

**Standard Specification for *Ocean Cushion*™
Foam-Filled Marine Fenders
With Chain & Aircraft Tire Nets
4.5 m (14.8 ft.) diameter x 9.0 m (29.5 ft.) long
Standard Capacity**



Scope: This specification covers foam-filled floating marine fenders with external chain & tire nets to be used for the protection of ships, harbor craft, wharves and piers from damage due to vessel maneuvers where vessel-to-pier or vessel - to-vessel contact may occur.

Applicable Documents: The following documents for the issue in effect on the date of this Invitation for Bids or Request for Proposal form a part of this specification to the extent specified herein.

Specifications:

<u>FEDERAL</u>	RR-C-271	-Chains and attachments, welded, Weldless and roller chain
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Standards:

<u>FEDERAL</u>	FED-STD-595	-Color
<u>MILITARY</u>	MIL-STD-129	-Marking for shipment and storage

American Welding Society (AWS)

AWS D1.1/D1.1 M	Structural Welding Code – Steel (2002)
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American Society for Testing and Materials (ASTM):

A-123	Zinc (Hot Galvanized) Coatings on Products fabricated from Rolled, pressed and forged shapes bar and strips
A-153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
D-412	Rubber Properties in tension, Test Methods for
D-624	Rubber Property Tear Resistance, Test for
D-1052	Measuring Rubber Deterioration, Method for (Cut Growth using Ross Flexing Apparatus)
D-1630	Rubber Property Abrasion Resistance, Test for (NBS Abrader)

D-1667	Flexible Cellular Materials – Vinyl Chloride Polymer and Copolymers (Closed – Cell Foam)
D-2240	Rubber Property - Durometer Hardness
D-3575 F 2192-02	Flexible Cellular Materials Made from Olefin Polymers Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Fenders

Configuration: Fender shall have a cylindrical mid-body with conical or semi hemispherical shaped ends. The diameter and length dimensions of the fender shall be as specified. The interior of the fender shall be completely filled with an energy absorbing closed-cell foam core as specified. No other material, such as steel shall be incorporated in the fender core. The exterior shall be covered with a reinforced urethane elastomer skin.

Foam Core: The energy absorbing foam core shall be a resilient closed-cell, cross-linked polyethylene foam with the following properties. The foam core construction shall utilize only a heat-laminated process, and yield a single solid foam core. Use of chipped or granulated particulate foam is not acceptable. The test, which are shown below all form a part of ASTM-D-3575.

Density	: 3.3 lb/ft ³ to 6.4 lb/ft ³
Tensile Strength	: 81 psi minimum
Elongation (Ultimate)	: 110 % minimum
Tear Strength	: 22 lb/in minimum
Water Absorption	: less than 0.05 lb/ft ² (1.0 kg/m ²) of cut surface
Working Temperature Range	: -65° TO 210° F

Fender Skin: The outer fender skin shall have a minimum skin thickness as specified under Performance section of this specification. The fender skin shall be constructed of elastomer and filament reinforcing as specified. Separate filament reinforcing wraps shall be applied as specified under Filament Wrap. The filament wraps shall be evenly distributed in the inner 80% to 90% of the coating thickness. The outer 10% to 20% of elastomer shall have no filament reinforcement. The elastomer and filaments shall be applied in a continuous manner to assure adhesion between the various layers. There shall be a least one wrap for every 0.116 in (2.9 mm) of skin thickness (rounded to the nearest complete wrap).

Elastomer: The elastomer used in the fender skin shall be solvent free polytetramethylene ether glycol (PTMEG), 2,4-toluene diisocyanate, and aromatic diamine based urethane elastomer, with the following unreinforced properties:

Elastomer:

Shore A. Hardness (ASTM D-2240)	: 75 to 95
Tensile Strength (ASTM D-412)	: 2600 psi minimum
Elongation (Ultimate) (ASTM D-412)	: 375 % Minimum
Tear Strength (ASTM D-624)	: 230 lb/in minimum
Flex Life (Ross) (ASTM D-1052)	: 243,000 cycles minimum
Abrasion Resistance (NBS) (ASTM D-1630)	: 116 minimum

Filament Wrap: Construct each filament-reinforcing wrap of continuous filaments applied in a helical pattern, at a helix angle of 0.79 to 1.05 rad 45° to 60° to the longitudinal axis of the fender. A wrap shall consist of two such filament helixes of equal but opposing helix angles. The spacing between the filaments in the same helix shall be no more than 0.125 in (3.2 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, for the purpose of distributing impact loads over the surface and conducting the forces of impact loads throughout the fender.

Filament Reinforcement: The reinforcing filaments in the outer skin shall be nylon tire cord of 2,520 denier (0.280 g/m) weight with the following properties:

Breaking Strength	: 52 lb
Elongation (Ultimate)	: 16%

Reinforced Skin Properties: The reinforced skin, when constructed in accordance with this specification, shall exhibit the following properties when tested in accordance with the guidelines below:

Tensile Strength: When a full-thickness specimen of the skin is tested in tension, with the longitudinal direction of pull aligned with the filament direction (in one helix direction), the specimen shall have the following breaking strength

: 5,600-psi minimum

Elongation (Ultimate): In the test for Tensile Strength, the specimen shall have the following Ultimate elongation at break

: 18% minimum

Tear Strength: When a full-thickness specimen of the skin is tested in tear, with the specimen Shaped like Die C in ASTM D-624, and with the direction of pull aligned with the filament Direction (in one helix direction), the specimen shall have the following tear strength

: 565 lb. ft/in

Hardware: The end fittings of the fender shall be steel and galvanized per ASTM A-123 or ASTM A-153. The end fittings shall be externally connected with the chains and shackles of the Chain & Tire Net, and shall be designed and sized to transmit the safe working load and accept the shackle size of 2.5 inches. Safe working end-pull load shall be 110 kips.

Chain & Tire Net: The Chain & Tire Net assembly shall be fabricated utilizing thicker walled aircraft tires. Tires shall be place on all fender surface areas including flats and ends to provide maximum protection of the fender skin. Rubber tubing / hose of a minimum of 5 inch outside diameter will be used on the exposed chains both ends of the fenders for additional protection. No inferior material such as water hose and none rubber tubing shall be used.

The Chain & Tire Net assembly shall be fabricated utilizing a minimum of 8 longitudinally lines of chains and tires and 6 transverse lines of chains and tires. The chain size shall be minimum 3/4-inch diameter Hi test galvanized chain. The longitudinal chains shall begin and terminate on a steel end fitting which will be connected with galvanized screw pin shackles and traveling through holes in the tires. The lateral chains will be inter-connected to the longitudinal chains also through the tires and locked in place with screw pin shackles. The chain & Tire net shall be designed to allow for the replacement of a tire or section of the chain & tire net.

Performance: The fender shall be designed so that when compressed across its diameter by two parallel flat plates extending the full length and width of the fender, the fender shall absorb the specified energy (+/- 15%) with a corresponding specified force (+/- 15%). This energy absorption performance shall be achieved prior to the point at which the deflection of the fender exceeds 60% of its initial diameter. The reaction force shall be determined at the deflection at which the rated energy is reached. Performance shall be based on the following characteristics:

Fender Body Diameter: _____ 4.9 m (14.8 ft)

Fender Diameter with Chain & Tire Net Assembly:	<u>5.1 m (16.8 ft)</u>
Length:	<u>9.0 m (29.5 ft)</u>
Skin Thickness:	<u>25 mm (1.0 inch)</u>
Energy Absorption (60% compression):	<u>650 ton-m (4,700 ft-kips)</u>
Reaction Force (60% compression):	<u>623 ton (1,374 kips)</u>
Fender Weight with Chain and Tire Nets:	<u>18,144 kgs. (40,000 lbs)</u>

* Actual performance values may vary plus or minus 15% from stated values due to variations in material properties dimensional tolerances, temperatures and speed of compression.