Designation: F2959 – 16

Standard Practice for Aerial Adventure Courses[1]

This standard is issued under the fixed designation F2959; 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 criteria for the Design, Manufacture, Installation, Operation, Maintenance, Auditing and Major Modification of Aerial Adventure Courses which occur(s) after the effective date of publication of this document except as noted in 1.3.

1.2 This practice applies to the following devices when operated for concession or commercial recreation:

1.2.1 Zip Lines.

1.2.2 Ropes Courses.

1.2.3 Challenge Courses.

1.2.4 Aerial Trekking Courses.

1.2.5 Canopy Tours.

1.2.6 Manufactured Climbing Walls.

1.3 This practice shall not apply to the following:

1.3.1 Aerial Adventure Courses when operated exclusively under the following applications:

1.3.1.1 Educational curriculum.

1.3.1.2 Physical fitness purposes.

1.3.1.3 Organized competitive events.

1.3.1.4 Therapeutic programs.

1.3.1.5 Training purposes.

1.3.1.6 Team and confidence building.

1.3.1.7 Playground equipment covered by Consumer Safety Performance Specification F1487.

1.3.2 Amusement rides and devices whose design criteria are specifically addressed in another ASTM standard.

1.3.3 Portions of an Aerial Adventure Course unaffected by a major modification.

1.3.4 Upgrades to electrical wiring, electrical motors and electrical components of Aerial Adventure Courses provided the original design and safety criteria are maintained or enhanced.

1.3.5 Pre-existing designs for Aerial Adventure Courses that are installed after the publication date of this practice if the design is service proven or previously compliant as specified by 1.3.5.1.

1.3.5.1 Aerial Adventure Course designs may qualify as "previously compliant" for five years following the date of publication of this practice. Thereafter, an Aerial Adventure Course design must qualify as "service proven" as defined in Practice F2291 or meet the requirements of this practice.

1.4 This practice includes an annex (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 annex information shall be interpreted as mandatory design criteria.

1.5 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.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use. Some specific hazards statements are given in Section 7 on Hazards.*

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

F846 Guide for Testing Performance of Amusement Rides and Devices (Withdrawn 2013)[3]

F1193 Practice for Quality, Manufacture, and Construction of Amusement Rides and Devices

F1487 Consumer Safety Performance Specification for Playground Equipment for Public Use

[1] This practice is under the jurisdiction of ASTM Committee F24 on Amusement Rides and Devices and is the direct responsibility of Subcommittee F24.61 on Adventure Attractions.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

F1772 Specification for Harnesses for Rescue, Safety, and Sport Activities
F1957 Test Method for Composite Foam Hardness-Durometer Hardness
F2137 Practice for Measuring the Dynamic Characteristics of Amusement Rides and Devices
F2291 Practice for Design of Amusement Rides and Devices
F2375 Practice for Design, Manufacture, Installation and Testing of Climbing Nets and Netting/Mesh used in Amusement Rides, Devices, Play Areas and Attractions
F2974 Guide for Auditing Amusement Rides and Devices

2.2 *ANSI Standards:*[4]
ANSI B77 Passenger Ropeways - Aerial Tramways, Aerial Lifts, Surface Lifts, Tows and Conveyors - Safety Requirements
ANSI Z359 Fall Protection Code

2.3 *European Standard:*[5]
EN 12277 Mountaineering equipment - Harnesses - Safety requirements and test methods

2.4 *NFPA Standard:*[6]
NFPA 1983 Standard on Life Safety Rope and Equipment for Emergency Services

2.5 *UIAA Standard:*[7]
UIAA 105 Mountaineering and Climbing Equipment: Harnesses

3. Terminology

3.1 Terminology shall be in accordance with Terminology F747.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aerial trekking course, n*—self-guided aerial adventure course containing elements intended to be obstacles.

3.2.2 *canopy tour, n*—aerial adventure course which provides patron access to the canopy of a forest.

3.2.3 *challenge course, n*—guided aerial adventure course containing elements intended to be obstacles.

3.2.4 *ropes course, n*—synonym for a challenge course.

3.2.5 *zip line, n*—an aerial adventure course element over an open span consisting of an inclined wire or fiber rope on which harnessed patron(s) suspended from a pulley or trolley are able to traverse with the primary force for propulsion being gravity.

3.3 *Abbreviations:*

3.3.1 *AAC, n*—aerial adventure course

3.3.2 *PSE, n*—personal safety equipment

4. Significance and Use

4.1 The rational for developing a separate standard practice for Aerial Adventure Courses is based on the unique functional, operational and patron participation requirements when compared to amusement rides and devices.

4.2 The purpose of this practice is to provide designers, manufacturers, constructors, system integrators, owners/operators, and auditors with criteria and references for use in the design, manufacture, construction, installation, integration, operation, maintenance, auditing, and major modification of Aerial Adventure Courses.

4.3 Unless this practice expressly provides otherwise in a particular provision, the term "Aerial Adventure Course" is to be used in place of "Amusement Rides and Devices" herein.

5. Ownership, Operation, Maintenance, Inspection, and Training Requirements

5.1 Ownership, operation, maintenance, inspection, and training requirements for aerial adventure courses shall be in accordance with Practice F770, and the exceptions and inclusions unique to aerial adventure courses. For convenience, all of these inclusions and exceptions have been incorporated into Practice F770 and are shown below.

5.2 Changes to common terms in Practice F770-15 are:

5.2.1 Replace the term "amusement rides and devices" with "aerial adventure courses,"

5.2.2 Replace the terms "amusement ride or device" or "ride or device" with "aerial adventure course,"

5.2.3 Replace the term "ride analysis" with "device analysis,"

5.2.4 Replace the term "passenger" with "patron,"

5.2.5 Replace the term "riders" with "patrons," and

5.2.6 Replace the term "rider" with "patron."

5.3 *Significance and Use*—The purpose of this practice is to delineate information and to establish procedures for the operation, maintenance, inspection, and training of aerial adventure courses.

5.4 *Owner/Operator's Responsibility:*

5.4.1 The owner/operator shall develop a program with necessary tasks and training to operate, maintain, and inspect the aerial adventure course, as designed. The program shall include, but not be limited to:

5.4.1.1 An operations program as outlined in 5.5,

5.4.1.2 A maintenance program as outlined in 5.6,

5.4.1.3 An inspection program as outlined in 5.7, and

5.4.1.4 A training program as outlined in 5.8.

5.5 *Operations Program:*

5.5.1 *Operating Document*—Each owner/operator shall prepare an operating document for each aerial adventure course or element based on the recommended instructions and specifications provided by the manufacturer. This operating document shall be made available to each aerial adventure course operator and attendant. The operating document shall include, but not be limited to:

5.5.1.1 Specific operation policies and procedures with pertinent information from the manufacturer's instructions, including, but not limited to:

(1) Description of the aerial adventure course operation;

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[6] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[7] Available from International Mountaineering and Climbing Federation (UIAA), 61 Postfach CH-3000 Bern 23 Switzerland, http://www.theuiaa.org/index.php.

(2) Specific duties of the assigned operator(s) and attendant(s) position(s) of the aerial adventure course;

(3) General safety procedures;

(4) Instructions on specific procedures to follow in the event of unusual conditions or an interruption of operation, including an evacuation plan outlined in 5.5.2;

(5) Additional instructions from the owner/operator; and

(6) The owner/operator shall also consider environmental condition(s) including, but not limited to, wind, rain, ice, and lightning when developing operating procedures.

5.5.1.2 Specific emergency procedures in the event of an abnormal condition or interruption in service.

5.5.2 *Evacuation Plan*—The owner/operator shall have and maintain an evacuation plan for each aerial adventure course.

5.5.2.1 The owner/operator shall consider:

(1) Standard load/unload area evacuations are the preferred method;

(2) Aerial adventure course manufacturer's recommendations;

(3) Conditions of the environment that could impact an evacuation;

(4) Personnel responsible for performing an evacuation;

(5) Notification and cooperation with the outside agencies and entities intended to participate in an evacuation;

(6) Identification and location of equipment to support an evacuation;

(7) Equipment that may be required to communicate with patrons during an evacuation process;

(8) Access and egress requirements for personnel and equipment to evacuate the aerial adventure course;

(9) Actions required prior to evacuation to prevent inadvertent motion of the aerial adventure course, patron(s), vehicle(s), carrier(s), and surrounding equipment in the evacuation pathway;

(10) Order or sequence of evacuation to evacuate patrons efficiently and safely;

(11) An appropriate means of egress for evacuees;

(12) Removal of patrons unable to assist in their own evacuation because of disability, medical conditions, or other reasons.; and

(13) Procedures for arranging medical assistance as required during an evacuation.

5.5.2.2 The owner/operator shall provide and document training on the evacuation plan.

5.5.2.3 The owner/operator shall periodically review the evacuation plan and make adjustments as needed.

5.5.2.4 The evacuation plan shall include an access plan for performing evacuation, first aid and ground care of evacuated patrons.

5.5.3 *Denying Entry*—The owner/operator of an aerial adventure course may deny entry to the aerial adventure course to any person, if in the opinion of the owner/operator the entry may cause above normal exposure to risk of discomfort or injury to the person who desires to enter, or if in the opinion of the owner/operator the entry may jeopardize the safety of other patrons or employees.

5.5.3.1 Aerial adventure course operators should be given guidelines on the special considerations concerning patron size, and the special considerations applicable to physically disabled and mentally impaired patrons, related to their particular aerial adventure course.

5.5.4 *Signage*—Signs presented by the owner/operator for instruction to the public shall be prominently placed and, bold in design, with wording short, simple, and to the point.

5.5.4.1 Signs to display operational instructions or requirements, or both, for use of the aerial adventure course may be posted at the waiting/loading area or other appropriate location and may include height, weight and other essential requirements and other duties and obligations of the patrons such as but not limited to those listed in 5.9.

5.5.4.2 Entrances to machinery rooms or restricted areas, or both should be posted when necessary to warn unauthorized persons not to enter.

5.6 *Maintenance Program:*

5.6.1 *Maintenance Documents*—Each owner/operator of an aerial adventure course shall read and become familiar with the contents of the designer/engineer, manufacturer, and training entity's maintenance instructions and specifications when received. Based on the designer/engineer, manufacturer, and training entity's requirements, each owner/operator shall implement a program of maintenance, testing, and inspection providing for the duties and responsibilities necessary in the care of each aerial adventure course. This program of maintenance shall include a checklist to be made available to each person performing the regularly scheduled maintenance on each aerial adventure course. The owner/operator's checklist (on an aerial adventure course basis) shall include, but not be limited to:

5.6.1.1 Description of preventive maintenance assignments to be performed;

5.6.1.2 Description of inspections to be performed;

5.6.1.3 Special safety instructions, where applicable;

5.6.1.4 The inspection criteria requirements, frequency, and retirement criteria shall be developed for the aerial adventure course components, including, but not limited to:

(1) Wire rope;

(a) Wire rope shall be subject to detailed visual inspection at regularly established intervals based on usage, but not to exceed one year by a qualified wire rope inspector, or immediately after any event possibly affecting the integrity of the wire rope. The following items shall be considered in determining the continued use of the wire rope:

- Broken wires,
- Displaced or loose wire,
- Physical damage at impact areas on wire rope,
- Visual inspection of impact areas on zip lines,
- *Diameter Reduction*—Original diameter of wire rope shall be recorded at time of commissioning and recorded for use in determining subsequent diameter reduction calculations, and
- Tensioning procedures to ensure wire rope tensions are within specified operating parameters;

(2) Wire-rope-associated hardware;

(3) Anchorage systems;

(4) Personal safety equipment (PSE);

(5) Support structures and connection hardware; and

(6) All components in the primary load path not listed above.

5.6.1.5 When one or more live tree(s) are utilized in an aerial adventure course, qualified person(s) shall perform an arboricultural inspection to determine that the tree(s) are healthy and suitable for the intended use and that the original design intent is maintained. The inspections shall be performed:

(1) At a frequency of not less than once per year;

(2) After the occurrence of any significant environmental event, such as hurricane, tornado, lightning, ice storms, earthquake, flooding or drought;

(3) After any change in surrounding environment that could alter the health and integrity of the trees utilized, such as removal of adjacent trees or development of adjoining properties;

(4) Physical damage such as a major limb failure, when there is a change in the visible health of the tree or canopy, or both, as a result of disease or insect infestation; and

(5) Arborist inspection criteria requirements:

(a) The arborist shall provide a written report evaluating the health and suitability of the tree(s) for the intended use, and

(b) The owner operator shall retain all arborist's inspection reports and maintenance records performed on the trees based on the arborist's report;

5.6.1.6 Any additional recommendations of the owner/operator; and

5.6.1.7 When developing the check lists as described in 5.6.1, the following terms are to be defined as follows:

(1) Inspection—Visual procedure;

(2) Test—Functional check;

(3) Quantitative measurement or analysis—Use of equipment to measure or analyze; and

(4) Diagnosis—Decision or conclusion based on data compiled from an inspection, test, quantitative measurement or analysis, or a combination thereof.

5.6.1.8 All inspection and maintenance and repair tasks performed shall be documented and available for review. All reports from outside agencies that may be required as specified by the designer/engineer shall form part of the documentation.

5.6.2 *Replacement Parts for Aerial Adventure Courses:*

5.6.2.1 Replacement parts for aerial adventure courses shall be:

(1) Procured from the original manufacturer of the aerial adventure course, using the appropriate manufacturer-supplied identifying nomenclature; or

(2) Procured or produced using appropriate original manufacturing drawings or specifications, or both, if available; or

(3) Procured or produced using specifications derived from sufficient analysis to ensure parts of equivalent functions and quality, to those provided by the original manufacturer and in accordance with Practice F1193.

5.6.2.2 The manufacture of replacement parts for aerial adventure courses shall conform to the applicable sections of Practice F1193.

5.6.3 The owner/operator shall be responsible for implementing a program of testing based on the recommendations of the section on Non-Destructive Testing Requirements of Practice F1193.

5.7 *Inspection Program:*

5.7.1 *Pre-Opening Inspection*—Owner/operators of aerial adventure course shall have an inspection program consistent with the inspections outlined in this practice and Practice F1193.

5.7.2 The operator(s) of each aerial adventure course shall conduct and document a daily pre-opening inspection of each aerial adventure course or element prior to carrying patrons. This inspection shall include but not be limited to the following:

5.7.2.1 Perform a visual inspection of the following components of the course, as applicable:

(1) Platforms, stairways, pathways, ramps, support structures, and trees included in and directly adjacent to the course;

(2) All fencing, guarding, and barricades;

(3) Course restraint and zip line hardware including wire rope, attachment hardware, and anchor system;

(4) Counterweight or other tension control system components;

(5) Personal safety equipment such as harnesses, lanyard, carabineers, pulleys/trolleys, and so forth; and

(6) Patron clearance envelope.

5.7.2.2 Verify proper operation of the following, as applicable:

(1) Specified manual and automatic patron control equipment,

(2) Specified safety related control system components,

(3) Braking systems, and

(4) Communication systems.

5.7.2.3 Ensure access routes and platforms are clear of debris such as ice and snow to the extent necessary to permit inspection and operation.

5.7.2.4 Additional instructions deemed necessary by the owner/operator.

5.7.3 Inspection documents deemed appropriate by the owner/operator to be maintained in the aerial adventure course file shall be filed in accordance with the procedures outlined in this practice and Practice F1193.

5.7.4 The owner/operator of an aerial adventure course shall promptly notify the manufacturer of an incident, failure, or malfunction which, in the owner/operator's judgment, may affect the continued proper operation of the aerial adventure course and is information of which the manufacturer should be aware.

5.8 *Training Program:*

5.8.1 *Operator Training*—The owner/operator shall provide and document training under the supervision of a trainer for each operator and attendant of an aerial adventure course. This training shall include, but not be limited to the following:

5.8.1.1 Instructions on aerial adventure course operating procedures;

5.8.1.2 Instructions on specific duties of the assigned operator and attendant position(s) of the aerial adventure course;

5.8.1.3 Instructions on general safety procedures;

5.8.1.4 Instructions on specific procedures to follow in the event of unusual conditions or an interruption of operation;

5.8.1.5 Demonstration by the trainer of the operation of the aerial adventure course;

5.8.1.6 Demonstration by the trainee, under the supervision of the trainer, of the operation of the aerial adventure course;

5.8.1.7 Additional instructions or training under the supervision of a trainer deemed necessary by the owner/operator; and

5.8.1.8 Instructions on rescue and retrieval procedures.

5.8.2 *Maintenance Training*—The owner/operator of the aerial adventure course shall ensure training is provided for each person performing the regularly scheduled maintenance on the aerial adventure course, pertaining to their assigned duties. This training shall include, but not be limited to, the following:

5.8.2.1 Instruction on inspection and preventive maintenance procedures;

5.8.2.2 Instruction on the specific duties of the assigned position;

5.8.2.3 Instruction on general safety procedures;

5.8.2.4 Demonstration of the physical performance of the assigned regularly scheduled duties and inspections;

5.8.2.5 Supervised observation of the maintenance person's physical performance of their assigned regularly scheduled duties and inspections; and

5.8.2.6 Additional instructions deemed necessary by the owner/operator.

5.9 *Patron Responsibility:*

5.9.1 There are inherent risks in the participation in or on any aerial adventure course or attraction of which requires appropriate patron awareness, participation, physical ability, and dexterity. Patrons of aerial adventure courses by participation accept the risks inherent in such participation of which the ordinary prudent person is or should be aware. Patrons have a duty to exercise good judgment and act in a responsible manner while in or on any aerial adventure course, and to obey all oral or written warnings, or both, before or during participation, or both.

5.9.2 Patrons have a duty to not participate in or on any aerial adventure course when under the influence of drugs or alcohol.

5.9.3 Patrons have a duty to properly use all aerial adventure course safety equipment provided.

5.9.4 Patrons have a duty to not participate in or on any aerial adventure course when their physical condition will prevent safe participation.

5.10 *Classification of Injuries and Illnesses:*

5.10.1 *Recording Recommendations:*

5.10.1.1 The administration of emergency health care service and treatment should be recorded as deemed appropriate by the owner/operator of the aerial adventure course to include the documentation of all first-aid treatment, including minor injuries and illnesses, in a first-aid log. Injuries and illnesses including minor injuries and illnesses, in a first aid log. Injuries and illnesses other than minor should be reported on a first-aid incident report in accordance with 5.10.1.2.

5.10.1.2 *First-Aid Incident Report*—A first-aid incident report should be completed for injuries or illnesses that result in hospital admission or where medical treatment is given, recommended, or may be required at a future date. All injuries or illnesses reported and other than those classified as minor, can be presumed to be in this category.

5.10.1.3 *Recorded Information*—Information recorded in the first-aid incident report should include, but not be limited to, the following, where applicable:

(1) Date the incident occurred;

(2) Name, address, and telephone number of the person to receive emergency health care service or treatment;

(3) Age of the person to receive emergency health care service or treatment;

(4) Manufacturer's name of the aerial adventure course where or on which the incident occurred;

(5) Description of the injury or illness, physical description of the injury or illness, and description of the events causing and related to the incident;

(6) Description of the first-aid service or treatment administered, including medications given;

(7) Incident classification in accordance with 5.10.2; and

(8) Additional information deemed necessary by the owner/operator.

5.10.2 *Classification of First-Aid Incidents*—When recording an applicable first-aid–related incident, the owner/operator of the Aerial Adventure Course should classify the injury or illness in accordance with each of the following categories based on the available reported or observed reliable information, or both:

5.10.2.1 *Aerial adventure course incidents classified in accordance with injury qualification and degree of injury*—Injury, illness, serious injury/illness, and minor injury/illness should be determined by the owner/operator to best describe the incident circumstances.

5.10.2.2 *Aerial adventure course incidents classified in accordance with facility implication:*

(1) Facility-related incidents—Injuries or illnesses that occur on facility premises shall be additionally classified as "facility related."

(2) Not-facility related incidents—Injuries or illnesses that occur off facility premises shall be additionally classified as "not facility related."

5.10.2.3 *Aerial adventure course incidents classified in accordance with facility location:*

(1) Aerial adventure course on aerial adventure course incident—Injuries or illnesses that actually occur to a person while participating during the operation of the aerial adventure course including during the start-up or shut-down procedures, shall be additionally classified as an aerial adventure course "on aerial adventure course incident."

(2) Loading and unloading incidents—Injuries or illnesses that actually occur to a person while he is within the area designated for loading and unloading of an aerial adventure course that was under the direct control of an operator or attendant shall be additionally classified as a "loading and unloading incident."

(3) Queue line incident—Injuries or illnesses that actually occur to a person while in a queue line for an aerial adventure course shall be additionally classified as a "queue line incident."

(4) Other incidents—Injuries or illnesses that occur to a person in a location other than as described in 5.10.2.3*(1) – (3)* shall be classified as other than the preceding classifications and should be categorized in accordance with other predetermined descriptions that may be established by the owner/operator.

5.10.3 *Manufacturer Notification*—The owner/operator of an aerial adventure course shall notify the appropriate manufacturer(s) of an incident that resulted in a serious injury within seven days of the occurrence of the incident.

5.11 *Information Transferred with Change of Ownership of Aerial Adventure Courses:*

5.11.1 *Seller's Requirements:*

5.11.1.1 The seller of a used aerial adventure course shall make available to the new owner a copy of all existing manufacturer's documentation, including but not limited to, the current operational and maintenance manuals, service bulletins, schematics, drawings, component identification information, and purchased equipment manuals in the seller's possession.

5.11.1.2 The seller of a used aerial adventure course shall provide therewith written notice of major modifications the seller has made or caused to be made along with the manufacturer's or other supporting documentation.

5.11.2 *Purchaser's Requirements*—Before the operation of a used aerial adventure course, a purchaser of that aerial adventure course shall:

5.11.2.1 Notify the original manufacturer or known successor, if available, of the change in ownership of the aerial adventure course;

5.11.2.2 Request from the original manufacturer or known successor, if available, information related to the ownership, operation, maintenance and inspection of the aerial adventure course, including but not limited to, current operational and maintenance manuals, service bulletins, schematics, drawings, component identification information, and purchased equipment manuals or other information in accordance with Practice F1193; and

5.11.2.3 Obtain, review, and become familiar with the above documents. Upon receipt of the information, incorporate the above materials in accordance with the requirements described in 5.4 – 5.8.

5.12 *Keywords:*

5.12.1 aerial adventure course; inspection; maintenance; operating procedures; operations; operator; training

6. Testing Performance

6.1 Testing performance shall be in accordance with Guide F846.

7. Auditing

7.1 Auditing requirements for aerial adventure courses shall be in accordance with Guide F2974, and the exceptions and inclusions unique to aerial adventure courses. For convenience, all of these inclusions and exceptions have been incorporated into Guide F2974 and are shown below.

7.2 Intentionally left blank.

7.3 Changes to common terms in Guide F2974-13:

7.3.1 Replace the term "amusement rides and devices" with "aerial adventure courses" except for in 2.1.

7.3.2 Replace the terms "amusement ride or device" or "ride or device" with "aerial adventure course."

7.4 *Significance and Use:*

7.4.1 The purpose of this guide is to establish guidelines for audits of aerial adventure courses.

7.4.2 An audit can include inspections, evaluations, or examinations during the design, manufacturing, installation, commissioning, operation, or major modification of an aerial adventure course.

7.4.3 This guide is not intended to require recurring design, manufacturing, installation, commissioning or major modification audits. Rather, it is intended that such audits be performed during the relevant stages of an aerial adventure course's design, manufacture, installation, commissioning or major modification.

7.5 *General:*

7.5.1 Auditor(s) shall have sufficient relevant education, experience, and training to properly audit an aerial adventure course as defined in this standard.

7.5.2 The auditor must prepare for and comply with all personal health and safety requirements as they pertain to the scope of the audit.

7.5.3 Inspection tools, test equipment, gauges, or other devices shall be in proper working order and, where applicable, calibrated. Calibration shall be established by a record of calibration showing calibration traceable to accepted standards specific to the equipment used (for example, AISC, ASME, ANSI, etc.).

7.6 *Design Audit Program*—When performing an audit of a new design of an aerial adventure course, the auditor shall review conformance to Section 11 of the current edition of Practice F2959 at the time of the design.

7.7 *Manufacturing Audit Program*—When performing an audit of the manufacturing of an aerial adventure course, the auditor(s) shall review conformance to Section 8 of Practice F2959.

7.8 *Installation and Commissioning Audit Program*—When performing an audit of the installation and commissioning of an aerial adventure course, the auditor(s) shall:

7.8.1 Perform an inspection of equipment condition per Section 8 of the Practice F2959 that references Section 9 through Section 13 of Practice F1193.

7.8.2 Review conformance to Section 5 of Practice F2959.

7.9 *Major Modification Audit Program:*

7.9.1 When performing an audit of the design of an aerial adventure course, the auditor shall review conformance that the design specific to the major modification meets Section 11 of Practice F2959.

7.9.2 When performing an audit of a major modification to an aerial adventure course as defined in Terminology F747, the auditor(s) shall perform the following where applicable:

7.9.2.1 Review conformance to Owner/Operator's Operations and Maintenance Training Program per Section 5 of Practice F2959.

7.9.2.2 Owner/operator's conformance to manufacturer's maintenance and inspection requirements.

7.9.2.3 Review conformance to manufacturer's requirements and documentation per Section 8 of Practice F2959.

7.9.2.4 Evaluate all documentation that is available for the modification and that this information reflects the in-field installation.

7.9.2.5 Confirm that all documentation pertaining to the modifications was included in the supporting documentation needed to properly train, inspect, maintain, and operate the aerial adventure course per the design requirements.

7.9.2.6 Review conformance of the operational functionality as it complies with the operational specifications provided by the engineer, designer, or manufacture as per Section 8 of Practice F2959.

7.10 *Compliance Audit*—A compliance audit shall be performed annually. When performing a compliance audit, the auditor(s) shall:

7.10.1 Review conformance to Owner/Operator's Operations and Maintenance Training and Inspection Program per Section 5 and 8 of Practice F2959.

7.10.2 Review conformance of documentation and that it reflects the current configuration of the aerial adventure course in operation.

7.10.3 Review conformance as to the operational functionality per the operational specifications as provided in Section 8 of Practice F2959.

7.11 *Keywords:*

7.11.1 inspection; inspector

8. Quality, Manufacture, and Construction Requirements

8.1 Quality, manufacture, and construction shall be in accordance with Practice F1193.

9. Testing Composite Foam

9.1 Testing Composite Foam shall be in accordance with Test Method F1957.

10. Measuring Dynamic Characteristics

10.1 Measuring Dynamic Characteristics shall be in accordance with Practice F2137.

11. Design Requirements

11.1 Design of Aerial Adventure Courses shall be in accordance with Practice F2291 with the following exceptions and inclusions:

11.1.1 *Practice F2291 Section 5.1.1.2 Patron Clearance Envelope Analysis*—Shall include the Patrons effects' on the dynamics within the Aerial Adventure Course in accordance with 11.1.2.

11.1.2 *Practice F2291 Section 5.1.1: Ride Analysis*—The ride analysis shall consider the Patrons' effects on the dynamics within the Aerial Adventure Course including but not limited to:

11.1.2.1 Patron orientation.

11.1.2.2 Patron consciousness.

11.1.2.3 Patron behaviors.

11.1.3 *Practice F2291 Section 5.1.3*—Shall include but not be limited to the following:

11.1.3.1 The deceleration and arrest of patrons arriving at landing zones shall be performed in a controlled manner.

11.1.3.2 Environmental factors including humidity, precipitation, temperature and the wind effects on patron velocity.

11.1.4 *Practice F2291 Section 5.5.3—Documentation supplied to the buyer, owner, or operator shall be complete and adequate for proper installation, maintenance, inspection, and operation of the amusement ride, device, or major modification. The documentation shall include, but not limited to the following:*

11.1.4.1 Daily pre-operational inspection. Prior to operating the course with patrons, a daily inspection shall be conducted which shall include, but not be limited to the following:

(1) Perform a visual inspection for the following components of the course, as applicable:

(a) Platforms, stairways, pathways, ramps, support structures and trees included in and directly adjacent to the course.

(b) Course restraint and zipline hardware including rope, attachment hardware and anchor system.

(c) Counterweight or other tension control system components such as cylinders or carriages shall have sufficient travel to operate as intended.

(d) Personal safety equipment such as harnesses, lanyard, carabineers, pulleys/trolleys and etc.

(e) Patron clearance envelope.

(2) Verify proper operation of the following, as applicable:

(a) Specified manual and automatic Patron control equipment.

(b) Specified safety related control system components.

(c) Braking systems.

(d) Communication systems.

(3) Ensure access routes and platforms are clear of ice and snow to the extent necessary to permit inspection and operation.

11.1.4.2 *Maintenance Inspection Requirements*—The inspection criteria requirements, frequency and retirement criteria shall be developed for the following components:

(1) Wire Rope—Wire rope shall be subject to detailed visual inspection at regularly established intervals based on usage, but not to exceed one year by a qualified wire rope inspector, or immediately after any event possibly affecting the integrity of the wire rope. The following items shall be considered in determining the continued use of the wire rope:

(a) Broken wires.

(b) Displaced or loose wire.

(c) Physical damage at impact areas on cables.

(d) Visual inspection of impact areas on the zip line.

(e) Diameter: Reduction— Original diameter of cable shall be recorded at time of commissioning and recorded for use in determining subsequent diameter reduction calculations.

(f) Tensioning procedures to ensure wire rope tensions are within specified operating parameters.

(2) Wire rope associated hardware.

(3) Anchorage systems.

(4) Personal Safety Equipment (PSE).

(5) Support structures and connection hardware.

(6) All components in the primary load path not listed above.

11.1.5 *Practice F2291 Section 6.6.2*—This requirement shall include the landing zone(s) of the course.

11.1.6 *Practice F2291 Section 6.6.3.2(3)* shall be replaced by the following:

11.1.6.1 The ability, as limited by the patron containment, of the patron to extend any body part, for example, arms and legs and shall include the patron's ability to move their position or posture on the course.

11.1.7 *Practice F2291 Section 7*—Acceleration limits shall have the following inclusion:

11.1.7.1 For restraint and containment cases on Aerial Adventure Courses that are not covered in Practice F2291 Section 7, the designer/engineer shall consider biodynamic effects on the patrons including the pendulum effect.

11.1.8 *Practice F2291, Section 8.6*—Patron weights shall be modified as follows:

11.1.8.1 Delete Practice F2291, Subsections 8.6.1 through 8.6.5 and replace with: The weight assigned for design purposes shall be determined by the designer/engineer.

11.1.9 *Practice F2291 Section 8 Loads and Strengths, Subsection 8.12*—Add the following:

11.1.9.1 When trees are included in the load path, the designer/engineer's shall consider the special requirements for trees when developing the operating and maintenance instructions such as, but not limited to the following:

(1) Effects to surrounding environment that could alter the health and integrity of the trees utilized, such as removal of adjacent trees or development of adjoining properties.

(2) Effects to the visible health of the tree or canopy, or both, such as disease, insect infestation, or physical damage.

11.1.10 Delete Practice F2291-11, Subsection 8.13.1 and allow Subsection 8.13.2 to be the design guide for wind.

11.1.11 Practice F2291-11, Section 8 Load and Strengths shall be modified with the following:

11.1.11.1 When trees are used in the primary load path course the following shall be performed:

(1) Trees shall be selected based on the intended loads including environmentally induced loads.

(2) An arboricultural assessment shall be performed prior to completing the design by a qualified person to determine that the selected tree(s) are healthy and suitable for the expected load conditions.

(3) The systems used to affix Aerial Adventure Course elements shall be designed to minimize damage to the trees.

(4) Measures shall be prescribed to protect the root system, particularly against compaction and erosion.

11.1.12 *Practice F2291 Section 13, Mechanical Systems and Components:*

11.1.12.1 *Practice F2291 Section 13.3 Wire Rope (Excludes Fiber, Synthetic, etc., Rope and Line)*—Delete the word "Excludes" and replace with "Including."

11.1.12.2 *Wire Rope:*

(1) Practice F2291 Section 13.3.5—Replace with the following:

(a) Primary load path systems strength including terminations, anchorage(s), anchorage connectors, and backups shall be designed to a minimum rated breaking strength of a minimum of five times the expected load (safety factor of 5:1). This calculation shall include rescue load limits and dynamics.

(b) A primary load path safety factor of less than 5:1 but greater than or equal to 3:1 shall be allowable for wire rope lifelines of nominal diameter greater than ½ in. (12.7 mm) when the requirements outlined in Practice F2291 Section 5 General Design Criteria are met.

(2) Practice F2291, Subsection 13.3.6—The wire rope factor of safety is defined as the ultimate tensile strength of the wire rope divided by the maximum expected load tension. This calculation shall include rescue load limits and dynamics.

(3) Vertical Load Paths—5000 lb minimum per person attached. The designer shall include in their testing procedures to measure and record actual tension to verify the design assumptions and calculations.

(4) Practice F2291, Subsection 13.3.11—Splices shall be done according to the wire rope splice specifications found in ANSI B77.

11.1.12.3 *Rope (includes, but not limited to Fiber, Synthetic, Rope, Line and etc.):*

(1) The strength and application of Rope, when used, shall be determined by the designer/engineer by applying standard structural engineering practice for expected dynamic, live and dead loads and uses materials that are applicable for the intended use.

(2) Rope and rope accessories in the primary load path shall have a minimum factor of safety of five (5). This calculation shall include rescue load limits and dynamics.

(3) The designer/engineer shall consider during the ride analysis, the effects of the environment and wear on the primary load path materials, including but not limited to Ultra-violet light, heat, vermin and etc.

11.1.12.4 *Practice F2291, Subsection 13.5.1 Machine Guards*—The ride analysis must identify unique risks and hazards associated with all moving elements risks and develop a mitigation plan.

11.1.12.5 *Practice F2291, Subsection 13.7 Brakes:*

(1) Substitute the word "device" to be "system."

(2) Landing Zone—When the landing zone is used as an integral part of the braking system, each landing area shall provide sufficient space for system operations including arrest, dismount, and participant traffic.

11.1.13 *Practice F2291, Section 14 Fencing, Guardrails, Handrails, Gates and Walkways for Amusement Rides and Devices*—Add the following:

11.1.13.1 Devices which restrict or inhibit individuals from falling may be used in lieu of guardrails, gates and fencing.

11.1.13.2 Walkway requirements do not apply to trails and paths used to lead in, lead out or to connect the elements.

11.1.14 *Site Specific Design Requirements:*

11.1.14.1 Environmental conditions such as annual weather cycles, drainage and erosion risk evaluation.

11.1.14.2 *Geotechnical Conditions*—If load transfer system is utilized that directly interact with the soil, a soil analysis shall be performed by a qualified person gathering sufficient geotechnical information to determine the design of the system; including, but not limited to:

(1) Anchoring system design to match soil or rock mechanical properties under the worst case conditions.

(2) Corrosion of Anchoring system equipment.

(3) The design shall incorporate means and methods to monitor settling or pull out of mechanical systems and instructions on how to address anomalies.

11.1.14.3 Access for emergency equipment.

11.1.14.4 Utilities.

11.1.14.5 Plants and vegetation.

11.1.15 *Aerial Adventure Course Equipment:*

11.1.15.1 Personal Safety Equipment (PSE) may include but is not limited to: Harnesses, Helmets, Lanyards, Connectors, Pulleys, Goggles, Gloves, Belay and Descent Control Devices.

11.1.15.2 The designer/engineer shall:

(1) Determine what PSE is required for each course based on the application.

(2) Determine the specification for each equipment item.

(3) Select and identify the equipment required to meet the specifications.

11.1.15.3 When harnesses are used:

(1) Sizing requirements in Practice F2291-11, Subsection 6.3.1 shall apply.

(2) Shall meet the most current edition of UIAA 105, ANSI Z359, Specification F1772, EN 12277, NFPA 1983 or acceptable applicable standard with regard to their performance and construction.

12. Netting

12.1 Netting requirements shall be in accordance with Practice F2375.

13. Keywords

13.1 aerial adventure course; aerial trekking courses; challenge course; harness; personal safety equipment; PSE; ropes course; trees; trolley; zip line; zipline