Recommended Practice for Qualification Testing of Steel Anchor Designs for Floating Structures

API RECOMMENDED PRACTICE 2M
FOURTH EDITION, MAY 1996

EFFECTIVE DATE: JUNE 1,1996

American Petroleum Institute

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Recommended Practice for Qualification Testing of Steel Anchor Designs for Floating Structures

1 Scope

1.1 Procedures for testing and qualification of the structural integrity of steel anchors are described. These procedures are suitable for use with "conventional" anchors designed with flukes, shank, stock, and padeye that are normally found in floating drilling structure service (see Figure 1). Qualification should apply to one anchor of each design.

1.2 Additional anchor sizes and designs shall be considered for inclusion in future editions of this publication upon submitting data to API, 1220 L Street, NW, Washington, D.C. 20005.

2 Tests and Testing Procedures

2.1 GENERAL

Tests should include proof tests to verify the structural integrity of the anchor flukes, crown, shank, shackle, and crown padeye. A hammering test (resonance) should also be conducted for any cast steel anchor components.

2.2 TESTING EQUIPMENT

All testing equipment should be in satisfactory condition and should have been inspected and calibrated by a recognized authority within the past 12 months.

2.3 PROOF TESTS

Proof tests should be performed on all anchors in the assembled condition. If the anchor has an articulated shank, the test should be made to both sides of the anchor.

2.4 PROOF LOADS

The anchor head flukes and shank should be tested in either of two alternative procedures shown in Figure 2. The proof load should be sufficient to create a moment at the pivot (crown) of 740 in.-lb/lb times the nominal anchor weight in pounds (184,000 Nm/ton times the anchor weight in tons). Proof loads for commonly used anchors are shown in Table 1. The anchor stock should be tested as shown in Figure 1 and the test loads should be as shown in Table 2.

2.5 STRAIN GAUGES

Strain gauges should be installed on the anchor prior to testing to allow the inspector to monitor strain values at selected locations to ensure that the anchor is not loaded above the yield strength of the material. The location of the strain gauges should be as follows and should be installed to measure the maximum combined strains:

Head Flukes and Shank Strain Gauge	Location (See Figure 3)
Aft-shank	25% of shank length from pivot, top and bottom
Mid-shank	50% of shank length from pivot; bottom
Fore-shank	75% of shank length from pivot; bottom
Aft-fluke	25% of fluke length from pivot; top and bottom
Mid-fluke	50% of fluke length from pivot; top and bottom
Fore-fluke (Fluke tip test only)	75% of fluke length from pivot; top and bottom

Anchor strain measurements should be recorded and plotted as shown in Figure 3. This data should be made available to the inspector.

2.6 PROCEDURE FOR TWO-THIRDS FLUKE LENGTH TEST

The procedure for two-thirds fluke length test is as follows:

a. Mark the center line of the inside edge of each fluke rib at a point two-thirds the length of the fluke, as measured from the center of the crown pivot (See Figure 2, point A).
b. Place the anchor in the test device from its crown shackle so that Point A on the fluke ribs is in a horizontal line with the center line of the anchor shackle and the proof-test device.
c. Mark the intersection of the horizontal line drawn from Point A with the upper edge of the fluke rib.
d. Weld a right-angle bracket on the upper surface of each fluke rib on the aft-side of the intersection mark as shown in Figure 2.
e. Pull the anchor forward with the proof-test device until the brackets contact the bar. If one of the brackets is not in contact, place shim stock between the bracket and the bar so that the flukes can be stressed uniformly.
f. Proceed with proof-test pull, stopping at increments of not more than 25 percent of the proof-test pull to take strain readings.
g. Terminate the test at the proof-test pull per Table 1 or when one of the strain gauges shows 1000 micro-inches per inch (0.001 mm/mm) of strain [(30,000 psi (207 MPa) yield strength material)]. Any anchor design failing to meet the required proof load or exhibiting any permanent deformation or cracking shall be rejected.

2.7 PROCEDURE FOR FLUKE TIP TEST

The procedure for the fluke tip test is as follows:

a. Place the anchor in the test device as shown in Figure 2.
b. Pull the anchor forward with the proof-test machine until the fluke tips contact the stop. If the fluke tips do not both contact the stop equally, place shim stock between the fluke tip and the stop so that the flukes are stressed equally.
c. Proceed with the proof-test pull, stopping at increments of not more than 25 percent of the proof-test pull to make the strain readings.
d. Terminate the test at the proof-test pull per Table 1 or when one of the strain gauges shows 1000 micro-inches per inch (0.001 mm/mm) of strain [(30,000 psi (207 MPa) yield strength material)]. Any anchor design failing to meet the required proof load or exhibiting any permanent deformation or cracking shall be rejected.

2.8 SHACKLE AND CROWN PADEYE TEST

The anchor should be placed on a flat surface and a tension test applied per Figure 1. The test load should be equal to the breaking strength of the mooring pendant to be used with the anchor or as listed in Table 2.

The test load should be applied to both the padeye and the anchor shackle. The padeye should be the magnetic particle inspected after the test; any anchor design which exhibits any cracking or permanent deformation as a result of this test should be rejected.

2.9 ANCHOR STOCK

The tests described in this recommended practice are applicable only to anchors with wrought steel stocks. The stock should be retained in the anchor head by means of welded keeper blocks in lieu of split keys or similar devices which induce high stress concentrations (See Figure 1).

2.10 HAMMERING TEST

A hammering test (resonance) should be carried out on each steel anchor component. For this test, the anchor should be suspended above the ground and well hammered to test the soundness of the anchor. Any anchor component found to have an inclusion (void) should be replaced with a new sound component.

2.11 ANCHOR WEIGHT

At the conclusion of the tests, the anchor should be weighed and the weight recorded on the test report.

2.12 CERTIFICATION AND ACCEPTANCE

Testing should be witnessed and certified by a qualified inspector. A comprehensive test report should be compiled. After a manufacturer has proven the structural integrity of a particular anchor design (by strain gauging an anchor and conducting a successful proof test as described herein), the anchor is considered acceptable.

Table 1—Equivalent Proof Tests for Floating Structure Anchors

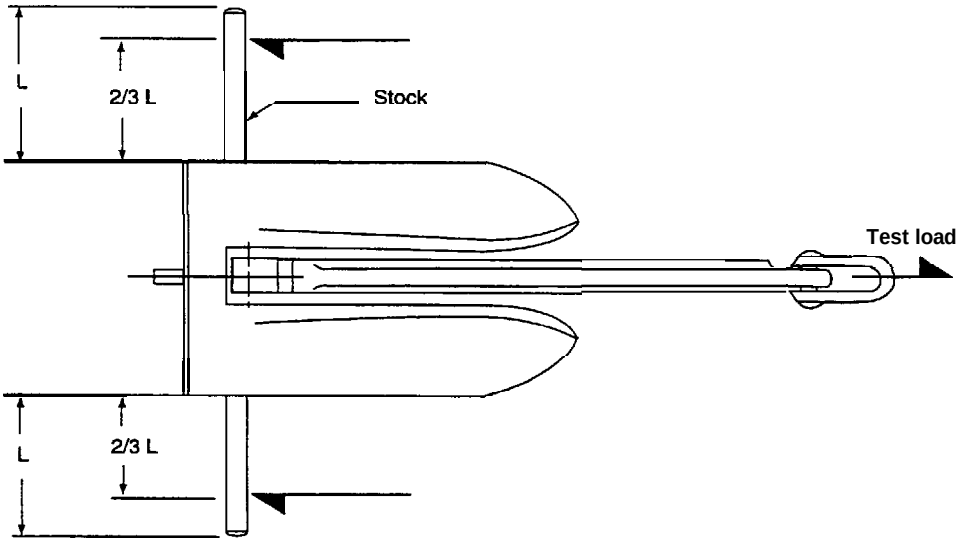
Type of Anchor	Weight		Fluke Length		Shank Length		Fluke Angle	Moment at the Pivot		Suggested Shackle Size		Proof Test: Fluke Tip		Proof Test: 2/3 Fluke Tip	
	inch	tons[a]	inch	mm	inch	mm	degree	lb inch x10^6	N•m x 10^3	inch	mm	lb x 10^3	tons	lb x 10^3	tons[a]
LWT	20	9.07	106.0	2692	173.0	4394	30	14.8	1669	4½	117	157	71.2	284	128.9
	25	11.34	114.0	2896	186.5	4737	30	18.5	2086	5½	127	182	82.6	330	149.7
	30	13.16	121.5	3086	198.0	5029	30	22.2	2503	5	142	205	93.0	371	168.3
Danforth	20	9.07	103.1	2619	171.7	4361	30	14.8	1669	4½	117	163	74.0	294	133.4
	25	11.34	110.8	2814	184.6	4689	30	18.5	2086	5	127	189	85.8	342	155.2
	30	13.61	119.7	3040	197.0	5004	30	22.2	2503	5½	142	209	94.8	378	171.5
Offdrill	20	9.07	98.4	2499	165.4	4201	34	14.8	1669	4½	117	163	74.0	285	129.3
	30	13.61	112.6	2860	189.5	4813	34	22.2	2503	5½	142	214	97.1	374	169.7
Moorfast	30	13.61	118.0	2997	189.0	4801	34	22.2	2503	5½	142	200	90.7	351	159.3

Note: lb = pound; mm = millimeters.
[a]Metric tons.

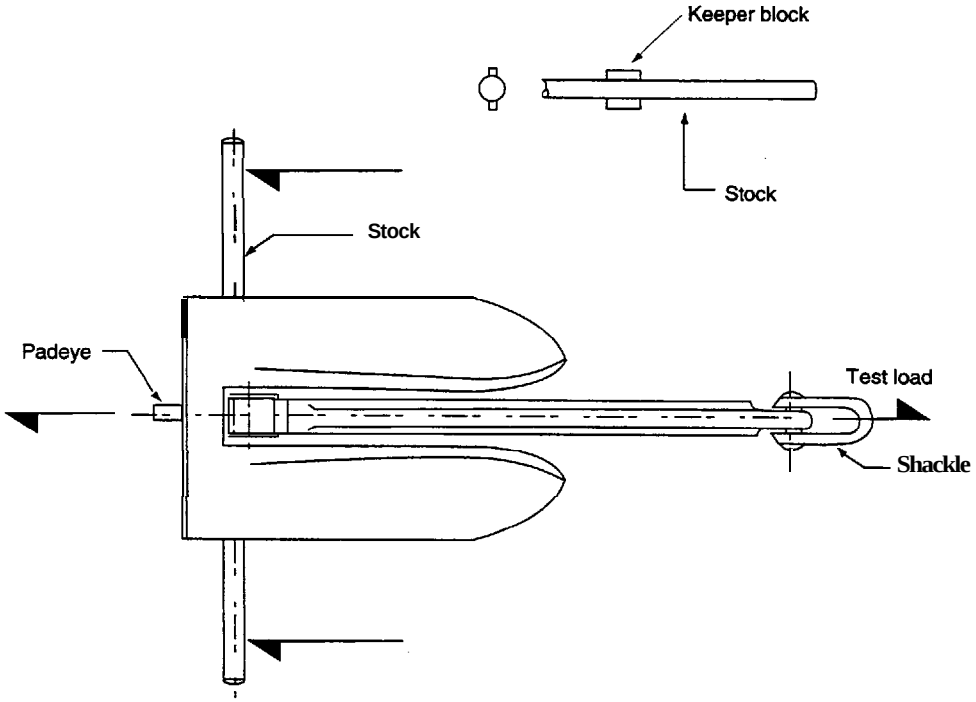
Table 2—Proof Loads

Anchor Weight		Test Load for Padeye and Shackle		Test Load for Anchor and Stock	
lb	tons[a]	lb	tons[a]	lb	tons[a]
20,000	9.07	340,000	154.3	29,000	13.2
25,000	11.34	420,000	190.6	33,000	15.0
30,000	13.61	510,000	231.4	35,000	15.9

Note: lb = pound
[a]Metric tons.

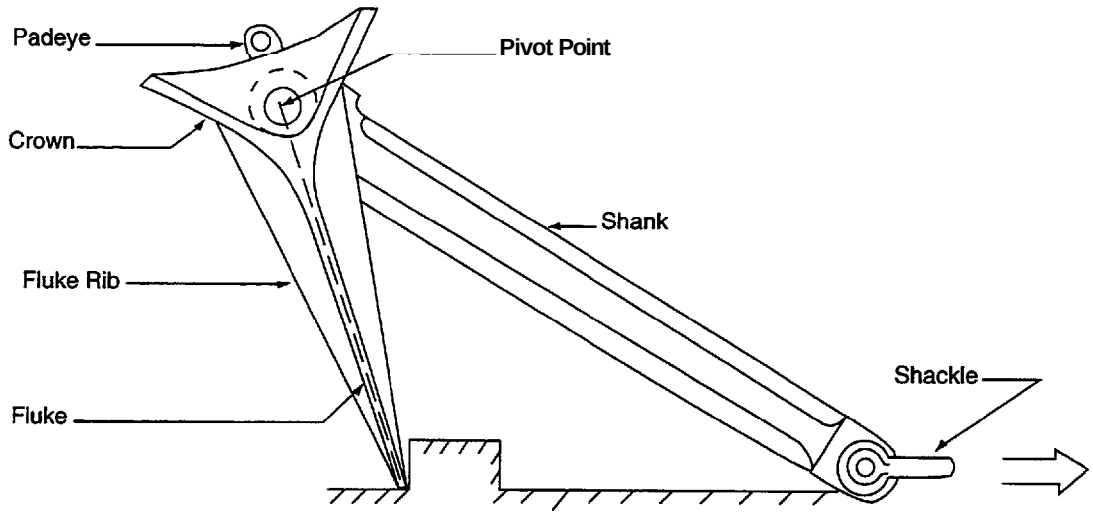


STOCK TEST

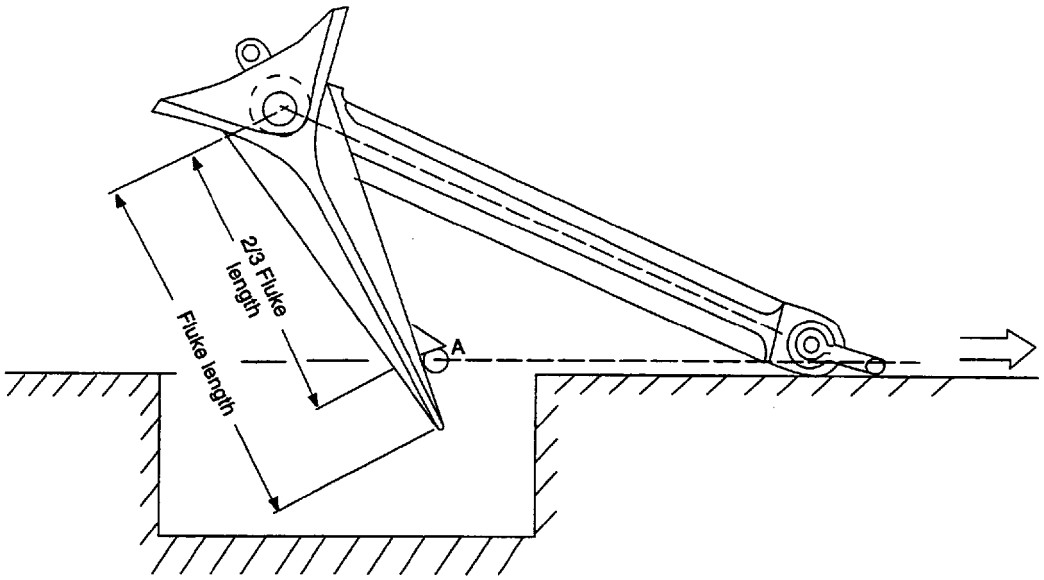


PADEYE TEST

Figure 1—Test Position for Stock and Padeye



A. FLUKE TIP PROCEDURE



B. TWO-THIRDS FLUKE LENGTH PROCEDURE

Figure 2—Method for Proof-Test Pull

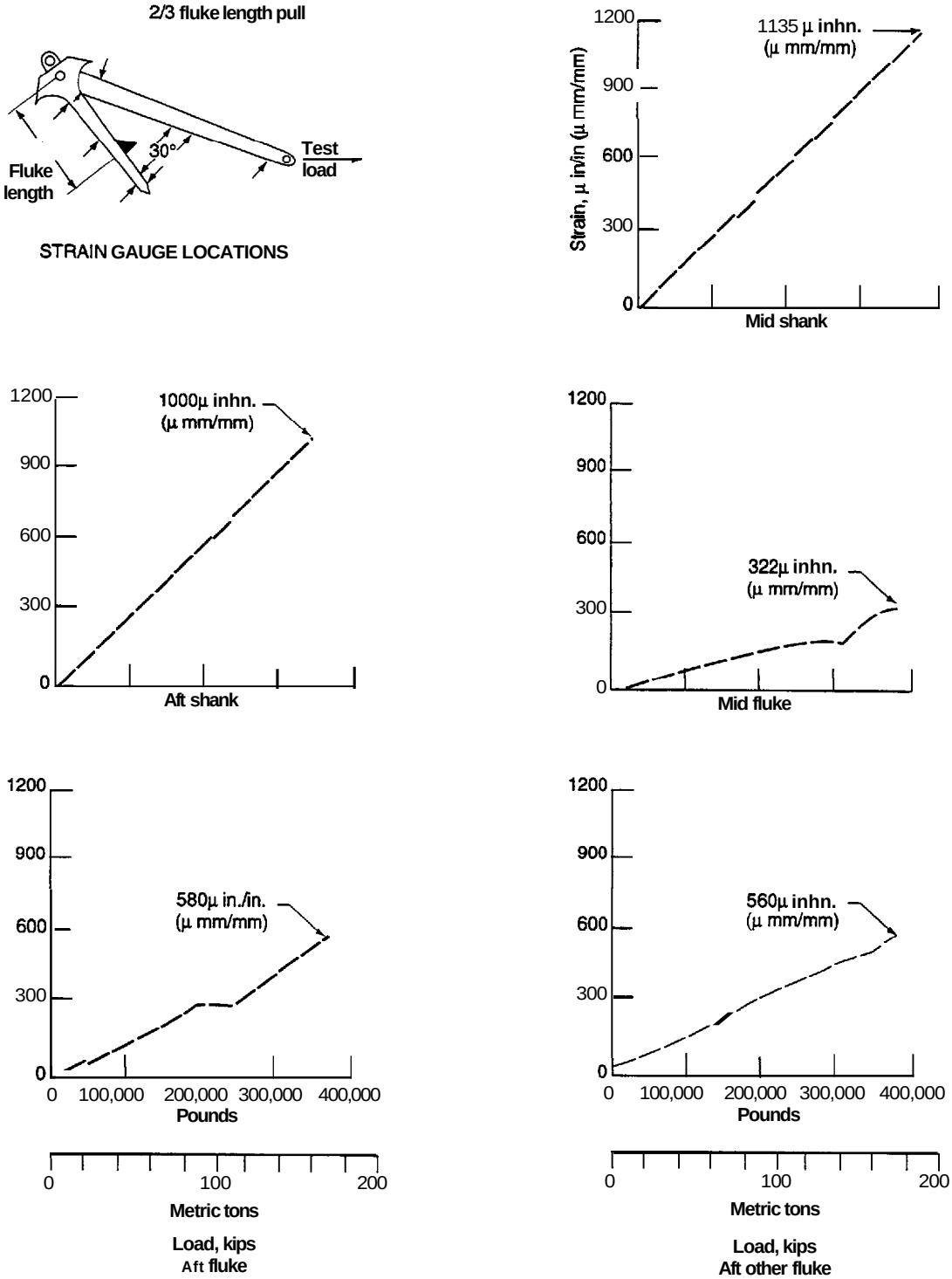


Figure 3—30,000 Pounds (13.61 Tons)—Two-Thirds Fluke Length Pull, Strain at 370,000 Pounds (167.85 Tons) Test Pull

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