



Designation: F2959 – 23a

Standard Practice for Aerial Adventure Courses¹

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1. Scope

1.1 This practice establishes criteria for the Design, Manufacture, Installation, Operation, Maintenance, Auditing and Major Modification of Aerial Adventure Courses.

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, health, and environmental 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

- E543** Specification for Agencies Performing Nondestructive Testing
- F747** Terminology Relating to Amusement Rides and Devices
- F770** Practice for Ownership, Operation, Maintenance, and Inspection of Amusement Rides and Devices
- F1159** Practice for Design of Amusement Rides and Devices that are Outside the Purview of Other F24 Design Standards
- F1193** Practice for Quality, Manufacture, and Construction of Amusement Rides and Devices
- F1772** Specification for Harnesses for Rescue and Sport Activities

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.

- F1950** Specification for Physical Information to be Transferred With Used Amusement Rides and Devices (Withdrawn 2008)³
- 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** Practice 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 *CDC (Center for Disease Control) Growth Charts:*⁵

- CDC Basic Body Measurements**

2.4 *European Standard:*⁶

- EN 280** Mobile elevating work platforms - Design calculations - Stability criteria - Construction - Safety - Examinations and tests
- EN 12277** Mountaineering equipment - Harnesses - Safety requirements and test methods

2.5 *NFPA Standard:*⁷

- NFPA 1983** Standard on Life Safety Rope and Equipment for Emergency Services

2.6 *SAE Standard:*⁸

- SAE J833** Human Physical Dimensions

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

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 Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA 30329-4027, <http://www.cdc.gov> [Search: anthropometrics].

⁶ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

⁷ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

⁸ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

2.7 UIAA Standard:⁹

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 rationale 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;

(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;

⁹ Available from International Mountaineering and Climbing Federation (UIAA), 61 Postfach CH-3000 Bern 23 Switzerland, <http://www.theuiaa.org/index.php>.

(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 When natural rock is utilized in an aerial adventure course, qualified person(s) shall perform an inspection to determine that the natural rock is 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 lightning exposure, weather impacts (wind, snow, and ice), fire, etc.

(3) When there is physical damage resulting in a change in the visible structural integrity of the rock structure; such as major fissures, cracking or loose rocks.

(4) *Natural Rock Inspection Criteria Requirements:*

(a) The qualified person inspecting the natural rock shall provide a written report evaluating the suitability of the natural rock for the intended use and whether the original design intent is maintained, and

(b) The owner operator shall retain all natural rock inspection reports and maintenance records performed based on the inspection report.

5.6.1.7 Any additional recommendations of the owner/operator; and

5.6.1.8 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.

5.6.1.9 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 proper fit and use of any required PSE:

(1) When harnesses are utilized, operators/attendants shall be trained to properly size, adjust, and fit the harness according

to the manufacturer's instructions, and in a manner that shall prevent the patron from slipping out during intended use.

(2) When connectors/connection systems are utilized, operators/attendants shall be trained to connect the patrons to the course with the manufacturer's specified connector(s) or connection system.

(3) When patrons are responsible for managing the connection system, the operators/attendants shall be trained to instruct patrons on the proper use of the connector(s) or connection system.

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

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

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

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

5.8.1.9 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 they are 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 Practice F1193.

7. Auditing

7.1 Auditing requirements for aerial adventure courses shall be in accordance with Practice F2974.

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

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

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

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

7.3 *Keywords:*

7.3.1 inspection; inspector

8. Quality, Manufacture, and Construction Requirements

8.1 Quality, manufacture, and construction shall be in accordance with Practice F1193, and the exceptions and inclusions unique to aerial adventure courses. For convenience, all of these inclusions and exceptions have been incorporated into Practice F1193 and are shown below.

8.2 Changes to common terms in Practice F1193-17 are:

8.2.1 Replace the term “amusement rides and devices” with “aerial adventure courses,”

8.2.2 Replace the terms “amusement ride or device” or “ride or device” with “aerial adventure course,”

8.2.3 Replace the term “ride analysis” with “device analysis,”

8.2.4 Replace the term “passenger” with “patron,”

8.2.5 Replace the term “riders” with “patrons,” and

8.2.6 Replace the term “rider” with “patron.”

8.3 *Significance and Use*—The purpose of this practice is to provide the minimum manufacturing requirements for aerial adventure courses and to provide the minimum requirements for a written quality assurance program for an aerial adventure course manufacturer, or component supplier. This is not intended to include suppliers of off-the-shelf components (for example, fasteners, electrical wire, etc.).

8.4 *Drawing Control Procedure*—A procedure shall be in effect so that appropriate manufacturing drawings, their engineering revisions, and related documents are utilized.

8.5 *Material and Component Control Procedure:*

8.5.1 A procedure shall be in effect so that materials, processes, and components, including raw materials, are in accordance with the engineering specifications.

8.5.1.1 This procedure shall provide the purchasing agent with all the information required to order appropriate material.

8.5.1.2 A receiving procedure shall be in effect so that incoming material and components are checked against the purchasing specifications.

8.5.1.3 A procedure shall be in effect so that material in stock can be properly identified for future use.

8.5.1.4 Documentation on any material, process, or components certified shall be filed for reference.

8.6 *Manufacturing:*

8.6.1 Aerial adventure course components and systems shall be manufactured and assembled in accordance with the designer/engineer specified criteria.

8.6.2 Changes to the designer/engineer specified criteria shall be documented and approved by the designer/engineer or a qualified engineer before components, subassemblies, or systems are placed into use.

8.6.3 *Quality Assurance Program:*

8.6.3.1 The manufacturer of an aerial adventure course shall have a written quality assurance program as specified in Practice **F1193** for use in conjunction with the design, manufacture, construction, modification, or reconditioning of the aerial adventure course.

8.6.3.2 Quality assurance documents, that is, material certifications, test reports, and inspection reports, shall be retained for a period of time as deemed appropriate by the manufacturers.

8.7 *Inspection:*

8.7.1 A procedure shall be in effect so that appropriate inspections are made on manufactured parts and subassemblies, for conformance with the designer/engineer specified criteria.

8.7.2 A procedure shall be in effect so that appropriate inspections are made on purchased components.

8.7.3 A procedure shall be in effect so that completed subassemblies, or where practical, the assembled aerial adventure courses are inspected prior to delivery.

8.7.4 Non-conforming components found in **8.7.1**, **8.7.2**, or **8.7.3** shall be identified and evaluated. Disposition of the nonconforming components shall be one of the following:

8.7.4.1 The non-conforming component shall be scrapped or rejected, or

8.7.4.2 The non-conforming component shall be altered such that it cannot be used in the specific intended application for the component, or

8.7.4.3 The non-conforming component shall be reworked to bring it into compliance and re-inspected in conformance with **8.7.1**, **8.7.2**, or **8.7.3** of this practice.

8.7.4.4 The design of the non-conforming component shall be re-evaluated in accordance with **8.6.2** of this practice, and the drawing or documentation shall be modified or created to allow the component to be used as is.

8.8 *Welding:*

8.8.1 Welding and welding procedures shall be in accordance with the appropriate American Welding Society (ANSI-.AWS D1 specification) or the American Society of Mechanical Engineers, or other equivalent standard, and be performed by appropriately certified or qualified welders as required by the standard.

8.8.2 Documentation for certified or qualified welders shall be maintained.

8.9 *Certification*—Before a manufacturer ships an aerial adventure course, the manufacturer shall generate a document certifying that the aerial adventure course is in compliance with Practice **F1193**. This certification shall be retained with other quality assurance documents for the aerial adventure course. When requested by an aerial adventure course-certifying authority, purchaser, or owner, the manufacturer shall provide a copy of this certification document.

8.10 *Information Requirements:*

8.10.1 The information given in **8.10.2** and **8.10.3 – 8.10.14.3** shall be included, where applicable, on the information plate as specified in **8.10.2**, and in the documented operating and maintenance instructions to be furnished by the manufacturer or seller at the time of sale of each aerial adventure course.

8.10.2 *Information Plate*—A manufacturer-issued information plate, printed in English, shall be permanently affixed to the aerial adventure course in a visible location, and shall be designed to remain legible for the expected life of the aerial adventure course. The plate shall include, but not be restricted to, all applicable items listed in **8.10.2 – 8.10.2.8**.

8.10.2.1 *Aerial Adventure Course Serial Number*—A manufacturer-issued unique identifying number or code affixed to the aerial adventure course in a permanent fashion.

8.10.2.2 *Aerial Adventure Course Name and Manufacturer*—A manufacturer issued unique identifying aerial adventure course name, including the name of the manufacturer by city, state, and country.

8.10.2.3 *Aerial Adventure Course Model Number*—A manufacturer-issued unique identifying number or code assigned to each manufactured type of aerial adventure course having the same structural design or components.

8.10.2.4 *Date of Manufacture*—The date (month and year) determined by the manufacturer that the given aerial adventure course met the manufacturer's required construction specifications.

8.10.2.5 *Aerial Adventure Course*—Maximum and minimum revolutions or distance per unit of time, as applicable.

8.10.2.6 *Direction of Travel*—When the proper direction of travel is essential to the design operation of the aerial adventure course, the manufacturer shall designate the direction of travel, including reference point for this designation.

8.10.2.7 *Patron Capacity by Weight*—Maximum total patron weight per patron position and per aerial adventure course.

8.10.2.8 *Patron Capacity by Number*—Maximum total number of adult or child patrons per patron position and per aerial adventure course.

8.10.3 *Aerial Adventure Course Duration*—The actual time the aerial adventure course is in operation or a patron is exposed to the elements of the aerial adventure course functions, including patron restrictions to maximum exposure time, shall be included.

8.10.4 *Recommended Balance of Patron Loading or Unloading*—When patron distribution is essential to the proper operation of the aerial adventure course, the appropriate

loading and unloading procedure with respect to weight distribution shall be provided.

8.10.5 *Environmental Restrictions*—Recommendations for operational restrictions relating to environmental conditions such as, but not limited to, wind, rain, salt corrosion, and extreme heat or cold.

8.10.6 *Recommended Patron Restrictions*—Where applicable, any recommended patron limitations such as, but not limited to, height patron placement, or any other appropriate restrictions.

8.10.7 *Electrical Power Requirements*—Total electrical power required to properly operate the aerial adventure course designated in watts and volts, including minimum and maximum voltage limits.

8.10.8 *Mechanical Power Requirements*—Minimum horsepower necessary to operate aerial adventure course properly.

8.10.9 *Static Information*—The following information shall be provided for the aerial adventure course when it is in a nonoperational state with no patrons: height, width, diameter, and weight.

8.10.10 *Dynamic Information*—The following information shall be provided for the aerial adventure course when it is in an operational state: height, width, diameter, and weight.

8.10.11 *Trailer Information*—Each trailer necessary for the transport of a portable aerial adventure course shall be provided with the following information: height, width, length, and weight.

8.10.12 *Fastener Schedule*—A manufacturer-issued schedule for the correct grade, torque, and placement of all fasteners used in the assembly, or erection, or both, of the aerial adventure course.

8.10.13 *Design Loads per Connection Point*—Loads for each footing or equivalent structural connection point as calculated for all the various load combinations as required by Section 11.8, Loads and Strengths, of Practice F2291.

8.10.14 *Elements and Structures*—Provided the proposed owner/operator furnishes the manufacturer with necessary data concerning proposed installation and usage of the aerial adventure course, the manufacturer shall provide to the proposed owner/ operator a description of all structural interface between the aerial adventure course and the owner/operator supports. This structural requirement definition shall include the following:

8.10.14.1 Maximum static design loads of each footing or equivalent structural connection,

8.10.14.2 Maximum dynamic design loads of each footing or equivalent structural connection, and

8.10.14.3 Any other structural interface design specification.

8.11 *Operational Instruction Requirements:*

8.11.1 The manufacturer of an aerial adventure course shall provide, with delivery of each aerial adventure course, documented, recommended operating instructions in the English language. These instructions shall include, but not be limited to the following:

8.11.1.1 Description of the aerial adventure course operation, including the function and operation of its major components.

(1) Description of the motion(s) of the aerial adventure course during operation.

(2) Description of the recommended patron loading procedures during operation, including recommended seating, where applicable.

8.11.1.2 Recommended safety procedures and instructions, and information about safety equipment pertaining to patrons and aerial adventure course operators and attendants.

(1) Maximum total patron weight and maximum number of patrons by carrier unit or aerial adventure course total.

(2) Description of the patron restraint system, its recommended use and operation.

(3) Aerial adventure course operator and attendant safety check: recommended visual or other inspections to be performed by aerial adventure course operators and attendants prior to and during each aerial adventure course cycle.

(4) Instructions to the patron: recommended information that should be made available to each patron of the aerial adventure course.

(5) Recommendations for operational restriction relating to environmental conditions such as wind, rain, or temperature fluctuation.

8.11.1.3 Manufacturer's recommended aerial adventure course operating procedures, including the location of aerial adventure course operators and attendants.

(1) Description of the recommended, daily preopening inspection to be performed by aerial adventure course operator(s) and attendants that is in addition to previously performed maintenance or other inspections.

(2) Description of the recommended aerial adventure course operator(s) and attendants positions and functions.

(3) Description of the recommended series of steps, to be followed in a definite order, to complete the operation of the aerial adventure course.

8.11.1.4 Manufacturer's recommended emergency procedures.

(1) Recommended evacuation procedures for the aerial adventure course.

(2) Use of emergency power equipment, if provided with the aerial adventure course.

(3) Description of any emergency equipment that is provided with the aerial adventure course, and its uses.

(4) Description of any emergency procedure made necessary by an interruption of power, and restart procedures.

8.12 *Testing Performance Requirements:*

8.12.1 *Developmental Testing Requirements*—Where applicable, as determined by the manufacturer/designer, the following test procedures shall be developed and performed on a prototype aerial adventure course or device in order that the manufacturer/designer may determine the appropriateness for use, of not only the parts, but the entire system of a newly designed aerial adventure course.

8.12.1.1 *Procedures to Verify Maximum Safe Design Loads:*

(1) Procedures to verify such design characteristics as relevant deflections, loads, and forces that are placed on both the equipment and the patron during operation of the aerial adventure course,

(2) A procedure to determine operational limits and restart criteria due to environmental conditions,

(3) Procedures to allow the manufacturer to determine such factors as component variability and certification requirements of components, and

(4) Any other procedures necessary to demonstrate an aerial adventure course appropriateness for its intended use.

8.12.2 *Installation Testing Requirements:*

8.12.2.1 This section of the guide covers those tests relevant not only to installation, but also includes post-modification and major modifications. The original manufacturer or supplier of an aerial adventure course shall also provide, where applicable, the following standard testing guides:

(1) *Materials Testing*—Acceptable test procedures for the certification of all major structural components shall be provided. Where possible, this testing should be referenced to ASTM or to other commonly accepted industry standards.

(2) *Erection/Modification Acceptance Testing*—Test procedures or criteria for the acceptance of such construction operations as welding and fastening shall be provided. Again, where possible, reference should be made to ASTM or to other currently accepted industry standards for this purpose.

(3) *Performance Testing*—This should consist of a series of specified tests that can be used to determine that the newly erected aerial adventure course conforms to the original design criteria.

8.12.3 *Operational Testing Requirements:*

8.12.3.1 The manufacturer of an aerial adventure course shall develop specific operational tests along with minimum intervals for these tests to be performed that will allow the owner/operator of the aerial adventure course to determine whether a given aerial adventure course is operating within prescribed operational limits.

8.12.3.2 All operational tests, except those necessarily recommended subsequent to the sale because of information not reasonably available to the manufacturer at the time of sale, should be recommended to the owner/operator at the time of sale. All tests, whether recommended at the time of sale, or subsequent tests, shall meet the following criteria:

(1) All tests shall have been satisfactorily performed by the manufacturer prior to sale.

(2) The tests must be such that the aerial adventure course or element can reasonably be expected to pass during the expected design life, assuming recommended maintenance and operative procedures have been followed.

(3) All tests must be reasonable and such that the owner/operator can reasonably be expected to be competent to perform or cause to be performed.

(4) Any operational test including load testing performed on an aerial adventure course shall be completely nondestructive in nature. Overload testing exceeding the above limits shall be deemed inappropriate.

(5) Any installation or operational testing conducted on an aerial adventure course shall be accomplished within the rated limits of the information provided by the manufacturer.

8.12.4 *Non-Destructive Testing Requirements:*

8.12.4.1 This section pertains to the nondestructive testing of aerial adventure course components as recommended by the

manufacturer. These tests shall be performed by a qualified NDT inspector in accordance with Practice E543 or ASNT Recommended Practice SNT-TC-1A, or both. It is not intended to preclude any other schedule of NDT, inspection, or testing.

(1) Nondestructive testing (NDT) is the development and application of technical methods such as radiographic, magnetic particle, ultrasonic, liquid penetrant, electromagnetic, neutron radiographic, acoustic emission, visual, and leak testing to examine materials or components in ways that do not impair the future usefulness and serviceability in order to detect, locate, measure and evaluate discontinuities, defects, and other imperfections; to assess integrity, properties and composition; and to measure geometrical characters.

(2) NDT shall be used to verify the integrity of components which due to their design, location, or installation, or combination thereof, cannot be adequately evaluated by other means.

(3) A schedule for testing on a given aerial adventure course component shall be defined in terms of hours, days, or other units of operation. The initial design shall be developed to expect a period between tests to be no more frequent than annually.

(4) The manufacturer shall recommend components to be tested along with appropriate acceptance criteria. The manufacturer may recommend the test method but shall not specify how the testing is to be conducted except where certain procedures might endanger other components on the aerial adventure course. Any changes or additions to these recommendations shall be communicated to all known owner/operators of the aerial adventure course, and inspection agencies via manufacturers' bulletins. Tests shall meet the requirements of 8.12.3.2(1) to 8.12.3.2(3).

(5) The manufacturer shall include in an appropriate section of the aerial adventure course manual the list and location of components to be tested, recommending specific areas to test and the schedule by which they shall be tested in accordance with 8.12.4.1(4).

(6) Components found to have relevant indications that do not meet the acceptance criteria shall be replaced or reconditioned in accordance with Practice F1193.

(7) Components found free of relevant indications that meet the acceptance criteria or have been reconditioned shall be further tested at the regular schedule in accordance with 8.12.4.1(3).

(8) Within a reasonable time following a request by an owner/operator or inspection agency, the manufacturer of an aerial adventure course whose manual does not contain testing recommendations shall either provide a component listing or statement that no NDT is recommended on the aerial adventure course as per the criteria outline of 8.12.4.1(2). When a manufacturer's list or statement is not available, it may be compiled by a registered professional engineer or engineering agency or by any individual qualified by training and experience to compile such a list or statement based upon the aerial adventure course's specifications and history and using accepted engineering practices.

8.13 *Maintenance Procedure Requirements:*

8.13.1 The manufacturer of an aerial adventure course shall provide, with delivery of each aerial adventure course, documented maintenance instructions in the English language. These instructions shall include, but not be limited to, the following:

8.13.1.1 Description of the designed path of the patron through the aerial adventure course elements, including the function and operation of its safety systems.

8.13.1.2 Description of the recommended procedures for installation, setup, disassembly, and transportation of an aerial adventure course.

8.13.1.3 Recommended lubrication procedures for the aerial adventure course.

(1) Recommended types and specifications of lubricants.

(2) Recommended frequency of lubrication.

(3) A lubrication drawing, chart, or instruction, showing the location of lubrication points.

(4) Recommended special method of lubrication, where applicable.

8.13.1.4 Description of the recommended daily, preopening inspection to be performed and identification of special care areas and recommended procedures for inspection and maintenance of these areas.

8.13.1.5 Description, including frequency, of recommended maintenance inspections and testing, other than daily preopening inspection.

(1) Recommended wear limits or tolerances, where deemed necessary by the manufacturer.

(2) Recommended operational tests, along with minimum intervals for these tests to be performed, that will allow the owner/operator of the aerial adventure course to determine whether a given aerial adventure course is operating within recommended prescribed operational limits.

(3) Where applicable, recommended nondestructive testing along with appropriate acceptance criteria, including suggested frequency and the special parts of areas to be tested.

(4) Tests recommended pursuant to 8.13.1.5 shall meet the following criteria:

(a) The tests shall have been performed satisfactorily by the manufacturer prior to the sale of the aerial adventure course.

(b) The test shall be a test that the aerial adventure course, or element, can reasonably be expected to pass during the expected life of the aerial adventure course, or element, assuming recommended maintenance and operating procedures have been followed, and

(c) The test shall be a test that is reasonable, and that the owner/operator can reasonably be expected to be competent to perform or cause to be performed.

8.13.1.6 Recommended specifications for the use of replacement fasteners, and recommended torque requirements for fasteners, where applicable. If appropriate, precautionary information will be provided relating to the continued use of fasteners that have been loosened or retorqued.

8.13.1.7 Schematics of electrical power, lighting, controls, and other systems, including location charts and troubleshooting guide, where applicable.

(1) Description of recommended maintenance procedures for electrical components.

(2) The name of the component manufacturer and appropriate identification number or specifications, or both, will be provided for electrical components used within the aerial adventure course.

(3) Each electrical component used within the aerial adventure course will be assigned an individual identification number, symbol, or code to facilitate its location and identity on the electrical schematics.

8.13.1.8 Schematics of hydraulic and pneumatic systems, including recommended pressures, location of components, line specification, fitting specification, type of fluid, location chart, and troubleshooting guide, where applicable.

(1) Description of recommended maintenance procedures for hydraulic and pneumatic systems and components.

8.13.1.9 List of parts used in the assembly of the aerial adventure course, or drawings showing component parts and their use.

8.13.1.10 Recommended procedures to be followed in the event of an extended period of non-operation or storage, or both.

8.13.1.11 Description of recommended assembly and disassembly techniques and procedures, pertaining to specific components, as deemed necessary by the manufacturer.

8.13.1.12 Recommended restrictions and special procedures, lubricants, materials, or equipment that may be necessary because of environmental conditions.

8.13.1.13 Other recommendations known to the manufacturer and specific to certain serial numbered aerial adventure course.

8.14 *Manufacturer Supplemental Bulletin Requirements:*

8.14.1 Supplemental notification bulletins delivered by the manufacturer of an aerial adventure course to the owner/operator that were not provided at the time of sale and contain new information or newly recommended inspections or testing, or both, shall be consistent with the following criteria in order to carry the force and effect of this practice:

8.14.1.1 Modifications, procedures, testing, or inspections shall conform to Practices **F770**, **F1193**, and **F2291**.

8.14.1.2 Modifications, procedures, testing, and inspections shall be reasonable, ethical, and consistent with the general manufacturing practices within the industry.

8.14.1.3 Supplemental notification bulletins when used shall have a page header that contains the following information, when available:

(1) The name, address and telephone number of the issuing entity,

(2) The date the bulletin is released,

(3) The date the bulletin takes effect,

(4) The period the bulletin recommends for completion,

(5) The name of the original aerial adventure course manufacturer,

(6) The name of the aerial adventure course,

(7) The model number of the aerial adventure course,

(8) The serial numbers of the affected aerial adventure courses,

(9) The applicable dates of manufacture for the affected aerial adventure courses,

(10) A number that uniquely identifies the bulletin,

(11) The number of the superseded bulletin, where applicable, and

(12) The page number and number of total pages.

8.14.1.4 The first page shall contain, in large bold upper case letters, one of the following titles:

(1) “SAFETY ALERT” for notifications that recommend immediate action (see Practice **F1193**, Fig. A1.1),

(2) “SERVICE BULLETIN” for notifications that do not recommend immediate action but do recommend future action (see Practice **F1193**, Fig. A1.2), and

(3) “NOTIFICATION” for notifications that do not necessarily recommend future action but are primarily for promulgation of information (see Practice **F1193**, Fig. A1.3).

8.14.1.5 The first page shall contain a summary of the information contained in the body of the bulletin.

8.14.1.6 The first page shall summarize the reason(s) that prompted the release of the bulletin.

8.14.1.7 The first page shall list the recommended action to be taken, for example: Inspection, modification, part replacement, new parts, nondestructive testing, procedural change, manual revision, operational revision, etc.

8.14.1.8 The remainder of the first page and any supplemental pages shall contain text detailing the information being promulgated. Drawings and diagrams may be used for clarification where applicable.

8.14.1.9 The supplemental notification bulletin, when printed, shall be in black ink on white paper. The following colored ink may be used to print titles:

(1) Red—for safety alert,

(2) Blue—for service bulletins, and

(3) Green—for notifications.

8.14.1.10 The supplemental notification bulletins shall follow the format provided in Practice **F1193**, Annex A1.

8.15 *Inspection Requirements:*

8.15.1 The manufacturer of an aerial adventure course shall provide the owner/operator with a written inspection procedure to be delivered with the aerial adventure course. The document shall outline the inspections as contained in Practices **F1193** and **F770**.

8.15.1.1 Any changes in the procedure prescribed in **8.15.1** deemed essential by the manufacturer due to information not available to the manufacturer at the time of delivery shall be communicated to all known owner/operators.

8.15.2 All inspections, whether recommended at the time of sale or subsequently, shall meet the following criteria:

8.15.2.1 Inspections are such that shall have been satisfactorily performed by the manufacturer.

8.15.2.2 Inspections are ones in which the aerial adventure course or element can reasonably be expected to pass during the expected design life of the aerial adventure course or element, assuming that recommended maintenance procedures have been followed; and

8.15.2.3 Inspections are reasonable and are such that the owner/operator can reasonably be expected to be competent to perform or cause to be performed.

8.15.3 Upon notification from an owner/operator of an incident involving a critical component, the manufacturer of an aerial adventure course shall promptly evaluate this information and disseminate their findings to the original owner/operator, along with any pertinent recommendations, to all known owner/operators.

8.16 *Used Ride or Device Information Requirements (from Specification **F1950**):*

8.16.1 The original manufacturer of the used aerial adventure course being sold shall make available, upon request by the purchaser, owner, operational, and maintenance information along with updates, if any.

8.16.2 The original manufacturer of the used aerial adventure course being sold shall make available to the purchaser information regarding any major modifications made to the aerial adventure course that the manufacturer authorized or otherwise performed on the aerial adventure course.

9. Testing Composite Foam

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

10. Measuring Dynamic Characteristics

10.1 Reserved for future use.

11. Design Requirements

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

11.2 Changes to common terms in Practice **F2291**-15 are:

11.2.1 Replace the term “*amusement rides and devices*” with “aerial adventure courses,”

11.2.2 Replace the terms “*amusement ride or device*,” “*ride*,” or “*ride or device*” with “aerial adventure course,”

11.2.3 Replace the term “*passenger*” with “patron,”

11.2.4 Replace the term “*riders*” with “patrons,” and

11.2.5 Replace the term “*rider*” with “patron.”

11.3 Reserved for future use.

11.4 Reserved for future use.

11.5 *General Design Criteria:*

11.5.1 *Aerial Adventure Course Analysis:*

11.5.1.1 The designer/engineer shall perform and document an aerial adventure course analysis that illustrates how hazards to persons have been managed. This documentation shall include but not be limited to the following:

(1) An identification of the scope of the analysis. The scope shall describe the equipment considered by the analysis. The scope shall identify the use cases of the aerial adventure course. The scope may be clarified by identifying excluded equipment or scenarios.

(2) An identification of hazards that includes potential sources and consequences of harm.

(3) An identification of hazardous scenarios.

(a) Hazardous scenarios shall consider physical areas where persons are expected to access.

(b) Hazardous scenarios shall consider exposure to hazards under all identified use cases.