

BIRO KLASIFIKASI INDONESIA

RULES

FOR OFFSHORE MOORING CHAINS



EDITION 2000

The following Rules come into force on 1st September 2000

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7	Bureau Veritas (BV)	France	Dual Class
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9	American Bureau of Shipping (ABS)	U S A	Dual Class
10	Lloyd's Register of Shipping (LR)	U K	Dual Class

General Terms and Conditions of Classification

A. Interpretation

The interpretation of the Rules for Classification and Construction remains the exclusive prerogative right of Biro Klasifikasi Indonesia (BKI).

B. Protective Rights

Application of the Rules for Construction of BKI does not infringe possible rights for protection of their products on part of the manufacturers.

C. Confidentiality

BKI will treat as confidential any documentation and information received in connection with orders placed with the Society. Such documentation and information may be passed on to third parties solely with prior written consent of the party entitled thereto.

The above is without prejudice to any obligations towards the authorities of the state of the flag.

D. Fees

For services rendered by BKI fees are to be paid in accordance with the BKI's Tariffs of Fees, even if no classification is granted. In addition to these fees, BKI will charge for any expenses incurred in connection with the

services rendered (e.g. travelling or other expenses and, where applicable, any value added/turnover tax).

E. Payment of Invoices

Fees for all services rendered by BKI are due for payment immediately upon receipt of the invoice. On default BKI is entitled to withhold certificates and other documents and to withdraw the classification.

F. Liability

BKI will use their best endeavors to ensure that their Surveyors and all other personnel employed for the proper execution of the functions of the Society, will be selected carefully. It is, however, to be understood that the Society is in no circumstances whatever to be held responsible or liable for any damage arising in consequence of any act or omission of these persons. And the responsible of BKI shall be limited in its amount up to maximum of the fee for that particular service.

G. Jurisdiction

The place of jurisdiction is North Jakarta and the governing law is Indonesian law.

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Rules for Offshore Mooring Chains

1. General Requirements

1.1 Scope

These rules apply to the materials, design, manufacture and testing of offshore mooring chain and accessories intended to be used for application such as: mooring of mobile offshore drilling units, mooring of floating production units, mooring of offshore loading-systems and mooring of gravity based structures during fabrication.

Mooring equipment covered are common links, connection common links (splice links), enlarged links, end links, detachable connecting links (shackles), end shackles, swivels and swivel shackles.

1.2 Chain grades

Depending on the nominal tensile strength of the steels used for manufacture, chains are to be subdivided into three grades, i.e. KI-R3, KI-R3S, KI-R4.

1.3 Approval of chain manufacturers

1.3.1 Offshore mooring chain are to be manufactured only by works approved by the Society. For this purpose approval tests are to be carried out, the scope of which is to include proof and breaking load tests, measurements and mechanical tests including fracture mechanic tests.

1.3.2 Manufacturers are to submit for review and approval the sequence of operations from receiving inspection to shipment and details of the following manufacturing processes :

- a) bar heating and bending including method, temperature control and recording
- b) flash welding including current, force, time and dimensional variables as well as control and recording of parameters
- c) flash removal including method and inspection
- d) stud insertion method
- e) heat treatment including furnace types, means of specifying, controlling and recording of temperature and chain speed and allowable limits, quenching bath and agitation, cooling method after exit
- f) proof and break loading including method/machine, means of horizontal support (if applicable), method of measurement, recording
- g) non destructive examination procedures

1.3.3 Calibration of furnaces shall be verified by measurement and recording of actual link temperature (surface and internal).

1.4 Approval of quality system at chain manufacturers

Chain manufacturers are to have a documented and effective quality system approved by the Society, e.g. ISO 9001.

1.5 Approval of steel mills for rolled bars

1.5.1 Bar material intended for chain and accessories are to be manufactured only by works approved by the Society. The approval is limited to a nominated supplier of bar material. If a chain manufacturer wishes to use material from a number of suppliers, separate approval tests must be carried out for each supplier.

Approval will be given only after successful testing of the completed chain. The approval will normally be limited to a thickness equal to that of the bars tested.

1.5.2 The steel maker is to submit a specification of the chemical composition of the bar material, which must be approved by the Society and by the chain manufacturer.

For Grade KI-R4 chain the steel should contain a minimum of 0,20 percent molybdenum.

1.5.3 A heat treatment sensitivity study simulating chain production conditions shall be applied in order to verify mechanical properties and establish limits for temperature and time combinations.

1.5.4 The bar manufacturer is to provide evidence that the material is resistant to strain ageing, temper embrittlement and hydrogen embrittlement.

1.6 Approval of forges and foundries for accessories

1.6.1 Forges and foundries intending to supply finished or semifinished accessories are to be approved by BKI. The scope of approval is to be agreed with BKI.

1.6.2 Manufacturers intending to supply accessories in machined condition (e.g. Kenter type shackles) are to submit detailed drawings for approval.

2. Materials

2.1 Scope

These rules apply to rolled steels, forgings and castings used for the manufacture of offshore mooring chain and accessories.

2.2 Rolled steel bars

2.2.1 Steel manufacture

The steels are to be manufactured by basic oxygen, electric furnace or such other process as may be specially approved. All steels are to be killed and fine grain treated.

2.2.2 Chemical composition

For acceptance tests, the chemical composition of ladle samples of each heat is to be determined by the steel maker and is to comply with the approved specification.

2.2.3 Mechanical tests

2.2.3.1 Bars of the same nominal diameter are to be presented for test in batches of 50 tonnes or fraction thereof from the same heat. Test specimens are to be taken from material heat treated in the same manner as intended for the finished chain.

2.2.3.2 Each heat of Grade KI-R3S and KI-R4 steel bars is to be tested for hydrogen embrittlement. In case of continuous casting, test samples representing the beginning and the end of the charge shall be taken. In case of ingot casting, test samples representing two different ingots shall be taken.

Two (2) tensile test specimens shall be taken from the central region of bar material which have been simulated heat treated. The specimens shall preferably have a diameter of 20 mm, alternatively 14 mm. One specimen is to be tested within max. 3 hours after machining. For a 14 mm \varnothing specimen, the time limit is 1,5 hours. (Alternatively, the specimen may be cooled to -60°C immediately after machining and kept at that temperature for a period of max. 5 days). The other specimen is to be tested after baking at 250°C for 4 hours, alternatively 2 hours for 14 mm \varnothing specimen.

A slow strain rate $\leq 0,0003 \text{ s}^{-1}$ must be used during the entire

test, until fracture occurs. (This means approximately 10 minutes for a 20 mm \varnothing specimen).

Tensile strength, elongation and reduction of area are to be reported. The requirement for the test is :

$$Z_1/Z_2 \geq 0,85$$

Where :

Z_1 = Reduction of area without baking

Z_2 = Reduction of area after baking

If the requirement $Z_1/Z_2 \geq 0,85$ is not met, the bar material may be subjected to a hydrogen degassing treatment after agreement with BKI. New tests shall be performed after degassing.

2.2.3.3 For all grades, one tensile and three Charpy V-notch specimens are to be taken from each sample selected. The test specimens are to be taken at approximately one-third radius below the surface, as shown in Fig. 1.

The results of all tests are to be in accordance with the appropriate requirements of Table 1.

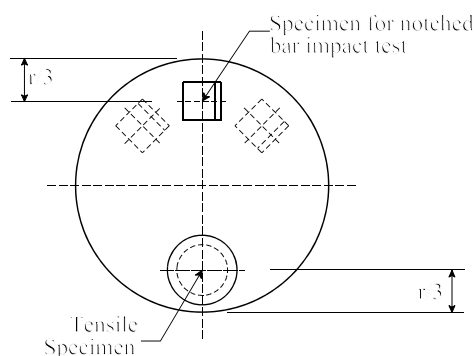


Fig. 1 Sampling of steel bars, forgings and castings

Table 1 Mechanical properties of offshore mooring chains

Grade	Yield stress [N/mm ²] minimum ¹⁾	Tensile strength [N/mm ²] minimum ¹⁾	Elongation A ₅ [%] minimum	Reduction of area ³⁾ [%] minimum	Charpy V-notch impact tests		
					Test temperature [°] ²⁾	Average energy [J] minimum	Average energy flash weld [J] minimum
KI-R3	410	690	17	50	0 -20	60 40	50 30
KI-R3S	490	770	15	50	0 -20	65 45	53 33
KI-R4	580	860	12	50	-20	50	36

¹⁾ Aim value of yield to tensile ratio : 0,92 max

²⁾ At the option of BKI the impact test of grade KI-R3 and KI-R3S may be carried out at either 0°C or minus 20°C

³⁾ Reduction of area of cast steel is to be for Grades KI-R3 and KI-R3S: min. 40%, for KI-R4: min. 35%, see 2.4.4.

2.2.3.4 If the tensile test requirements are not achieved, a retest of two further specimens selected from the same sample shall be permissible. Failure to meet the specified

requirements of either or both additional tests will result in rejection of the batch represented unless it can be clearly attributable to improper simulated heat treatment.

2.2.3.5 If the impact test requirements are not achieved, a retest of three further specimens selected from the same sample shall be permissible. The results shall be added to those previously obtained to form a new average. The new average shall comply with the requirements. No more than two individual results are to be lower than the required average and no more than one result is to be below 70 % of the specified average value.

Failure to meet the requirements will result in rejection of the batch represented unless it can be clearly attributable to improper simulated heat treatment.

2.2.4 Dimensional tolerances

The diameter and roundness shall be within the tolerances specified in Table 2, unless otherwise agreed.

Table 2 Dimensional tolerance of bar stock

Nominal diameter [mm]	Tolerance on diameter [mm]	Tolerance on roundness ($d_{max} - d_{min}$) [mm]
Less than 25	-0 + 1,0	0,6
25 - 35	-0 + 1,2	0,8
36 - 50	-0 + 1,6	1,1
51 - 80	-0 + 2,0	1,50
81 - 100	-0 + 2,6	1,95
101 - 120	-0 + 3,0	2,25
121 - 160	-0 + 4,0	3,00

2.2.5 Non-destructive examination and repair

The bars shall be free from pipe, cracks and flakes. Bar material is to be subjected to ultrasonic examination at an appropriate stage of the manufacture.

One hundred percent of the bar material is to be examined by magnetic particle or eddy current methods. The bars shall be free of injurious surface imperfections such as scams, laps and rolled-in mill scale. Provided that their depth is not greater than 1 % of the bar diameter, longitudinal discontinuities may be removed by grinding and blending to a smooth contour.

The frequency of NDE may be reduced at the discretion of BKI provided it is verified by statistical means that the required quality is consistently achieved.

2.2.6 Marking

Each bar is to be stamped with the steel grade designation and the charge number (or a code indicating the charge number) on one of the end surfaces. Other marking methods may be accepted subject to agreement.

2.3 Forged steels

2.3.1 Forged steels used for the manufacture of accessories must be in compliance with specifications

submitted and approved.

2.3.2 Chemical composition

Para 2.2.2 applies.

2.3.3 Heat treatment

Finished forgings are to be properly heat treated in compliance with specifications submitted and approved.

2.3.4 Mechanical properties

The forgings must comply with the mechanical properties given in Table 1, when properly heat treated.

2.3.5 Mechanical tests

For test sampling, forgings of similar dimensions (diameters do not differ by more than 25 mm) originating from the same heat treatment charge and the same heat of steel are to be combined into one test unit. From each test unit one tensile and three impact test specimens are to be taken and tested. For the location of the test specimens see Fig. 1.

2.3.6 Ultrasonic examination

The forgings are to be subjected to ultrasonic examination at an appropriate stage of manufacture and in compliance with the standard submitted and approved.

2.3.7 Marking

Marking is to be similar to that specified in 2.2.6.

2.4 Cast steels

2.4.1 Cast steels used for the manufacture of accessories must be in compliance with specifications submitted and approved.

2.4.2 Chemical composition

Para 2.2.2 applies.

2.4.3 Heat treatment

All castings are to be properly heat treated in compliance with specifications submitted and approved.

2.4.4 Mechanical properties

The castings must comply with the mechanical properties given in Table 1. The requirement for reduction of area is, however, reduced to 40 % for grades KI-R3 and KI-R3S and 35 % for grade KI-R4.

2.4.5 Mechanical tests

For test sampling, castings of similar dimensions originating from the same heat treatment charge and the same heat of steel are to be combined into one test unit. From each test unit one tensile and three impact test specimens are to be taken and tested. For the location of the test specimens see Fig. 1.

2.4.6 Ultrasonic examination

The castings are to be subjected to ultrasonic examination in compliance with the standard submitted and approved.

2.4.7 Marking

Para 2.3.7 applies.

2.5 Materials for studs

The studs are to be made of steel corresponding to that of the chain or in compliance with specifications submitted and approved. In general, the carbon content should not exceed 0,25 per cent if the studs are to be welded in place.

3. Design and Chain Manufacture

3.1 Design

Drawings giving detailed design of chain and accessories made by or supplied through the chain manufacturer are to be submitted for approval. Typical designs are given in ISO 1704:1991 or equivalent.

In addition, drawings showing the detailed design of the stud shall be submitted for information. The stud shall give an impression in the chain link which is sufficiently deep to secure the position of the stud, but the combined effect of shape and depth of the impression shall not cause any harmful notch effect or stress concentration in the chain link.

Machining of Kenter shackles shall result in fillet radius min. 3 % of nominal diameter.

3.2 Manufacturing process

Offshore mooring chains shall be manufactured in continuous lengths by flash butt welding and are to be heat treated in a continuous furnace; batch heat treatment is not permitted.

The use of joining shackles to replace defective links is subject to the written approval of the end purchaser in terms of the number and type permitted. The use of connecting common links is restricted to 3 links in each 100 m of chain.

3.3 Manufacturing process records

Records of bar heating, flash welding and heat treatment shall be made available for inspection by the Surveyor.

3.3.1 Bar heating

For electric resistance heating, the heating phase shall be

controlled by an optical heat sensor. The controller shall be checked at least once every 8 hours and records made.

For furnace heating, the temperature shall be controlled and continuously recorded using thermocouples in close proximity to the bars. The controls shall be checked at least once every 8 hours and records made.

3.3.2 Flash welding

The following welding parameters shall be controlled during welding of each link :

- a) Platen motion
- b) Current as a function of time
- c) Hydraulic pressure

The controls shall be checked at least every 4 hours and records made.

3.3.3 Heat treatment

Chain shall be austenitized, above the upper transformation temperature, at a combination of temperature and time within the limits established.

When applicable, chain shall be tempered at a combination of temperature and time within the limits established.

Temperature and time or temperature and chain speed shall be controlled and continuously recorded.

3.4 Mechanical properties

The mechanical properties of finished chain and accessories are to be in accordance with Table 1. For the location of test specimens see Figs. 1 and 2.

3.5 Proof and breaking load tests

Chains and accessories are to withstand the proof and breaking load tests given in Table 3.

3.6 Freedom from defects

All chains are to have a workmanshiplike finish consistent with the method of manufacture and be free from defects. Each link is to be examined in accordance with section 4.5 using approved procedures.

3.7 Dimensions and dimensional tolerances

3.7.1 The shape and proportion of links and accessories must conform to ISO 1704:1991, or to the designs specially approved.

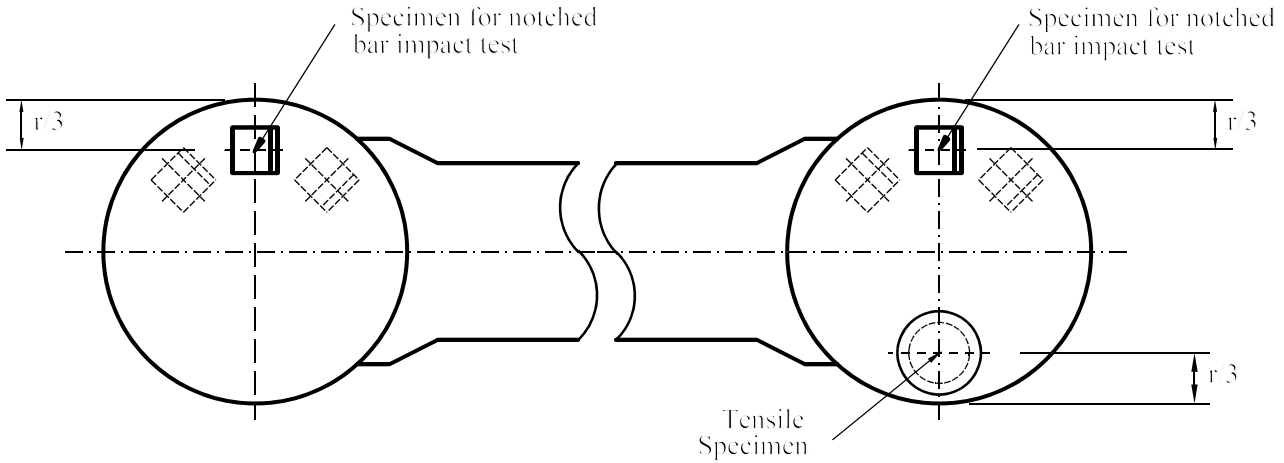


Fig. 2 Sampling of Chain Links

Table 3 Formulas for proof and breaking load test, weight and length over 5 links

	Grade KI-R3	Grade KI-R3S	Grade KI-R4
Proof test load [kN]	0.0148 d ² (44 - 0.08d)	0.0180 d ² (44 - 0.08d)	0.0216 d ² (44 - 0.08d)
Break test load [kN]	0.0223 d ² (44 - 0.08d)	0.0249 d ² (44 - 0.08d)	0.0274 d ² (44 - 0.08d)
Chain weight [kg/m]	0.0219 d ²		
Length over 5 links			
min [mm]	22 d		
max [mm]	22.55 d		

3.7.2 The following tolerances are applicable to links:

- a) Nominal diameter measured at the crown:
 - up to 40 mm diameter : - 1 mm
 - over 40 up to 84 mm diameter : - 2 mm
 - over 84 up to 122 mm diameter : - 3 mm
 - over 122 mm : - 4 mm

The plus tolerance may be up to 5 % of the nominal diameter. The cross sectional area at the crown must have no negative tolerance.

- b) Diameter measured at locations other than the crown:

The diameter is to have no negative tolerance. The plus tolerance may be up to 5% of the nominal diameter. The approved manufacturer's specification is applicable to the plus tolerance of the diameter at the flash butt weld.

- c) The allowable manufacturing tolerance on a length of five links is + 2.5 %, but may not be negative.

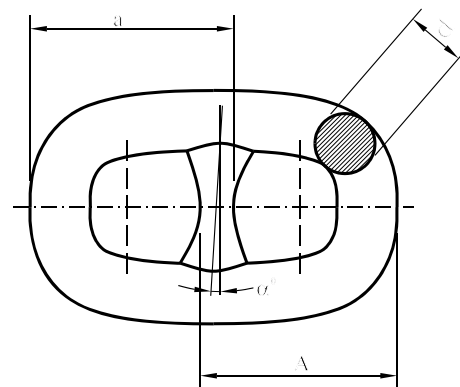
- d) All other dimensions are subject to a manufacturing tolerance of ± 2.5 % provided always that all parts fit together properly.

- e) Studs must be located in the links centrally and at right angles to the sides of the link. The following tolerances are acceptable provided that the stud fits snugly and its ends lie flush against the inside of the link:

Maximum off-centre distance "X" is 10 % of the nominal diameter

Maximum deviation "α" from the 90° -position is 4°.

The tolerances are to be measured in accordance with Fig. 3.



Off - centre distance :

$$X = \frac{A - a}{2}$$

Fig. 3 Manufacturing tolerances

3.7.3 The following tolerances are applicable to accessories:

- a) Nominal diameter : + 5 %, - 0 %
- b) Other dimensions : ± 2.5 %

3.8 Welding of studs

A welded stud may be accepted for grade KI-R3 and KI-R3S chains. Welding of studs in grade KI-R4 chains is not permitted unless specially approved.

3.8.1 Where studs are welded into the links this is to be completed before the chain is heat treated.

3.8.2 The stud ends must have a good fit inside the link and the weld is to be confined to the stud end opposite to the flash butt weld. The full periphery of the stud end is to be welded unless otherwise approved.

3.8.3 Welding of studs at both ends is not permitted unless specially approved.

3.8.4 The welds are to be made by qualified welders using an approved procedure and low-hydrogen approved consumables.

3.8.5 The size of the fillet weld shall as a minimum be as per API specification 2F or equivalent.

3.8.6 The welds are to be of good quality and free from defects such as cracks, lack of fusion, gross porosity and undercuts exceeding 1 mm.

3.8.7 All stud welds shall be visually examined. At least 10 per cent of all stud welds within each length of chain shall be examined by dye penetrant or magnetic particle after proof load testing. If cracks or lack of fusion are found, all stud welds in that length methods are to be examined.

3.9 Connecting common links

3.9.1 Single links to substitute for test links or defective links without the necessity for re-heat treatment of the whole length are to be made in accordance with an approved procedure. Separate approvals are required for each grade of chain and the tests are to be made on the maximum size of chain for which approval is sought.

3.9.2 Manufacture and heat treatment of connecting common link is not to affect the properties of the adjoining links. The temperature reached by these links is nowhere to exceed 250°C.

3.9.3 Each link is to be subjected to the appropriate proof load and non-destructive examination as detailed in Table 3 and Section 4.5. A second link shall be made identical to the connecting common link; the link shall be tested and inspected per Section 4.4 and 4.5.

3.9.4 Each connecting common link is to be marked on the stud in accordance with Section 4.7 plus an unique number for the link. The adjoining links are also to be marked on the studs.

4 Testing and Inspection of Finished Chain

4.1 General

All chains are to be subjected to proof load tests, breaking load tests and mechanical tests after final heat treatment in the presence of a Surveyor. Where the manufacturer has a procedure to record proof loads and the Surveyor is satisfied with the adequacy of the recording system, he need not witness all proof load tests. The Surveyor is to satisfy himself that the testing machines are calibrated and maintained in a satisfactory condition.

Prior to test and inspection the chain is to be free from scale, paint or other coating. The chain shall be sand or shot blasted to meet this requirement.

4.2 Proof and breaking load tests

4.2.1 The entire length of chain shall withstand the proof load specified in Table 3 without fracture and shall not crack in the flash weld. The load applied shall not exceed the proof load by more than 10 % when stretching the chain. Where plastic straining is used to set studs, the applied load is not to be greater than that qualified in approval tests.

4.2.2 A breaking load test specimen consisting of at least 3 links is to be either taken from the chain or produced at the same time and in the same manner as the chain. The test frequency is to be based on tests at sampling intervals according to Table 4 provided that every cast is represented. Each specimen shall be capable of withstanding the break load specified without fracture and shall not crack in the flash weld. It shall be considered acceptable if the specimen is loaded to the specified value and maintained at that load for 30 seconds.

If the loading capacity of the testing machine is insufficient, another equivalent method shall be agreed with BKI.

Table 4 Frequency of breaking load and mechanical tests

Nominal Chain Diameter [mm]	Maximum sampling interval [m]
min - 48	91
49 - 60	110
61 - 73	131
74 - 85	152
86 - 98	175
99 - 111	198
112 - 124	222
125 - 137	250
138 - 149	274
150 - 162	297
163 - 175	322

4.3 Dimensions and dimensional tolerances

4.3.1 After proof load testing measurements are to be taken on at least 5 per cent of the links in accordance with

Section 3.7.

4.3.2 The entire chain is to be checked for the length, five links at a time. By the five link check the first five links shall be measured. From the next set of five links, at least two links from the previous five links set shall be included. This procedure is to be followed for the entire chain length. The measurements are to be taken preferably while the chain is loaded to 5 - 10 % of the minimum proof load. The links held in the end blocks may be excluded from this measurement.

4.4 Mechanical tests

Links of samples detached from finished, heat treated chain shall be sectioned for determination of mechanical properties. A test unit shall consist of one tensile and nine impact specimens. The tensile specimen shall be taken at the side opposite the flash weld. Three impact specimens shall be taken across the flash weld with the notch centered in the middle. Three impact specimens shall be taken across the unwelded side and three impact specimens shall be taken from the bend region.

The test frequency is to be based on tests at sampling intervals according to Table 4 provided that every cast is represented. Mechanical properties shall be as specified in Table 1.

The frequency of impact testing in the bend may be reduced at the discretion of BKI provided it is verified by statistical means that the required toughness is consistently achieved.

4.5 Non-destructive examination

4.5.1 After proof load testing, all surfaces of every link shall be visually examined. Burrs, irregularities and rough edges shall be contour ground. Links shall be free from mill defects, surface cracks, dents and cuts, especially in the vicinity where gripped by clamping dies during flash welding. Studs shall be securely fastened.

4.5.2 Magnetic particle procedures shall be employed to examine the flash welded area including the area gripped by the clamping dies. Procedures and equipment in accordance with those approved shall be used. The frequency of examination shall be every link. Link surface at the flash weld shall be free from cracks, lack of fusion and gross porosity.

4.5.3 Ultrasonic procedures shall be employed to examine the flash weld fusion. Procedures and equipment in accordance with those approved shall be used. On-site calibration standards for chain configurations shall be approved.

The frequency of examination shall be every link.

The flash weld shall be free from defects causing ultrasonic back reflections equal to or greater than the calibration standard.

4.6 Retest, rejection and repair criteria

4.6.1 If the length over 5 links is short, the chain may be stretched by loading above the proof test load specified provided that the applied load is not greater than that approved and that only random lengths of the chain need stretching.

If the length exceeds the specified tolerance, the over length chain links shall be cut out and 4.6.2 shall apply.

4.6.2 If single links are found to be defective or to not meet other applicable requirements, defective links may be cut out and a connecting common link inserted in their place. The individual heat treatment and inspection procedure of connecting common links is subjected to approval of BKI.

Other methods for repair is subject to the written approval of BKI and the end purchaser.

4.6.3 If a crack, cut or defect in the flash weld is found by visual or magnetic particle examination, it shall be ground down no more than 5 % of the link diameter in depth and streamlined to provide no sharp contours. The final dimensions must still conform to the agreed standard.

4.6.4 If indications of interior flash weld defects in reference to the accepted calibration standards are detected during ultrasonic examination, 4.6.2 shall apply.

4.6.5 If link diameter, length, width and stud alignment do not conform to the required dimensions, these shall be compared to the dimensions of 40 more links; 20 on each side of the affected links. If a single particular dimension fails to meet the required dimensional tolerance in more than 2 of the sample links, all links shall be examined. Section 4.6.2 shall apply.

4.6.6 If a breaking load test fails, a thorough examination with the Surveyor informed in a timely manner is to be carried out to identify the cause of failure. Two additional breaking test specimens representing the same sampling length of chain are to be subjected to the breaking load test. Based upon satisfactory results of the additional tests and the results of the failure investigation, it will be decided what lengths of chain can be accepted. Failure of either or both additional tests will result in rejection of the sampling length of chain represented and 4.6.2 shall apply.

4.6.7 If a link fails during proof load testing, a thorough examination with the Surveyor informed in a timely manner is to be carried out to identify the probable cause of failure of the proof load test. In the event that two or more links in the proof loaded length fail, that length is to be rejected.

The above failure investigation is to be carried out especially with regard to the presence in other lengths of factors or conditions thought to be causal to failure.

In addition to the above failure investigation, a breaking load test specimen is to be taken from each side of the one

failed link, and subjected to the breaking load test. Based upon satisfactory results of both breaking load tests and the results of the failure investigation, it will be decided what length of chain can be considered for acceptance. Failure of either or both breaking load tests will result in rejection of the same proof loaded length.

Replacement of defective links is to be in accordance with 4.6.2.

4.6.8 If the tensile test fails to meet the requirements, a retest of two further specimens selected from the same sample shall be permissible. Failure to meet the specified requirements of either or both additional tests will result in rejection of the sampling length of chain represented and 4.6.2 shall apply.

4.6.9 If the impact test requirements are not achieved, a retest of three further specimens selected from the same sample shall be permissible. The results shall be added to those previously obtained to form a new average. The new average shall comply with the requirements. Not more than two individual results are to be lower than the required average and not more than one result is to be below 70 per cent of the specified average value.

Failure to meet the requirements will result in rejection of the sampling length represented and 4.6.2 shall apply.

4.7 Marking

4.7.1 The chain shall be marked at the following places:

- At each end.
- At intervals not exceeding 100 m.
- On links next to shackles or connecting common links.

All marked links shall be stated on the certificate, and the marking shall make it possible to recognize leading and tail end of the chain. In addition to the above required marking, the first and last common link of each individual charge used in the continuous length shall be adequately and traceably marked.

The marking shall be permanent and legible throughout the expected lifetime of the chain.

4.7.2 The chain shall be marked on the studs as follows:

- Chain grade
- Certificate No.
- Society's stamp

The Certificate number may be exchanged against an abbreviation or equivalent. If so, this shall be stated in the certificate.

The chain certificate shall contain information on number and location of connecting common links. The certificate number and replacement link number may be exchanged against an abbreviation or equivalent. If so, this shall be stated in the certificate.

4.8 Documentation

A complete Chain Inspection and Testing Report in booklet form shall be provided by the chain manufacturer for each continuous chain length. This booklet shall include all dimensional checks, test and inspection reports, NDT reports, process records, photographs as well as any non-conformity, corrective action and repair work.

Individual certificates are to be issued for each continuous single length of chain.

All accompanying documents, appendices and reports shall carry reference to the original certificate number.

The manufacturer will be responsible for storing, in a safe and retrievable manner, all documentation established for a period of at least 10 years.

5. Testing and Inspection of Accessories

5.1 General

All accessories are to be subjected to proof load tests, breaking load test and mechanical tests after final heat treatment in the presence of a Surveyor. Where the manufacturer has a procedure to record proof loads and the Surveyor is satisfied with the adequacy of the recording system, he need not witness all proof load tests. The Surveyor is to satisfy himself that the testing machines are calibrated and maintained in a satisfactory condition.

Prior to test and inspection the chain accessories are to be free from scale, paint or other coating.

5.2 Proof and breaking load tests

5.2.1 All accessories are to be subjected to the proof load specified for the corresponding chain.

5.2.2 Chain accessories are to be tested to the breaking test loads prescribed for the grade and size of chain for which they are intended. At least one accessory out of every batch or every 25 accessories, whichever is less, is to be tested.

For individually produced accessories or accessories produced in small batches, alternative testing will be subject to special consideration. Accessories which have been subjected to a breaking load test are to be scrapped.

5.3 Dimensions and dimensional tolerances

At least one accessory (of the same type, size and nominal strength) out of 25 is to be checked for dimensions after proof load testing. The manufacturer is to provide a statement indicating compliance with the purchaser's requirements.

5.4 Mechanical tests

Accessories are to be subjected to mechanical testing as described in Section 2.3 and 2.4. For individually produced accessories or accessories produced in small batches, alternative testing will be subjected to special consideration.

5.5 Non-destructive examination

After proof load testing all chain accessories are to be subjected to a close visual examination. Special attention is to be paid to machined surfaces and high stress regions. All non-machined surfaces are to be sand or shot blasted to permit a thorough examination. All accessories are to be checked by magnetic particle or dye penetrant methods.

The manufacturer is to provide a statement that non-destructive examination has been carried out with satisfactory results. This statement should include a brief reference to the techniques and to the operator's qualification.

5.6 Test failures

In the event of a failure of any test the entire batch represented is to be rejected unless the cause of failure has been determined and it can be demonstrated to the Surveyor's satisfaction that the condition causing the failure is not present in any of the remaining accessories.

5.7 Marking

Each accessory is to be marked as follows:

- Chain grade

- Certificate No.
- Society 's stamp

All detachable component parts shall be stamped with a serial number to avoid mixing of components.

The Certificate number may be exchanged against an abbreviation or equivalent. If so, this shall be stated in the certificate.

5.8 Documentation

A complete Inspection and Testing Report in booklet form shall be provided by the manufacturer for each order. This booklet shall include all dimensional checks, test and inspection reports, NDT reports, process records as well as any nonconformity, corrective action and repair work.

Each type of accessory shall be covered by separate certificates.

All accompanying documents, appendices and reports shall carry reference to the original certificate number.

The manufacturer will be responsible for storing, in a safe and retrievable manner, all documentation established for a period of at least 10 years.