



BUOY CHAINS AND SHACKLES

QUALITY REQUIREMENTS

CONTENTS

0. GENERAL 3

1. DOCUMENTS TO BE OBSERVED IN MANUFACTURE 3

2. QUALITY SYSTEM 3

3. MATERIAL..... 3

 3.1 Chain 3

 3.2 Shackle..... 4

4. MANUFACTURE 4

 4.1 Chain 4

 4.2 Shackle..... 4

5. DIMENSIONS..... 5

6. TESTING 5

 6.1 Proof loads 5

 6.2 Elongation measurements 5

 6.3 Visual inspection..... 6

7. MARKING OF ITEMS 6

8. COATING 6

9. PACKING 6

10. PROOF OF SUITABILITY 6

0. GENERAL

The buoy chains and shackles will be used as ice buoy mooring chains in Finnish sea areas. Due to the movement of ice and waves the mooring chains are subject to fatigue loadings, heavy impacts and wear against the seabed, and the corrosion caused by seawater.

1. DOCUMENTS TO BE OBSERVED IN MANUFACTURE

- Buoy chain and shackle drawing No. 5995-1
- Buoy chains and shackles: quality requirements
- Standards: SFS-EN, SFS, DIN, ISO, BS, SS and EN (applicable sections)
- Classification society documents (e.g. Lloyd's Register of Shipping, Det Norske Veritas, Germanischer Lloyd, American Bureau of Shipping) where applicable

2. QUALITY SYSTEM

The manufacturer shall have the required, functioning, systematically planned and documented quality system demanded by the work. A description of the system shall be supplied to the client for inspection before manufacturing is begun, see sections 4.1 and 4.2.

3. MATERIAL

3.1 Chain

The chain material must be alloyed or unalloyed tempered steel in accordance with SFS-EN 10020 and Lloyd's Register of Shipping quality class U3 or ORQ (or corresponding).

Tensile strength	$R_m \geq 640 \text{ MPa}$
Break elongation	$A_5 \geq 15\%$
Reduction of area	$Z \geq 40\%$
Impact toughness	$K_v = 58 \text{ J (0°C)}$ $K_v = 49 \text{ J (0°C), at weld}$
Brinell hardness	$HB \geq 220$

The chemical composition of the steel must be such that the above technical requirements are met after tempering and that the composition is suitable for the welding method to be used.

The following alloying elements shall not be exceeded:

- $C \leq 0,33\%$
- $Si = 0,20...0,35\%$
- $P \leq 0,04\%$
- $S \leq 0,04\%$
- $Mn \leq 1,90\%$

A certificate of the composition of the material in accordance with SFS-EN 10204-3.1 (DIN EN 10204-3.1, SS-EN 10204-3.1) must be provided.

In addition it is required that each rod bundle is permanently and uniquely marked with a code for the individual melt number or other manufacturing batch.

3.2 Shackle

The shackle material must be an alloyed or un alloyed special steel in accordance with SFS-EN 10020 whose technical requirements are:

Tensile strength	$R_m \geq 850 \text{ MPa}$
Break elongation	$A_5 \geq 12\%$
Reduction of area	$Z \geq 40\%$
Impact toughness	$K_v = 58 \text{ J (0}^\circ\text{C)}$
Brinell hardness	$HB \geq 280$

The chemical composition of the steel must be such that the above technical requirements are met after handling.

The following alloying elements shall not be exceeded:

$C \leq 0,45\%$
$Si \leq 0,45\%$
$P \leq 0,04\%$
$S \leq 0,04\%$
$Mn \leq 1,90\%$

A certificate of the composition of the material in accordance with SFS-EN 10204-3.1 (DIN EN 10204-3.1, SS-EN 10204-3.1) must be provided.

4. MANUFACTURE

4.1 Chain

A detailed manufacturing and quality plan for chain manufacture must be prepared in which is presented, among other things.

The chain must be manufactured in accordance with DIN standards 685 and 5687-1 (or corresponding).

Welds must be ground so that each link can move freely.

4.2 Shackle

A detailed manufacturing and quality plan for shackle manufacture must be prepared in which is presented, among other things, the link bending and heat treatment method, as well as proof of suitability.

5. DIMENSIONS

The main dimensions of the items are given in the drawing 5995-1.

Dimension tolerances are in accordance with the ISO 1704 standard.

The unit of the length of the chain is one lock ($L = 27,5$ m).

6. TESTING

6.1 Proof loads

Proof loading shall be carried out in accordance with DIN standards 685 and 5687-1.

The following loading test shall be carried out on the chains and shackles:

Tensile strength loading on the chains: 1 No. / 110 m, or at least every fourth chain

Tensile strength loading on the shackles: 1 No. / 25 shackles

Test loading on the chains and shackles: 100 %

Test loading values:

Chain \varnothing 32 and extension shackle:	anchor shackle:
$F_{\text{break}} \geq 770$ kN	$F_{\text{break}} \geq 675$ kN
$F_{\text{test}} \geq 540$ kN	$F_{\text{test}} \geq 270$ kN

Chain \varnothing 42:

$F_{\text{break}} \geq 1300$ kN

$F_{\text{test}} \geq 910$ kN

There must be sufficient additional shackles and chain links for the carrying out of yield strength tests.

All loading tests will be carried in an independent testing institute.

6.2 Elongation measurements

Elongation measurements shall be carried out in accordance with DIN 5687-1, in conjunction with the yield strength test, on a test piece which consists of three chain links. The sum of the stretch of the internal dimension of the three links shall be checked in the elongation measurements.

Chain break elongation $\varepsilon_m \geq 15$ %.

6.3 Visual inspection

Visual inspection consists of dimension inspection and visual structural inspection.

The inspection shall be carried out by the representative of the Finnish Transport Agency at the factory or delivery site.

7. MARKING OF ITEMS

All individually supplied items must be stamped with a permanent and unique marking which gives the strength, quality class and manufacturing year of the item. There must be one mark per shackle or at least three per chain (marks at regular intervals). The markings must not be so deep or sharp that they reduce the structural strength.

8. COATING

After loading tests the chains and the joining shackles shall be coated on all surfaces with a bitumen paint in accordance with BS EN 10300. The anchor shackles must not be coated.

9. PACKING

Each chain lock shall be formed into one bundle and tied so that individual bundles can be easily separated from each other.

10. PROOF OF SUITABILITY

During manufacture the above mentioned inspections and certificates required by the quality system shall be procured and stored so that it is possible to show that the structures have the properties which are required by the design documents. The manufacturer must supply these documents to the client.