Multiple flying performers on an automated performing flying system.

ANSI E1.43: Performer flying from the ground up

BY **STU COX**

IF YOU ARE ADDING FLYING EFFECTS to your production, or if you are considering incorporating performer flying into a future project, you should take a look at one of ESTA's newest releases from the Technical Standards Program. In February of this year, the Rigging Working Group published *ANSI E1.43-2016, Entertainment Technology – Performer Flying Systems.* It is available to everyone at http://tsp.esta.org/tsp/documents/published_docs.php as a free download, thanks to ProSight Specialty Insurance.

Performer flying has been around for quite some time, and while it is often categorized as a niche market "special effect," it has become an increasingly popular element in recent years, and not just in Broadway shows and motion pictures. Productions on all levels, and from all corners of our industry, from cruise ships

to church pageants to high school plays, are flying actors, aerialists, and musicians to name just a few. Accompanying all of these spectacular effects whizzing back and forth overhead, are a list of obvious (and some cases, not so obvious) safety and technical concerns. *ANSI E1.43* has compiled and addressed these in a document covering performer flying, if you'll pardon the pun, from the ground up.

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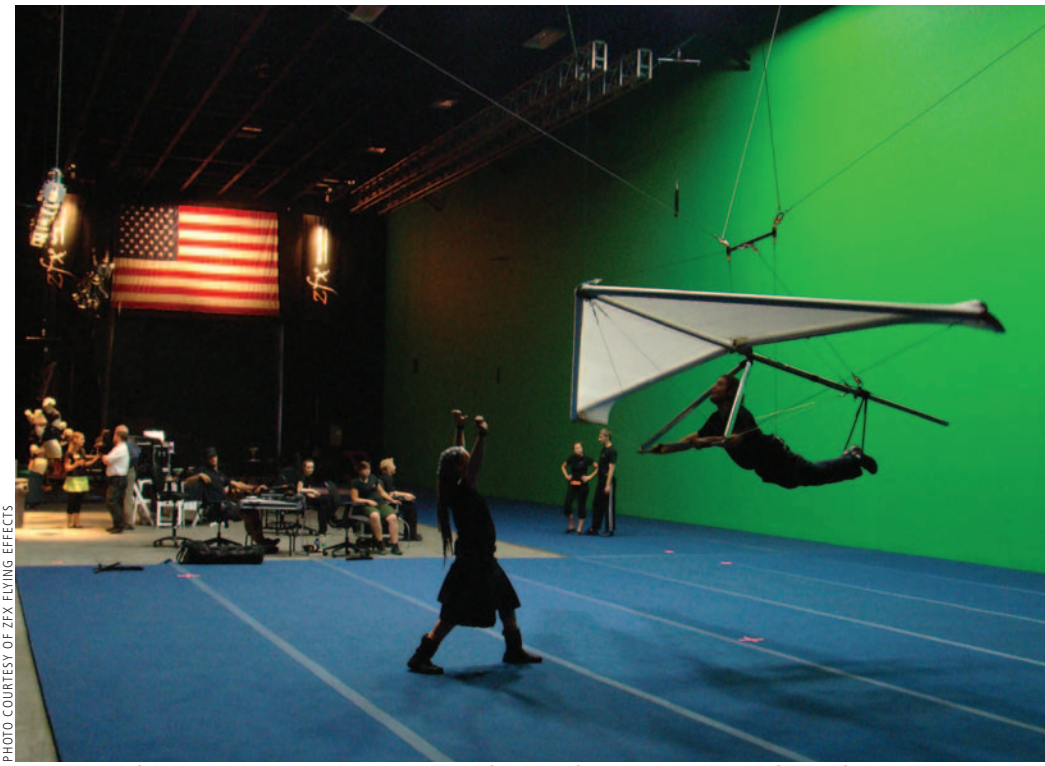
The foreword states, "There have been no specific American National Standards that cover performer flying in the entertainment industry." It goes on to explain ESTA's intention to produce a standard aimed at improving safety and presenting "a coordinated set of rules that may serve as a guide to government and other regulatory bodies and municipal authorities responsible for the guarding and inspection of the equipment falling within its scope."

Looking at the contents pages, you can see that the standard is extensive, and after the preliminary definitions and responsibilities, the document follows what could be considered a chronological order. Following the formal standard, there is a commentary annex providing citations and background explanations for many of the clauses. In the scope, it states, "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." It goes on to make some clarifications on what the standard will cover, including the flying equipment, its attachment to the venue's structure, harnesses and ride-on props that will support the performers, and the "lifting medium" and connection hardware that will link it all together.

The scope also lists some specific exclusions that should be noted before moving into the rest of the standard. Among these are systems for flying the general public, non-overhead suspension machinery such as lifts, turntables, or wagons, fall protection, and bungee cords. There are also some delineations outlining the differences between "theatrical-style performer flying" and acrobatic or aerial acts, whereas the performer is supported by a harness, or by the performer's own strength and ability, respectively. In short, for the former, the standard covers everything down to, and including, the flying performer harness, but for the latter, the line is drawn to not include any "flexible medium" such as aerial silks or strap act webbing, or any prop in which the performer's connection is provided by their own strength.



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The Flying Safety Supervisor choreographing with a flying performer to create a performer flying effect.

Definitions follow next, and a handful of these should be highlighted as they are particular to performer flying systems and this standard. While "performer flying system" is defined, and has been previously clarified in the scope, it should be noted that in this standard there are actually three categories of these systems. A "manual performer flying system" relies on human power to fly the performer, usually by pulling ropes. Second, a "mechanized performer flying system" utilizes powered machinery, and lastly, an "automated performer flying system" takes that machine

power a step further by two or more of these machines being controlled by a Programmable Electronic System.

"Lifting medium" appears throughout the standard, and it refers to the load carrying element that connects the components, ultimately lifting the performer. In many systems this is wire rope, and its required strengths and design factors are cited in the standard. Affecting the choice of lifting medium, "characteristic load," calculated using the working load limit (WLL), self-weight of the system and performer, and the forces from dynamics and inertia, refers to "the maximum force applied to the performer flying system resulting from normal intended operating conditions." Contrasted with this is "peak load," the maximum force on the same system during abnormal conditions, such as emergency stops or extreme environmental conditions, and "performer peak load," the maximum force resulting from abnormal conditions acting on the performer.

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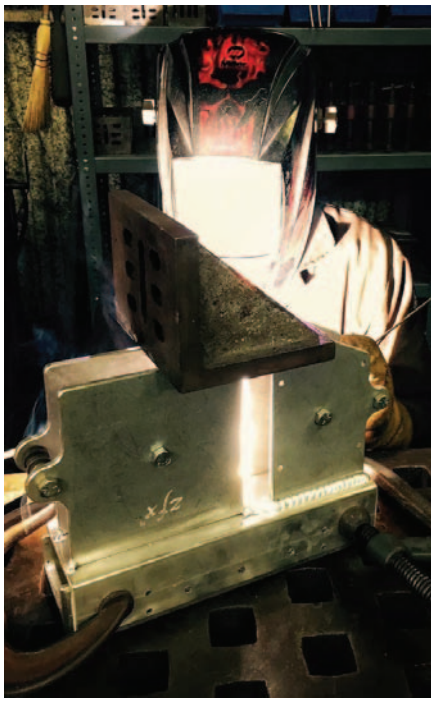
Lastly, "risk assessment/risk reduction (RA/RR)" appears throughout the standard, and is the process of risk identification, risk alleviation, and then repeating that process until that risk is acceptable. While this is familiar to many in the industry, it plays a major role in many stages of preparing a performer flying system from flying component and systems design, to hardware choices, flying choreography decisions, and even rescue procedure.

The annex notes for the third section of *E1.43* lay out that one of the primary intents of the standard was to define the roles and responsibilities integral to performer flying, and that ultimately, there should be a party responsible for making sure that qualified persons fill these roles. The standard states that these are "not necessarily job titles," and depending on the size and complexity of the flying effect being created, one individual may be responsible for more than one role. It is worth taking a closer look at a few of these, and how they relate to the performer flying system, the flying effect, and each other.

One of these roles, cited specifically as critical, is the "Flying System Designer," who is not only responsible for the performer flying system's safety and integrity, but also ensures that it satisfies the artistic needs of the effect. Whether designing from scratch for a large new effect, or choosing existing flying components for a simple one, the Flying System Designer is most likely associated with that ultimately responsible party, and will be making the decisions on what gear will be used, how it will attach to the support structure, and how the performer flying system will be used and operated.

Once installed, a "Flying Safety Supervisor" becomes one of the next major roles, responsible for the performer flying system's operational safety. This individual must know the workings and capabilities of the flying system, as well as the intended flying effects, so they can train the system's operators and performers, as well as creating schedules for maintenance and inspections. After the flying effects have been established, the "Flying Supervisor" will be charged with overseeing the operational safety of the system and the flying performers through the run of the effects. For the many folks who may have already used a professional flying effects provider, your Flying Safety Supervisor and Flying Supervisor are often known as a *Flying Director*.

Lastly, the "User" should be noted, and though the term is somewhat self-explanatory, this person or company is



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A performer flying system component being manufactured.

responsible for the performer flying system while it is in use for the intended flying effect. Regardless of whether the User owns the performer flying system, or not (they are often rented for the run of the rehearsals and show), the User will manage the various operators, performers, stage managers, and rescuers needed to safely conduct the flying effects. The User is also responsible for documenting these various duty assignments and the state of the performer flying system (inspections, incidents, etc.) for the period of its intended use.

The meat of the standard really comes in the Design and Engineering section. It comprises close to half of the standard, laying out applicable existing standards and design factors, requirements for both manufacturing and purchasing machinery, components, hardware, and, very important to performer flying, a lot of data illustrating how all of this relates to the performer's safety. While very technical in nature, the information in this section is useful to both those designing and manufacturing flying systems, and those Users choosing a provider of performer flying effects.

Designing a performer flying system is different from other technical systems you find on stage, because the performer is actually part of the system. Most of the decisions and choices can be traced back to how things affect the performer. Within this Design and Engineering section and its annex notes, the authors of the standard devoted several pages of both to how the performer relates to the overall system. There are descriptions, graphs, and illustrations describing how G forces affect the human body depending on the direction of motion and the performer's orientation.

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You can't talk flying performers without talking harnesses, and there are notes regarding contact points between the performer and the harness, suspension trauma, flying harnesses versus fall-protection harnesses, body positions during flight, and what peak loads should be taken into account. Included is also a list of information that shall be present on the harness label. References are made to NASA studies, seat belts, and even ejection seats. The reader will find it interesting that many of these studies were conducted more than half a century ago, but are still referenced today.

Some of the other points stressed in this section are selecting machinery appropriate for the chosen flying system so no components can be forced to the point of failure, as well as guidelines for dealing with situations in which single point or cascading points of failure cannot be avoided. Risk Assessment/Risk Reduction appears many times in this section, and shall be used in the two former examples, as well as conceptual design, evaluation of components not originally manufactured for performer flying, emergency stops, and determining use of design factors.

The Manufacturing section puts forth standard requirements for welding, fastener torques including the use of tamper-resistant witness marks, and flexible lifting medium terminations. Factory acceptance testing is detailed with a nice list of elements to be tested and to what percentage of their WLL. There is also detailed information regarding the documentation needed for the performer flying system, its operation, maintenance, and even the factory acceptance testing.

The section on Installation is short, but to the point, specifying that the performer flying system shall be installed by a qualified person, and in accordance with local, state, and federal regulations. It also provides guidelines for the system's commissioning inspection and testing to ensure that the system has been installed correctly, is operating as intended, and is appropriate for the effect to be created. Details for necessary documentation are also included.

Anyone who has added a flying effect to their production will recognize many of the elements in the Operational Use section. The information here covers how the performer flying system is used during the rehearsal and the show run, including necessary documentation, maintenance and inspection schedules, training, and rescue procedures. This section also goes back to many of those responsibilities listed in the third section, clarifying how those various roles function during the system's operation.

Documentation regarding the system's description, operating limits, and how it attaches to and affects the supporting structure shall be provided to the User. Operational documentation includes not only how the system shall be operated, but also how and when it should be inspected, any scheduled maintenance that will need to be followed, who is performing for the various responsibilities, and what should be documented throughout the use of the performer flying system.

Training is one of the most important phases of performer flying, and it involves everyone associated with the rehearsal and show operation of the system. It ensures that all roles and responsibilities are covered, inspection and maintenance schedules and procedures are explained and assigned, communications protocols are established, and that a rescue plan and team has been planned and rehearsed.

In the last two sections, the standard provides guidelines for proper system storage, repair procedures of worn or damaged equipment, and disposal of components or systems beyond repair or have reached their end of service life.

E1.43 is a detailed document, providing a large amount of information on the specific topic of performer flying. To those of us in the entertainment industry, this standard provides a comprehensive guide relevant to all those individuals who will be involved adding performer flying to a production. Purchasers, technical directors, stage crews, and flying performers, among many others, should all find this useful. ■

Stu Cox has traveled the planet as a ZFX Flying Director, rigging and choreographing performer flying effects, along with aerialists, oversized inflatable scenery, 500' motorized zip lines, and no shortage of flying monkeys, ghosts, angels, and Peter Pans. He received a BFA in Theatre Design and Production from the University of Louisville. He has worked with *Wicked*, the 2010 Vancouver Winter Olympics, Green Day's *American Idiot*, FOX Sports, and FIFA in between consuming the exotic, local cuisines. He was also a contributing author to *Entertainment Rigging for the 21st Century* by Bill Sapsis. Stu is an ETCP Theatre and Arena Rigger, and an ETCP Recognized Trainer. In his downtime, Stu snowboards, and spends time with his family in Ontario, Canada.