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Entertainment Technology—Performer Flying Systems

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Interest category codes

CP = custom-market producer DE = designer

DR = dealer rental company G = general interest

MP = mass-market producer U = user

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FOREWORD

(This foreword is not part of the standard, and contains no mandatory requirements.)

There have been no specific American National Standards that cover performer flying in the entertainment industry. It should be noted that other ANSI Standards may be relevant, depending on the application and intended use. In an attempt to improve safety and standards in the industry, the Entertainment Services and Technology Association convened a series of meetings to prepare a draft standard.

It is the intention of ESTA that this standard be put forward as the basis for an American National Standard to the American National Standards Institute.

It has been assumed in the drafting of this standard that the execution of its design provisions are entrusted to appropriately qualified and experienced people, and that the fabrication and use is carried out by qualified and suitably experienced people and organizations.

This standard presents a coordinated set of rules that may serve as a guide to government and other regulatory bodies and municipal authorities responsible for the guarding and inspection of the equipment falling within its scope. The suggestions leading to accident prevention are given both as mandatory and advisory provisions; compliance with both types may be required by employers of their employees.

Safety codes and standards are intended to enhance public safety. Revisions result from committee consideration of factors such as technology advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate.

Compliance with this Standard does not of itself confer immunity from legal obligations.

This document uses annex notes to provide additional reference information about certain specific section requirements, concepts, or intent. Subject matter with a corresponding annex note reference is identified by the note (See Annex note), and the associated reference text is found in Appendix A, Commentary, identified with the referring text section number – e.g. an annex note to section 3.2 will be identified in Appendix A, Commentary as A.3.2. The annex notes are informational only, and do not add or subtract from the mandatory requirements of this standard.

1 Scope

This document establishes a minimum level of performance parameters for the design, manufacture, use, and maintenance of performer flying systems used in the production of entertainment events. The purpose of this guidance is to achieve the adequate strength, reliability, and safety of these systems to ensure safety of the performer, other production personnel, and audiences under all circumstances associated with performer flying.

Performer flying systems within the scope of this standard include devices and systems supporting people or components to which people are attached, flying or suspended in the air. Situations covered by this standard pertain to any and all locations of the flight path, including over the stage or audience.

This document covers the machinery, mechanisms, and mechanical attachments used to support flying persons or ride-on flown props, including attachment to the facility/structural support down to the termination of the lifting medium or the quick-connect hardware, if used. This document also covers the harness or other device that provides direct support for the flying performer whose connection does not ultimately rely on the strength or ability of the flying performer.

The scope of this document excludes the following:

- Systems for flying the general public or for people engaged in non-entertainment flying effects.
- Systems for supporting a performer in a non-overhead suspension manner, such as lifts, elevators, turntables in stages, raked stages, treadmills in stages, or stage wagons.
- Fall protection.
- Any connection that ultimately relies on the strength or ability of the Flying Performer.
- Bungee cord or other comparable high-stretch lifting medium in the load path.
- Flexible medium onto which performers actively engage their bodies, such as strap act webbing, silk act fabric, and natural fiber ropes.

The typical goal of theatrical-style performer flying is to entertain the audience by creating the illusion of flight; this is most often accomplished by adding a harness to the performer to provide a safe means of levitation. The typical goal of acrobatic flying, aerial dance, and some other aerial acts is to entertain the audience by displaying spectacular human feats of strength, agility, form and/or balance; this is often accomplished by skilled performers sometimes without the use of a harness. While these types of live performer flying as described exemplify the wide range of differing traditions and technologies, the governing principles of performer and non-performer safety (risk assessment and risk reduction, operational preparedness, and many other subject matters) are common to all performer flying situations. This document covers the elements that are common to all types of performer flying regardless of the style or type of flying performance.

2 Definitions

The definitions for various participants in performer flying and their roles are defined in Section 3 *Responsibilities*.

2.1 Allowable Stress Design (ASD): A structural engineering analysis method in which service load stresses in a structure remain below a given stress limit by a specified factor. The stress limits and factors vary depending on what failure mode is being examined, such as tensile rupture or tensile yielding.

2.2 Authority Having Jurisdiction (AHJ): The organization, office, or individual responsible for approving equipment, an installation, or a procedure. (See annex note.)

2.3 automated performer flying system: A system of mechanical components driven by machine power where two or more axes of motion are under command of a Programmable Electronic System such as a PLC or Motion Control Computer.

2.4 axis (pl. axes): A common term used to describe the combined elements that create motion in a single geometric plane. Motion can be linear or rotational and the prime mover can consist of electric, hydraulic, pneumatic, or other sources including human power in a manual system. Multiple axes can be combined to create motion of an object in more than one plane. (See annex note.)

2.5 brake: A load securing device that is capable of stopping and securing a load.

2.6 Category 0 stop: An uncontrolled stop caused by the immediate removal of power from the machine actuators.

2.7 Category 1 stop: A controlled stop with power to the machine actuators available to achieve the stop, then when the stop is achieved, power is removed from the machine actuators.

2.8 Category 2 stop: A controlled stop with power left available to the machine actuators.

2.9 characteristic load: The maximum force applied to the performer flying system resulting from normal intended operating conditions while the system is at rest or in motion. This includes the working load limit (WLL), self-weight including that due to load carrying devices and lifting medium, and forces due to inertia and dynamics in normal use. (See annex note.)

2.10 competent person: A person who is capable of identifying existing and predictable hazards in the workplace and who is authorized to take prompt corrective measures to eliminate them.

2.11 D/d ratio: ratio of the drum or sheave tread diameter to that of the rope diameter.

2.12 design factor: A ratio of the design load limit to the ultimate load carrying capacity (i.e., breaking strength) of a material or component. For ASD, the minimum design factor specified shall replace the appropriate safety factor from the design code being applied. For LRFD, the LRFD live load factor divided by the minimum design factor specified, shall replace the resistance factor from the design code being applied. (See annex note.)

2.13 design factor against yield: A ratio of the design load limit to the yielding value of a material or component. For ASD, the minimum design factor against yield specified shall replace the appropriate safety factor from the design code being applied. For LRFD, the LRFD live load factor divided by the minimum design factor against yield specified, shall replace the resistance factor from the design code being applied. (See annex note.)

2.14 fabricated component: A component that is custom built for an application in the performer flying system.

2.15 Factory Acceptance Test (FAT): A period of offsite testing prior to installation during which the System Supplier demonstrates that the performer flying system meets the performance and safety specifications to the extent possible during offsite testing. FAT testing requirements and performance criteria shall be agreed upon between the System Supplier and the User prior to FAT.

2.16 fleet angle: the included angle between a line representing the travel of a rope, from the groove in a sheave or drum, and a line drawn perpendicular to the axis of rotation of the sheave or drum. (See annex note.)

2.17 full speed: The maximum designed operating speed of a Performer Flying System. (See annex note.)

2.18 harness: A component that is worn by the Flying Performer to either support the Flying Performer's body weight, or to secure the Flying Performer to a ride-on prop such that the harness is fully capable of supporting the Flying Performer's weight, throughout the flying routine.

2.19 lifting medium: The load carrying element, either static or driven by the means of actuation to move the performer and any ride-on props. (See annex note.)

2.20 limit, normal: a limit switch that prevents further movement in the direction of travel, i.e., end of travel, initial, hard.

2.21 limit, software (soft): A programmed reference position that prevents further movement in the direction of travel.

2.22 limit, ultimate: a limit switch that senses over-travel in the event of failure of the normal position limit, i.e., over-travel, E-Stop.

2.23 load-bearing hardware: Purchased elements, such as fasteners, rigging components, and equipment, which are part of the load path.

2.24 load path: All contiguous mechanical elements that support the flying performer and ride-on prop, if used, up to the supporting structure. Portions of the ride-on prop that directly connect the flying performer to the lifting medium shall be considered part of the load path.

2.25 Load Resistance Factor Design (LRFD): A structural engineering analysis method in which factored load stresses in a structure remain below a given stress limit. The load factors and stress limits vary depending on what type of load or combination of loads is being applied and what failure mode is being examined.

2.26 manual performer flying system: A system of mechanical components where human power alone is used to fly a performer.

2.27 mechanized performer flying system: A system of mechanical components driven by powered machinery used to fly a performer.

2.28 operating cycles: One complete series of motions consisting of a move in one direction followed by a move in the opposite direction. Programmed cues may consist of multiple operating cycles in one motion profile.

2.29 peak load: The maximum force applied to the performer flying system resulting from abnormal conditions, or irregular operation (e.g., effects of emergency stops, uncontrolled stops, drive electronics or power failure, stalling of the actuation equipment, extreme environmental conditions).

2.30 performer peak load: The maximum force applied to the performer resulting from abnormal conditions, or irregular operation (e.g., effects of emergency stops, uncontrolled stops, drive electronics or power failure, stalling of the actuation equipment, extreme environmental conditions).

2.31 performer flying system: A system of components specifically designed to suspend an aerial performer or transport a performer through the air. The performer flying system includes the attachment to the facility/structural support down to and including the elements to which the performer is attached. (See annex note.)

2.32 purchased component: A serially manufactured, commercially available component.

2.33 qualified person: A person who, by possession of a recognized degree or certificate of professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

2.34 quick-connect hardware: A component that is used to quickly connect or disconnect the performer or ride-on prop to/from the lifting medium.

2.35 rescue: The prompt return of the Flying Performer to a safe location and disconnecting from the performer flying system in the event of a flying system malfunction, medical emergency, or other emergency situation that requires aborting flight.

2.36 rescue plan: The operational procedures used to perform a rescue.

2.37 rescue system: A system of components used to land a flown performer in a safe location in case of a flying system malfunction, medical emergency, or other emergency situation that requires aborting flight.

2.38 ride-on prop: Scenic element supported by the performer flying system that bears the weight of the performer.

2.39 rigid lifting medium: Truss, structural shapes, arms, fabricated components, etc. used to directly suspend or transport the performer and any ride-on props.

2.40 risk: Combination of the probability of occurrence of harm and severity of that harm.