Designation: F2682 – 07 (Reapproved 2012)ε1 F2682 – 07 (Reapproved 2018)

Standard Guide for Determining the Buoyancy to Weight Ratio of Oil Spill Containment Boom[1]

This standard is issued under the fixed designation F2682; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 NOTE—Editorial changes were made to Sections 3, 6, 7, and 9 in June 2012.

1. Scope

1.1 This guide describes a practical method for determining the buoyancy to weight (B/W) ratio of oil spill containment booms.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety safety, health, and healthenvironmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F818 Terminology Relating to Spill Response Booms and Barriers

F1523 Guide for Selection of Booms in Accordance With Water Body Classifications

3. Terminology

3.1 *boom section*—length of boom between two end connectors. **F818**

3.2 *boom segment*—repetitive identical portion of the boom section. **F818**

3.3 *buoyancy to weight ratio*—gross buoyancy divided by boom weight. **F818**

3.4 *gross buoyancy*—weight of fresh water displaced by a boom totally submerged.

3.5 *reserve buoyancy*—gross buoyancy minus boom weight. **F818**

4. Significance and Use

4.1 This guide describes a method of determining the buoyancy to weight ratio of spill response booms. The principle is based on Archimedes Law, which states that a body either wholly or partially immersed in a fluid will experience an upward force equal and opposite to the weight of the fluid displaced by it.

4.2 Unless otherwise specified, when used in this guide, the term *buoyancy to weight ratio (B/W ratio)* refers to the gross buoyancy to weight ratio. Buoyancy is an indicator of a spill response boom's ability to follow the water surface when exposed to current forces, fouling due to microbial growth (which adds weight), and wave conditions. Surface conditions other than quiescent will have an adverse effect on collection or containment performance. When waves are present, conformance to the surface is essential to prevent losses. Minimum buoyancy to weight ratios for oil spill containment booms are specified in Guide F1523 for various environmental conditions.

4.3 This guide provides the methodology necessary to determine the buoyancy to weight ratio using a fluid displacement method. This method is typically applied to booms having relatively low B/W ratios (in the range of 2:1 to 10:1). Booms with

[1] This guide is under the jurisdiction of ASTM Committee F20 on Hazardous Substances and Oil Spill Response and is the direct responsibility of Subcommittee F20.11 on Control.

Current edition approved June 1, 2012April 1, 2018. Published June 2012May 2018. Originally approved in 2007. Last previous edition approved in 20072012 as F2682 – 07.F2682 – 07(2012)ε1. DOI: 10.1520/F2682-07R12E01.10.1520/F2682-07R18.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

greater buoyancies may also be tested in this manner. It is acceptable to use calculation methods to estimate boom displacement for booms with buoyancies greater than 10:1, where the potential error in doing so would have a less significant effect on performance.

~~4.4 When evaluating the B/W ratio of a spill response boom, consideration must be given to the inherent properties of the boom that may affect the net B/W ratio while in use. These considerations include, but are not limited to, absorption of fluids into flotation materials, membranes that are abraded during normal use, and entry of water into components of the boom.~~

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The entry of water into boom components is of particular concern with booms that contain their flotation element within an additional membrane. (This is the case for many booms that use rolled-foam flotation and relatively lightweight material for the boom membrane.) It is also important for booms that have pockets that enclose cable or chain tension members or ballast. When new, the membrane enclosure may contain air that would result in increased buoyancy. In normal use, the membrane material may be easily abraded such that it would no longer contain air, and water would be allowed in at abrasion locations. For such booms, the membrane enclosure shall not be considered as part of the flotation of the boom, and the membrane shall be intentionally punctured to allow water to enter during the test procedure.

5. Summary of Test Method

5.1 *Displacement Method*—Buoyancy to weight ratio is estimated using two key values, the dry weight of the boom and the gross buoyancy of the boom. Weight of the boom is measured directly. The gross buoyancy is equal to the weight of fresh water displaced by a boom totally submerged. Gross buoyancy is measured by submerging the boom, measuring the volume of water that is displaced, and calculating the weight of the displaced water.

6. Equipment Requirements

6.1 This method requires a scale to measure the dry weight of the boom, an open-top tank sufficient in volume and footprint area to physically hold the boom section or segment, a means of submerging the test section, a fresh water supply, and a method of accurately measuring the volume of water that is delivered to the tank. A recommended method of restraining the boom's buoyant force is to use a fabricated grid of dimensional lumber or steel that fits inside the tank surface area. The grid would be positioned above the boom such that it holds the boom underwater when the tank is filled.

6.2 The preferred method of determining the displacement of the boom is to use a complete boom section including end connectors, tension members and ballast, and so forth. Depending on the size of the boom, it may be more practical to measure only a portion of the boom (several segments, for example) and to scale the results. It is helpful, but not essential, that the tank have a consistent cross-sectional area. Prior to use, the tank shall be leveled and a datum established from which to obtain relative measurements.

6.3 For accurate results, the surface area of the tank shall not greatly exceed the area that the boom occupies within the tank. A recommended rule-of-thumb for this is that the surface area of the tank be no greater than twice the area occupied by the boom or boom segments being tested.

7. Test Method

7.1 The following is a summary of the methodology for measuring buoyancy-to-weight ratio. The methodology is intentionally generalized to allow the user to employ alternative test apparatus that may be readily available.

7.2 Obtain the dry weight of the boom to be tested (section, segments, and/or components) and record the weight.

7.3 Inspect the boom for areas that may trap air during the test. These include: ballast chain pocket, layers of fabric sown together, and voids at hinges, connectors, and flotation chambers. A means of allowing water to fill these air pockets must be provided for accurate results.

7.4 Place the boom within the (empty) tank, orienting it in a close to upright position as it would be deployed for use. When placing the boom in the tank, care shall be taken to not introduce folds in the boom skirt that could trap air, and orienting the boom in a close to upright position is recommended to aid in this.

7.5 Place the submerging grid (or other device to restrain the boom below water) in position. There shall be enough space for the boom to float freely as the tank is filled.

7.6 Fill the tank with water and allow sufficient time for trapped air to escape. Filling the tank to submerge the boom shall take no less than one hour, during which time the flotation element and the skirt shall be moved around to facilitate the release of trapped air. (Note that this must be done periodically, and will be difficult or impossible once the boom is submerged and its buoyant force is holding the boom against the restraining grid.)