

UNITED STATES COAST GUARD

OCEAN ENGINEERING DIVISION

WASHINGTON, D.C.

NOVEMBER 2005

SPECIFICATION FOR THE MANUFACTURE

OF

OPEN LINK, WELDED STEEL CHAIN AND BRIDLES

SPECIFICATION NO. 377

REVISION K

1. SCOPE

1.1 Purpose. This specification describes the requirements for the manufacture of open link, welded steel chain and bridles used for mooring aids to navigation buoys in the coastal and inland waters of the United States.

1.2 Precedence. In the event of a conflict between the requirements of this specification, the drawings, the contract, and the applicable documents, the order of precedence is as follows:

- a. The contract
- b. This specification
- c. The drawings listed in paragraph 2.2
- d. The applicable documents listed in paragraph 2.1

1.3 Classification. Chain and Bridles are classified by size (Tables I and II), which is defined as the bar diameter in inches (in) or millimeters (mm) of the common links used in the chain or bridles combined with the respective length in feet or meters. Chain and Bridle dimensions shall be either U.S. Customary Sizes (inches/feet) or Metric Sizes (millimeters/meters); these two measurement standards shall NOT be combined.

1.3.1 Chain. Lengths of chain are called “shots” (90ft (27.4m) lengths) and “half-shots” (45ft (13.7m) lengths).

Table I

U.S. Customary Sizes (inches)	Metric Sizes (millimeters)	U.S. Customary Sizes (inches)	Metric Sizes (millimeters)
1/2	12.7	1-3/4	44
3/4	19	1-7/8	48
1	25	2	51
1-1/8	28	2-1/8	54
1-1/4	32	2-1/4	57
1-1/2	38		

1.3.2 Bridles. Bridle lengths are expressed in either U.S. Customary sizes in feet or Metric sizes in meters.

Table II

U.S. Customary Sizes (in x feet)	Metric Sizes (mm x meters)
7/8 x 10	22 x 3.1
1 x 12	25 x 3.6
1-1/4 x 15	32 x 4.5
1-1/2 x 18	38 x 5.5
1-1/2 x 20	38 x 6.1
1-1/2 x 26	38 x 7.9

2. APPLICABLE DOCUMENTS

2.1 Industry publication. The following document of the issue specified forms a part of this specification to the extent referenced herein. The suffix denoting the specific issue of the document will be omitted from future references to the document in this specification.

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)

ANSI/ASQC Quality Systems - Model for Quality Assurance in Production,
Q9002-1994 Inspection, and Servicing

2.1.1 Source of document. The document may be obtained from the following source:

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)
310 West Wisconsin Avenue
Milwaukee, Wisconsin 53203

2.2 Drawings. The latest revisions of the following United States Coast Guard Ocean Engineering Drawings form a part of this specification, and are hereafter referred to as "the drawings."

<u>Number</u>	<u>Title</u>
121031	Buoy Bridles
121032	Buoy Chain

3. REQUIREMENTS

3.1 General. The chain and bridles shall be manufactured in accordance with the drawings and shall meet the requirements of this specification.

3.2 Material. The chain and bridles shall be manufactured of carbon steel of uniform quality and shall be resistance welded. The chemical composition of the steel shall be determined at the steel mill for each heat of steel and shall conform to the following values:

<u>Element</u>		<u>Weight % (Max.)</u>
Carbon	(C)	0.36
Manganese	(Mn)	1.90
Silicon	(Si)	0.55
Phosphorus	(P)	0.05
Sulfur	(S)	0.05

3.2.1 Material certificates. The Contractor shall furnish material certificates from the steel mill for each heat of steel used. The report shall indicate the heat number, steel designation, chemical composition, and quantity of steel represented by the report.

3.3 Traceability. The Contractor shall maintain the traceability of steel throughout the production, testing, and inspection processes. Each shot and each bridle offered shall be traceable to the heat of steel from which it was made through the batch and serial numbers described below.

3.3.1 Batch number. A batch is defined as all chain and bridles of the same size manufactured from the same heat of steel. The Contractor shall assign a unique number to each batch of chain and bridles. The Contractor may use the heat number assigned by the steel mill as the batch number provided it meets the requirements of this paragraph.

3.3.2 Serial number. The Contractor shall assign a unique sequential number to each shot and each bridle submitted under this specification. See marking requirements in paragraph 3.12.

3.4 Design.

3.4.1 Chain. Chain shall be furnished in shots of at least 90-feet (27.4m) and 45-feet (13.7m) lengths (tolerance = +3%, -0%). The common links and end links shall conform to the shapes, dimensions, and tolerances shown on the drawings. End links are required only on 1/2in (12.7mm) and 3/4in (19mm) chain.

3.4.2 Bridles. Bridles shall be constructed of a specific number of common links and shall be the applicable length within specified tolerances shown in the Table III and on the drawings. The common links, end links, and center rings shall conform to the shapes, dimensions, and tolerances shown on the drawings. End links are required on all bridles.

Table III

U.S. Customary Sizes (inches x feet)			Total Common Links	Metric Sizes (millimeters x meters)		
Bridle Size	Minimum Length	Maximum Length		Bridle Size	Minimum Length	Maximum Length
7/8 x 10	10ft	10ft 7in	28	22 x 3.1	3.00m	3.20m
1 x 12	11ft 3in	12ft 3in	28	25 x 3.6	3.38m	3.65m
1-1/4 x 15	14ft	15ft 3in	28	32 x 4.5	4.24m	4.57m
1-1/2 x 18	17ft	18ft 3in	28	38 x 5.5	5.12m	5.50m
1-1/2 x 20	19ft	20ft 3in	32	38 x 6.1	5.70m	6.12m
1-1/2 x 26	25ft	26ft 3in	44	38 x 7.9	7.46m	8.00m

3.4.3 Inside curvature of links. The common links and end links of chain and bridles shall be

made such that the inside curvature shall allow a round bar, of the diameter listed in Table IV, to pass through the link at either end. When the bar is held perpendicular to the link, it shall not be restricted from making contact with, or coming within 1/32in (0.8 mm) of, all points along the curvature, or from freely passing between both ends of the link.

Table IV

Minimum Inside Curvature Mating			
Chain Size		Minimum Bar Diameter	
inch	millimeter	inch	millimeter
1/2	12.7	5/8	15.9
3/4	19	1	25.4
1	25	1-5/16	33.3
1-1/8	28	1-1/2	38.1
1-1/4	32	1-11/16	42.9
1-1/2	38	2	50.8
1-3/4	44	2-3/8	60.3
1-7/8	48	2-9/16	65.1
2	51	2-3/4	69.9
2-1/8	54	3	76.2
2-1/4	57	3-1/8	79.5

3.5 Welding. Welding shall be performed by resistance welding.

3.5.1 Weld defects. The welds shall not contain craters, undercutting, overlap, or porosity.

3.5.2 Weld Diameter. The diameter of the weld at any one point shall not be less than the bar diameter, nor shall it exceed the bar diameter by more than 10 percent.

3.5.3 Bar end misalignment. Bar end misalignment shall not exceed 5 percent of the bar diameter.

3.6 Proof load. Every shot of chain and every bridle offered for acceptance shall have successfully withstood the proof load specified in Table V without rupture, deformation, cold welding, or stretching beyond the tolerances shown on the drawings. A horizontal test bed or an incremental calibrator shall be used to apply the proof load. This process shall be recorded in the documentation of inspections and tests required by paragraph 4.1.2. The Contractor shall certify conformance with this requirement by submitting a Certificate of Performance (Appendix A) for each batch of chain or bridles offered.

3.7 **Breaking load.** Chain and bridles shall be capable of withstanding the applicable breaking load specified in Table V for a minimum of 15 seconds without rupture.

Table V

Proof and Breaking Loads					
Chain/Bridle Link Diameter		Proof Load		Breaking Load	
inch	millimeter	lb	kg	lb	kg
1/2	12.7	7,500	3,402	15,000	6,804
3/4	19	16,000	7,257	32,000	14,515
7/8	22	22,000	9,979	44,000	19,958
1	25	29,000	13,154	58,000	26,308
1-1/8	28	38,500	17,463	77,000	34,927
1-1/4	32	45,500	20,638	91,000	41,277
1-1/2	38	65,500	29,710	131,000	59,421
1-3/4	44	86,500	39,236	173,000	78,472
1-7/8	48	100,000	45,360	200,000	90,720
2	51	116,000	52,616	232,000	105,232
2-1/8	54	131,000	59,420	262,000	118,841
2-1/4	57	147,000	66,678	294,000	133,355

3.8 **Elongation.** The elongation of the chain and bridles shall be at least 15 percent before rupture. The elongation shall be determined in accordance with paragraph 4.2.4.6.

3.9 **Cracks.** A crack is defined as a linear defect that has a length of more than three (3) times its width. Chain and bridles shall be free from cracks in the interior link radius and weld fusion zone.

3.10 **Surfaces.** Each link shall be free from mill defects, burrs, slag, weld spatter, or rough surfaces which might present a safety hazard or cause kinking of the chain or bridle in service.

3.11 **Finish.** Chain and bridles shall be submitted in natural color and finish. Varnish or other coatings shall not be used.

3.12 **Marking.** The last link on both ends of each shot of chain and one end link on each bridle shall be legibly and permanently stamped or engraved with the manufacturer's name or trademark, the serial number per paragraph 3.3.2, and the year of manufacture.

4. INSPECTION AND ACCEPTANCE

4.1 General. The Contractor shall have a quality assurance program in place prior to beginning the manufacture of the chain and bridles. This quality assurance program shall meet the minimum requirements of ANSI/ASQC Q9002. However, the Contractor does not have to be Q9002 certified. The Contractor shall ensure that every shot and bridle submitted to the Coast Guard meets the requirements of this specification.

4.1.1 Test equipment calibration system. The Contractor shall maintain a calibration and maintenance system to control the accuracy of measurement and test equipment used in the fulfillment of the requirements of this specification. The system shall include, as a minimum, prescribed calibration intervals, source of calibration, and a monitoring system to ensure adherence to calibration schedules. All testing equipment shall have been calibrated traceable to the International Standards within 12 months prior to the testing. At the time of final inspection, documentation in support of this requirement shall be made available to the Contracting Officer's Technical Representative (COTR).

4.1.2 Documentation of inspections and tests. The Contractor shall maintain, and make available to the COTR, documentation of all inspections and tests performed throughout the entire manufacturing process and during the final inspection.

4.2 Coast Guard final inspection. The following inspections and tests are not intended to limit or supplant any inspections or tests normally performed by the Contractor to ensure product quality.

4.2.1 Sampling. Samples for inspections and tests performed during the final inspection will be randomly selected from batches by the COTR. The actual number of samples selected for testing will be at the discretion of the COTR.

4.2.2 Units of inspection.

4.2.2.1 Overall shot and bridle length requirement. The unit of inspection for the overall length requirement in paragraphs 3.4.1 and 3.4.2 will be one shot or one bridle.

4.2.2.2 Proof load, breaking load, and elongation test requirements. The unit of inspection for the requirements in paragraphs 3.6, 3.7, and 3.8 will be one shot or one bridle.

4.2.2.3 Other requirements. The unit of inspection for the requirements in paragraphs 3.4.3, 3.5.1, 3.5.2, 3.5.3, 3.9, 3.10, 3.11, and 3.12 will be one link.

4.2.3 Rejection Criteria.

4.2.3.1 Rejection criteria for material composition defects. Failure to comply with the requirements of paragraphs 3.2, 3.2.1, and 3.3 will result in rejection of the entire batch. A batch thus rejected shall not be resubmitted.

4.2.3.2 Rejection criteria for visual defects. Failure to comply with the requirements in

paragraphs 3.4.1, 3.4.2 (except for bridle length – see paragraph 4.2.3.3), 3.4.3, 3.5.1, 3.5.2, 3.5.3, 3.10, 3.11, and 3.12 will result in rejection of the entire batch in accordance with the rejection criteria in Tables VI and VII. The rejected batch may, at the discretion of the COTR, be reworked and resubmitted for inspection when it complies with this specification.

Table VI

Overall Length Rejection Criteria		
Number of shots or half-shots per batch	Defective shots or half-shots	
	Accept	Reject
2 to 15	0	1
16 to 50	1	2
51 to 90	2	3
91 to 150	3	4
151 to 280	5	6
281 and above	7	8

Table VII

Rejection Criteria for Visual Defects (other than overall length)		
Number of links in batch	Defective links	
	Accept	Reject
up to 500	2	3
501 to 1,200	3	4
1,201 to 3,200	5	6
3,201 to 10,000	7	8
10,001 to 35,000	10	11
35,001 and above	14	15

4.2.3.3 Rejection criteria for bridle length defects. Failure of any sample to comply with the bridle length requirements of paragraph 3.4.2, Table III will result in rejection of the entire batch. The rejected batch may, at the discretion of the COTR, be reworked and resubmitted for inspection.

4.2.3.4 Rejection criteria for welds. Links shall not rupture at the weld when subjected to the tests outlined in paragraphs 4.2.4.4, 4.2.4.5, and 4.2.4.6. Any link that ruptures at the weld will result in rejection of the entire batch. A batch thus rejected shall not be reworked or resubmitted.

4.2.3.5 Rejection criteria for strength and elongation defects. Failure of any sample to comply with the requirements of paragraphs 3.6, 3.7, and 3.8 will result in rejection of the entire batch. A batch thus rejected shall not be reworked or resubmitted.

4.2.3.6 Rejection criteria for cracks. Failure of any sample to comply with the requirement of paragraphs 3.9 will result in rejection of the entire batch. A batch thus rejected shall not be reworked or resubmitted.

4.2.4 Inspections and tests.

4.2.4.1 Material conformance inspection. The COTR will review the material certificates required by paragraph 3.2.1 to verify conformance with paragraph 3.2. In addition, the COTR will review the Contractor's traceability system to verify conformance with paragraph 3.3. Rejection criteria for the material conformance inspection will be in accordance with paragraph 4.2.3.1.

4.2.4.2 Visual inspection. The Contractor shall perform all visual inspections necessary to ensure compliance with the requirements of paragraphs 3.4.1, 3.4.2, 3.4.3, 3.5.1, 3.5.2, 3.5.3, 3.10, 3.11, and 3.12. At the time of final inspection, the COTR will verify compliance by performing visual inspections on selected samples. Rejection criteria for visual inspections will be in accordance with paragraphs 4.2.3.2 and 4.2.3.3.

4.2.4.3 Proof load test. The COTR will review the Certificates of Performance required by paragraph 3.6. In addition, the COTR will witness proof load tests performed on selected samples. Rejection criteria for the proof load test will be in accordance with paragraph 4.2.3.5.

4.2.4.4 Breaking load test. The breaking load tests shall be performed in the presence of the COTR. Samples for these tests shall be cut from the ends of the sample shots or bridles chosen by the COTR. Samples shall consist of 3 to 7 links (excluding the end links) as required by the testing machine being used, or as determined by the COTR. Samples shall be free from twist, and shall be secured to the testing machine with a bar, pin, or half link having a diameter no greater than the "minimum bar diameter" listed in Table IV for the diameter of the sample links being tested. All stresses bearing on the terminal links shall be the same as those applied to every link in the sample. The samples shall be brought to the breaking load and held for 15 seconds. The highest load applied to each sample shall be recorded on the documentation of inspections and tests as required by paragraph 4.1.2. Rejection criteria for the breaking load test will be in accordance with paragraph 4.2.3.5.

4.2.4.5 Weld strength testing. During the breaking load test, the COTR may require that the load be increased until the sample ruptures. Samples that break at the weld will result in rejection of the batch in accordance with paragraph 4.2.3.4. The highest load applied to each sample shall be recorded on the documentation of inspections and tests as required by paragraph 4.1.2.

4.2.4.6 Elongation test. The elongation test shall be performed in the presence of the COTR. Samples for these tests may be the same as those used for the breaking load tests at the discretion of the COTR. The setup criteria shall be as specified in paragraph 4.2.4.4. Elongation shall be determined using an autographic recorder, or by measuring the sample manually before and after the test. When performing manual measurements, ten percent of the applicable proof load shall be applied to each sample for the initial measurement to ensure that the links are properly set. Subsequent measurements of each sample shall be taken with the load reduced to ten percent of the proof load. The elongation for each sample shall be recorded on the documentation of inspections and tests as required by paragraph 4.1.2. Rejection criteria for the elongation test will be in accordance with paragraph 4.2.3.5.

4.2.4.7 Testing for cracks. The COTR will test selected samples for cracks using magnetic particle or dye penetrate inspection procedures. Rejection criteria for cracks will be in accordance with paragraph 4.2.3.6.

4.3 Disposition of shot and bridle remains.

4.3.1 Shots. Shots which have had no more than 9 links (including the end link) cut from one end for purposes of the breaking load and elongation tests may be submitted as deliverables. Although the shots may not meet the overall length requirements of paragraph 3.4.1, they shall meet all other requirements of this specification. The marking required by paragraph 3.12 shall be located on the last common link.

4.3.2 Bridles. Bridles which have had sample links cut out for the breaking load and elongation tests shall be reworked to replace the sample links (including the end link) and proof tested again. If they successfully pass the proof test (and all other requirements of this specification), then they may be submitted as deliverables. The Contractor shall certify conformance of the proof load test by submitting a Certificate of Performance (Appendix A) for each batch of bridles that have been reworked.

5. PACKAGING AND MARKING

5.1 Preservation, Packaging, Packing. Chain and bridles shall be bundled with wire rope or bundling chain of sufficient size and strength to ensure safe handling and delivery, or shall be contained in barrels. Bundling chain and barrels, as used, shall become the property of the Coast Guard. The maximum number of shots per bundle and the maximum number of bridles per bundle are listed in Tables VIII. The shipment shall be packaged in a manner that will facilitate unloading at destination by standard lifting equipment (i.e., forklift or crane).

Table VIII

Chain Bundling			Bridle Bundling		
Chain Size		Shots per Bundle	Bridle Size		Bridles per Bundle
inch x feet	millimeter x meter		inch x feet	millimeter x meter	
1/2 x 45	12.7 x 13.7	10	7/8 x 10	22 x 3.1	10
1/2 x 90	12.7 x 27.4	10	1 x 12	25 x 3.6	10
3/4 x 90	19 x 27.4	5	1-1/4 x 15	32 x 4.5	8
1 x 90	25 x 27.4	3	1-1/2 x 18	38 x 5.5	5
1-1/8 x 90	28 x 27.4	1	1-1/2 x 20	38 x 6.1	4
1-1/4 x 90	32 x 27.4	1	1-1/2 x 26	38 x 7.9	4
1-1/2 x 90	38 x 27.4	1			
1-3/4 x 90	44 x 27.4	1			
1-7/8 x 90	48 x 27.4	1			
2 x 90	51 x 27.4	1			
2-1/8 x 90	54 x 27.4	1			
2-1/4 x 90	57 x 27.4	1			

5.2 Marking. Each barrel or bundle shall be tagged with metal shipping tags indicating the complete name and address of consignee, contract number, contract item number, lot number, quantity contained, size, and name of manufacturer.

5.3 Material Inspection and Receiving Report (DD-250 Form). A form DD-250 shall be used as a certification of Contract Quality Assurance (CQA), as a packing list, and as a certification of acceptance. The Contractor shall prepare a separate DD-250 for each shipping lot. Three copies of the DD-250 shall be delivered with each lot. Two copies of the signed DD-250 shall be retained by the receiving unit. One copy of the signed DD-250 shall be mailed to the Contracting Officer at the address shown in the contract. The copy returned to the Contracting Officer shall be clearly marked “Information Only” and shall be used as supporting documentation for and must be submitted with each invoice. In addition, Block 23 of the DD-250 shall contain the following information:

“DELIVERY DESTINATION: Inspect all items for correct quantity and damage. Indicate any discrepancies below. Sign block 22 and retain one for unit files, one copy for District/Sector Commander (as necessary) and fax one copy to Commandant (CG-432B) at (202) 267-4788.”

SPECIFICATION FOR THE MANUFACTURE OF OPEN LINK, WELDED STEEL CHAIN
AND BRIDLES

SPECIFICATION NO. 377 REVISION K

NOVEMBER 2005

PREPARED BY:

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15 November 2005

Harley R. Cleveland
Chief, Ocean Engineering Division

Date

APPENDIX A

CERTIFICATE OF PERFORMANCE

Contract No.

Chain/Bridle Size _____

Batch/Heat No. _____

I hereby certify that all shots and bridles in the above numbered batch consisting of shots numbered _____ through _____ and/or bridles numbered _____ through _____ submitted for the above numbered contract have successfully passed the proof load test as specified in paragraph 3.6 and Table V of U.S. Coast Guard Specification No. 377K.

Signed _____ Date _____

Title _____