Designation: ~~F3158 – 21~~ F3158 – 22

Standard Practice for Patron Transportation Conveyors Used with a Water Related Amusement Ride or Device[1]

This standard is issued under the fixed designation F3158; 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, and operation of patron transportation conveyors, integral with the operation of water related amusement rides or devices as scoped in Practice F2376~~:~~-21a.

1.2 This practice applies to conveyors used for patron loading/unloading or to transport patrons on rafts, tubes, or other vehicles. Loading, sequencing, transitioning, starting, and unloading conveyors that carry patrons are included in the scope of this practice.

1.3 This practice shall affect new conveying systems or major modifications of conveyors used in an amusement ride or attraction.

1.4 This practice includes an appendix (non-mandatory), which provides additional information (for example, rationale, background, interpretations, drawings, commentary, and so forth) to improve the user's understanding and application of the criteria presented in this practice. The appendix information shall not be interpreted as mandatory design criteria.

1.5 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *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]

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
F2376 Practice for Classification, Design, Manufacture, Construction, and Operation of Water Slide Systems

[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.

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[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.

2.2 *ANSI Standards:*[3]
ANSI/ASME B20.1 Safety Standard for Conveyors and Related Equipment
ANSI B77.1 Passenger Ropeways—Aerial Tramways, Aerial Lifts, Surface Lifts, Tows and Conveyors—Safety Requirements
2.3 *ASME Standard:*[4]
ASME A17.1 Safety code for Elevators and Escalators

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 This space is reserved (see X1.1).

4. Classification

4.1 *Type 1 Riding Position Conveyor*—The conveyor may not move while a patron is on the conveyor unless the patron is in riding position on a ride vehicle. Type I conveyors may perform, but are not limited to, one or more of the following functions:

4.1.1 Transport,

4.1.2 Sequencing,

4.1.3 Acceleration,

4.1.4 Ingress, and

4.1.5 Egress.

4.2 *Type 2 Walk On/Off Conveyor*—Conveyors in which patrons are allowed to walk on or off of the moving conveyor during vehicle loading or unloading. These conveyors are also known as moving station conveyors.

5. Significance and Use

5.1 The purpose of this practice is to provide designers, engineers, manufactures, owners, and operators with criteria and references for use in designing, inspecting, and operating patron transportation conveyor systems which are integral with a water related ride or device.

6. Design Criteria

6.1 In addition to the design requirements of Section 5, General Design Criteria, of Practice F2291,-21, the following considerations and requirements shall be included.

6.2 *Geometry:*

6.2.1 The length of a conveyor is defined from the center of the tail pulley to the center of the head pulley.

6.2.2 *Belt Width*—The actual width of the belt.

6.2.3 *Riding Surface Width*—The exposed width of the belt surface.

6.2.3.1 *Minimum Riding Surface Width for a Type 1 Riding Position Conveyor*—The width of the vehicle traction surface plus 4 in. (10 cm).

6.2.3.2 *Minimum Riding Surface Width for a Type 2 Walk On/Off Conveyor*—36 in. (0.92 m) minimum is required for patron travel.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

6.2.4 The carrying side of the conveyor belt shall maintain a fixed path of travel under all load conditions and maintain contact with the support track, slide deck or support rollers.

6.2.5 *Limits to the Maximum Slope Angle of the Belt:*

6.2.5.1 *Type 1 Riding Position Conveyor*—The maximum slope shall be determined by ride analysis and shall be limited such that loaded vehicles being transported by the conveyor will not slide in a reverse direction. This slope analysis shall consider the maximum and minimum operational design conditions such as ride vehicle, live load, belt wear, expected water from the ride, and environmental conditions.

6.2.5.2 *Type 2 Walk On/Off Conveyor*—The maximum slope shall be determined by ride analysis and shall not exceed the following limitations:

(1) The angle of inclination from the horizontal shall not exceed 3° within 36 in. (0.92 m) of the ingress and egress ends.

(2) At the vehicle load position, the slope of the conveyor shall match the slope of vehicle travel at the load position.

(3) For conveyors running up an incline the angle of inclination of the conveyor shall not exceed 18° at any point. For conveyors intended to be accessible the inclination shall not exceed 10° at any point.

(4) The ride analysis for declining conveyors shall consider the slope of the conveyor, the deceleration rate under braking and the patron restraints.

6.2.6 *Maximum Cross Slope*—2 %.

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

6.3.1 *Restraints*—The designer/engineer shall consider accelerations generated by the conveyor system in the ride analysis.

6.3.2 *Clearance Envelope:*

6.3.2.1 *Type 1 Riding Position Conveyor:*

(1) The clearance envelope shall be determined ~~based on the "Patron Clearance Envelope Analysis"~~ as outlined in subsection ~~6.6~~ 6.6, Patron Clearance Envelope Analysis, of Practice F2291~~.~~-21.

(2) If the pathway of the conveyor belt is used for emergency evacuation egress, then the minimum head room shall match the value listed in 6.3.2.2(2).

6.3.2.2 *Type 2 Walk On/Off Conveyor:*

(1) The clearance envelope shall be determined ~~based on the "Patron Clearance Envelope Analysis"~~ as outlined in subsection ~~6.6~~ 6.6, Patron Clearance Envelope Analysis, of Practice F2291~~.~~-21.

(2) The headroom shall be 7 ft (2.14 m) minimum over the patron path of travel, as measured vertically from the conveyor belt and ride vehicle access surfaces.

(3) Handrails and solid balustrades may be used as needed to assist and guide patrons while on the conveyor. These shall be considered in the "Patron Clearance Envelope Analysis."

6.4 *Speed and Acceleration Limits:*

6.4.1 *Maximum Belt Speed:*

6.4.1.1 *Type 1 Riding Position Conveyor*—The conveyor belt must remain stationary until the patron is in riding position on the ride vehicle. Once the patron is in riding position on the ride vehicle, the maximum speed shall be based on the ride analysis, however the designer/engineer shall consider the accelerations entering a belt, between succeeding belts, and launch speed required at the belt exit in the ride analysis. These accelerations shall meet the requirements of 6.4.2.

6.4.1.2 *Type 2 Walk On/Off Conveyor:*

(1) The design speed of a Type 2 Walk On/Off Conveyor should be considered as part of the ride analysis.

(2) The designer/engineer shall consider lateral accelerations of the pedestrian when loading/unloading a conveyor.

(3) Additional design consideration should be taken when loading/unloading a conveyor at angles not parallel with the direction of travel. At a minimum the edge of the belt in the loading and unloading areas shall be marked in accordance with 6.11.9.

6.4.2 *Acceleration/Deceleration:*

6.4.2.1 *Type 1 Riding Position Conveyor*—Under all public operating conditions a conveyor shall not produce accelerations/decelerations that induce hazardous motion to a rider in the proper riding position and using the provided restraint device, such as handles on the ride vehicle.

6.4.2.2 *Type 2 Walk On/Off Conveyor*—The maximum accelerations/decelerations of the patron shall be determined by the ride analysis with regard to the conveyor belt construction, profile, and speed transitions.

6.4.2.3 When the conveyor may transport more than one patron at a time, the ride analysis shall consider the effects of acceleration and deceleration on all patrons standing or walking on the conveyor.

6.5 *Loads and Strengths*—The loads and strengths used in performing the calculations and analyses used in the design process shall be as defined in Section 8, Loads and Strengths, of Practice F2291~~, Section 8.~~-21. In addition to these referenced criteria, the following conditions shall apply.

6.5.1 The environmental conditions associated with water related amusement rides or attractions can be very corrosive, especially for those conveyors which are adjacent to or submerged in treated water. The design shall consider these operating conditions.

6.5.2 Plastic and plastic composite structural elements strengths shall be designed in accordance with subsection 4.3.10, Plastic and Plastic Composite Structures, of Practice F2376~~, subsection 7.10.~~-21a.

6.6 *Hydraulic Equipment for Conveyors*—The criteria used in selecting and sizing hydraulic components, designing the hydraulic system, and performing the analyses used in the process of hydraulic system design shall be in accordance with Section 9, Hydraulic Equipment for Amusement Rides and Devices, of Practice F2291~~, Section 9.~~-21.

6.7 *Pneumatic Systems and Components*—The criteria used in selecting and sizing pneumatic components, designing the pneumatic system, and performing the analyses used in the process of pneumatic system design shall be in accordance with Section 10, Pneumatic Systems and Components, of Practice F2291~~, Section 10.~~-21.

6.8 *Safety Related Control Systems*—The safety related control system shall be designed and installed in accordance with Section 11, Safety Related Control Systems, of Practice F2291~~, Section 11.~~-21.

6.9 *Electrical Requirements*—The criteria used in selecting and sizing electronic components, assemblies, designing the electronic systems, and performing the analyses used in the process of electronic system design shall be in accordance with Section 12, Electrical Requirements, of Practice F2291~~, Section 12.~~-21.

6.10 *Mechanical Systems and Components*—Unless otherwise noted in the following, the criteria used in selecting and sizing mechanical components, designing mechanical systems, and performing the analyses used in the process of mechanical system design shall be in accordance with Section 13, Mechanical Systems and Components, of Practice F2291~~, Section 13.~~-21.

6.10.1 *Conveyor Belt Material:*

6.10.1.1 The maximum design tension shall not exceed the working strength published by the belt manufacturer under any normal operating condition.

6.10.1.2 Openings in the conveyor belt material shall not allow passage of a sphere larger than ¼ in. (6.35 mm) diameter.

6.10.1.3 Conveyor splices shall be in accordance with the design and any related belt manufacturer requirements. Splicing of the conveyor belt shall be made in such a manner as to result in a continuous conveyor belt surface.

6.10.1.4 Cleated conveyor belts shall require specific consideration in the ride analysis in accordance with subsection 5.1, Ride Analysis, of Practice F2291~~-17, Section 5.~~-21.

6.10.2 *Service Brake*—A service brake shall be required if the stopping distance, including dynamic braking by the drive, exceeds the maximum stopping distance as determined in 6.12.2 or otherwise in the ride analysis.

6.10.2.1 If installed, the service brake shall be located at any point in the drive train such that there is no drive belt, friction clutch, or similar friction-type device between the brake and the drive drum.

6.10.2.2 The service brake shall be applied by springs, weights, or other forms of stored energy when any stop circuit is interrupted.

6.10.3 *Rollback Device*—The occupied portion of the conveyor belt shall be designed to limit reverse travel. Either the ride analysis shall determine that the belt maintains a safe state in the event that the conveyor belt breaks, or the safety related control system shall continuously monitor and stop the conveyor for belt damage.

6.11 *Machine Guards:*

6.11.1 Machine safeguarding methods shall be implemented to inhibit persons from contacting drive belts, chains, pulleys, gears, drivelines, and similar moving machinery while the conveyor is in operation.

6.11.2 When the ride analysis determines that parts can break free on power transmissions provisions shall be made to contain the components.

6.11.3 Equipment guards shall be provided to minimize the hazard associated with a drive shaft failure.

6.11.4 Material used in the construction of guards shall be of such design and strength as to protect individuals from identified hazards. The design and construction of the guard shall ensure that individuals cannot inadvertently reach the hazard by reaching over, under, around, or through the guard.

6.11.5 When tasks such as testing, setup, repair, adjustment, or maintenance require removing, disabling, bypassing, or suspending one or more safeguards, alternate risk reduction measures shall be required. Only properly trained and authorized personnel shall be allowed access to areas behind guards. The bypass process shall be documented and shall include specific procedures and appropriate training of personnel.

6.11.6 Protection against static electricity shall be provided.

6.11.7 All stationary surfaces along the conveying path and within limb's reach of a patron being transported shall be smooth and free from any points of entrapment or entanglement in accordance with the patron clearance envelope analysis. The designer shall consider the probability that the typical patron of a water related amusement ride or attraction will not be wearing foot wear, and may have minimal clothing.

6.11.8 *Edge Guards*—The designer/engineer shall consider the entrapment point between the edge of the belt and the conveyor frame. In the case in which belt edge guards are used to maintain the opening at the edge of the belt, the edge guard should completely cover the edge of the belt, under each operating conditions, and the gap between the top of the belt and lower lip of the edge guard should be no larger than ¼ in. (6 mm). This gap shall be measured from the top of the exposed belt surface.

6.11.9 *Edge Marking*—For Type 2 Walk on/off conveyors where the patron may load or unload the conveyor from the side, the transition from the moving belt to the fixed surface shall be marked with a contrasting color to clearly designate the surface change.

6.11.10 Where any portion of a conveyor is located under water, the pool space around the conveyor shall be physically guarded so as to minimize risk of entanglement or entrapment. The guards shall meet the requirements of 6.5.1.

6.12 *Exit Transition Zone (see Fig. 1):*

6.12.1 The ride analysis shall consider hazards associated with the exit transition zone.

6.12.2 The ride analysis shall consider any potential for entanglement in the transition zone and determine the maximum stopping distance for the conveyor belt in the event of such an entanglement. An appropriate automatic or manual control shall be provided for this purpose.

6.13 *Fencing, Guardrails, Handrails, and Gates:*