

Guideline No.: W-11(202011)



W-11

**MOORING CHAINS AND
ACCESSORIES FOR POSITIONING
OF OFFSHORE INSTALLATIONS**

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Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at <http://www.ccs.org.cn>. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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Main changes:

- 1、 The requirements intended for R6 mooring chains and its accessories is added to this guideline.

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MOORING CHAINS AND ACCESSORIES FOR POSITIONING OF OFFSHORE INSTALLATIONS

1 Application

1.1 This Guideline is applicable to the products of mooring chains and accessories for offshore installations (Such as: the positioning of mobile offshore units, mooring of floating production units, mooring of offshore loading systems and mooring of gravity based structures, etc).

1.2 The products in this guideline included common stud and studless links, connecting common links(splice links), enlarge links, end links, detachable connecting links(shackles), end shackles, swivels and swivel shackles.

1.3 Studless link chain is normally deployed only once, being intended for long-term permanent mooring systems with per-determined design life.

1.4 Requirement for chafing chain for single point mooring arrangements are referred to this guideline.

1.5 According to raw material normal tensile strength, mooring chains are to be divided into five grades, i.e., R3, R3S, R4, R4S ,R5 and R6.

1.6 Manufactures propriety specification for R4S,R5and R6 may vary subject to design conditions and acceptance of CCS.

2 Normative references

2.1 The requirements in Chapter 10, Part One of CCS Rules for Materials and Welding.

2.2 IACS UR W22 Offshore Mooring Chain.

3 Terms and definitions

3.1 For the purpose of this Guideline, the terms and definitions given in CCS Rules for Materials and Welding apply.

3.2 The term “mooring chains and accessories for positioning of offshore installations” are hereinafter referred to as “mooring chains and accessories”.

4 Plans and documents

A manufacturer intending for works approval of mooring chains and accessories is to submit the following documents to CCS.

4.1 The following documents are to be submitted to CCS for information:

- (1) Particulars of the manufacturer, including the name, address, history, production capacity, technical and inspection personnel, main products, subordinate relationship, trademark, etc.;
- (2) Details of the products for approval; Quality management documents; Document of entering to the register of enterprise; Qualification certificate and/or production license; Specimen of products quality certificate; Quality control scheme (where applicable);
- (3) Source of raw materials: information on the manufacturer and its approval;
- (4) Production, inspection and test equipment. According to the approved product, a manufacturer must submit documents related to production and inspection of mooring chains to CCS. The documents include name/purpose, specification and capacity of chains manufacturing equipment, proof-load testing machines, forging equipment, casting equipment, welding equipment, heat treatment equipment, test equipment for mechanical properties and NDT , together with copies of calibration certificates of the equipment;
- (5) Manufacturing process: flow chart of manufacturing from the materials to the final products of mooring chains and accessories (including connecting common links), with main process and corresponding inspection points indicated;
- (6) Quality management documents;
- (7) Document of entering to the register of enterprise;
- (8) Qualification certificate and/or production license;
- (9) Specimen of products quality certificate;
- (10) Quality control scheme(where applicable);
- (11) Qualified supplier list(where applicable);
- (12) Manufacturers are to submit for review and approval the sequence of operations from

receiving inspection to shipment and details of the following manufacture processes:

- ① Bar heating and bending including method, temperatures, temperature control and recording;
- ② Flash butt welding, including current, force, time and dimensional variables as well as control and recording of parameters, the maintenance procedure and programme for welding machine;
- ③ Burr removal, including method and inspection;
- ④ Stud insertion, including method and impression, plastic yielding after heating, measurements and recording of impression;
- ⑤ Heat treatment, including furnace types, means of specifying, controlling and recording of temperature, and chain speed and allowable limits, quenching bath and agitation;
- ⑥ Proof and break loading tests, including method and equipment, means of horizontal support (if applicable), method of measurement, recording;
- ⑦ NDT procedure, including method, equipment, standard, and qualification of operators;
- ⑧ The manufacturer's surface quality requirement of mooring components;
- ⑨ The manufacturer's procedure for removing and replacing defective links without heat treatment of the entire chain.

4.2 The following documents are to be submitted to CCS for approval:

- (1) Drawings giving detailed design of chains and accessories, including drawings showing the detailed design of the stud;
- (2) Design drawings of connecting common links;
- (3) The type test program.

5 Design and technical requirements

5.1 Mooring chains and accessories are to be manufactured only by works approved by CCS. The approval test specifications see the Table 7.1. Each grade of mooring chains and accessories is to

be individually approved. Approval for a higher grade does not constitute approval of lower grade. If it is demonstrated to the satisfaction of CCS that the higher and lower grades are produced to the same manufacturing procedure using the same chemistry and heat treatment, consideration will be given to qualification of a lower grade by a higher. The parameters applied during qualification are not to be modified during production.

5.2 Calibration requirements of heat treatment furnace used for mooring chains

Except for chafing chains, mooring chains must be heat-treated in continuous furnace and not be permitted in batch furnace.

Calibration of furnace shall be verified by measurement and recording of a calibration test piece with dimensions equivalent to the maximum size of link manufactured. The manufacturer shall submit a procedure for furnace temperature surveys which shall include the following requirements: The temperature uniformity of furnaces is to be surveyed whenever approval of manufacturer is requested and at least annually during normal operating conditions. Furnaces are to be checked by conveying a monitoring link instrumented with two thermocouples through the furnaces at representative travel speed. One thermocouple shall be attached to the surface of the straight part and one thermocouple shall be inserted in a drilled hole located at the mid thickness position of straight part of the calibration block. The time-temperature curves shall show that the temperatures throughout the cross section and the soaking times are within specified limits as given in heat treatment procedure.

5.3 Calibration requirements of heat treatment furnace used for accessories

Calibration of furnaces shall be verified by measurement and recording of a calibration test pieces with dimensions equivalent to the maximum size of link manufactured. Thermocouples are to be placed both on the surface and in a drilled hole located to the mid thickness position of the calibration block. The furnace dimensions shall be such as to allow the whole furnace charge to be uniformly heated to the necessary temperature. Temperature uniformity surveys of heat treatment furnaces for forged and cast components shall be carried out according to API Spec 6A/ISO 10423 Annex M or ASTM A991. The initial survey shall be carried out with maximum charge(load) in the furnace. Subsequent surveys shall be carried out annually and may be carried out with no furnace charge.

The quench bath maximum temperature and the maximum heat treatment transfer times from furnace to quench are to be established and documented. During production the established quenching parameters are to be followed and records are to be maintained of bath temperatures and transfer times.

5.4 Additional requirements for R4S,R5 and R6 mooring chains and accessories

For R4S ,R5 and R6 chain and accessories, prior to approval, the manufacturer is to be have undertaken experimental tests or have relevant supporting data to develop the chain and accessory material. The tests and data may include: fatigue tests, hot ductility tests (no internal flaws are to develop whilst bending in the link forming temperature range), welding parameter research, heat treatment study, strain age resistance, temper embrittlement study, stress corrosion cracking (SCC) data and hydrogen embrittlement (HE) study, using slow strain test pieces in hydrated environments. Reports indicating the results of experimental tests are to be submitted.

5.5 Approval of quality system at chain and accessory manufacture

Chain and accessory manufacturers are to have a documented and effective quality system approved by CCS. The provision of such a quality system is required in addition to , and not in lieu of , the witnessing of tests by a Surveyor.5.6 The technical requirements for mooring chains and accessories are given in the following Table5.6.

Table of Mooring Chains and Accessories Technical Requirements **Table 5.6**

Number	Content	Requirements in CCS Rules for Materials and Welding	Remark
1	Steel for welded mooring chain	10.3.3	
2	Forged steel for mooring chain	10.3.3	
3	Materials for studs	10.3.3	
4	Shape and dimension of chains	10.3.4 10.3.8	
5	Manufacture of mooring chains	10.3.5	
6	Mechanical properties	10.3.8	
7	Proof and break tests	10.3.8	
8	Welding of studs	10.3.6 10.3.4	
9	Connecting common links	10.3.5.3 10.3.7	
10	Non-destructive examination	10.3.8.11 10.3.8.12	
11	Testing and inspection of chains	10.3.8 10.3.9 10.3.11	
12	Testing and inspection of accessories	10.3.11	
13	Marking	10.3.10	

6 Material and parts

Steel intended for mooring chains and accessories are to be manufactured only by works approved by CCS. The approval is limited to a nominated supplier of steel. If a mooring chain or accessory manufacturer wishes to use material from a number of suppliers, separate approval tests must be carried out for each supplier.

7 Type test

7.1 The each grade product with maximum diameter is to be individually selected for common links and connecting common links (splice links) for approval. The approval of enlarged links(EL) and end links(E) are to be in accordance with the test items and requirements for links. The mooring chains tested are to have adequate number of links for the items in the table 7.1.

7.2 The approval will normally be limited to the type of accessory. The product with maximum diameter or thickness equal to that of completed accessory is to be selected for approval. However for the different accessories that have the same geometry, the tests for initial approval are to be carried out on the one having the lowest reduction ratio. Qualification of accessory pins to maximum diameters is also required.

7.3 In an initial approval, the capacity of different units to manufacture chains of maximum diameter is to be verified.

7.4 The added items, change and renewal of the works approval certificate may be referred to the related requirements of WORK APPROVAL PROCEDURE(CCS WPMP704).

7.5 The approval test items and requirements see table 7.1

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INSTALLATIONS

Table of Test Items

Table 7.1

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)	Links	Accessories	Remark
1	Chemical composition	10.3.3	√	√	Materials for links and accessories
2	Tensile test	10.3.8.8	√	—	
		10.3.11 Specimens of swivels to be taken on the body and pin respectively.	—	√	
3	Impact test	10.3.8.8 Test temperatures to be -40°C, -20°C and 0°C respectively	√	—	The value at -40°C for reference only
		10.3.11 Specimens of swivels to be taken on the body and pin respectively	—	√	
4	Break load test	10.3.8.5 (links), 10.3.11 (accessories)	√	√	
5	Proof load test	10.3.8.5 (links), 10.3.111 (accessories)	√	√	
6	Magnetic particles test	10.3.8.11 (links) 10.3.11.12 (accessories)	√	√	
7	Ultrasonic test	10.3.8.12(links), 10.3.11.12(accessories)	√	√	
8	Stud weld examination	10.3.6	√	—	
9	Dimensions	10.3.4 10.3.8 (links) 10.3.11.7 (accessories)	√	√	
10	Visual examination	10.3.8.3 (links), 10.3.11.2 (accessories)	√	√	
11	Stud impression examination	Specimen to be the section at the centerline of links, the depth of impression and radius of corner are to be measured, recorded and photographed	√	—	Applicable to stud chain cables
12	Metallographic phase examination	Three micro-specimens to be taken to show flash weld, the impression corner and parent materials respectively. Corrosion of micro-specimens to be photographed (×100 magnification and ×500 magnification)	√	—	
		Three micro-specimens to be taken on the surface, at the center and 1/3r to the surface of the accessories. Specimens of swivels to be taken on the body and pin respectively. Corrosion of micro-specimens is to be photographed (×100 magnification and ×500 magnification)	—	√	
13	Macro-examination	Two macro-specimens, one of which is longitudinal section of links to show flash weld side stud impression area and two crown cross sections, the other is section at the centerline of links to show flash weld, stud impression depth and corner radius and stud weld (if applicable). Corrosion of macro section to be photographed (×1magnification). Impression area (×10 magnification) to be examined and free from cracks, laps or other defects	√	—	Macro-examination may be exempted where the compression ratio is not less than 7:1
		The macro-specimens to be cross sections of accessories. Corrosion of macro section to be photographed (×1magnification) and free from cracks, laps or other defects	—	√	
14	Hardness test	Vickers or Rockwell hardness tester to be adopted to measure hardness distribution through diameter. The maximum space between two measuring points to be 2.5mm. The distribution diagram to be submitted	√	√	

Continued Table7.1

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)	Links	Accessories	Remark
15	Crack tip opening displacement (CTOD)	<ul style="list-style-type: none"> ▶For initial approval, CTOD tests are to be carried out on the each grade of mooring chains and accessories. ▶CTOD test are to be tested in accordance with a recognized standard such as BS 7448 Part 1 & part 2 or BS EN ISO 15653: ▶The CTOD specimen to be standard 2×1 bending specimen, with one open side. The position of test specimen see figure 7.5.1 and 7.5.2. The notch of the CTOD specimen is to be located as close to the surface as practicable. ▶For mooring chains and accessories with circular geometries, where the diameter of chain cable is less than 120mm, the minimum cross section of the test piece of specimen is 50×25mm. Where the diameter of chain cable is over 120mm, the minimum cross section of the test piece of specimen is 80×40mm. ▶For rectangular accessories, the CTOD test piece is full thickness of material to be tested. Subsize specimens can be used subject to approval of CCS. ▶ CTOD specimens of mooring chains are to be taken from both the side of the link containing the weld and from the opposite side. 3×2 CTOD specimens manufactured from 3 links are to be selected for testing . ▶ Three CTOD tests of accessories are to be tested. The geometry of accessories can vary. The figure 7.5.2 a) shows the CTOD location for circular cross sections such as those of the D-shackle, and figure 7.5.2 b) shows rectangular cross sections such as the accessories fabricated from rectangular sections. ▶ The orientation of specimen shall consider the direction of the grain flow. The figure 7.5.2 b) shows two possible sampling position for CTOD test specimens with notch orientation for rectangular type accessories. ▶ The value of CTOD not to be less than that specified in 3 of this Chapter. The test temperature to be -20°C 	√	—	
16	Assessment of welding procedure	The welding procedure of studs to be assessed	√	—	At discretion of CCS

Continued Table 7.1

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)	Links	Accessories	Remark
17	Environmentally assisted cracking tests for R6 (slow strain rate testing)	<ul style="list-style-type: none"> ▶ At least one accessory shall be tested. The accessory for tensile and impact testing may be used. ▶ Two test pieces for each test condition shall be prepared as close as possible to the surface. ▶ Testing shall be in accordance with ASTM G129 or an equivalent standard using uniaxial smooth tension test pieces. ▶ Testing shall be performed under the following conditions: in artificial seawater according to ASTM D1141 at free corrosion potential, at applied potential -850 mV (SCE), at applied potential -1200 mV (SCE) and in dry air (control environment). ▶ Testing shall be performed at a strain rate of 10^{-5} [s⁻¹]. Testing at lower rates is acceptable. ▶ Test results shall be reported as reduction in area after fracture including reduction in area ratio. 	√	√	
18	Environmentally assisted cracking tests for R6 (K _{IEAC} testing)	<ul style="list-style-type: none"> ▶ At least one accessory shall be tested. The accessory for tensile and impact testing may be used. ▶ Two test pieces for each test condition shall be prepared. ▶ Testing shall be in accordance with ASTM E1820 or an equivalent standard using compact tension specimens with thickness 25 mm. ▶ Testing shall be performed under the following conditions: in artificial seawater according to ASTM D1141 at applied potential -950 mV (SCE) and at applied potential -1050 mV (SCE). ▶ Specimens shall be hydrogen pre-charged for 48 hours prior to testing. ▶ Testing shall be performed at a rate of 6×10^{-9} m/s. Testing at lower rates is acceptable. ▶ Test results shall be reported as K_{IEAC} values indicating the sensitivity to the environment. 	√	√	

Note: “√” indicates “applicable”; “—” indicates “not applicable”.

7.5.1 Specified value of CTOD and the sample location.

Table Value of CTOD for Links

Table 7.5.1(1)

Grade / Place	R3 (mm)		R3S (mm)		R4 (mm)		R4S&R5 (mm)		R6 (mm)	
	link back	weld	link back	weld	link back	weld	link back	weld	link back	weld
With stud link	0.20	0.10	0.22	0.11	0.24	0.12	0.26	0.13	0.27	0.14
Without stud link	0.20	0.14	0.22	0.15	0.24	0.16	0.26	0.17	0.27	0.18

Table Value of CTOD for Accessories

Table 7.5.1(2)

Grade	R3(mm)	R3S(mm)	R4(mm)	R4S/R5(mm)	R6(mm)
CTOD	0.20	0.22	0.24	0.26	0.27

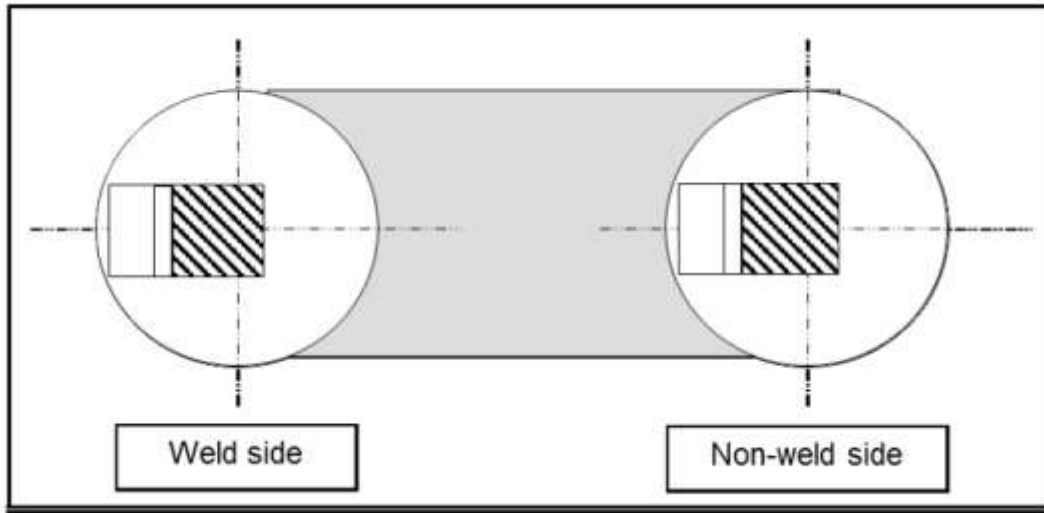


Figure 7.5.1(1) Location of CTOD test specimens for links

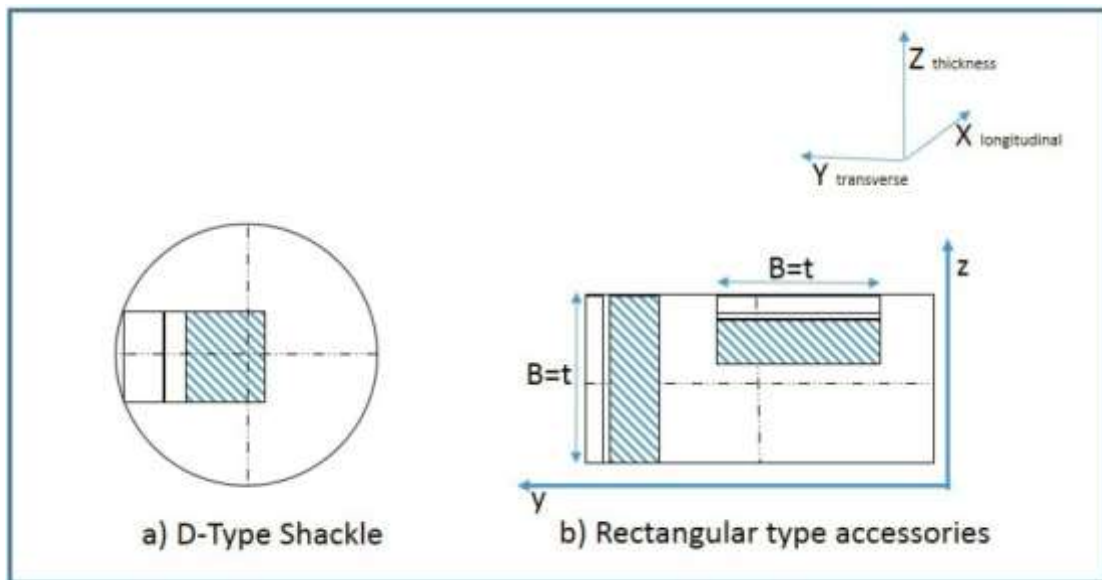


Figure 7.5.1(2) Location of CTOD test specimens: a) Circular type accessory and b) rectangular type accessory. B corresponds to the thickness of material, the grain flow is considered in the longitudinal direction X

8 Unit/batch inspection

8.1 The test items and requirements are given in Table 8.1.

Table of Test Items

Table 8.1

No.	Test items	Test requirements (corresponding paragraphs from CCS Rules for Materials and Welding)		Remark
		links	accessories	
1	Mechanical properties test (tensile and impact tests)	10.3.8.8	10.3.11	
2	Break load test	10.3.8.5	10.3.11	
3	Proof load test	10.3.8.5	10.3.11	
4	Magnetic particles test	10.3.8.11	10.3.11.12	
5	Ultrasonic test	10.3.8.12	-----	
6	Stud weld examination	10.3.6	-----	
7	Dimensions	10.3.4 10.3.8	10.3.11.6	
8	Visual examination	10.3.8.3	10.3.11.2	

8.2 The relevant records or reports submitted by the manufacturer is to contain the materials certificate, mechanical property test, breaking test, proof-load test, non-destructive test, stud weld examination, dimensions, external quality, heat treatment, photograph, non-conforming links, repairs, number and location of connecting common links.