Designation: F 1159 – 97a

Standard Practice for the Design and Manufacture of Amusement Rides and Devices[1]

This standard is issued under the fixed designation F 1159; 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 establishes information and procedures for the design and manufacture of amusement rides and devices.

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

2. Referenced Documents

2.1 *ASTM Standards:*

F 846 Guide for Testing Performance of Amusement Rides and Devices[2]

2.2 *Federal Documents:*[3]

Dept. of Health, Education, and Welfare *Pediatric Growth Development Chart*, 1983

USDA Agricultural Handbook 72, Rev. 0—*The Wood Handbook*, by the U.S. Dept. of Agricultural Forest Products Laboratory

2.3 *Society of Automotive Engineers Standards:*[4]

SAE J 833 Recommended Practice for USA Human Physical Dimensions

SAE Hydraulic Fluid Standards

SAEJ-10 Pneumatic Storage Tanks

SAE Pneumatic Tubing Standards

2.4 *American Society of Mechanical Engineers Documents:*[5]

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

ASME Welding Standards

2.5 *American Institute of Steel Construction Document:*[6]

AISC Manual on Steel Construction

2.6 *American Welding Society Standard:*[7]

ANSI/AWS D1.1 Structural Welding Code

2.7 *National Fire Protection Association Standard:*[8]

National Electrical Code

2.8 *ANSI Standard:*[9]

ANSI (NFPA/JIC) T2.24.1–1991 Hydraulic Fluid Power Systems Standard for Stationary Industrial Machinery,[9]

3. Significance and Use

3.1 This practice provides designers and manufacturers of amusement rides and devices with design references and criteria to use in designing and manufacturing amusement rides and devices.

4. Procedures for Developing Documentation and Records

4.1 *Design and Calculations*—Manufacturers' basic documentation and engineering analysis shall include, but not be limited to, the following:

4.1.1 Performance characteristics of structural, mechanical, and electrical components, and

4.1.2 Forces on passengers due to the action of the ride based on design loading.

4.2 *Drawings and Records*—Records shall be kept on the characteristics and forces explained in 4.1.1 and 4.1.2 for all versions and revisions of a ride or device so long as deemed appropriate by the designer/manufacturer.

4.3 *Testing*—Document and record the testing performance of amusement rides and devices in accordance with the tests given in Guide F 846.

DESIGN PROCEDURES

5. Designing in Accordance with Passenger Weights

5.1 The weight assigned to an adult passenger, for design purposes, shall be 170 lb (77 kg) or 12 lb/in. (5.4 kg/25.4 mm) of hip width at the seat, whichever is greater. Reference SAE

[1] This practice is under the jurisdiction of ASTM Committee F-24 on Amusement Rides and Devices and is the direct responsibility of Subcommittee F24.24 on Design and Manufacture.

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[2] *Annual Book of ASTM Standards*, Vol 15.07.

[3] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[4] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

[5] Available from Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017.

[6] Available from the Institute of Steel Construction, P.O. Box 4588, Chicago, IL 60680.

[7] Available from the American Welding Society, 550 N. LeJeune Rd., Miami, FL 33126.

[8] Available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

[9] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

J 833 on USA Human Physical Dimensions, using the "medium man" for passenger weight.

5.2 The weight assigned to a 12-year-old child passenger, for design purposes, shall be 90 lb (41 kg) or 9 lb/in. (4.1 kg/25.4 mm) of hip width at the seat, whichever is greater. Reference U.S. Department of Health, Education, and Welfare Pediatric Growth Development Chart 1983.

6. Passenger Carrying Devices

6.1 *Design of Seats*—Design passenger seating to provide adequate support padding and containment for the passenger's body during operation, and to be consistent with the design intent of the ride.

6.2 *Methods of Restraint*—Where appropriate, base the passenger restraint on the design intent of the ride or device with consideration given, but not limited to, the height, speed, and forces on passengers.

6.3 *Passenger Clearance*—Design clearance to minimize the opportunity for contact between a contained passenger and any object where said contact is likely to cause injury during operation of a ride or device.

7. Amusement Ride and Device Structures

7.1 *Metal Structures*—Where applicable, design metal structures in accordance with the AISC *Manual of Steel Construction*, as applicable.

7.1.1 Allowable loads or stresses as indicated in the AISC *Manual of Steel Construction* shall be reduced as deemed adequate by the manufacturer/designer, to allow for special combinations of conditions which may include, but are not limited to, stress concentrations, shock, dynamics, load cycles, degree of risk, and environment.

7.2 *Timber Structures*—Design timber structures in accordance with USDA Agricultural Handbook 72, Revision 0, *The Wood Handbook.*

7.2.1 Allowable loads or stresses as indicated by the above data shall be reduced as deemed adequate by the manufacturer/designer to allow for special combinations of conditions which may include, but are not limited to, stress concentrations, shock, dynamics, load cycles, degree of risk, and environment.

7.3 *Welding*—Welding and welding procedures shall be in accordance with American Welding Society (ANSI/AWS D1.1) or American Society of Mechanical Engineers, or other equivalent standards, and be performed by appropriately certified or qualified welders as required by the standard.

7.4 *Bolting Specifications*—All threaded fasteners used on an amusement ride or device in connecting components shall meet accepted engineering standards for each application in the system, and grade shall be identified where appropriate.

7.5 *Chain and Wire Rope*—Chain and wire rope used in ride systems shall meet existing industrial ratings considering the loads, conditions, dynamics, and potential fatigue involved.

7.6 *Air-Supported Structures*—Where applicable, air-supported structures shall be designed and manufactured with flame-resistant materials that meet or exceed a 2-s flame-out standard.

7.6.1 Hold-down provisions shall be designed for the structure to allow operation of the device within the wind conditions specified by the manufacturer.

7.6.2 Provision shall be made to ensure that patrons cannot conceal themselves from the operator's view.

7.6.3 Enclosed structures shall have within 100 ft of the normal point of egress adequately lighted emergency exits.

7.6.4 Power failure, of an inflation means, shall not increase the risk of injury to anyone on the device.

8. Electrical Components

8.1 Design, manufacture, and install electrical components in accordance with the National Electric Code or the equivalent.

8.2 Emergency stop circuits shall be energized systems which are fail-safe in case of power failure.

8.3 The emergency stop switches shall be manually reset. The resetting of the stop switch shall not start the ride.

9. Hydraulic Components

9.1 The applicable provisions of ANSI (NFPA/JIC) T2.24.1–1991 or the equivalent shall be used as the standard for the design and manufacture of fixed and portable Amusement Rides and Devices except as expanded or modified in the following sections or sub-sections. This section shall apply to all Amusement Rides and Devices manufactured after January 1, 1999.

9.2 Deviation from ANSI T2-24-1, section 6.7.1, shall be permitted only when components are designed for higher temperature opertion and adequate shielding is provided to prevent hot fluid from reaching any passenger or observer on or near the Ride or Device.

9.3 Changes or additions, or both, to ANSI T2.24.1 shall be incorportated for use in the design and manufacture of Amusement Rides and Devices as defined by sub-sections herein.

9.3.1 The following changes (**bold**) to ANSI T2.24.1, Section 7.2.3.1 are incorporated as follows:

7.2.3.1 Adjustments of control **should** not require access between, over or in close proximity to moving equipment or parts.

9.3.2 The following deletion (**bold**) to ANSI T2.24.1, Section 7.4.1 is incorporated as follows:

7.4.1 Emergency stop and/or return controls

Delete in its entirety, item e: **e) Shall provide a blocking device in servovalve(s) supply line(s).**

9.3.3 The following changes (**bold**) to ANSI T2.24.1, Section 7.7.1 are incorporated as follows:

7.7.1 **Emergency safety device or means**

When the possibility exists that undesirable motion will result due to an emergency or uncontrolled stop condition, a **device or means** shall be provided in the proportional **or servo** control **circuit** to prevent such motion.

9.3.4 The following changes (**bold**) to ANSI T2.24.1, Section 12.2.4 are incorporated as follows:

12.2.4 Filters **should** be sized to provide a minimum of 800 hours of operation under normal system conditions.

9.3.5 The following changes (**bold**) or deletions (**bold**) to ANSI T2.24.1, Section 18.3.4 are incorporated as follows:

18.3.4 Diagnostic pressure test points, **when used**, should be, accessibly installed in hydraulic circuits to verify system pressure, and also where pressure can be adjusted from the main system pressure.

9.3.6 The following deletions (**bold**) to ANSI T2.24.1, Section 18.5 are incorporated as follows:

18.5 Oil sampling

Sample test points shall be made available close to hydraulic pumps and at other key locations for the purpose of checking fluid for contamination. Sample test points must provide safe, reliable access to fluid **while under full system pressure**.

9.4 *Position Limits*—Effective means are provided to prevent a linear actuator, where piston and rod are the same diameter, from traveling beyond to physical limits of the actuator.

9.5 *System Failures*—In the event of a system failure or malfunction of the hydraulic system, the velocity or acceleration, or both, shall be controlled with respect to forces acting on the passengers.

10. Pneumatics

10.1 Maximum pressure shall not exceed the component rating.

10.2 Pneumatic storage tanks shall conform to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or SAE J-10.

10.3 Pneumatic accumulators shall conform to ASME pressure vessel standards.

10.4 Pneumatic tubing hose and fittings shall conform to SAE standards or the equivalent.

10.5 Loss of air pressure below design minimums in critical applications shall cause the system to revert to the appropriate emergency mode.

10.6 The pneumatic system shall include components to provide lubrication and moisture extraction where deemed appropriate by the designer.

10.7 Where deemed appropriate by the designer, provisions shall be made for dumping accumulator tanks when systems are shut down.

11. Operator Controls

11.1 Design operator controls to be located within easy reach of the operator when the operator is in a position to observe the ride while the ride is in operation.

11.2 Operator control systems shall be designed to avoid unintentional activation.

11.3 Operator controls shall be identified in the English language as to their function.

11.4 Operator control system design shall incorporate a control access system.

12. Brakes

12.1 The design shall provide sufficient braking capacity to satisfy the designer's recommended operation parameters.

12.1.1 Design a *block system* for those rides and devices where, by the ride design, it is necessary to prevent independent passenger carrying units from occupying the same block section of the ride.

12.2 Design critical braking systems to be energized systems which remain activated in the event of power failure, where appropriate.

12.3 Operator-monitored braking systems designed to be normally activated in the absence of the operator shall be considered by the designer.

13. Machine Guards

13.1 Design machine guards to protect employees and guests from hazards associated with, but not limited to, belts, chains, and pulleys.

14. Fencing for Amusement Rides and Devices Manufactured After January 1, 1993

14.1 When fences and gates are designed and manufactured to provide protection to spectators and riders, they shall be constructed to meet the following minimum requirements:

14.1.1 They shall be a height of at least 42 in. above the surface on which the spectators or riders stand.

14.1.2 They shall be constructed in such a fashion so as to reject a 4-in. ball at all openings.

14.1.3 They shall be designed, constructed, and erected to inhibit overturning by spectators or riders.

14.1.4 Where used, entrance, exit, and loading gates shall open away from the ride or device unless equipped with a positive latching device.

14.1.5 Gates shall be designed such that if opened during the amusement ride or device cycle, the gate will not contact the amusement ride or device or cause a hazard to riders.

14.1.6 Fences and gates shall be constructed as to inhibit spectator contact with the ride or device, or rider contact with fences or gates, or both.

NOTE 1—Horizontal members in a fence or gate may be used to improve construction or efficiency, but should be minimized to reduce the ease of climbing.

15. Keywords

15.1 amusement rides and devices; design; manufacture