Designation: F2376 – 23

Standard Practice for Classification, Design, Manufacture, Construction, and Operation of Water Slide Systems[1]

This standard is issued under the fixed designation F2376; 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.

1. Scope

1.1 This practice applies to the classification, design, manufacture, construction, auditing, major modification, and operation of water slide systems. Water slide systems shall be defined as rides intended for use by riders in bathing attire where the action of the ride involves possible and purposeful immersion of the rider's body either in whole or in part in water, and uses circulating water to mobilize or lubricate the rider's transportation along a purpose built path. This includes slides used with or without vehicles as defined below. The terms water slides, waterslides, and slides shall be considered equivalent when used in this practice.

1.1.1 Owner/operator requirements of this standard are required of all water slide systems regardless of date of construction.

1.1.2 The design, manufacture and construction of an existing water slide or portions of a water slide system unaffected by a major modification shall meet the standard requirements in existence at the time of the construction.

1.2 For the purposes of this practice, a water slide system includes:

1.2.1 The flume,

1.2.2 The water-circulation system,

1.2.3 The starting platform with associated means of access and egress,

1.2.4 The structural supports,

1.2.5 Vehicles or other aquatic accessories that are part of the water slide as defined by the manufacturer, and

1.2.6 Means of slide termination.

1.3 This practice shall not apply to:

1.3.1 Any water slides installed in private residences,

1.3.2 Water flume amusement rides where contact with water is merely incidental (for example, log flume rides, shoot-the-chutes),

1.3.3 Amusement rides and devices whose design criteria are specifically addressed in another ASTM standard,

1.3.4 Lazy river type attractions operating at constant elevation, constructed in the ground,

1.3.5 Inflatable water slides (constant air supply) that are mounted on land (refer to Practice F2374-22 for the requirements of these types of water slides),

1.3.6 Inflatable water slides (captured air) that are floating on a body of water (refer to EN/ISO 25649-2017, parts 1 through 7), and

1.3.7 Water slides less than 6 ft tall. (Refer to Practice F2461-20a for the requirements of slides less than 6 ft tall.)

1.4 Pre-existing designs manufactured after the effective date of publication of this practice if the design is service proven or previously compliant, as defined in Terminology F747-22, and the manufacturer provides:

1.4.1 A historical summary of the water slide, or major modification as defined in Terminology F747-22, and

1.4.2 A statement that the design is service proven or previously compliant. Water slides and major modifications to water slides may qualify as previously compliant for five years following the date of publication of this practice. Thereafter, water slides and major modifications to water slides must qualify as service proven or meet the requirements of this practice.

1.4.3 Service proven or previously compliant designs shall comply with Section 4.

1.5 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

NOTE 1—The conversion factor from inch-pound to metric units is 1 in. = 25.4 mm, and 1 lb = 4.4482 N.

1.6 This practice includes an Appendix, which provides additional information to enhance the user's understanding of and application of the criteria presented in this practice, for example, rationale, background, drawings, interpretation, or commentary. The information in the Appendix shall not be considered a mandatory part of this practice.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

[1] This practice is under the jurisdiction of ASTM Committee F24 on Amusement Rides and Devices and is the direct responsibility of Subcommittee F24.70 on Water Related Amusement Rides and Devices.

Current edition approved June 1, 2023. Published August 2023. Originally approved in 2006. Last previous edition approved in 2022 as F2376 – 22. DOI: 10.1520/F2376-23.

responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.8 *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]

D570 Test Method for Water Absorption of Plastics
D638 Test Method for Tensile Properties of Plastics
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
F747 Terminology Relating to Amusement Rides and Devices
F770 Practice for Ownership, Operation, Maintenance, and Inspection of Amusement Rides and Devices
F1193 Practice for Quality, Manufacture, and Construction of Amusement Rides and Devices
F2291 Practice for Design of Amusement Rides and Devices
F2374 Practice for Design, Manufacture, Operation, and Maintenance of Inflatable Amusement Devices
F2461 Practice for Manufacture, Construction, Operation, and Maintenance of Aquatic Play Equipment
F2974 Practice for Auditing Amusement Rides and Devices
F3158 Practice for Patron Transportation Conveyors Used with a Water Related Amusement Ride or Device
F3493 Practice for Measuring Dynamic Characteristics of Water Slide Systems Using Instrumented Humans

2.2 *ACI Standard:*[3]

ACI-318 Building Code Requirements for Structural Concrete

2.3 *ASCE Standard:*[4]

ASCE/SEI 7-16 Minimum Design Loads for Buildings and Other Structures

2.4 *EN/ISO Standard:*[5]

EN/ISO 25649 Floating leisure articles for use on and in the water

2.5 *USDA Document:*[6]

USDA-72 The Wood Handbook

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *fall distance*—vertical distance between the terminus of the slide surface and the water surface of the landing pool.

3.1.2 *flume riser (splashguard)*—extension of the side wall of an open flume to contain riders or water and is capable of use as a riding surface.

3.1.3 *landing pool*—pool intended to receive riders from a water slide.

3.1.4 *landing zone*—area in a landing pool intended for receiving riders from a particular slide.

3.1.5 *run-out section*—flume surface of a water slide where riders are intended to decelerate or come to a stop, or both.

3.1.6 *slide height*—difference in elevation from the centerline of the flume at the slide exit to the centerline of the flume at slide entry, measured at the riding surface.

3.1.7 *slide path*—geometric layout of the flume sections that make up the water slide.

4. Design

4.1 *General Design Criteria:*

4.1.1 General design criteria shall be in accordance with Section 5, General Design Criteria, of Practice F2291-22a with the following revisions:

4.1.1.1 Exclude Practice F2291-22a subsection 5.1.1.4 (2) Patron Restraint and Containment Analysis.

4.1.1.2 Exclude Practice F2291-22a subsection 5.1.1.4 (3) Patron Clearance Envelope Analysis.

4.1.1.3 Exclude Practice F2291-22a subsection 5.5.2.

4.1.1.4 The coordinate system as defined in Terminology F747-22 shall be used as the standard reference for acceleration directions.

4.1.1.5 Exclude Practice F2291-22a subsection 5.6.4.1.

4.1.1.6 General drawings or diagrams in plan, elevation, and section views showing the general arrangement of components, including slide clearance envelope as described in 4.3.

4.1.2 The ride analysis shall include assessment and mitigation of potentially hazardous conditions associated with the design rider path and rider path variations.

4.1.3 If systems or devices are used to affect the speed of the rider or ride vehicle in order to mitigate a hazard, these systems or devices shall meet the requirements of Practice F2291-22a, Subsection 5.2 Hazard Mitigations.

4.1.4 A water slide system shown to comply with this practice shall meet all applicable requirements specified in this practice. Anyone representing compliance with this practice shall keep such essential records as are necessary to document any claim that the requirements within this specification have been met.

4.1.5 The following are minimum requirements and should not be substituted where manufacturer experience suggests more acrimonious values.

4.1.6 A water slide shall be designed and constructed so that forces on riders allow the rider to use the slide in accordance with the rules and instructions under normal operating conditions.

4.2 *Slide Classification:*

4.2.1 Water slides are classified by their physical and intended use characteristics. The classification may be a

[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.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333.

[4] Available from The American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191.

[5] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

[6] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

combination of the specific rider vehicle used the type of geometric path, often serpentine or straight, and the designation as a speed slide if the rider's velocity exceeds 25 ft/s. The following are definitions of the types of water slides.

4.2.1.1 *body slides*—water slide used without a vehicle.

4.2.1.2 *children's slides*—Water slides generally intended only for use by persons under the height of 48 in. Water slide has a maximum fall distance of 3 in. from slide exit where the rider enters the water and water depth is no greater than 24 in.

4.2.1.3 *mat slides*—water slide used with a designated mat as a vehicle.

4.2.1.4 *serpentine slide*—curved path as viewed in geometric slide path.

4.2.1.5 *specialty slides*—proprietary water slide design, such as an uphill, half-pipe, or bowl ride, which does not conform to standard classification.

4.2.1.6 *specialty vehicle slides*—water slide used with a proprietary vehicle specified by the manufacturer.

4.2.1.7 *speed slide*—water slide where the rider(s) achieve a velocity of 25 ft/s or more during the course of the ride.

4.2.1.8 *tube slides*—water slide used with a single or multi-person water slide tube.

4.3 *Patron Restraint, Clearance Envelope, and Containment Design Criteria:*

4.3.1 *Patron Restraint and Containment Analysis*—A patron restraint and containment analysis shall be performed.

4.3.2 *Patron Clearance Envelope Analysis*—A patron clearance envelope analysis shall be performed in accordance with Practice F2291-22a subsection 6.6, with the following revision:

(1) Exclude Practice F2291-22a subsection 6.6.4.2.

4.3.2.1 In accordance with Practice F2291-22a Subsection 6.6.3.6, reasonably foreseeable variations in the position or orientation of the patron or patron carrying device shall be considered. Fig. 1 is an example illustration of this consideration.

4.3.3 Surfaces in reach by slide attendants and riders shall be made in such a way as to reduce the potential for injury.

4.4 *Structural Design of Water Slides:*

4.4.1 This section defines the loading and strength criteria that shall be used in the structural engineering of water slide flumes and supporting structures. The strength and stability of the water slide system shall be demonstrated by generally accepted engineering methods certified by a professional engineer.

4.4.1.1 Basic load descriptions are provided below and within Appendix X2.

4.4.1.2 In the absence of a recognized national building code, the basic loads defined below shall be combined with guidance provided by Practice F2291-22a, with the exception that ASCE/SEI 7-16 shall be used.

4.4.1.3 The ASCE/SEI 7-16 and later calculates basic wind loads as ultimate wind loads. This document provides the ultimate wind speeds for use with the load combinations provided in Appendix X2.

4.4.1.4 Basic loads are forces, pressures, movements, etc. defined by a magnitude, direction, and application location. Basic loads are not yet combined with other loads.

4.4.1.5 Basic load case values such as wind, live, and dead shall be combined using pre-defined Load Combinations within ASCE/SEI 7-16 when no other load combination guidance is required by the jurisdiction. Some of these load combinations are provided within Appendix X2 as they appear within ASCE/SEI 7-16. Load combinations are defined for allowable stress design (ASD) and ultimate strength design (USD) methodologies, respectively. The engineer will ensure that load combinations are used consistently with matching resistance levels.

4.4.2 *Dead Loads (symbol D)*—Forces resulting from weight of all components of the ride and includes all loads that do not fluctuate with respect to time.

4.4.2.1 *Ice Loads (symbol D,i)*—Forces resulting from the calculated accumulation of ice on exterior water slide components that correspond to the location's ice risk category.

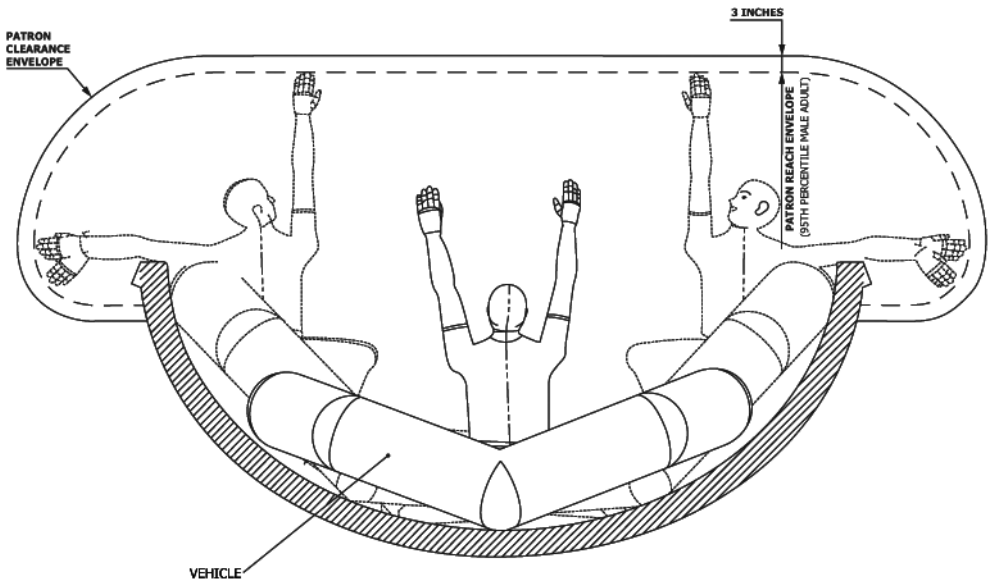

FIG. 1 Sample Patron Clearance Envelope Illustration with Variation in Position (Raft)