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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
MANILA

18 JAN 2018

DEPARTMENT ORDER)
)
No. 07)
Series of 2018 01.19.18)

SUBJECT: Amendment to DPWH Standard Specification for Item 1403 – Rubber Dock Fenders

In line with the mandate of the Department to provide effective standard specifications in the implementation of various infrastructure projects. As such, the attached amendment to **DPWH Standard Specification for Item 1403 – Rubber Dock Fenders** is hereby prescribed, for the guidance and compliance of all concerned.

This Standard Specification will form part of the on-going revision of the DPWH Standard Specifications for Public Works Structures – Buildings, Ports and Harbors, Flood Control and Drainage Structures and Water Supply Systems, Volume III, 1995 Edition.

This Order shall take effect immediately.

MARK A. VILLAR
Secretary

14.1.2 FET/RGT

Department of Public Works and Highways
Office of the Secretary
WIN8U01565

DPWH Standard Specification for Item 1403– Rubber Dock Fenders

1403.1 Description

This pay item shall consist of furnishing and installing rubber dock fenders of special approved type of quality of unused natural or synthetic rubber by extrusion or molded/ processed at the location and in the manner shown on the Plans and in accordance with this Specifications.

1403.2 Material Requirements

1403.2.1 Extruded Fender

Fenders shall be extruded and continuous in the length indicated on the Plans. The fenders shall be black in color. The fenders shall have a truncated "A" cross section shape and be attached to the structure at the widest base dimension of the arch. The connecting hardware shall be fully exposed. No encased hardware or molded fenders shall be allowed. The fender and hardware shall be designed and factory tested to the loads per linear meter of fender specified in paragraph entitled "Performance," for approach angles of zero (0) and 15 degrees. Fender anchor bolts and method of anchorage shall be of the size and spacing required by the manufacturer's design and testing; however, the size and spacing of anchor bolts indicated on the drawings shall be construed to be the minimum required, unless exceeded by the requirements of the fender manufacturer's design.

1403.2.2 Molded Fender

Fenders shall be molded and continuous in the length indicated on the plans. The fenders shall be black in color. Each fender shall be molded of rubber, homogeneous and free from any defects, impurities, pores or cracks, and bonded to integral, steel mounting plates. The mounting plates shall be fully encased in rubber with a minimum thickness of 1.6 mm. The fender and hardware shall be designed and factory tested to the loads specified. Fender anchor bolts and method of anchorage shall be of the size and spacing dimensions required by the manufacturer's design and testing; however, the size and spacing of anchor bolts indicated on the drawings shall be construed to be the minimum required, unless exceeded by the requirements of the fender manufacturer's design.

1403.2.3 Elastomer

The elastomer shall be the ethylene propylene diene monomer (EPDM), as specified in ASTM D2000, Standard Classification System for Rubber Products in Automotive Applications, with the following line callout:

1. 3BA 720 A14 B13 C12 EA14 F17
2. 3BA 620 A14 B13 C12 EA14 F17

Tests shall include Ozone Resistance, Low Temperature Impact Resistance, Water Absorption, Heat Resistance.

1403.2.3.1 Break-In Deflection

Break-in deflection is required for buckling type fenders with reaction ratings of 100 tonnes or more, or if the energy-absorbing material has a reaction decrease of more than ten (10) percent between its original deflection and its fifth deflection. Break-in deflection shall be up to at least the manufacturer's rated deflection. The number of break-in cycles shall be sufficient to assure each elements first on-dock reaction will not exceed its fully broken-in reaction by more than five (5) percent.

1403.2.3.2 Stainless Steel Hardware

1403.2.3.2.1 Plates and Angles

Type 316L stainless steel for plates, angles and miscellaneous hardware required to attach the fenders to the structure shall be in accordance with ASTM A479M, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

1403.2.3.2.2 Bolts, Nuts, and Washers

Bolts, nuts and washers shall conform to the applicable requirements of ASTM F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs or ASTM F594, Standard Specification for Stainless Steel Nuts, Group 2 (316 alloy) stainless steel for nuts and bolts and ASTM F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use, except fabricated washers of 316 alloy stainless steel.

1403.2.3.3 Galvanized Steel Hardware

All hardware shall be hot-dip galvanized in accordance with ASTM A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, ASTM A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware or ASTM B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel, as applicable.

1403.2.3.3.1 Plates

Galvanized steel plates shall conform to the applicable requirements of ASTM A36M, Standard Specification for Carbon Structural Steel.

1403.2.3.3.2 Bolts, Nuts and Washers

Bolts, nuts and washers shall conform to the applicable requirement of ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength. Nuts shall conform to the applicable requirement of ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts, grade A heavy hex. Washers shall conform to the applicable requirement of ASTM F844 of carbon steel.

1403.2.3.4 Restraint Chains and Shackles

Chain and shackles shall meet the requirements of FS RR-C-271F, Federal Specification: Chains and Attachments, Carbon and Alloy Steel. The chain assembly shall have a design safety factor of 3:1 based on minimum breaking strength.

1403.2.3.5 Panels

Panel design shall be of closed box construction for optimum strength and corrosion resistance. The minimum thickness of the material shall be 9.5 mm when one side is exposed and 12.7 mm when both sides are exposed.

1403.2.3.5.1 Facing

Facing on the panels shall be Ultra High Molecular Weight Polyethylene (UHMWPE), ultraviolet stabilized with 2.5 percent carbon black or equivalent, minimum 12.7 mm wear thickness, with a 0.20 maximum coefficient of friction per ASTM D1894, Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting. The UHMWPE shall exhibit no failure when tested per ASTM D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics, Method B. The facing connections shall be configured to account for the thermal properties of the polyethylene.

1403.2.4 Foam-Filled Fenders

Fenders shall have cylindrical mid-bodies with conical or hemispherical shaped ends terminating in an end fitting on the cylinder's centerline at each end. If conical ends are provided, they shall have an angle of 60 to 75 degrees, when measured from the central axis of the fender. The fittings at either end shall be connected through the center of the fender by a chain, shall terminate in a clevis fitting sized for the indicated shackle and shall swivel to allow the end fitting to rotate freely on the axis of the fender. Design end fitting shall be as small as possible to transmit the ultimate load of the shackle to the fender. End fitting shall be sized so as not to contact loading surfaces when the fender is compressed to 30 percent of its original diameter (70 percent compression). Fill interior of the fender with energy absorbing closed-cell foam as specified. The use of chipped or particulate foam is not acceptable.

1403.2.4.1 Foam Core

The energy absorbing foam core shall be a closed-cell cross-linked polyethylene foam with the following properties:

Test Items	Test Method	Properties
1. Density	ASTM D1667	52 to 104 kg/m^3
2. Tensile strength	ASTM D3575 or ASTM D412	550 kPa (Min.)
3. Elongation (ultimate)	ASTM D3575 or ASTM D412	40 percent (Min.)

4. Water absorption percent volume after 24-hour exposure	ASTM D1667	5.0 percent (Max.)
5. Continuous service temperature		-54 to +49 degrees C
6. 25 percent compressive set	ASTM D1667	8 percent (Max.) *
7. 50 percent compressive set	ASTM D3575	12 percent (Max.) *

* Contractor option: Compressive Set of foam core material shall be based on either the 25 percent or the 50 percent requirement listed.

1403.2.4.2 Fender Skin

The minimum thickness of the outer fender skin shall be 32 mm thick and constructed of elastomer as specified. Filament reinforcing is required. Twelve (12) separate filament reinforcing wraps shall be applied as specified under Filament Wrap. The filament wraps shall be evenly distributed in the inner 80 percent to 90 percent of the coating thickness. The outer ten (10) percent to 20 percent of elastomer shall have no filament reinforcing. The elastomer and filaments shall be applied in a continuous manner to assure adhesion between the various layers. The connection of the skin to the end fittings shall be designed and sized to transmit twice the safe tensile capacity of the chain into the fender skin.

1403.2.4.3 Elastomer

The elastomer used in the fender skin shall be 100 percent PTMEG (Polytetramethylene Ether Glycol) polyether urethane elastomer, ultraviolet stabilized with 2.5 percent carbon black or equivalent, with the following unreinforced properties:

Test Items	Test Method	Values
1. Shore A hardness	ASTM D2240	80 to 95
2. Tensile strength	ASTM D412	19.3 MPa (Min.)
3. Elongation (ultimate)	ASTM D412	300 percent (Min.)
4. Tear strength	ASTM D470	1.25 kg per mm (Min.)
5. Flex life (Ross)	ASTM D1052	200,000 cycles (Min.)
6. Abrasion resistance (NBS)	ASTM D1630	100 (Min.)

1403.2.4.4 Filament Wrap

Construct each filament reinforcing wrap of continuous filaments applied in a helical pattern, at a helix angle of 45 to 60 degrees to the longitudinal axis of the buoy. A wrap shall consist of two (2) such filament helixes of equal but opposing helix angles. The spacing between the filaments in the same helix shall be not more than three (3) mm, measured in a direction parallel to the longitudinal axis of the fender.

Each wrap shall extend along the entire longitudinal axis of the fender and shall also encase the fender end fittings and secure them to the fender body. The reinforcing filaments shall be nylon tire cord of 0.00028 kg per m weight with breaking strength of 235 N and elongation (ultimate) of 18 percent.

1403.2.4.5 Color

Fender skin color shall be black throughout the entire thickness. Galvanized hardware shall be unpainted.

1403.2.4.6 Repair

The fender casing shall be repairable in the event of tears or punctures in the elastomer skin. The repaired area shall have not less than 90 percent of the properties as specified in Subsection 1403.2.4.3 Elastomer. Required repair materials shall be readily available from the fender manufacturer.

1403.2.4.7 Internal Hardware

The internal chain connecting the two end fittings and the two end fittings shall be galvanized in accordance with ASTM A123M or ASTM A153M as appropriate. The chain and end clevis fitting shall have a minimum ultimate tensile capacity of 640,000 N.

The internal chain and end clevis fitting shall have a minimum ultimate tensile capacity of 578,000 N. Shackles shall be 45 mm and shall have a minimum ultimate tensile capacity of 289,000 N.

1403.2.4.8 Performance Requirements

The resilient, foam filled marine fenders shall be designed so that when compressed across its diameter by two (2) parallel flat plates extending the full length and width of the fender, the fender shall absorb 300,265 Newton-meters of energy plus 15 percent when 60 percent compressed with a corresponding load of not more than 712,000 N plus 15 percent. The fender shall also be designed to withstand a sustained reaction force of 667,200 N for a duration of not less than 24 hours each occurrence for at least 200 occurrences during its ten-year predicted life.

1403.2.5 Pneumatic and Hydro-Pneumatic Fenders

Fenders shall be manufactured in accordance with ISO 17357-1, Ships and marine technology – Floating pneumatic rubber fenders – Part 1: High pressure. Fenders shall have cylindrical mid-bodies with hemispherical shaped ends terminating in an end fitting on the cylinder's centerline at each end. The flange opening fittings shall be sized (not to exceed 12 percent of fender diameter) so as not to contact loading surfaces when the fender is compressed to 20 percent of its original diameter (80 percent compression).

Pneumatic and Hydro-Pneumatic fenders shall incorporate a safety valve for fenders 2,500 mm diameter or larger and pressure monitoring system in their manufacture.

1403.2.5.1 Fender Skin

The fender skin shall have a minimum strength in accordance with ISO 17357-1. When designing the skin thickness, the manufacturer shall consider skin strength and the stress induced by the internal operating and berthing pressure, and the abrasion and impact loads

caused by handling and berthing operations. The manufacturer shall ensure that adequate margin of safety is incorporated for the fender's intended use. The connection of the skin to the end fittings shall be designed to resist the specified minimum endurable pressure at 60 percent compression in ISO 17357-1 for the respective operating pressure. For hydro-pneumatic fenders, the Minimum Endurable Pressure value in Table 5 of ISO 17357-1 (Pneumatic 80 fender pressure requirements) should be used.

1403.2.5.2 Elastomer

The elastomer shall meet the requirements of ISO 17357-1, Material Test of Rubber.

The elastomer used in the outer skin shall be made of rubber material, with the following unreinforced properties:

Test Items	Test Method	Values
1. Durometer Hardness, Shore A	(ASTM D2240)	
Before Aging		50 to 70
After Aging		Not to exceed the original property by more than 8
2. Minimum Tensile strength	(ASTM D412)	
Before Aging		18 MPa
After Aging		Not less than 80 percent of original property
3. Minimum Elongation (ultimate)	(ASTM D412)	
Before Aging		400 percent
After Aging		Not less than 80 percent of original property
4. Minimum Tear strength	(ASTM D624)	400 N per cm
5. Compression set	(ISO 815-1)	30 percent (70 degrees C plus/minus 1 degree C, 22 hours) or less
6. Static ozone aging test		No cracks after elongation by 20 percent and exposure to 50 pphm (parts of ozone per hundred million of air by volume) at 40 degrees Centigrade for 96 hours.

The elastomer used in the inner skin shall be made of rubber material, with the following unreinforced properties:

Test Items	Test Method	Values
1. Durometer Hardness, Shore A	ASTM D2240	
Before Aging		40 to 60
After Aging		Not to exceed the original property by more than 8
2. Minimum Tensile strength	ASTM D412	
Before Aging		10 MPa
After Aging		Not less than 80 percent of original property
3. Minimum Elongation (ultimate)	ASTM D412	
Before Aging		400 percent
After Aging		Not less than 80 percent of original property

1403.2.5.3 Color

Fender skin color shall be black throughout the entire thickness. Galvanized hardware shall be unpainted.

1403.2.5.4 Repair

The fender casing shall be repairable in the event of tears or punctures in the elastomer skin. The repaired area shall have not less than 90 percent of the properties as specified in Subsection 1403.2.5.2 Elastomer. Required repair materials shall be readily available from the fender manufacturer.

1403.2.5.5 Performance Requirements

The performance of each fender shall met the requirements of ISO 17357-1. The performance of the fender shall be confirmed with a prototype fender performance confirmation per ISO 17357-1. The tests shall include a parallel performance, angular compression, durability, compression-recovery, and puncture-resistance.

1403.3 Construction Requirements

1403.3.1 Preparation

Clean surfaces thoroughly prior to installation. Do not begin installation until substrates have been properly prepared.

Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

1403.3.2 Installation

Fenders shall be installed in the position and at the spacing indicated on the drawings. It shall be installed in accordance with manufacturer's instructions.

Angle end frames shall be secured to dock face of concrete, steel angle embedded in concrete, steel plate embedded in concrete and timber.

1403.3.2.1 Welding

Welding shall be performed in accordance with AWS D1.1M, Structural Welding Code-Steel. Only Welders that passes qualification test shall be allowed to perform welding. The Contractor shall be held responsible for the qualification of his personnel.

1403.3.2.2 Protection

Protect and secure the installed products until the completion of project. Touch-up, repair or replace any damaged products before Substantial Completion.

1403.3.2.3 Fender Marking

Fender shall be marked with the following items.
1. Size (height, inside diameter and outside diameter)
2. Date of manufacture or its abbreviation.
3. Name of the manufacturer or its trademark.

1403.3.3 Delivery, Handling and Storage

Fenders shall be undamaged when delivered and shall be handled and stored properly so as to prevent damage, such as bending or abrading end fittings, cutting of rubber, or damage to coating of hardware among others. Protect fenders from exposure to damaging liquids, oils, greases and extended exposure to sunlight.

1403.3.4 Rejection

Fenders that are delivered to the site with damage or that are not in conformance with this Specifications are subject to rejection. Any rejected materials shall be replaced at no additional cost to the Government.

1403.3.5 Quality Assurance

1403.3.5.1 Extruded Fenders, Molded Fenders

Fender elements shall be molded of rubber, homogeneous and free from any defects, impurities, pores or cracks. Where internal plates are used, the rubber shall be bonded to integral steel mounting plates. The plates shall be fully encased in rubber with a minimum thickness of 1.6 mm.

1403.3.5.2 Pneumatic and Hydro-Pneumatic Fenders

The fender is made of synthetic-cord-reinforced rubber sheet with compressed air inside, at initial pressure of 50 kPa or 80 kPa, to enable it to float on the water. The Contractor is required to fabricated a prototype fender for a confirmatory test such as material test of rubber, dimensional inspection, air leakage test, hydrostatic-pressure test and pressure relief valve test.

1403.3.5.2 Elastomer Skin

The elastomer skin of the fender shall be free from cracks, burrs, warpage, checks, chipped or blistered surfaces, and shall have a smooth surface.

1403.3.5.3 Foam Core

The foam core shall be homogeneous and of one (1) piece fabricated construction and shall not be in chip or granular form. The foam core shall not contain scraps, strips, or sheets of foam either rolled or stuffed into the required shape unless pieces are bonded together in layers of uniform patterns to form a homogeneous, one (1) piece core. Homogeneous foam rings of adequate thickness to insure performance of the fender are acceptable provided the contractor can show a minimum five (5)-year performance of similar fenders.

1403.3.5.4 Steel Fabrication

The steel used in fabrication shall be free from kinks, sharp bends, and other conditions which would be detrimental to the finished product. Manufacturing processes shall not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes shall be done neatly and accurately. Make bends by controlled means to ensure uniformity of size and shape.

1403.3.5.5 Welding

AWS D1.1M. Welds shall be of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds shall transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

1403.4 Method of Measurement

The amount to be paid for shall be the number of meter of rubber dock fenders installed or placed of special quality as specified, accepted and finished.

1403.5 Basis of Payment

The number of meter of rubber dock fenders as stated above, shall be paid for at the contract unit price per meter installed. The price and payment thereof shall constitute to the full compensation for furnishing all materials and installation of the rubber dock fenders in-place, and for all labor, materials, equipment or tools and other incidentals necessary to complete this Pay Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1403 (1)	Rubber Dock Fenders	Meter

References:

1. *American Society for Testing and Materials (ASTM International)*
ASTM D2000 - 12(2017) Standard Classification System for Rubber Products in Automotive Applications
ASTM A479M-17 "Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels"
ASTM F593-17 "Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs"
ASTM F594-09 (2015) "Standard Specification for Stainless Steel Nuts",
ASTM F844 - 07a (2013) "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use",
ASTM A123M - 17 "Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products",
ASTM A153M - 16a "Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware"
ASTM B695 - 04(2016) "Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel",
ASTM A36M - 14 "Standard Specification for Carbon Structural Steel".
ASTM A307 - 14e1 "Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength".
ASTM A563 - 15 "Standard Specification for Carbon and Alloy Steel Nuts",
ASTM F844 - 07a (2013) "Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use", of carbon steel.
FS RR-C-271F, "Federal Specification: Chains and Attachments, Carbon and Alloy Steel
ASTM D1894 - 14 "Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting".
ASTM D256 - 10e1 "Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics",
ASTM D1667 – 17 "Standard Specification for Flexible Cellular Materials-Poly (Vinyl Chloride) Foam (Closed-Cell)"
ASTM D3575 – 14 "Standard Test Methods for Flexible Cellular Materials Made From Olefin Polymers"
ASTM D412 – 16 "Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension"
ASTM D2240 – Standard Test Method for Rubber Property-Durometer Hardness"
ASTM D470 – 13 "Standard Test Methods for Crosslinked Insulations and Jackets for Wire and Cable"
ASTM D1052 – 09(2014) "Standard Test Method for Measuring Rubber Deterioration-Cut Growth Using Ross Flexing Apparatus"
ASTM D1630 – 16 "Standard Test Method for Rubber Property-Abrasion Resistance (Footwear Abrader)"
ISO 17357-1 "Ships and marine technology – Floating pneumatic rubber fenders – Part 1: High pressure".
ISO 37
AWS D1.1M "Structural Welding Code-Steel".
ASTM D624 – 00(2012) "Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers"
2. *International Organization for Standardization (ISO)*
ISO 34-1 (2015)(en) "Rubber, vulcanized or thermoplastic – Determination of tear strength –Part 1: Trouser, angle and crescent test pieces"
ISO 815-1:2014 "Rubber, vulcanized or thermoplastic -Determination of compression set-Part 1: At ambient or elevated temperatures"
3. *UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS-35 59 13.16)*
4. *https://www.dot.ny.gov/spec-repository-us/593.01000016.pdf*
5. *https://www.dot.ny.gov/spec-repository/593.02----16.pdf*
6. *http://www.chennaiport.gov.in/Articles_6_2013/Tenders/Engineering%20Department/wm5-7073.pdf*
7. *www.arcat.com/sdspecs/htm/11165dur.htm*