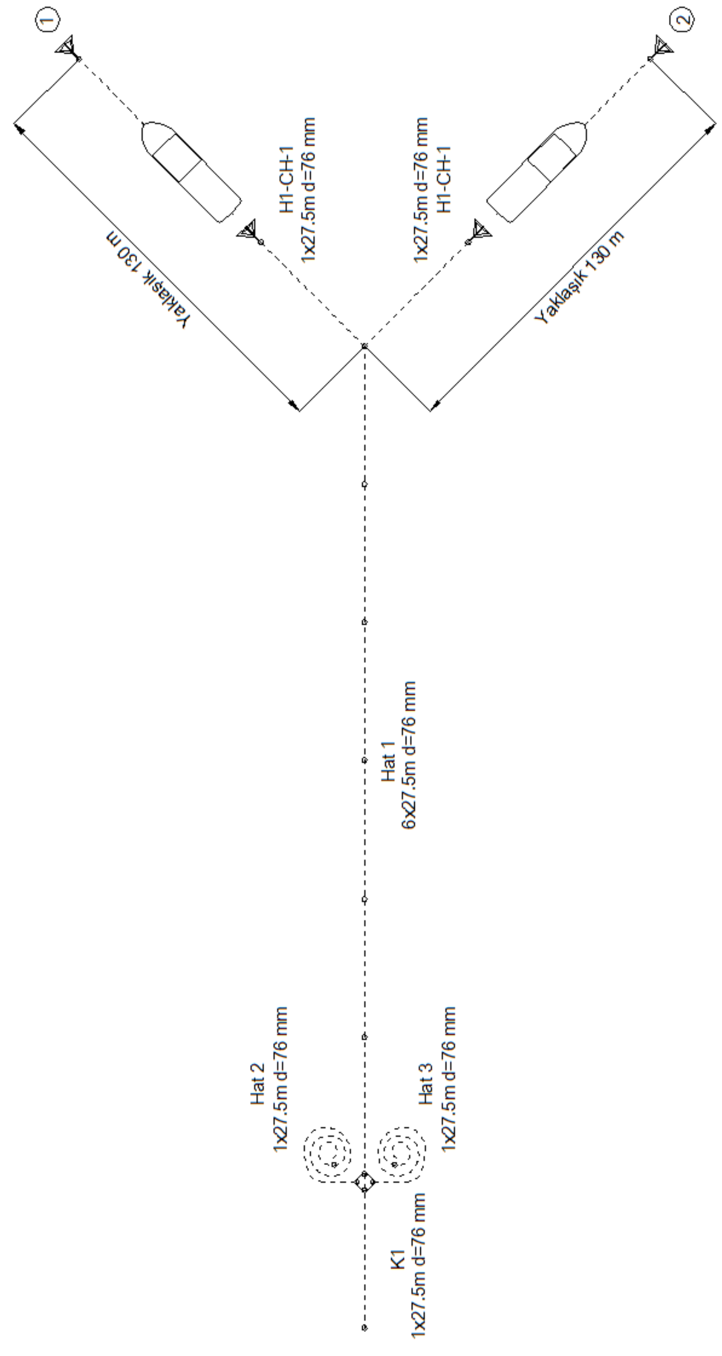
Report title:			
Report No:			
Date:		**Date:**	
Correction No:		**Correction No:**	

MOORING LINE INSTALLATION METHOD
Stage 1/6



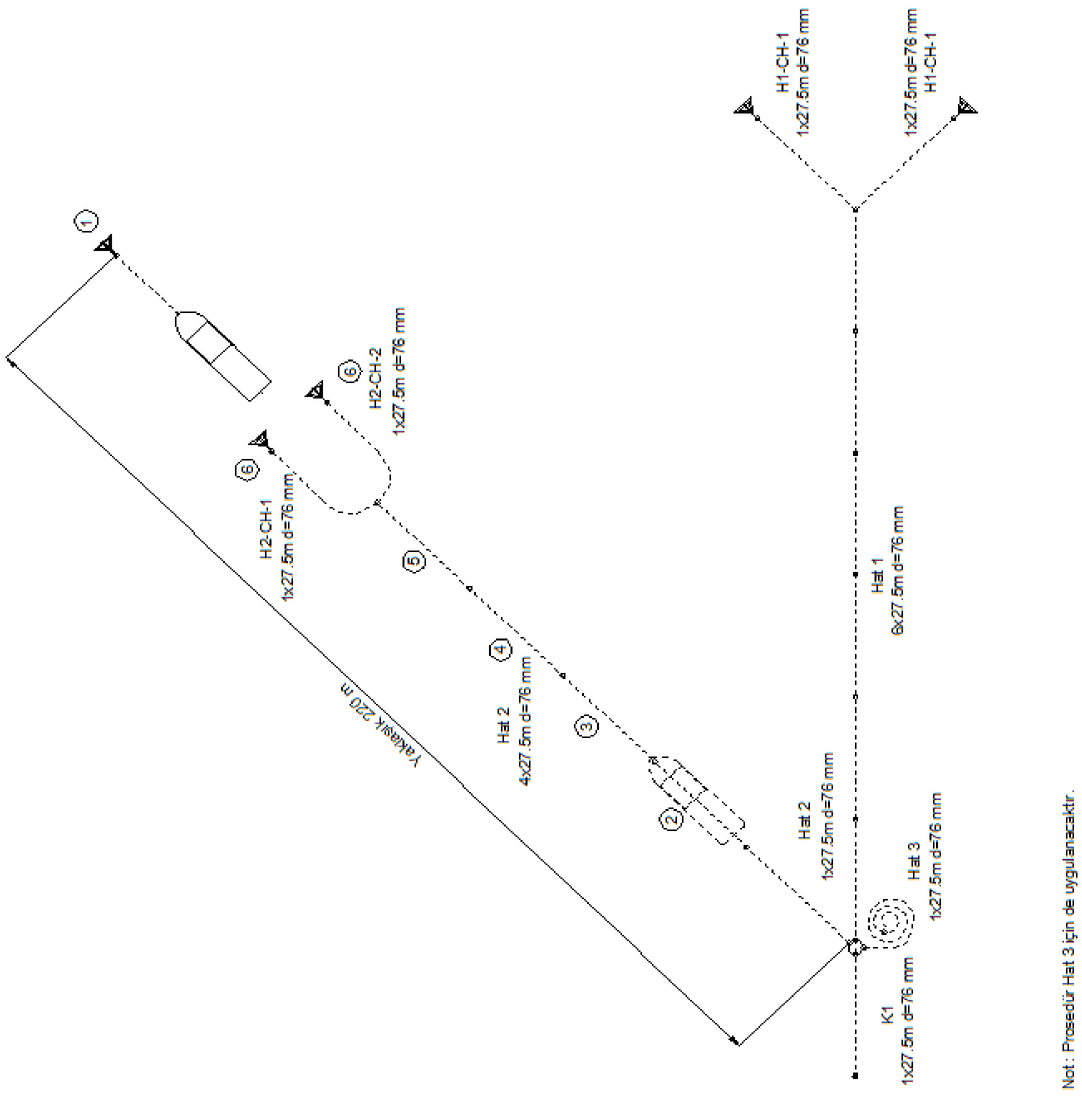
Report title:			
Report No:			
Date:		**Prepared by:**	
Correction No:		**Controlled by:**	

MOORING LINE INSTALLATION METHOD
Stage 2/6

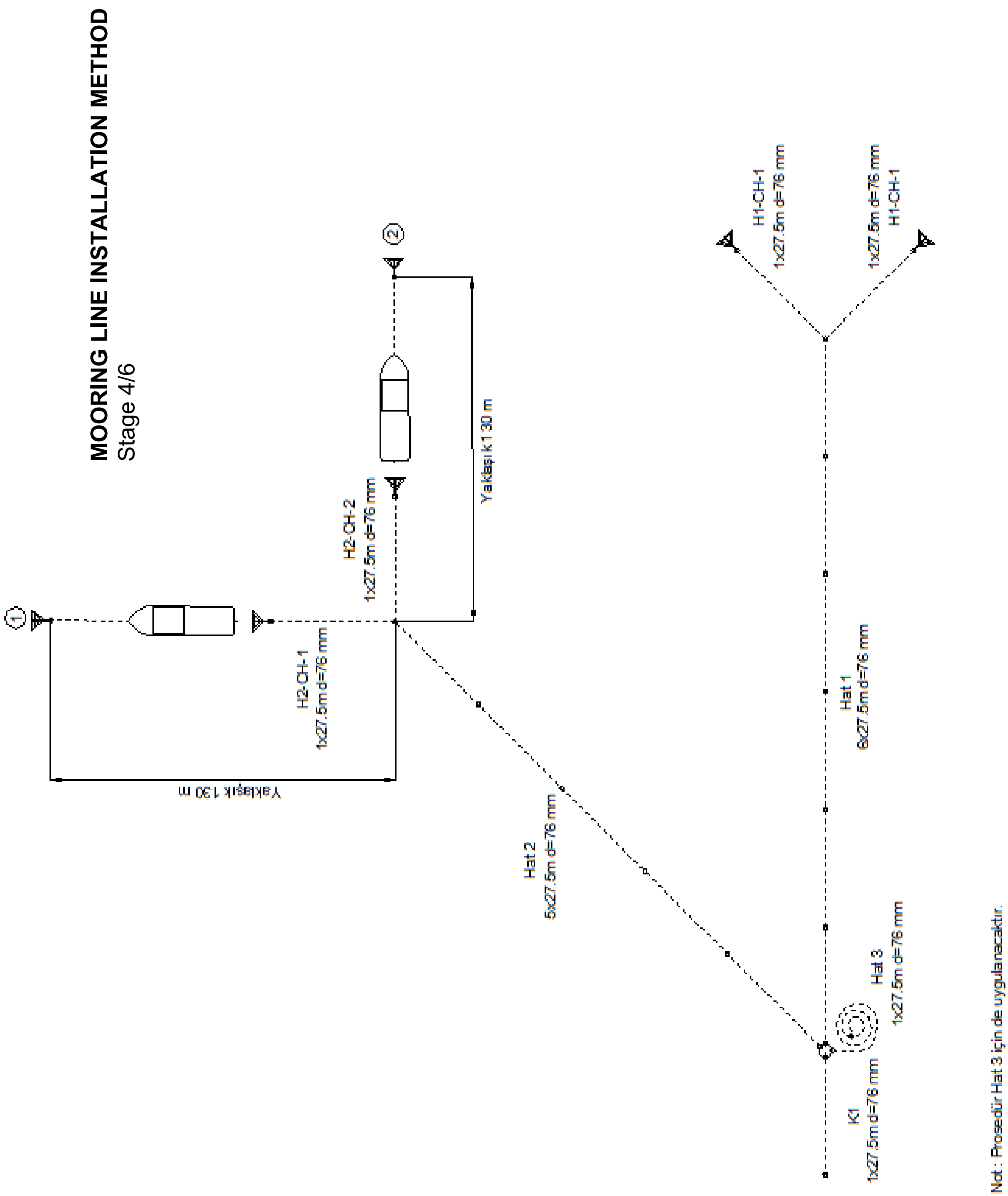


Report title:			
Report No:			
Date:		**Date:**	
Correction No:		**Correction No:**	

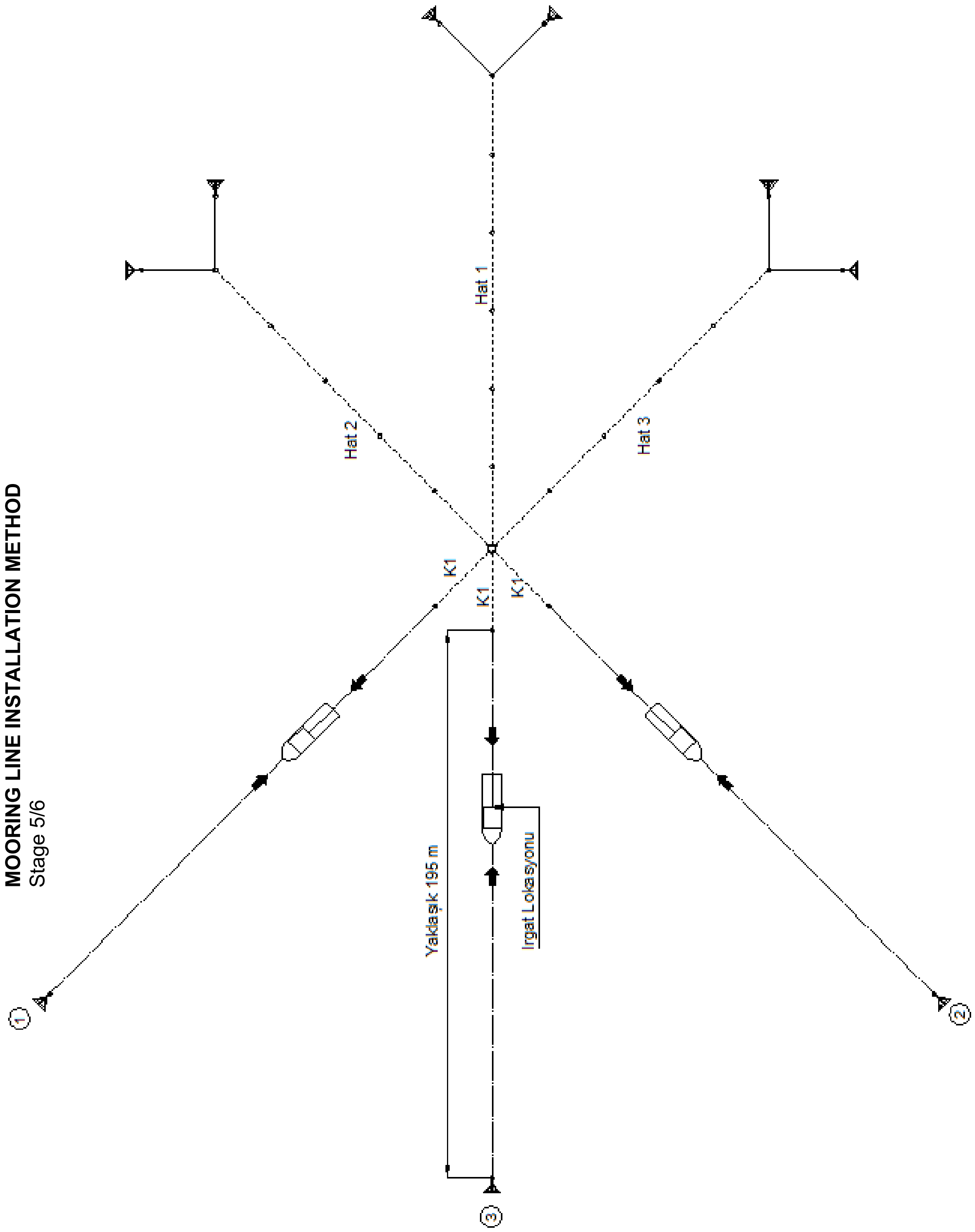
MOORING LINE INSTALLATION METHOD
Stage 3/6



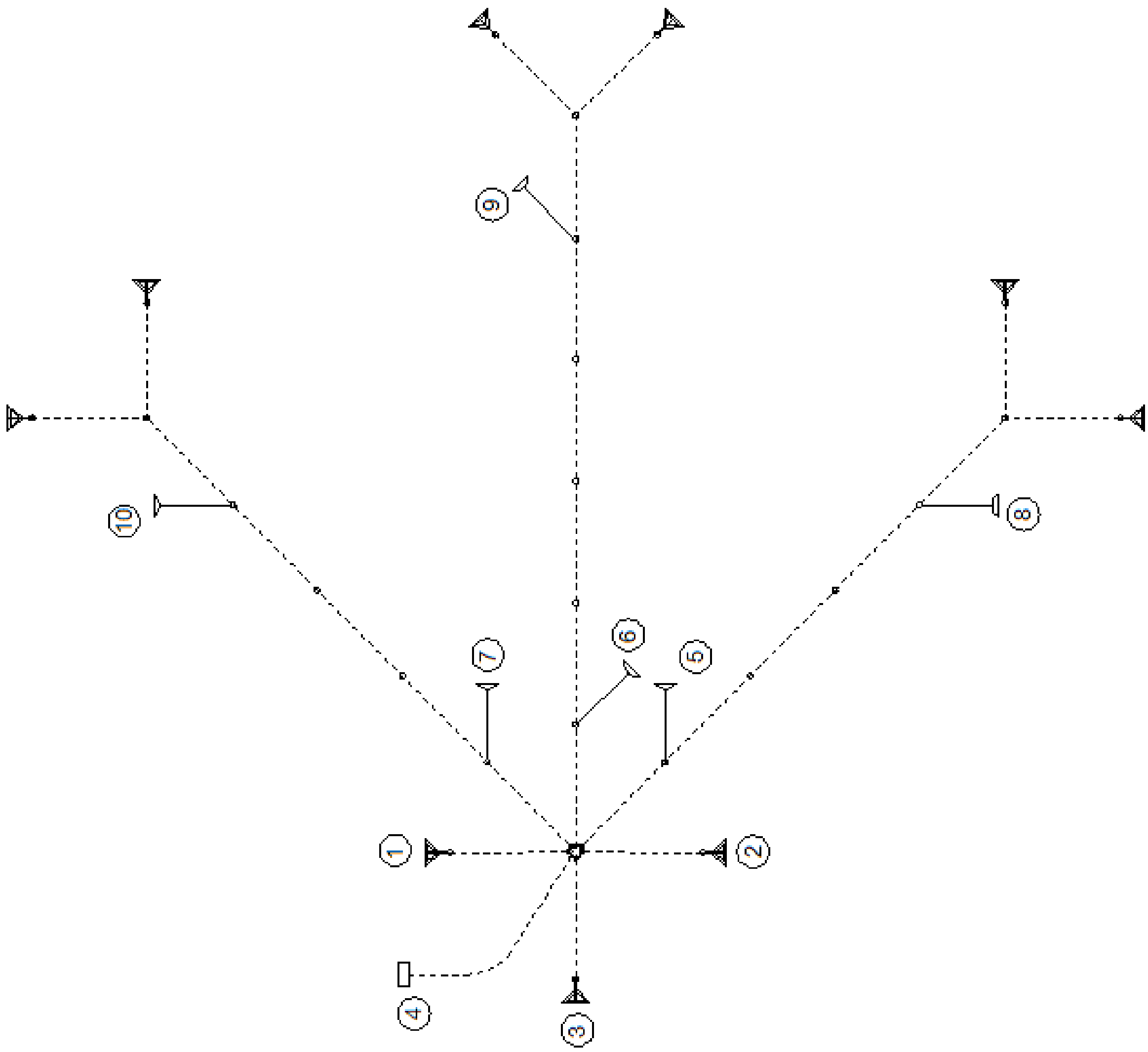
Report title:			
Report No:			
Date:		**Prepared by:**	
Correction No:		**Controlled by:**	



Report title:			
Report No:			
Date:		**Date:**	
Correction No:		**Correction No:**	



Report title:			
Report No:			
Date:		**Prepared by:**	
Correction No:		**Controlled by:**	



MOORING LINE INSTALLATION METHOD
Stage 6/6

Report title:			
Report No:			
Date:		**Date:**	
Correction No:		**Correction No:**	

Estimated Drag Distances for Tandem Anchors

Anchor type : Stabilized stockless anchors with approximately 45^0 fixed working angle (fluke angle)

Ground type : Mud

Stockless Anchor - Working Angle : 45^0 – Ground type : Mud												
	Horizontal Design Load (kN)											
	111	**222**	**334**	**445**	**556**	**667**	**778**	**890**	**1001**	**1112**	**1223**	**1334**
Anchor Weight (kN)	**Drag Distance (m)**											
22	**1.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
27	1.2	16.5	-	-	-	-	-	-	-	-	-	-
31	**1.2**	**9.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
36	0.9	6.4	-	-	-	-	-	-	-	-	-	-
40	**0.9**	**4.0**	**21.3**	**0.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
44	0.6	2.7	14.3	0.0	-	-	-	-	-	-	-	-
49	**0.6**	**1.8**	**10.7**	**55.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
53	0.3	1.8	8.2	30.2	-	-	-	-	-	-	-	-
58	**0.3**	**1.8**	**6.4**	**19.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
62	0.0	1.5	4.6	14.3	61.0	-	-	-	-	-	-	-
67	**0.0**	**1.5**	**3.7**	**12.2**	**39.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
71	0.0	1.5	3.0	10.1	24.1	-	-	-	-	-	-	-
76	**0.0**	**1.2**	**2.1**	**8.2**	**19.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
80	0.0	1.2	2.1	6.7	15.2	46.9	-	-	-	-	-	-
85	**0.0**	**1.2**	**2.1**	**5.2**	**13.4**	**29.0**	**-**	**-**	**-**	**-**	**-**	**-**
89	0.0	0.9	2.1	4.3	11.6	23.5	-	-	-	-	-	-
93	**0.0**	**0.9**	**1.8**	**3.7**	**10.1**	**19.5**	**54.6**	**-**	**-**	**-**	**-**	**-**
98	0.0	0.6	1.8	3.0	8.5	16.2	37.8	-	-	-	-	-
102	**0.0**	**0.6**	**1.8**	**2.4**	**7.0**	**14.6**	**27.4**	**-**	**-**	**-**	**-**	**-**
107	0.0	0.6	1.8	2.4	5.8	12.8	23.5	61.6	-	-	-	-
111	**0.0**	**0.3**	**1.5**	**2.4**	**5.2**	**11.3**	**19.8**	**46.3**	**-**	**-**	**-**	**-**
116	0.0	0.3	1.5	2.4	4.6	10.1	17.1	31.7	-	-	-	-
120	**0.0**	**0.3**	**1.5**	**2.1**	**4.0**	**8.8**	**15.5**	**27.1**	**68.3**	**-**	**-**	**-**
125	0.0	0.3	1.5	2.1	3.4	7.6	14.0	23.8	53.9	-	-	-
129	**0.0**	**0.0**	**1.2**	**2.1**	**3.0**	**6.4**	**12.8**	**20.7**	**40.2**	**-**	**-**	**-**
133	0.0	0.0	1.2	2.1	2.7	5.8	11.6	18.0	30.8	74.7	-	-

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Tandem Anchors

Anchor type: Stabilized stockless anchors with approximately 36^0 fixed working angle (fluke angle)

Ground type : Sand

Stockless Anchor - Working Angle : 36^0 – Ground type : Sand												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	Drag Distance (m)											
22	4.0	6.1	9.8	-	-	-	-	-	-	-	-	-
27	4.0	5.8	8.2	-	-	-	-	-	-	-	-	-
31	4.0	5.5	7.6	11.3	-	-	-	-	-	-	-	-
36	4.0	5.2	7.3	10.1	-	-	-	-	-	-	-	-
40	4.0	5.2	7.0	8.8	12.8	-	-	-	-	-	-	-
44	4.0	5.2	6.7	8.5	11.6	-	-	-	-	-	-	-
49	4.0	5.2	6.4	8.2	10.4	14.0	-	-	-	-	-	-
53	4.0	5.2	6.4	7.9	9.8	13.1	-	-	-	-	-	-
58	4.0	5.2	6.1	7.9	9.4	11.9	-	-	-	-	-	-
62	4.0	5.2	6.1	7.6	9.1	11.3	14.3	-	-	-	-	-
67	4.0	5.2	6.1	7.3	8.8	10.7	13.4	-	-	-	-	-
71	4.0	5.2	6.1	7.3	8.8	10.4	12.5	15.8	-	-	-	-
76	4.0	5.2	6.1	7.0	8.5	10.1	11.9	14.9	-	-	-	-
80	4.0	5.2	6.1	7.0	8.5	9.8	11.3	14.0	-	-	-	-
85	4.0	5.5	6.1	7.0	8.2	9.8	11.0	13.4	16.2	-	-	-
89	4.0	5.5	6.1	7.0	8.2	9.4	10.7	12.5	15.2	-	-	-
93	4.0	5.5	6.1	6.7	7.9	9.4	10.7	12.2	14.6	17.4	-	-
98	4.0	5.5	6.1	6.7	7.9	9.1	10.4	11.9	14.0	16.5	-	-
102	4.0	5.5	6.1	6.7	7.9	9.1	10.4	11.6	13.4	15.8	-	-
107	4.3	5.5	6.1	6.7	7.6	8.8	10.1	11.3	12.8	15.2	17.7	-
111	4.3	5.5	6.1	6.7	7.6	8.8	10.1	11.0	12.5	14.6	17.1	-
116	4.3	5.2	6.1	6.7	7.6	8.5	9.8	11.0	12.2	14.0	16.5	18.9
120	4.3	5.2	6.1	7.0	7.6	8.5	9.8	11.0	12.2	13.7	15.8	18.3
125	4.3	5.2	6.4	7.0	7.6	8.5	9.8	10.7	11.9	13.1	15.2	17.7
129	4.3	5.2	6.4	7.0	7.6	8.5	9.4	10.7	11.6	13.1	14.9	17.1
133	4.3	5.2	6.4	7.0	7.6	8.2	9.4	10.7	11.6	12.8	14.3	16.5

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Tandem Anchors

Anchor type: Stabilized STATO anchors with approximately 50^0 fixed working angle (fluke angle)

Ground type : Mud

Stato Anchor - Working Angle : 50^0 – Ground type : Mud												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	Drag Distance (m)											
22	**0.0**	**1.2**	**3.0**	**7.0**	**12.5**	**19.5**	**30.2**	**48.2**	**98.8**	**-**	**-**	**-**
27	0.0	0.9	1.8	4.6	8.8	13.7	20.1	29.3	42.7	71.9	-	-
31	**0.0**	**0.6**	**1.5**	**3.0**	**5.8**	**10.4**	**14.6**	**20.7**	**28.7**	**38.7**	**55.5**	**98.1**
36	0.0	0.6	1.5	2.1	4.3	7.6	11.9	15.8	21.3	28.3	37.2	51.2
40	**0.0**	**0.3**	**1.2**	**1.8**	**3.4**	**5.5**	**9.1**	**13.1**	**16.8**	**21.9**	**28.3**	**36.6**
44	0.0	0.3	0.9	1.8	2.4	4.3	6.7	10.7	14.0	17.4	22.6	28.7
49	**0.0**	**0.3**	**0.9**	**1.5**	**2.1**	**3.4**	**5.5**	**8.2**	**11.9**	**15.2**	**18.3**	**23.2**
53	0.0	0.0	0.6	1.2	2.1	2.7	4.6	6.4	9.8	13.1	16.2	19.2
58	**0.0**	**0.0**	**0.6**	**1.2**	**1.8**	**2.4**	**3.7**	**5.5**	**7.6**	**11.0**	**14.0**	**17.1**
62	0.0	0.0	0.3	0.9	1.5	2.1	3.0	4.6	6.4	8.8	12.2	15.2
67	**0.0**	**0.0**	**0.3**	**0.9**	**1.5**	**2.1**	**2.7**	**4.0**	**5.5**	**7.3**	**10.4**	**13.1**
71	0.0	0.0	0.3	0.9	1.2	1.8	2.4	3.0	4.9	6.4	8.5	11.3
76	**0.0**	**0.0**	**0.0**	**0.6**	**1.2**	**1.8**	**2.4**	**3.0**	**4.0**	**5.5**	**7.3**	**9.8**
80	0.0	0.0	0.0	0.6	1.2	1.5	2.1	2.7	3.4	4.9	6.4	8.2
85	**0.0**	**0.0**	**0.0**	**0.6**	**0.9**	**1.5**	**2.1**	**2.4**	**3.0**	**4.3**	**5.8**	**7.3**
89	0.0	0.0	0.0	0.3	0.9	1.5	1.8	2.4	3.0	3.7	5.2	6.4
93	**0.0**	**0.0**	**0.0**	**0.3**	**0.9**	**1.2**	**1.8**	**2.1**	**2.7**	**3.4**	**4.6**	**5.8**
98	0.0	0.0	0.0	0.3	0.6	1.2	1.5	2.1	2.7	3.0	4.0	5.2
102	**0.0**	**0.0**	**0.0**	**0.3**	**0.6**	**1.2**	**1.5**	**2.1**	**2.4**	**3.0**	**3.4**	**4.6**
107	0.0	0.0	0.0	0.3	0.6	0.9	1.5	1.8	2.4	2.7	3.4	4.0
111	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.9**	**1.2**	**1.8**	**2.1**	**2.7**	**3.0**	**3.7**
116	0.0	0.0	0.0	0.0	0.3	0.9	1.2	1.5	2.1	2.4	3.0	3.4
120	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.6**	**1.2**	**1.5**	**2.1**	**2.4**	**2.7**	**3.4**
125	0.0	0.0	0.0	0.0	0.3	0.6	1.2	1.5	1.8	2.4	2.7	3.0
129	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.6**	**0.9**	**1.5**	**1.8**	**2.1**	**2.7**	**3.0**
133	0.0	0.0	0.0	0.0	0.3	0.6	0.9	1.2	1.8	2.1	2.4	3.0

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Tandem Anchors

Anchor type: Stabilized STATO anchors with approximately 30^0 fixed working angle (fluke angle)

Ground type : Sand

Stato Anchor - Working Angle : 30^0 – Ground type : Sand												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	Drag Distance (m)											
22	3.7	4.6	5.5	6.4	7.6	8.5	10.4	11.9	13.7	16.8	23.8	-
27	4.0	4.6	5.5	6.1	7.3	8.2	9.1	11.0	12.5	13.7	15.8	19.2
31	4.0	4.6	5.5	6.1	7.0	8.2	8.8	9.8	11.3	12.8	14.0	15.5
36	4.0	4.6	5.5	6.1	6.7	7.9	8.5	9.1	10.4	11.9	13.1	14.3
40	4.3	4.6	5.5	6.1	6.7	7.6	8.5	9.1	9.8	11.0	12.2	13.7
44	4.3	4.6	5.5	6.4	6.7	7.3	8.2	9.1	9.8	10.1	11.6	12.8
49	4.6	4.9	5.5	6.1	6.7	7.3	7.9	8.8	9.8	10.1	10.7	12.2
53	4.6	4.9	5.5	6.1	6.7	7.3	7.9	8.5	9.4	10.1	10.7	11.3
58	4.6	4.9	5.5	6.1	7.0	7.3	7.9	8.5	9.1	10.1	10.7	11.0
62	4.9	5.2	5.5	6.1	7.0	7.3	7.9	8.2	9.1	9.8	10.4	11.0
67	4.9	5.2	5.5	6.1	6.7	7.3	7.9	8.2	8.8	9.8	10.4	11.0
71	4.9	5.2	5.5	6.1	6.7	7.3	7.9	8.2	8.8	9.4	10.4	11.0
76	4.9	5.2	5.5	6.1	6.7	7.3	7.9	8.2	8.5	9.4	10.1	10.7
80	5.2	5.5	5.8	6.1	6.7	7.3	7.9	8.2	8.5	9.1	9.8	10.7
85	5.2	5.5	5.8	6.1	6.7	7.3	7.9	8.2	8.5	9.1	9.8	10.4
89	5.2	5.5	5.8	6.1	6.7	7.3	7.9	8.2	8.8	9.1	9.8	10.4
93	5.2	5.5	5.8	6.1	6.7	7.3	7.9	8.2	8.8	9.1	9.4	10.1
98	5.5	5.8	5.8	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	10.1
102	5.5	5.8	6.1	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	9.8
107	5.5	5.8	6.1	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	9.8
111	5.5	5.8	6.1	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	9.8
116	5.8	5.8	6.1	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	9.8
120	5.8	6.1	6.1	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	9.8
125	5.8	6.1	6.4	6.4	6.7	7.3	7.9	8.2	8.8	9.1	9.4	9.8
129	5.8	6.1	6.4	6.7	7.0	7.3	7.9	8.2	8.8	9.1	9.4	9.8
133	5.8	6.1	6.4	6.7	7.0	7.3	7.9	8.2	8.8	9.1	9.4	9.8

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Single Anchors

Anchor type: Stabilized stockless anchors with approximately 45^0 fixed working angle (fluke angle)

Ground type : Mud

Stockless Anchor - Working Angle : 45⁰ – Ground type : Mud												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	**Drag Distance (m)**											
22	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
27	16.5	-	-	-	-	-	-	-	-	-	-	-
31	**9.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
36	6.4	-	-	-	-	-	-	-	-	-	-	-
40	**4.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
44	2.7	-	-	-	-	-	-	-	-	-	-	-
49	**1.8**	**55.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
53	1.8	30.2	-	-	-	-	-	-	-	-	-	-
58	**1.8**	**19.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
62	1.5	14.3	-	-	-	-	-	-	-	-	-	-
67	**1.5**	**12.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
71	1.5	10.1	-	-	-	-	-	-	-	-	-	-
76	**1.2**	**8.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
80	1.2	6.7	46.9	-	-	-	-	-	-	-	-	-
85	**1.2**	**5.2**	**29.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
89	0.9	4.3	23.5	-	-	-	-	-	-	-	-	-
93	**0.9**	**3.7**	**19.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
98	0.6	3.0	16.2	-	-	-	-	-	-	-	-	-
102	**0.6**	**2.4**	**14.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
107	0.6	2.4	12.8	61.6	-	-	-	-	-	-	-	-
111	**0.3**	**2.4**	**11.3**	**46.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
116	0.3	2.4	10.1	31.7	-	-	-	-	-	-	-	-
120	**0.3**	**2.1**	**8.8**	**27.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
125	0.3	2.1	7.6	23.8	-	-	-	-	-	-	-	-
129	**0.3**	**2.1**	**6.4**	**20.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
133	0.0	2.1	5.8	18.0	74.7	-	-	-	-	-	-	-

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Single Anchors

Anchor type: Stabilized stockless anchors with approximately 36^0 fixed working angle (fluke angle)

Ground type : Sand

Stockless Anchor - Working Angle : 36^0 – Ground type : Sand												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	**Drag Distance (m)**											
22	**6.1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
27	5.8	-	-	-	-	-	-	-	-	-	-	-
31	**5.5**	**11.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
36	5.2	10.1	-	-	-	-	-	-	-	-	-	-
40	**5.2**	**8.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
44	5.2	8.5	-	-	-	-	-	-	-	-	-	-
49	**5.2**	**8.2**	**14.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
53	5.2	7.9	13.1	-	-	-	-	-	-	-	-	-
58	**5.2**	**7.9**	**11.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
62	5.2	7.6	11.3	-	-	-	-	-	-	-	-	-
67	**5.2**	**7.3**	**10.7**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
71	5.2	7.3	10.4	15.8	-	-	-	-	-	-	-	-
76	**5.2**	**7.0**	**10.1**	**14.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
80	5.2	7.0	9.8	14.0	-	-	-	-	-	-	-	-
85	**5.5**	**7.0**	**9.8**	**13.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
89	5.5	7.0	9.4	12.5	-	-	-	-	-	-	-	-
93	**5.5**	**6.7**	**9.4**	**12.2**	**17.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
98	5.5	6.7	9.1	11.9	16.5	-	-	-	-	-	-	-
102	**5.5**	**6.7**	**9.1**	**11.6**	**15.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
107	5.5	6.7	8.8	11.3	15.2	-	-	-	-	-	-	-
111	**5.5**	**6.7**	**8.8**	**11.0**	**14.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
116	5.2	6.7	8.5	11.0	14.0	18.9	-	-	-	-	-	-
120	**5.2**	**7.0**	**8.5**	**11.0**	**13.7**	**18.3**	**-**	**-**	**-**	**-**	**-**	**-**
125	5.2	7.0	8.5	10.7	13.1	17.7	-	-	-	-	-	-
129	**5.2**	**7.0**	**8.5**	**10.7**	**13.1**	**17.1**	**-**	**-**	**-**	**-**	**-**	**-**
133	5.2	7.0	8.2	10.7	12.8	16.5	-	-	-	-	-	-

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Single Anchors

Anchor type: Stabilized STATO anchors with approximately 50^0 fixed working angle (fluke angle)

Ground type : Mud

Stato Anchor - Working Angle : 50^0 – Ground type : Mud												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	**Drag Distance (m)**											
22	**1.2**	**7.0**	**19.5**	**48.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
27	0.9	4.6	13.7	29.3	71.9	-	-	-	-	-	-	-
31	**0.6**	**3.0**	**10.4**	**20.7**	**38.7**	**98.1**	**-**	**-**	**-**	**-**	**-**	**-**
36	0.6	2.1	7.6	15.8	28.3	51.2	121.3	-	-	-	-	-
40	**0.3**	**1.8**	**5.5**	**13.1**	**21.9**	**36.6**	**62.5**	**-**	**-**	**-**	**-**	**-**
44	0.3	1.8	4.3	10.7	17.4	28.7	45.1	85.3	-	-	-	-
49	**0.3**	**1.5**	**3.4**	**8.2**	**15.2**	**23.2**	**36.0**	**55.8**	**107.3**	**-**	**-**	**-**
53	0.0	1.2	2.7	6.4	13.1	19.2	29.3	42.7	65.8	127.4	-	-
58	**0.0**	**1.2**	**2.4**	**5.5**	**11.0**	**17.1**	**24.7**	**36.0**	**51.5**	**81.1**	**-**	**-**
62	0.0	0.9	2.1	4.6	8.8	15.2	20.7	30.2	42.1	61.0	101.5	-
67	**0.0**	**0.9**	**2.1**	**4.0**	**7.3**	**13.1**	**18.6**	**25.9**	**36.0**	**48.2**	**69.8**	**120.4**
71	0.0	0.9	1.8	3.0	6.4	11.3	16.8	22.3	31.1	42.1	57.3	80.8
76	**0.0**	**0.6**	**1.8**	**3.0**	**5.5**	**9.8**	**15.2**	**20.1**	**27.4**	**36.6**	**47.5**	**65.8**
80	0.0	0.6	1.5	2.7	4.9	8.2	13.4	18.6	23.8	32.3	42.1	54.6
85	**0.0**	**0.6**	**1.5**	**2.4**	**4.3**	**7.3**	**11.9**	**17.1**	**21.6**	**28.7**	**37.2**	**47.5**
89	0.0	0.3	1.5	2.4	3.7	6.4	10.4	15.5	20.1	25.3	33.2	42.4
93	**0.0**	**0.3**	**1.2**	**2.1**	**3.4**	**5.8**	**9.1**	**14.0**	**18.6**	**22.9**	**29.9**	**37.8**
98	0.0	0.3	1.2	2.1	3.0	5.2	7.9	12.5	17.1	21.3	26.8	34.1
102	**0.0**	**0.3**	**1.2**	**2.1**	**3.0**	**4.6**	**7.3**	**11.0**	**15.8**	**20.1**	**24.1**	**31.1**
107	0.0	0.3	0.9	1.8	2.7	4.0	6.7	9.8	14.3	18.6	22.6	28.0
111	**0.0**	**0.3**	**0.9**	**1.8**	**2.7**	**3.7**	**6.1**	**8.5**	**13.1**	**17.4**	**21.3**	**25.3**
116	0.0	0.0	0.9	1.5	2.4	3.4	5.5	7.9	11.9	16.2	20.1	23.8
120	**0.0**	**0.0**	**0.6**	**1.5**	**2.4**	**3.4**	**4.9**	**7.3**	**10.7**	**14.9**	**18.9**	**22.6**
125	0.0	0.0	0.6	1.5	2.4	3.0	4.6	6.7	9.4	13.4	17.7	21.3
129	**0.0**	**0.0**	**0.6**	**1.5**	**2.1**	**3.0**	**4.0**	**6.4**	**8.5**	**12.5**	**16.5**	**20.1**
133	0.0	0.0	0.6	1.2	2.1	3.0	3.7	5.8	7.9	11.3	15.2	19.2

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**

Estimated Drag Distances for Single Anchors

Anchor type: Stabilized STATO anchors with approximately 30^0 fixed working angle (fluke angle)

Ground type : Sand

Stato Anchor - Working Angle : 30^0 – Ground type : Sand												
	Horizontal Design Load (kN)											
	111	222	334	445	556	667	778	890	1001	1112	1223	1334
Anchor Weight (kN)	Drag Distance (m)											
22	**4.6**	**6.4**	**8.5**	**11.9**	**16.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
27	4.6	6.1	8.2	11.0	13.7	19.2	-	-	-	-	-	-
31	**4.6**	**6.1**	**8.2**	**9.8**	**12.8**	**15.5**	**23.5**	**-**	**-**	**-**	**-**	**-**
36	4.6	6.1	7.9	9.1	11.9	14.3	18.0	27.7	-	-	-	-
40	**4.6**	**6.1**	**7.6**	**9.1**	**11.0**	**13.7**	**16.2**	**20.4**	**31.4**	**-**	**-**	**-**
44	4.6	6.4	7.3	9.1	10.1	12.8	15.2	17.7	22.6	35.4	-	-
49	**4.9**	**6.1**	**7.3**	**8.8**	**10.1**	**12.2**	**14.3**	**16.8**	**19.8**	**26.8**	**-**	**-**
53	4.9	6.1	7.3	8.5	10.1	11.3	13.7	15.8	18.0	21.9	30.8	-
58	**4.9**	**6.1**	**7.3**	**8.5**	**10.1**	**11.0**	**13.1**	**15.2**	**17.4**	**19.8**	**24.1**	**34.7**
62	5.2	6.1	7.3	8.2	9.8	11.0	12.5	14.6	16.8	18.6	21.9	27.7
67	**5.2**	**6.1**	**7.3**	**8.2**	**9.8**	**11.0**	**11.9**	**14.0**	**16.2**	**18.0**	**19.8**	**23.8**
71	5.2	6.1	7.3	8.2	9.4	11.0	11.6	13.4	15.5	17.4	19.2	21.9
76	**5.2**	**6.1**	**7.3**	**8.2**	**9.4**	**10.7**	**11.6**	**12.8**	**14.9**	**16.8**	**18.6**	**20.4**
80	5.5	6.1	7.3	8.2	9.1	10.7	11.6	12.5	14.3	16.5	18.0	19.8
85	**5.5**	**6.1**	**7.3**	**8.2**	**9.1**	**10.4**	**11.6**	**12.5**	**14.0**	**15.8**	**17.7**	**19.2**
89	5.5	6.1	7.3	8.2	9.1	10.4	11.6	12.2	13.4	15.2	17.1	18.9
93	**5.5**	**6.1**	**7.3**	**8.2**	**9.1**	**10.1**	**11.3**	**12.2**	**13.1**	**14.9**	**16.8**	**18.3**
98	5.8	6.4	7.3	8.2	9.1	10.1	11.3	12.2	13.1	14.3	16.2	18.0
102	**5.8**	**6.4**	**7.3**	**8.2**	**9.1**	**9.8**	**11.0**	**12.2**	**13.1**	**14.0**	**15.8**	**17.4**
107	5.8	6.4	7.3	8.2	9.1	9.8	11.0	12.2	12.8	13.7	15.2	17.1
111	**5.8**	**6.4**	**7.3**	**8.2**	**9.1**	**9.8**	**11.0**	**12.2**	**12.8**	**13.7**	**14.9**	**16.5**
116	5.8	6.4	7.3	8.2	9.1	9.8	10.7	11.9	12.8	13.4	14.3	16.2
120	**6.1**	**6.4**	**7.3**	**8.2**	**9.1**	**9.8**	**10.7**	**11.9**	**12.8**	**13.4**	**14.0**	**15.8**
125	6.1	6.4	7.3	8.2	9.1	9.8	10.7	11.6	12.8	13.4	14.0	15.2
129	**6.1**	**6.7**	**7.3**	**8.2**	**9.1**	**9.8**	**10.4**	**11.6**	**12.5**	**13.4**	**14.0**	**14.9**
133	6.1	6.7	7.3	8.2	9.1	9.8	10.4	11.3	12.5	13.4	14.0	14.6

- **The value of the Horizontal Design Load shall be specified above the working limit condition, Serviceability Limit State (SLS).**